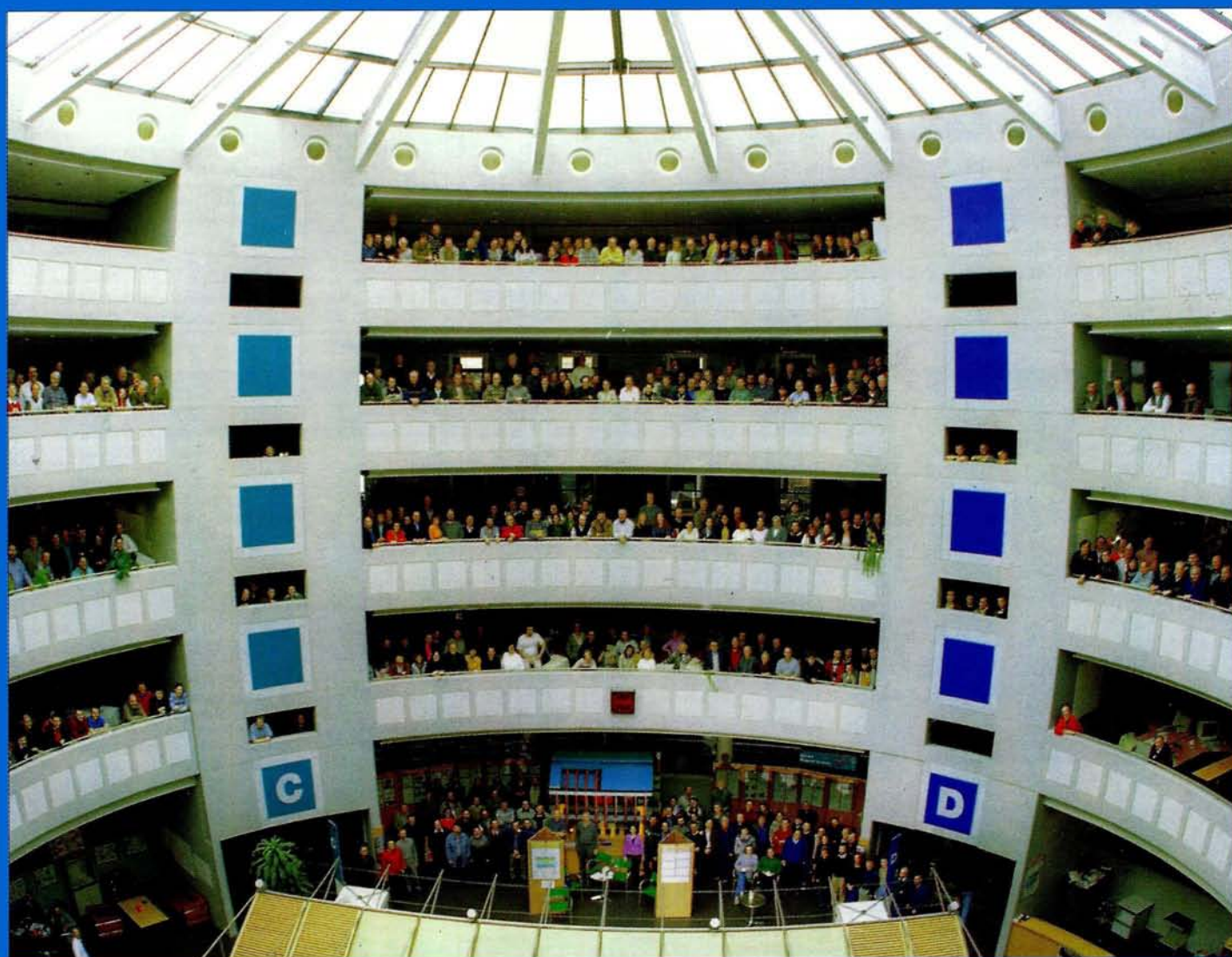


INTERNATIONAL JOURNAL OF HIGH-ENERGY PHYSICS

CERN COURIER

VOLUME 41 NUMBER 4 MAY 2001



Lining up for big experiments

TECHNOLOGY TRANSFER

Finnish Web techniques deal with the data mountain p21

ART AND SCIENCE

Interpreting physics from a different perspective p23

PERSONALITY

Jack Steinberger recalls the bubble chamber boom p24

Instrumentation for Measurement & Control

► Magnetic Field

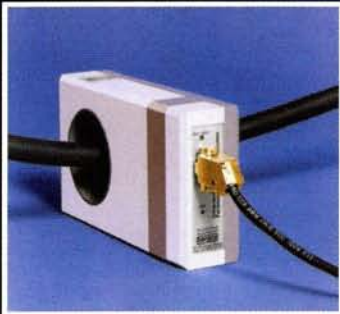


THM-7025

Application ▼	Product ▼	Specifications		
		Range ▼	Resolution ▼	Bandwidth ▼
Linear sensing. Non-contact measurement of position, angle, vibration. Small size, low power.	CYH-22 1-axis Hall element	± 20mT	± 4μT	DC to 10kHz
	2D-VD-11 2-axis Hall element	User option	± 30μT	DC to 10kHz
	3D-H-30 3-axis Hall element	User option	± 100μT	DC to 10kHz
High sensitivity and accuracy for low fields. Site surveys and monitoring. Active field cancellation.	MAG-01 1-axis Fluxgate Teslameter	± 2mT	± 0.1nT	DC to 10Hz
	MAG-03 3-axis Fluxgate Transducer	± 1mT	± 0.1nT	DC to 3kHz
Linear measurement. Feedback control. Mapping, quality control.	YR100-3-2 Hall Transducer, 1-axis	± 2T	± 12μT	DC to 10kHz
	3R100-2-2 Hall Transducer, 3-axis	± 2T	± 12μT	DC to 10kHz
Hand-held, low-cost, 3-axis for magnet and fringe fields.	THM 7025 Hall Teslameter, 3-axis	± 2T	± 10μT	DC
Precision measurement and control. Laboratory and process systems.	DTM-133 Hall Teslameter, 1-axis	± 3T	± 5μT	DC to 10Hz
	DTM-151 Hall Teslameter, 1-axis	± 3T	± 0.1μT	DC to 3Hz
Calibration of magnetic standards. Very high resolution and stability (total field).	2025 NMR Teslameter (total field)	± 13.7T	± 0.1μT	DC
	FW101 NMR Teslameter (total field)	± 2.1T	± 0.5nT	DC
Precision flux change measurement.	PDI 5025 Digital Voltage Integrator	40 V.s	± 2E-8V.s	1ms to 2 ²³ ms

Field units: 0.1nT = 1μG, 100nT = 1mG, 100μT = 1G, 1mT = 10G, 1T = 10,000G

► Electric Current (isolated measurement)



IPCT

Application ▼	Product ▼	Specifications		
		Range ▼	Resolution ▼	Bandwidth ▼
High sensitivity for low currents, currents at high voltage, differential currents.	IPCT Current Transducer	± 2A	± 10μA	DC to 4kHz
	MPCT Current Transducer	± 5A	± 10μA	DC to 4kHz
Linear sensor for low-noise, precision current regulated amplifiers and power supplies.	864I-2000 Current Transducer	± 2000A	<4ppm	DC to 300kHz
	866-600 Current Transducer	± 600A	<4ppm	DC to 100kHz
Instruments for calibration, development, quality control.	860R-600 Current Transducer	± 600A	<5ppm	DC to 300kHz
	860R-2000 Current Transducer	± 2000A	<8ppm	DC to 150kHz
	862 Current Transducer	± 16kA	<5ppm	DC to 30kHz
Passive sensor for rf and pulse current.	FCT Fast Current Transformer	1:5 to 1:500	limited by following amplifier	150Hz to 2GHz
Passive sensor for pulse charge.	ICT Integrating Current Transformer	± 400nC	± 0.5pC	1μs to <1ps

► Distributed I/O



CNA



FTR

Application ▼	Product ▼	Specifications		
		Range ▼	Resolution ▼	Bandwidth ▼
High resolution Input/Output modules that can be placed locally at the transducer or controlled unit. High Voltage and/or high noise environments. PC, PCI, VME, CAMAC host computer options.	DNA for DeviceNet	± 100mV to ± 10V	16 bit	DC to 150Hz
	CNA with fiber optic communication	± 100mV to ± 10V	16 bit	DC to 150Hz
	FTR fiber optic to RS-232-C			50 to 200kB

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 January and August, in English and French editions. The views expressed are not necessarily those of the CERN management.

Editor: Gordon Fraser
CERN, 1211 Geneva 23, Switzerland
E-mail cern.courier@cern.ch
Fax +41 (22) 782 1906
Web <http://www.cerncourier.com>
News editor: James Gillies

Advisory Board: R Landua (Chairman), F Close, E Lillestøl, H Hoffmann, C Johnson, K Potter, P Sphicas

Laboratory correspondents:

Argonne National Laboratory (USA): D Ayres
Brookhaven, National Laboratory (USA): P Yamin
Cornell University (USA): D G Cassel
DESY Laboratory (Germany): Ilka Flegel, P Waloschek
Fermi National Accelerator Laboratory (USA): Judy Jackson
GSI Darmstadt (Germany): G Siebert
INFN (Italy): A Pascolini
IHEP, Beijing (China): Qi Nading
Jefferson Laboratory (USA): S Corneliusen
JINR Dubna (Russia): B Starchenko
KEK National Laboratory (Japan): A Maki
Lawrence Berkeley Laboratory (USA): Christine Celata
Los Alamos National Laboratory (USA): C Hoffmann
NIKHEF Laboratory (Netherlands): P Mulders
Novosibirsk Institute (Russia): S Eidelman
Orsay Laboratory (France): Anne-Marie Lutz
PSI Laboratory (Switzerland): P-R Kettle
Rutherford Appleton Laboratory (UK): Jacky Hutchinson
Saclay Laboratory (France): Elisabeth Locci
IHEP, Serpukhov (Russia): Yu Ryabov
Stanford Linear Accelerator Center (USA): M Riordan
TRIUMF Laboratory (Canada): M K Craddock

Produced for CERN by Institute of Physics Publishing Ltd
IOP Publishing Ltd, Dirac House, Temple Back, Bristol BS1 6BE, UK
Tel. +44 (0)117 929 7481
E-mail nicola.rylett@iop.org
Web <http://www.iop.org>

Head of magazines: Richard Roe
Sales manager: Justin Mafham
Marketing manager: Tessa Edgcombe
Art director: Andrew Giaquinto
Production editor: Lucy Farrar
Technical illustrator: Alison Tovey
Advertising manager: Nicola Rylett
Deputy advertising manager: Chris Thomas
Recruitment sales: Andrew Hardie and Jayne Purdy
Advertisement production: Katie Graham
Product manager: So-Mui Cheung

Advertising: Nicola Rylett, Chris Thomas,
Andrew Hardie or Jayne Purdy
Tel. +44 (0)117 930 1027
E-mail sales@cerncourier.com
Fax +44 (0)117 930 1178

General distribution: Jacques Dallemagne, CERN, 1211 Geneva 23, Switzerland. E-mail jacques.dallemagne@cern.ch
In certain countries, to request copies or to make address changes, contact:

China: Chen Huaiwei, Institute of High-Energy Physics, P.O. 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
United Kingdom: Su Lockley, Rutherford Appleton Laboratory, Chilton, Didcot, Oxfordshire OX11 0QX. E-mail U.K.Lockley@rl.ac.uk
USA/Canada: Janice Voss, Creative Mailing Services, P.O. Box 1147, St Charles, Illinois 60174. Tel. 630-377-1589. Fax 630-377-1569

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

USA: Controlled Circulation Periodicals postage paid at St Charles, Illinois

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

© 2001 CERN

ISSN 0304-288X

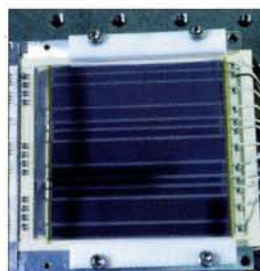


CERN COURIER

VOLUME 41 NUMBER 4 MAY 2001



STAR detector milestone p11



Progress in instrumentation p17



Steinberger's bubbly era p24

News

HERA upgrade increases luminosity. DESY announces major new project plans. Run II begins at the Tevatron. KEK solenoid passes full power test. EC to fund project for faster optical detectors. Awards high-light top suppliers. STAR detector gets new silicon heart. Making Tevatron magnets.

5

Physicwatch

13

Astrowatch

15

Features

Major instrumentation meeting visits Europe

17

Chris Damerell and Chris Parkman report on the Nuclear Science Symposium and Medical Imaging Conference in Lyon

Finnish technology takes on CERN's data mountain

21

Dealing with the data generated by CERN

CERN project brings science and art together

23

An exhibition of art inspired by physical concepts opens in London

When the bubble chamber first burst onto the scene

24

Nobel laureate Jack Steinberger looks back on his career during the 1950s and early 1960s

Workshop looks through the lattice

29

Using approximation techniques to understand quarks and gluons

People

33

Recruitment

39

Bookshelf

46

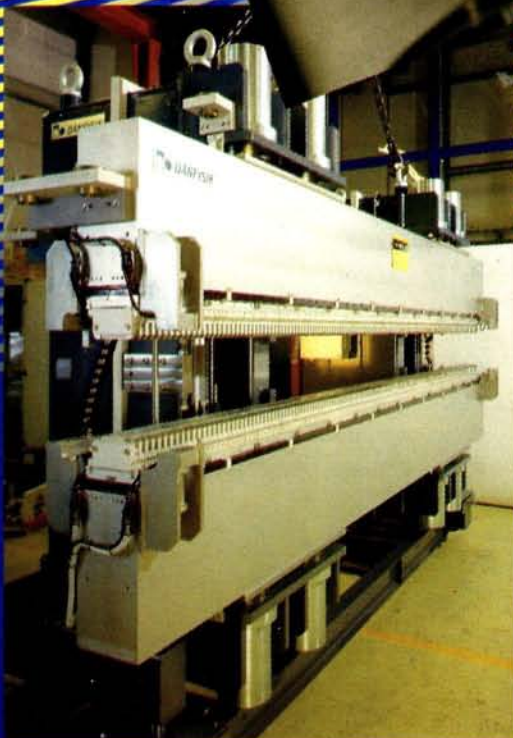
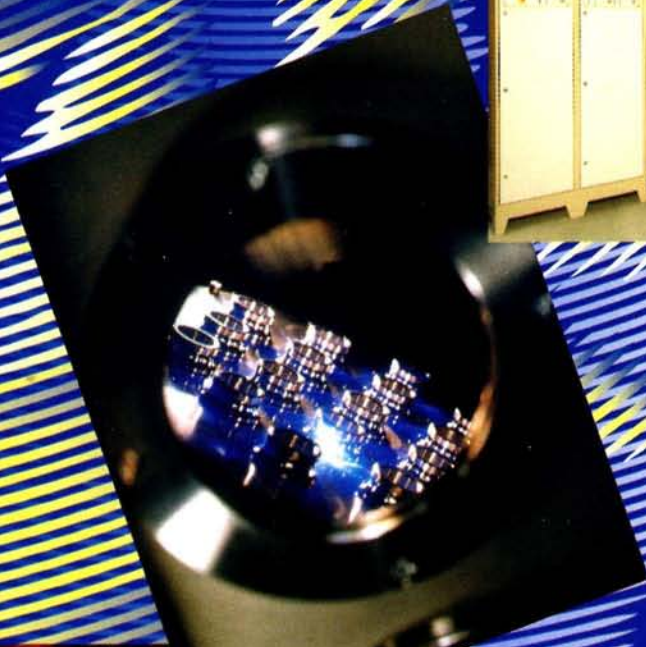
Torleif Ericson on The Legacy of Léon Van Hove

Cover: Although it took a lot of effort to arrange this group photograph of the ATLAS collaboration at CERN, such enterprise is commonplace for the major detectors at CERN's LHC collider (p8).

All you need ...

- for particle accelerators

- MAGNET TECHNOLOGY
- MAGNET POWER SUPPLIES
- CURRENT TRANSDUCERS
- ELECTRON ACCELERATORS
- ION ACCELERATORS
- ELECTROSTATICS
- BEAM DIAGNOSTICS



We cover all your needs "from source to target".

Our team cooperates very closely with customers from an early stage in any request or project.

We have the experienced engineers who can match all requirements including beam optics, mechanics, vacuum and electronics.

We offer tested and documented products and complete installations of all equipment worldwide.

DANFYSIK makes the total optimum solution.



DANFYSIK

DK-4040 Jyllinge, Denmark

Tel.: +45 4678 8150 - Fax.: +45 4673 1551 - e-mail: sales@danfysik.dk - www.danfysik.dk

In USA: GMW Associates; Tel.: (650) 802 8292 - Fax (650) 802 8298 - e-mail: sales@gmw.com

In India: Transact India Corporation, Tel.: (22) 285 5261 - Fax: (22) 285 2326 - e-mail: trans@vsnl.com

In Japan: Marubun Corp., Tel.: (03) 3639-9652 - Fax: (03) 5644-7627 - e-mail: vacuum@marabun.co.jp

DESY

HERA upgrade increases luminosity

Major changes are under way at Hamburg's DESY laboratory. Both the HERA electron-proton collider and its experiments are being upgraded following successful runs in 1999 and 2000 in which each experiment accumulated more than 100 inverse picobarns of data.

HERA has achieved a peak luminosity (collision rate) exceeding $2 \times 10^{31}/\text{cm}^2/\text{sec}$, well beyond its design specification. Nevertheless, a long shutdown began last September to upgrade the luminosity by a factor of around five and to install spin rotators to provide polarized beams for the collider's two general-purpose detectors, H1 and ZEUS.

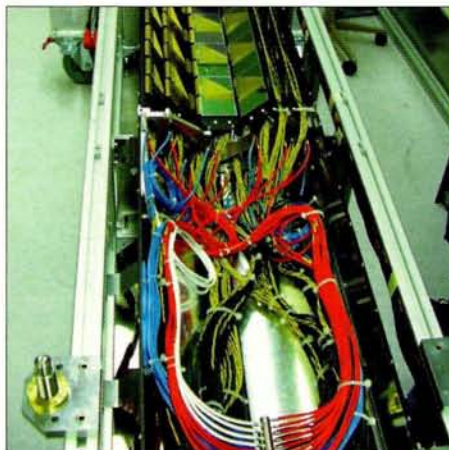
Polarized electron or positron beams will open up the precision exploration of the helicity structure of the electroweak current at unprecedented momentum transfer.

HERA's increased luminosity will be achieved by introducing new superconducting magnets well inside the H1 and ZEUS detectors, as well as rebuilding 200 m of the accelerator around the interaction points. Both collaborations are refurbishing their current detectors and introducing completely new capabilities to exploit the full potential of the upgraded HERA. They are paying particular attention to the forward direction – the direction of the 920 GeV proton beam – and to vertex and luminosity measurement.

At the largest momentum transfers, both hadrons and the scattered lepton tend to go forward. To deal with the higher track density in this region, ZEUS is adding two modules filled with straw tube chambers; H1 has rebuilt its forward detector to host five additional planar drift chambers; and both are complementing their forward detectors with additional wheels of silicon detectors – eight for H1, four for ZEUS – positioned around new elliptical beryllium-aluminium beam pipes.



H1's new proportional chamber being inserted into the central detector assembly.



One half of the ZEUS silicon vertex detector. The barrel is in the centre of the picture, with the halves of the four forward wheels furthest from the camera.

The ZEUS silicon detector is the most challenging single upgrade project currently underway at DESY. Its central barrel consists of 30 "ladders", each of which contains five modules of four single-sided silicon microstrip detectors arranged in pairs with orthogonal strip directions. The elliptical shape of the beam pipe is necessary to avoid the intense synchrotron radiation generated by the new superconducting quadrupoles. This shape implies a complex geometry in

which ladders are placed such that most emerging charged particles intersect three detector layers.

H1, which has used silicon detectors for several years, is extending the number of layers in the backward direction and adapting its silicon detector arrangement to the new beam-pipe shape. A challenge when introducing the new silicon detectors from the far end of the H1 detector is that more than 1000 electrical contacts are neither visible nor accessible during installation. A precision docking mechanism – nicknamed "The MIR Solution" because of resemblances to the space programme – is activated remotely to establish the necessary connections. Moreover, H1 will replace its central proportional chamber with a five-layer chamber surrounding the vertex detector and providing sufficient redundancy for triggering.

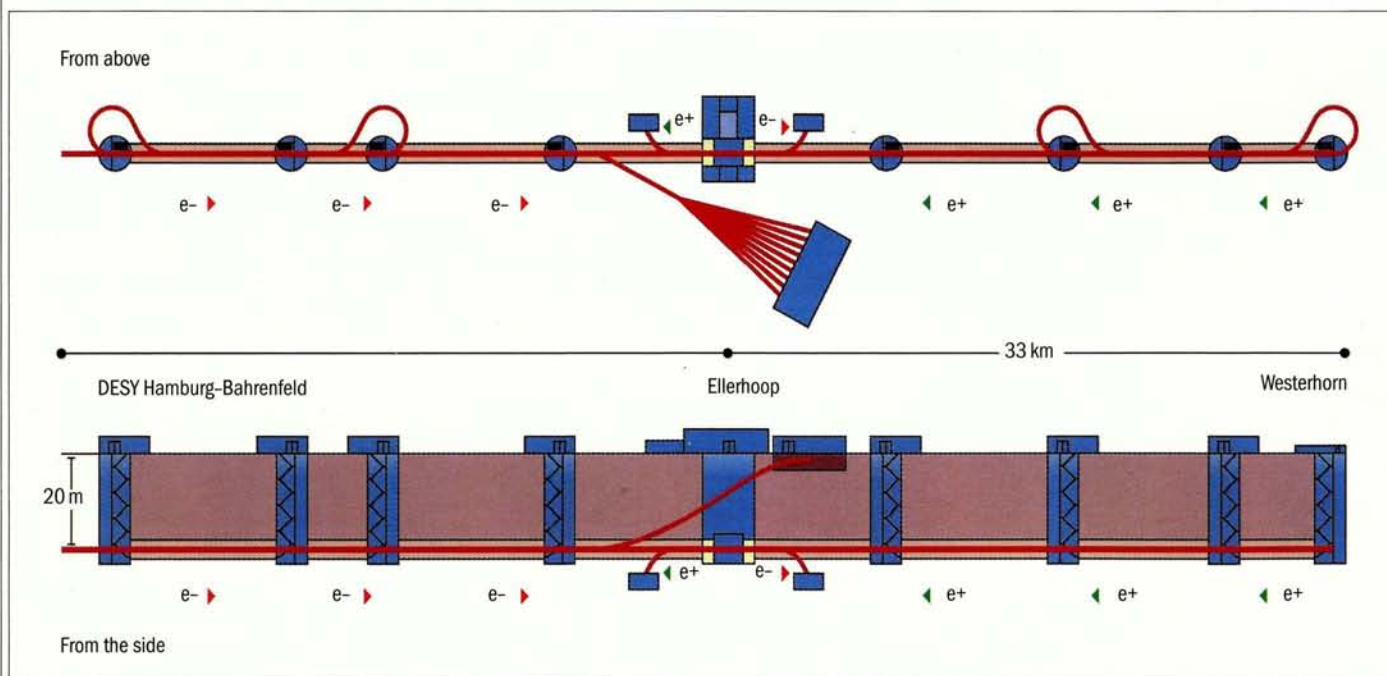
Further detector modifications are also needed to cope with the higher luminosity. Multiple photons from the Bethe-Heitler process in a single bunch, accompanied by much increased synchrotron radiation, make it necessary for both experiments to rebuild their luminosity monitors. H1 has developed a new tungsten-fibre calorimeter with high-rate sampling of Cerenkov light. The new ZEUS monitor consists of two main elements: a lead scintillator sandwich calorimeter fronted by "active filters" – two carbon absorbers separated by aerogel counters – and a spectrometer that detects electron-positron pairs from photons converting in a thin window in the beam pipe. Other upgrades will improve the trigger selectivity and the data handling.

The HERA shutdown ends in June, with the first dedicated high luminosity run planned before the end of 2001. Polarization tuning will start next year.

VAT www.vatvalve.com

LINEAR COLLIDERS

DESY announces major new project plans



Schematic of the proposed TESLA collider at DESY, showing the branch from the electron machine for the Free Electron Laser.

At a major presentation in Hamburg on 23 March, the DESY laboratory formally unveiled the future with a plan for a 33 km superconducting electron-positron collider. This TESLA (TeV-Energy Superconducting Linear Accelerator) will supply 500 GeV collision energy, extendable to 800 GeV. It will also have an integrated X-ray laser laboratory.

As well as catering for particle physics, the new machine will offer research facilities for condensed matter physics, chemistry, material science and structural biology.

A high-energy electron-positron collider such as the TESLA machine is widely seen as the natural next step for particle physics after CERN's LHC proton collider, now under construction and scheduled to begin operation for physics in 2006.

In addition, the machine could drive a free electron laser (FEL) to provide intense polarized X-rays in the 0.1 nm wavelength range to take snapshots of macromolecules, chemical reactions and bulk physical processes.

An impressive amount of technical research and development work by the worldwide TESLA collaboration has provided the groundwork for the Technical Design Report. This collaboration, involving research institutes in Armenia,

China, Finland, France, Germany, Italy, Poland, Russia, Switzerland and the US, has built the TESLA Test Facility at DESY, which has been in operation for several years and provides a wealth of valuable information and experience. The FEL technique has also been convincingly demonstrated at DESY (July 2000 p26).

TESLA consists of two long linear accelerator (linac) cannons – one for electrons, the other for positrons – pointing directly at each other. Each cannon will have its own source, the positrons being generated (via electron-positron pairs) from the high-energy electron beam. Damping rings will groom the beams at 15 GeV prior to final acceleration. The design foresees 2820 bunches of 2×10^{10} particles per pulse, with a bunch spacing of 337 ns and a pulse length of 950 μ s. The electron linac will also drive the X-ray laser.

After passing through a 1.6 km beam delivery system and final focus, the electron and positron bunches will be squeezed down to a tiny size of 5 nm height and 550 nm width, and will collide in a central region for high-energy physics experiments. The design luminosity is 3.4×10^{34} cm²/s.

Each linac will contain about 10 000 1 m superconducting cavities to power the beam,

using 1.3 GHz radiofrequency fields supplied by 2×292 klystrons, each generating about 10 MW. The superconducting cavities have to provide 23.4 MV/m accelerating fields, and the development of the necessary technology is a major achievement for the collaboration.

The nine-cell cavities of solid niobium will be cooled by superfluid helium at 2 K. More than 60 such cavities have been made to date, and the 23.4 MV/m required for 500 GeV are now exceeded routinely by cavities built by industry.

Using a new surface treatment (electropolishing) single-cell test cavities have reached gradients as high as 42 MV/m, thus opening the way for operating TESLA at 800 GeV, which needs gradients of 35 MV/m. Two complete accelerator modules, with eight nine-cell cavities each, are part of a 300 MeV prototype accelerator of the TESLA Test Facility, which has been operated successfully for more than 8600 hours, providing valuable system experience and the first proof of the laser principle.

The baseline design can permit collision energies of up to 650 GeV, but 800 GeV would require substantial upgrades of cooling for cryogenics and of radiofrequency power.



The TESLA test facility at DESY has provided a wealth of valuable information and experience over a number of years.

The superfluid helium cryogenic system for the 33 km TESLA project would be comparable in size to that being built for CERN's LHC collider, which is 27 km in circumference.

On this basis, DESY has put forward a proposal to the international scientific community, the German Federal government and the North German state governments that TESLA should be built in the Hamburg region. One possible approach to such a collaboration would be a "Global Accelerator Network" (June 2000 p19). The Federal German Research Ministry has asked the National Science Council to review the project.

The cost of the 500 GeV collider is estimated at € 3 136 million, the accelerator components for the X-ray FEL € 241, equipment for FEL experiments (5 beamlines each with 3 experiments, plus 5 beamlines with 1 experiment) € 290, and € 210 for the particle physics detector. Building the accelerators would require a total of 7000 man-years, over a total of eight years.

A fuller description of the TESLA proposal will be published in the next issue of *CERN Courier*.

US

Run II begins at the Tevatron



Part of the 4-mile tunnel housing Fermilab's superconducting Tevatron proton-antiproton collider, which is now running for physics at 980 GeV per beam (1960 GeV collision energy). The tunnel was originally built for Fermilab's Main Ring, which has now been removed.

Back in operation for particle physics for the first time since 1996, Fermilab's superconducting Tevatron proton-antiproton collider is set to write a major new chapter of science history. What is officially called Run II of the collider will continue, with interruptions for maintenance and upgrades, until 2007, by which time CERN's LHC collider will have made its debut.

For Run II the Tevatron's beams have been boosted from 900 to 980 GeV (collision energy 1960 GeV), the highest-energy particle accelerator now operating in the world. As well as providing extra energy, the Run II Tevatron is fed by Fermilab's 150 GeV Main Injector synchrotron, which was commissioned in 1999 and replaced Fermilab's original Main Ring.

The Tevatron and the Main Ring originally shared the same tunnel, which had a four mile circumference. However, the Main Ring, which has now been removed, became a bottleneck in Fermilab's particle supply. With the new Main Injector, proton-antiproton collision rates (luminosity) should be boosted twentyfold.

Monitoring these collisions are the Tevatron's two major collider detectors, CDF and D0.

Each have completed five-year upgrades costing USD 100 million to take advantage of the Tevatron's enhanced capabilities.

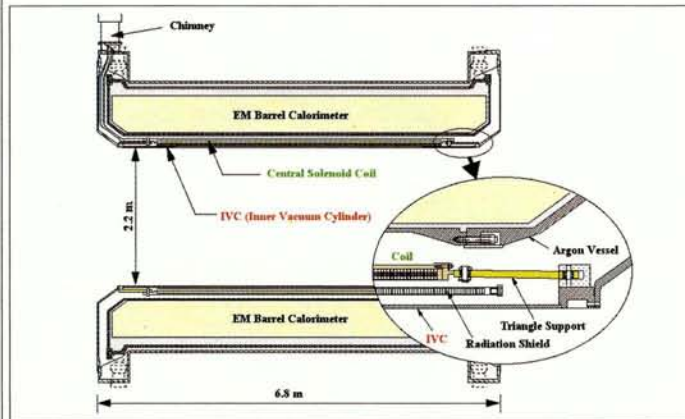
Late last year, experiments at CERN's Large Electron-Positron (LEP) collider detected hints of the long-awaited Higgs particle, the source of mass in the unified theory of weak and electromagnetic interactions. However, LEP was shut down before scientists could either confirm or rule out a Higgs sighting (March p25). For the next few years, the Tevatron has no competitor in the Higgs race.

Run II also has the potential for revealing much more, including evidence for supersymmetry – a possible doubling of the known number of fundamental particles, new insights into the CP-violation mechanism responsible for asymmetry between matter and anti-matter, and a better understanding of the sixth "top" quark, discovered at Fermilab in 1995 during Tevatron Collider Run I.

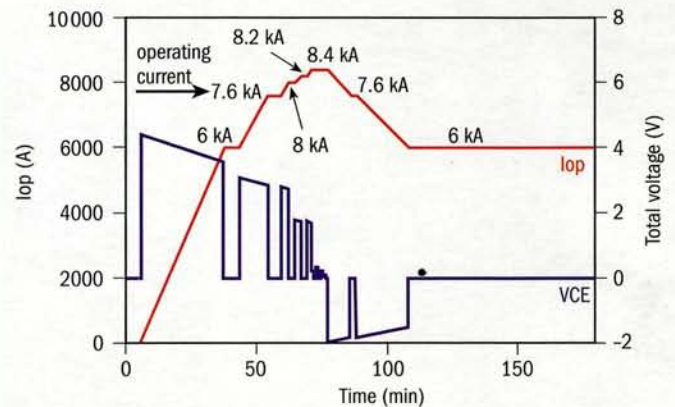
The Tevatron saw its first proton-antiproton collisions in 1985, and for its first phase of operations (pre-Run I, until 1989) ran with a single detector, CDF. For Run I (1992–1996), CDF was joined by the D0 detector.

JAPAN

KEK solenoid passes full power test



Cross-section of the ATLAS solenoid and barrel LAr calorimeter.



Excitation curve when design maximum current (8.4 kA) was achieved.

On 26 December 2000 the Japanese KEK laboratory accomplished full powering of the superconducting solenoid magnet for the forthcoming giant ATLAS experiment at CERN's LHC collider. On the initiative of Prof. Takahiko Kondo, this solenoid was designed and constructed under the leadership of Prof. Akira Yamamoto of KEK as Japan's contribution to the ATLAS magnet system.

The large solenoid, which is 5.5 tonnes in weight, 2.5 m in diameter and 5.3 m in length, will provide an axial magnetic field of 2 T at the centre of the ATLAS tracking volume. As the solenoid coil precedes the barrel liquid-argon (LAr) electromagnetic calorimeter, its thickness must be minimized to achieve maximal calorimeter performance.

Since the early 1980s, starting with the coil for the CDF experiment at Fermilab's Tevatron, KEK has been steadily accumulating technical know-how on thin superconducting detector coils. Prof. Yamamoto and his team developed and constructed a full-diameter, quarter-length prototype of the superconducting solenoid for the proposed SDC experiment of the ill-fated US Superconducting Supercollider (SSC) project. This prototype was almost complete when the SSC project was cancelled late in 1993.

KEK nevertheless encouraged the team to carry out its test, which took place at the KEK PS experimental hall in early 1994. Precious technical data taken during this test essentially eliminated the necessity for major R&D on the ATLAS thin solenoid.

An idea to make the coil thinner, originally proposed by Prof. Yamamoto, is to use the superconductor not only as a current carrier but also as a main structural body to sustain the magnetic forces. He proposed a high-strength aluminium stabilizer for the superconductor. R&D on high-strength conductors began in the late 1980s at KEK and its usefulness was proven by the SDC prototype solenoid test. As the ATLAS solenoid shares the same conceptual design, it is not surprising that the ATLAS solenoid technical design report devoted a lot of attention to the experimental results of the SDC prototype.

The 12 km superconductor was developed and constructed by Furukawa Electric and Hitachi Cables. The conductor was coiled into 1151 turns inside an aluminium cylinder made by Oxford Instruments. The coil winding and curing, as well as subsequent assembly, were carried out by Toshiba in Yokohama.

Another distinctive design feature of the ATLAS solenoid is that the coil and the barrel LAr calorimeter share a single common cryostat and vacuum. This feature eliminates two vacuum walls. The coil is mounted inside the innermost vacuum cylinder (IVC) of the LAr cryostat using specially developed triangular glass-fibre supports.

The ATLAS barrel LAr cryostat, an in-kind US contribution designed by Brookhaven, is being constructed at Kawasaki Heavy Industry near Kobe in Japan. Early last year its vacuum vessel was completed and tested. Meanwhile KEK asked Toshiba to construct a "test IVC" for

initial solenoid tests in Japan with a design similar to that of Brookhaven's final IVC.

Thus in spring 2000 two nearly identical IVCs existed in Japan. KEK proposed to exchange these two before coil mounting. This would eliminate coil disassembly for the test IVC and remounting to the final IVC, which is planned to happen at CERN some time in 2003, when the full barrel LAr calorimeter is finally completed.

IVC exchange would not only save time and cost but also enhance quality assurance since all the delicate operations associated with coil mounting could be finished in the best working environment at Toshiba's factory.

Although the argon vessel was still under fabrication, the Brookhaven team (led by J Sondericker) and Kawasaki agreed to accept KEK's request for IVC exchange. However, on the administrative side this exchange of property was complicated by legal issues of ownership, as well as liability.

Finally the six interested parties - KEK, Brookhaven, CERN, ATLAS, Kawasaki and Toshiba - reached an agreement in early 2000, and soon the two IVCs were duly transferred between Yokohama and Kobe, a distance of about 500 km.

In the summer and autumn of 2000, Toshiba proceeded with the system assembly of the coil, radiation shields, triangle supports, helium pipes, power lines, control dewar and the test cryostat with the final inner vacuum vessel. Meanwhile the KEK cryogenic team completed the new liquid helium control system.



The ATLAS central solenoid being tested.



The KEK/Toshiba team celebrates the success of full current excitation.

Early in December the assembly was completed and a KEK/Toshiba team began cooling and power tests at Toshiba's works on the chilly shore of Yokohama Bay. Three observers from CERN followed the tests.

Initially the coil experienced two unexpected quenches, at 7.0 kA and at 7.6 kA. The voltage and temperature sensors indicated that both were caused by excess epoxy between the coil ends and the end flanges. No unexpected quenches were encountered during some 30 powerings. On 26 December the team achieved the maximum design current of 8.40 kA. This exceeded 7.6 kA, the operating point of 2 T, by 10% in current and by 20% in magnetic forces.

After a short New Year break the team continued further tests for emergencies such as power and cryogenics failures. The coil survived the worst possible case of full energy dump at 7.6 kA, and can be safely de-energized without quench following a sudden interruption of liquid helium supply. In addition tests verified that the coil is adequately and uniformly cooled, leaving at least two degrees of margin for superconducting operation.

At the February ATLAS collaboration meeting at CERN, the success of full performance tests was greeted by warm applause: the KEK solenoid team is now the front-runner in the long, tough race for ATLAS detector construction.

This autumn the solenoid and its associated cryogenics equipment will be shipped to CERN, where the solenoid and the barrel LAr calorimeter will be combined and fully tested.

OPTICAL DETECTORS

EC to fund project for faster optical detectors

The development of more efficient and faster optical detectors is the subject of a prestigious € 2 million Research Technology & Development contract awarded by the EC to Sussex University, together with two UK companies, Photek Ltd and Electron Tubes, the Laser Centrum (Hanover), the Autonoma University (Madrid), CIEMAT (Spain) and Novara Technology (Italy).

The project, known as "Impeccable" (standing for Improved Photon Efficient Cathodes with Applications in Biological Luminescence), will fund the development of more efficient and faster optical detectors by the newly formed consortium, leading to their subsequent production by Photek and Electron Tubes. Existing industrial and research uses for photon counting, detection and imaging are already immense, but the particular thrust of these new developments should greatly increase their value for medical diagnostics, with medical, biological and new sensor applications.

The new concepts have arisen partly as a result of friendly collaborations over the last ten years between Photek and Peter Townsend at Sussex University: Townsend constructed a new standard for spectral analysis of thermoluminescence based on the Photek photon counting cameras. That equipment has not only advanced basic research into new optical and photonic materials, but is also being applied to problems of mineralogy and geological dating.

Although the Sussex system is still well regarded, there is now a major need to improve the sensitivity for long wavelengths (near infra-red) signals and to have much faster sensors. The work at Sussex led to a patent for a development that can, potentially, give much greater sensitivity and has already established a new technique to speed up the response time of Photek detectors into the sub-nanosecond range. The new grant will take this research further and faster with the aim of giving European dominance to both the

subject and any resulting products.

The partners have already begun to interact - the Laser Centrum in Hanover is collaborating with Photek on another EC-funded project (Femto) on laser machining. Electron Tubes and Photek have had discussions in the past, and Sussex-UAM -CIEMAT have also worked on joint projects over many years.

The collaboration between Sussex University and Electron Tubes began more recently when the latter was launched independently of Thorn/EMI. Electron Tubes is a leading European manufacturer of photomultipliers and detector modules that detect light down to single photons. Its role will be the development of new high-efficiency photocathode layers and the fundamental measurements on the cathodes to be used in this project.

The detection of low light levels is also critical to a wide variety of industrial and scientific instrumentation. Industrial applications range from the measurement of steel thickness as it is rolled from the furnace through to the identification of oil-bearing rock immediately behind the drill bit as an oil well is formed. Scientific applications range from the detection of solar neutrinos deep underground to astronomical observations of distant stars. The target processes for the new high-efficiency photocathodes will be in the very challenging area of the detection of light emitted during biological processes or from luminescence which distinguishes between healthy and imperfect cells.

Among the applications foreseen for this technology is a new technique for the early diagnosis and subsequent monitoring of Alzheimer's disease, and luminescence analysis for a variety of types of cancer. Demonstrations of such possibilities are planned within the three-year programme but routine applications will take longer. Contact Ian Ferguson at "sales@photek.co.uk" for further information.

SUPPLIER AWARDS

Awards highlight top suppliers

The CMS and ATLAS collaborations currently building experiments for CERN's LHC collider have recently been handing out their very own Oscars to their most meritorious suppliers.

At the second such ceremony held at the recent CMS week at CERN, four CMS suppliers received Gold Awards, and the exceptional work by two of them was further rewarded with the CMS Crystal Award for innovation and management.

One Crystal Award went to Japanese firm Kawasaki Heavy Industries which, under a contract with the University of Wisconsin, manufactured six steel discs 15 m in diameter making up the two endcaps of the yoke. Reassembled, the two thinner discs at each end will weigh 300 tonnes, the two intermediate ones 700 tonnes and the two innermost discs 1250 tonnes.

The other Crystal Award recipient was Fermilab contractor Felguera Construcciones Mecanicas, the Spanish firm which produced the wedge-shaped structures for the two 550 tonne half-barrels of the CMS hadron calorimeter. This involved in the region of 1100 tonnes of brass plates, the largest some 4 m in length and weighing in at more than a tonne.

The two other companies to receive CMS Gold Awards were Hudong Heavy Machinery, under the CERN-China agreement, for the 30 tonne support carts for each endcap disc, and the American firm Superbolt for more than 1500 high-strength bolts for the endcap discs.



Award time at the collaboration building the ATLAS experiment at CERN's LHC collider. ATLAS spokesman Peter Jenni (left) and ATLAS Transition Radiation Tracker (TRT) project leader Daniel Froidevaux present the ATLAS supplier award to Patrick and Simon Hester, directors of UK company Lamina Dielectrics, which supplied 180 000 high-tech straws for the ATLAS TRT.



This year the collaboration building the CMS experiment at CERN's LHC collider awarded its highest distinction to two suppliers – the Spanish firm Felguera Construcciones Mecanicas, represented by Ernesto Alavarez (left), and the Japanese firm Kawasaki Heavy Industries, represented by Kazuo Mizuno (right).

CMS also presented its prize for the most outstanding PhD thesis of 2000. It was the first time such an award has been handed out to underline the important contribution made by students' work. The winner was Pascal Vanlaer of the Université Libre de Bruxelles for his R&D work on microstrip gas counters and the reconstruction of charged particle tracks.

Just four days earlier, the ATLAS collaboration had organized its first supplier award ceremony. "Firms really appreciate this," explained ATLAS financial coordinator Markus Nordberg, "because being a CERN supplier is a reference and generates important marketing spin-offs."

One ATLAS award went to a small UK family business, Lamina Dielectrics, which manufactured the 180 000 straws for the Transition Radiation Tracker. These 1.66 m long polyimide (Kapton) tubes are just 4 mm in diameter and are manufactured to a tolerance of 15 μm . Each straw is produced by winding and bonding together two thin strips of film coated with aluminium and graphite on one side and polyurethane on the other.

The other ATLAS award-winner was Czech firm Valvovna, supplier of 3000 tonnes of steel sheeting for the ATLAS barrel's tile hadron calorimeter. Even more impressive than the quantity was the precision obtained over the entire manufacturing process. The trapezoidal plates, 4 and 5 mm thick, were manufactured to a tolerance of 0.04 mm.

US STAR detector gets new silicon heart

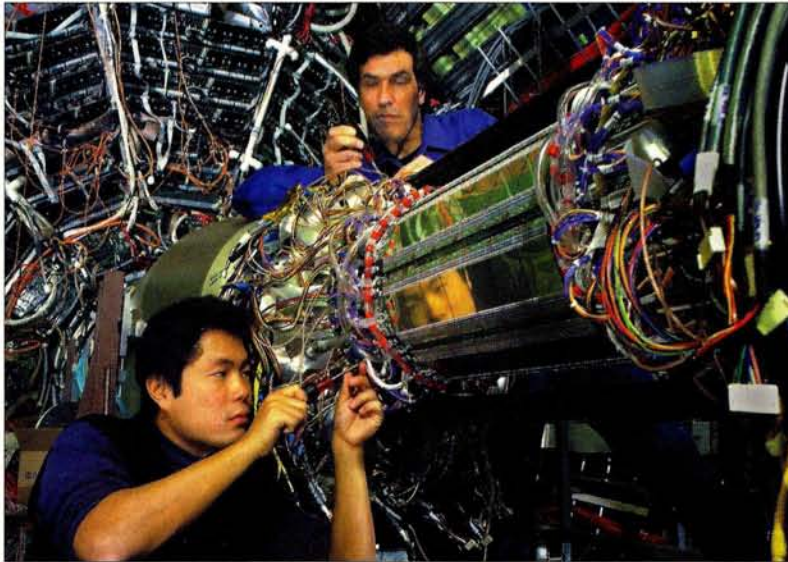
Recently Brookhaven's RHIC (Relativistic Heavy Ion Collider) achieved another major milestone with the insertion of the Silicon Vertex Tracker (SVT) into the heart of the Solenoidal Tracker At RHIC (STAR) detector.

Since the RHIC startup, people have consistently admired the beautifully complex images of high-energy gold ion collisions provided by the STAR Time Projection Chamber. The images from STAR's first run were remarkable, and the data provided led to a wealth of early scientific results. But for the experts there was still something missing – information on the particle tracks close to the colliding beams.

That blank space in the tracking coverage of STAR is about to be filled with information provided by the Silicon Vertex Tracker, a state-of-the-art instrument which is based on silicon drift technology and was developed at Brookhaven.

The completion of the STAR SVT is the culmination of an eight-year research and development effort by a team of more than 50 people, sponsored by the Office of Science of the US Department of Energy. Other institutions collaborating on the project include Wayne State University, Ohio State, the University of Texas and Lawrence Berkeley National Laboratory.

The SVT consists of three concentric layers of silicon



Jun Takahashi (Wayne State/São Paulo) and Robert Soja (Brookhaven) make final adjustments to the cooling system for the STAR SVT just prior to its insertion inside the inner field cage of the STAR Time Projection Chamber. STAR is one of the major detectors at Brookhaven's new RHIC collider. In the foreground, Takahashi's image is visible in the reflection from several of the state-of-the-art silicon drift detectors used as the technology for this system.



The STAR Silicon Vertex Tracker prior to insertion in the STAR Time Projection Chamber. Also shown is the team that was leading the construction and the installation of the detector. From left to right are Rolf Beuttenmuller (Brookhaven), Veljko Radeka (Brookhaven), Robert Willson (Ohio State), Phil Kuczewski (Brookhaven), Jun Takahashi (São Paulo), Robert Soja (Brookhaven), Bill Leonhardt (Brookhaven), Rene Bellwied (project leader, Wayne State) and David Lynn, Don Pinelli, and Tom Ludlam (Brookhaven).

drift detectors at 5 cm, 10 cm and 15 cm from the beam. These record the passage of charged particles in time and space, providing important information which can then be used in the STAR global tracking software. This allows for the detection of charged particles that decay quickly or curl up in the magnetic field before reaching the STAR Time Projection Chamber.

According to SVT project leader Rene Bellwied of Wayne State: "The installation of the SVT will provide essential tracking information to allow the detection of particles with short lifetimes, such as the cascade and the omega. It will also afford STAR an important low momentum tracking capability that it hasn't had until now."

Silicon drift detection is a new semiconductor technology developed in the mid-1980s by Brookhaven physicist Pavel Rehak in collaboration with Emilio Gatti from Milan. It was employed in the design of the SVT, allowing for a thirty-fold increase in space resolution compared with the TPC. This is necessarily close to the interaction point because of the high density of charged particle tracks produced when the gold ions collide.

The SVT will be commissioned this year when RHIC starts colliding beams of gold ions late in the spring. *Timothy J Hallman.*

RUSSIA

Making Tevatron magnets



Testing a superconducting solenoid: the Tevatron Electron Lens (TEL), to be installed in Fermilab's proton-antiproton collider ring. The TEL development is part of a collaboration between Fermilab and the Institute for High Energy Physics.

A new magnetic system for Fermilab's Tevatron collider has been designed and built in a collaboration between Fermilab and the Institute for High Energy Physics (IHEP) in Protvino, near Moscow. The Tevatron Electron Lens (TEL), to be installed in the proton-antiproton collider ring, produces a solenoidal field to focus an electron beam. This affects the antiproton beam, compensating beam-beam effects.

The TEL magnetic system was fabricated at IHEP, and tested at Fermilab last autumn. It consists of seven superconducting magnets (a solenoid and six steering dipoles) and two conventional solenoid magnets equipped with correction coils.

The electron beam from an electron gun cathode is transported through the interaction region in a strong field of the superconducting solenoid and absorbed in the collector. The main TEL element is the superconducting solenoid, which is 2.5 m long with a 6.5 T field. The solenoid coil (inner radius 76 mm) is made of flat transposed cable consisting of 10 wires (niobium-titanium filaments in a copper matrix), each 0.85 mm in diameter.

With 7289 superconducting coil turns the inductance was 0.6 H (operating current 1.8 kA, stored energy 950 kJ). Studies of the quench processes have shown that the coil is not self-protected against resistive transition and some protective precautions, namely fast quench detection and removal of stored energy to the external dump resistor, must be taken.

In the first high-current test of the superconducting solenoid, 5.64 T was reached at the current ramp rate of 3 A/s. The second quench took place at 6.6 T at 3 A/s, and after that the solenoid could not be quenched up to 6.7 T at 10, 20 and 30 A/s (the maximum allowed by the power supply). The magnet quenches very quietly and does not consume much helium at the quench.

Two field-measuring systems record the magnetic field distributions. The first uses a Hall probe in three dimensions, which records the field in every direction for each position. The second tracks field lines by a magnetic rod. A small trolley holds a freely rotating magnetic rod with a mirror. This trolley is moved inside the solenoid, and small deviations in the local field move the mirror and reflect the laser beam.

Six steering superconducting dipoles are placed on the outer surface of the superconducting solenoid coil. All are for correction of the electron-beam trajectory inside the magnetic system. The superconducting solenoid and the steering dipoles are enclosed in a yoke of low carbon steel. This improves the magnetic-field homogeneity inside the solenoid aperture. All superconducting coils together with the steel yoke are enclosed in a helium vessel. The TEL cryostat is part of the Tevatron magnet string cooling system.

For more information see "http://www-bd.fnal.gov/lug/tev33/ebeam_comp/new/".

New synchrotron radiation project

Following the shipment of a venerable electron machine from the Dutch NIKHEF laboratory to the Joint Institute for Nuclear Research (JINR), Dubna, near Moscow (February 1999 p21), the DELSY Dubna Electron Synchrotron project has been

proposed by NIKHEF, JINR and the Budker Institute, Novosibirsk. DELSY would be a third-generation synchrotron radiation source, allowing a broad spectrum of research in the areas of physics, chemistry, biology and medicine.

CERN COURIER.COM

Explore

Absorb

Search

Discover

Browse

Digest

Surf

Link

Bookmark

Molecular nanowires benefit from sharp treatment

At Brookhaven, molecular nanowires millions of times smaller than a human hair have been developed. At Stanford, researchers have subsequently discovered that nudging these tubes with a sharp tip can alter their ability to carry an electric current.

The team employed the tip of an atomic force microscope (AFM) to poke the nanotube. As in real-space microscopy techniques, the AFM was used to make images of surface topography by dragging a sharp tip over the bumps and folds on the structure's surface.

An array of finely powdered metal nanoparticles was placed on a silicon dioxide substrate. A carbon-containing gas (methane) was then fed over the substrate, which was heated to a high temperature. The carbon infused into the metal particles, which acted as catalysts and converted carbon atoms into honeycomb-lattice nanotubes.

After an electrode had been attached to a single nanotube across a silicon dioxide trench, the AFM tip was used to push the wire down into the trench while measuring its electrical conductance. Researchers were amazed to observe that the flow of electricity dropped sharply as the nanotube bent.

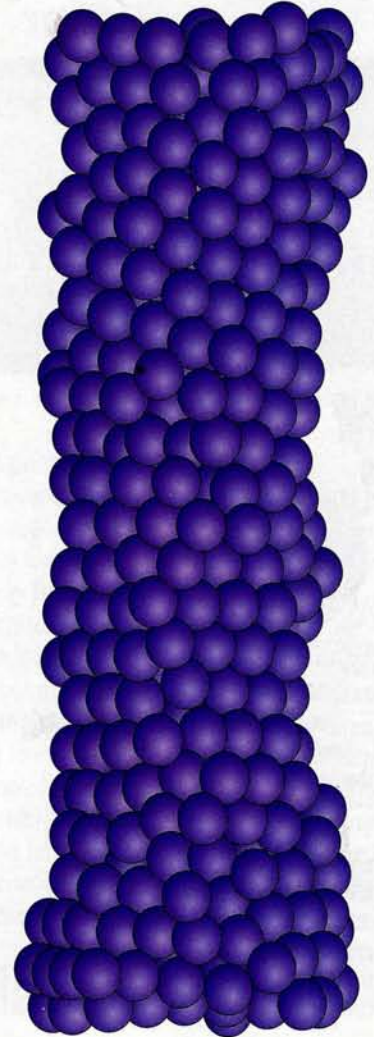
When the AFM tip was removed, the tube straightened and the flow of electricity returned to normal. Previous theoretical studies had predicted no significant change

in the conductance of nanotubes due to mechanical deformation.

As one side of the tube is pushed closer to the other during the experiment, carbon atoms form bonds across the inside of the tube. Normally, each carbon atom binds to three other carbons, leaving one electron free for conducting electricity. However, when the walls of the tube are forced closer together, each carbon atom binds to four rather than three other carbons. The resulting reduction in the number of free electrons decreases the electrical conductance.

As the AFM tip squashes the tube, causing each atom to bond with more atoms, the tube changes from an electrical conductor into an insulating structure similar to that found in diamonds. Remarkably, the dent disappears once the perturbing tip is removed. This high level of mechanical reversibility allows a full recovery of the nanotube's electrical property. Local nanotube deformation is a way to develop different functional components of nanotube transistors.

The discovery could be used for making tiny electromechanical devices, such as transducers for converting mechanical movements into electrical signals. Other possible applications might include high-frequency telephone lines for carrying voice and data, and on/off switches for nanoscale computer chips. *Brookhaven Bulletin/AIP*



This nanotube structure resembles a rolled-up graphitic sheet of carbon atoms arranged in a honeycomb pattern.

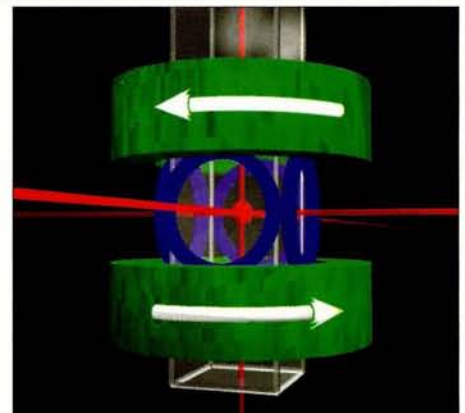
Supernova is confined to the laboratory

Progress in the Bose-Einstein condensate domain comes from Colorado, where rubidium-85 atoms were confined in a condensed form at 3 nK within an atomic trap. In a Bose-Einstein condensate (BEC) – a relatively newly discovered state of matter – thousands, or sometimes millions, of identical atoms act as one.

By varying the magnetic fields it is possible to change the interaction between the atoms from mildly repulsive to mildly attractive, resulting in an implosion and subsequent

explosion of BEC atoms. This sequence is similar to the series of events in a stellar supernova, but at an energy scale some 75 orders of magnitude as small.

The nova effect, like its stellar counterpart, leads either to an outward-going shell or to collimated jets and a residue. Half of the BEC atoms apparently disappear, because they are not present in the remnant or the expanding gas shell. The novel atomic physics behind this "Bosenova" phenomenon is as yet unknown.



A magneto-optical trap confines and further cools a Bose-Einstein condensate.



The new name in ion implantation power



The Series OL20K answers industry demands for highly reliable high voltage sources designed to meet the rigorous requirements of ion and electron beam systems within a compact assembly. The design utilises IGBT technology operating at 30kHz to achieve superior performance coupled with unrivalled protection against damage from surges and arcs.

The power converter uses zero voltage switching to minimise IGBT dissipation, enhancing their long term reliability.

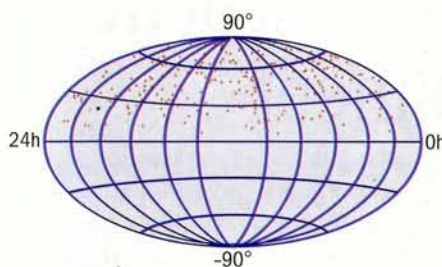
Output voltages range from 100kV to 200kV with up to 20kW of output power available. Each system consists of two units: the converter, housed in a 6U 19" rack mounting unit and a separate high voltage multiplier assembly based on HiTek Powers proven proprietary DISC technology.

www.hitekpower.com
Tel: +44(0)1243 841888

BLUE CHIP POWER SOLUTIONS

PHYSICSWATCH

AMANDA spots icebound neutrinos



Neutrino sky map – AMANDA's PMTs saw 263 high-energy neutrinos in 138 days.

An array of super-sensitive light detectors has seen its first high-energy neutrinos. The antarctic muon and neutrino detector array (AMANDA) is buried in up to 2 km of Antarctic ice, and was built in 1997 to test whether polar ice is a natural neutrino detector. Most neutrinos detected on Earth come from the planet's atmosphere – where they are generated by cosmic rays hitting air molecules – and from the Sun; a few are produced in nearby exploding stars (supernovae) or come from further afield.

Neutrinos are hard to spot because they are small and have no charge and very little mass. The vast majority of them rip right through the Earth without stopping. Since they rarely interact, high-energy neutrinos tend to travel in straight lines, thereby revealing the location

of the energetic regions of the universe from which they originate. It is for this reason that they are of profound interest to astronomers.

Cerenkov radiation (a fleeting glow produced when a speeding neutrino collides head-on with a terrestrial particle, releasing another particle, usually a muon) allows physicists to infer the presence of neutrinos. A cone of Cerenkov light reveals the direction of the original neutrino.

Although other detectors have already made important contributions to this field, a large detector is required to catch rare, high-energy neutrinos. AMANDA compromises fine-scale sensitivity for size; it consists of 302 photomultiplier tubes (PMTs) suspended in 20 000 cubic metres of ice. Deep polar ice is spotless and transparent enough to allow the dim, transient flash of Cerenkov radiation to be detected without deformation.

AMANDA doesn't look up into the sky because Cerenkov light from locally produced solar or atmospheric neutrinos would overwhelm the PMTs; the detector instead looks "through" the Earth towards the North Pole, using the planet itself as a filter.

A far larger detector – the proposed "Icecube" – will be required to observe exactly where high-energy neutrinos come from. *Nature*

Cold chips could shrink 'hot' trackers

Chillers the size of a speck of dust could soon be cooling silicon chips as they pulse with electrical currents. A team of scientists in Santa Barbara has made "microcoolers" less than 0.05 mm in diameter that can be built onto chips to stop them overheating – one of the barriers to the further miniaturization of microelectronics.

The cooling units consist of 200 alternating layers of two semiconductors that are heaped on top of one another like tiles. Each layer of this "superlattice" is just 10 nm thick. The layers can reduce the local temperature on a silicon chip by up to 7 °C when the chip is operating at a temperature of 100 °C. Better performance is expected after further R&D.

In microelectronics, thermoelectric coolers are generally manufactured separately from the chips or devices and bolted on to cool the entire chip. The new microcoolers are more

efficient to make and use because they can be fabricated directly onto a chip. They are also small enough to regulate "hot-spots", which severely reduce the working lifetime of a chip.

Microcoolers are made from silicon and an alloy consisting of silicon, germanium and carbon, allowing the layers to fit together at the interface between them. Previously, superlattices made only from silicon and germanium for thermoelectric cooling had to sit on a thick "buffer layer" to reduce the mismatch with the underlying silicon surface, hindering good thermal contact between the chip and its cooler and reducing efficiency. *AIP*

Further reading

X Fan *et al.* 2001 SiGeC/Si superlattice microcoolers *Applied Physics Letters* **78** 1580–1582.

Edited by Emma Sanders

Keck heralds a new era for optical astronomy



Left: the VLT interferometer in Chile. The path taken by light is shown in white. (ESO.) Right: the Keck interferometer in Hawaii. (Keck.)

On the night of 12 March, the Keck interferometer in Hawaii began operations. It is currently the largest optical telescope in the world, with a resolution equivalent to that of a single telescope with a diameter of 85 m. Just five days later, interferometry began at the European Southern Observatory's Very Large Telescope (VLT) in Chile. The test was carried out with small 40 cm telescopes, but, when full-scale observations begin later in the year, the facility will give a resolution equivalent to that of a 200 m telescope.

Interferometry – combining data from several different telescopes to simulate the effect of using one large telescope – was originally the

preserve of radioastronomers. At longer wavelengths, the level of precision required to combine signals from the different telescopes is easier to obtain. Thanks to interferometry, milliarcsecond resolution has been commonplace in radioastronomy for many years.

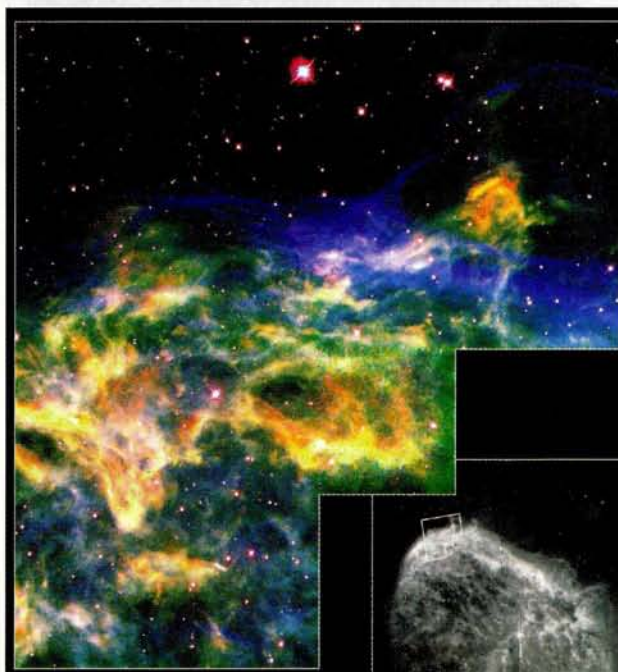
Owing to great technological advances, optical interferometry is finally catching up, opening the door to a wealth of new discoveries. In particular, astronomers can now look forward to the direct imaging of planets in other solar systems; seeing views of the surfaces of stars other than our Sun; studying the environment close to black holes; and looking back in time to the epoch when the first stars

and galaxies started to shine.

However, although interferometry increases the resolution of observations, sensitivity is much lower than that of a single large telescope. The mirrors do not collect as much light, so faint objects are difficult to image. The Keck interferometer consists of two 10 m telescopes made up of 1.8 m mirror segments. Meanwhile, the VLT has four 8.2 m telescopes and several 1.8 m auxiliary telescopes under construction. This larger collecting area will give increased sensitivity.

The future is exciting, and *CERN Courier* readers can look forward to some stunning "Pictures of the month" in years to come.

Picture of the month



The material thrown out from Wolf-Rayet star WR 136 is travelling at more than 6 million kilometres per hour. This image, captured using the Hubble Space Telescope, shows the shell of material being blown apart by the fierce stellar wind – a stream of charged particles ejected from the surface of the star. A picture taken by a ground-based telescope (lower right) shows almost the entire nebula. The structure is about 16 light-years wide and 25 light-years long. (NASA/ESA.)

Black hole survey

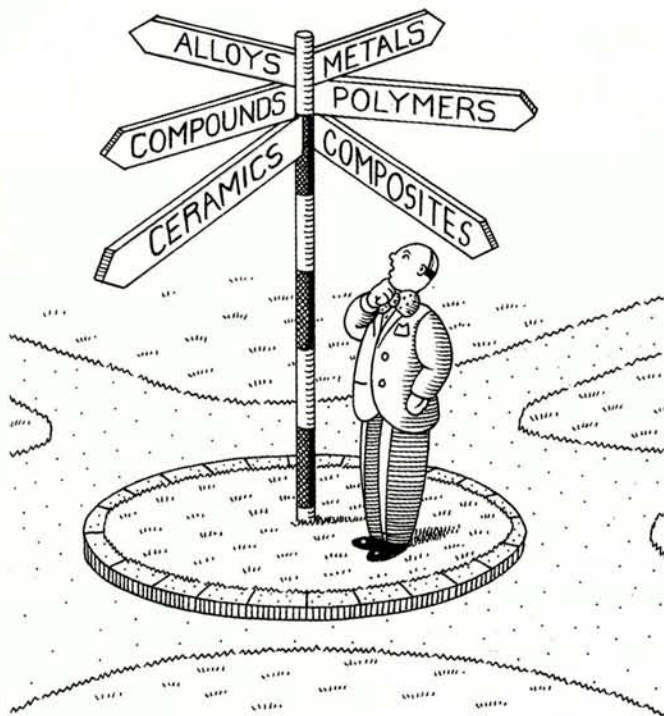
NASA has chosen the first six science projects for its Space Infrared Telescope Facility (SIRTEF). By far the biggest chunk of observing time will go to the Black Holes and Galaxies project – an infrared survey of galaxies up to 10 billion light-years away to find out whether black holes are the principal energy source in bright distant galaxies.

Other projects include a survey of the most distant galaxies to study galactic birth and evolution, and observations of the first stages of star formation taking place deep inside molecular clouds.

Infrared telescopes reach parts of the sky that other telescopes can't see. The radiation emitted by stars is absorbed by large dust clouds and the heated dust glows in the infra-red, revealing what would otherwise be hidden behind.

SIRTEF will be launched in July next year.

Your choice



Metals, Alloys, Ceramics, Polymers...

If you're looking for small quantities of any of these, then look no further...

Our range of materials is second to none and includes foils, rods, wires, tubes and many other forms. And in case you can't find precisely what you need, then our custom manufacturing service may be just what you're looking for.

So put an end to fruitless searches - contact Goodfellow!

Goodfellow

Goodfellow Cambridge Limited

Ermine Business Park, Huntingdon, PE29 6WR, Great Britain

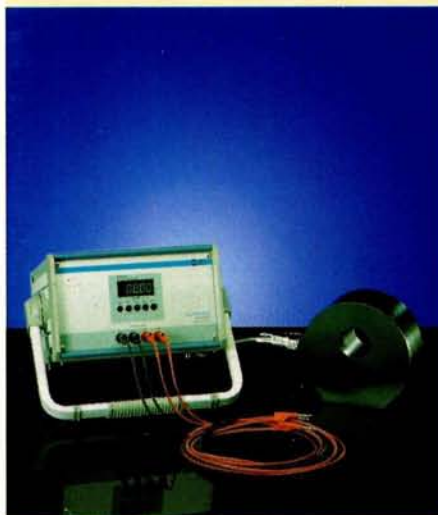
Tel: +44 (0)1480 424 800

Fax: +44 (0)1480 424 900

E-mail: info@goodfellow.com Web: www.goodfellow.com

The proven performers

Zero-flux™ DC measuring systems



Ultracc The workbench performer

Multi-range Zero-flux™ system with voltage output

Current range
100-200-500-1.000-2.000 A

Linearity error less than 2.5 ppm

Temperature stability < 0.25 ppm/K

Used for calibration and testing or as DC reference



Hitec Power Protection by
Division Special Measuring Systems
P.O. Box 4
7550 GA Hengelo, The Netherlands



Phone : +31 74 246 28 53
Fax : +31 74 246 26 78
E-mail : sales@hitecsms.com
Internet: www.hitecsms.com

THERE IS ALWAYS A PANTECHNIK
ECR SOURCE
READY FOR YOUR APPLICATION !



MICROGAN :
an ECR ion source devoted to industrial applications requiring high current at low charge states.

High charge state
low energy ion beam bench,
equipped with NANOGAN



NEW !
PHOENIX : A second stage ECR source
for the production of radioactive ions.

ASK FOR DETAILS :

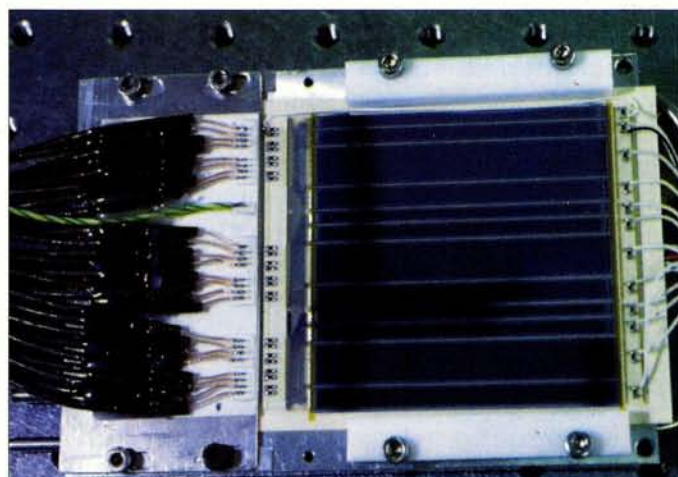


12, rue Alfred Kastler
14000 CAEN
FRANCE
Phone : +33 231 95 13 79
Fax : +33 231 95 13 91
E-mail : pantechnik@compuserve.com

a Eurisys Mesures Company Web site : www.pantechnik.net

Major instrumentation meeting visits Europe

When new experiments require new instrumentation, the resulting R&D can also provide spin-off developments with wider uses. A major shop window for these is the annual Nuclear Science Symposium and parallel Medical Imaging Conference. *Chris Damerell and Chris Parkman* report on the latest event in the series.



Left: CERN director Hans Hoffmann at the Hadrons for Health exhibition illustrating the application of particle beams for medicine, which accompanied the IEEE Nuclear and Plasma Physics Society's combined annual Nuclear Science Symposium and Medical Imaging Conference in Lyon. Right: the use of silicon microstrips is a booming imaging technique. This shows a module for the CMS experiment's tracker at CERN's LHC collider.

An expert, runs the saying, is one who knows more and more about less and less. An annual mecca for instrumentation experts is the Institute of Electronic and Electrical Engineers (IEEE) Nuclear and Plasma Physics Society's combined annual Nuclear Science Symposium (NSS) and Medical Imaging Conference (MIC). In 2000, this major event visited Europe for the first time in its more than 45-year history, and a major theme was to amplify expert knowledge by refocusing specialists' attention onto important developments across a wider front.

Although they share many technologies, the NSS and MIC have traditionally been separate but concurrent events. In recent years a number of combined sessions have been held, but the 2000 event set out to bring the two communities together, with instrumentation-related contributions classified according to their fundamental technologies rather than their areas of application.

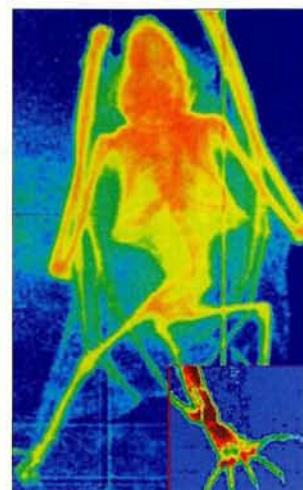
Topics covered included radiation detection and new detector materials; electronics and image reconstruction algorithms; complex radiation detector systems for physical science; and advanced

imaging systems for applications in biological and medical research.

Held on 15–20 October at the Palais de Congrès in Lyon, France, under the general chairmanship of Patrick Le Dû of CEA Saclay, the event was sponsored by all of the leading European laboratories, including the CEA and CERN, as well as the local and regional governments.

The scientific programme, chaired by Chris Damerell of the Rutherford Appleton Laboratory in the UK for the NSS and Stig Larsson of the Karolinska Hospital in Stockholm for the MIC, made a major effort to boost communication between the two traditional communities. It attracted more than 750 papers, from which the Programme Committee, under Jean-Pierre Dufey of CERN, was able to put together a compelling agenda.

The overview talks covered a range of subjects: the impact of deep submicron electronics on science and society; micropattern gas detectors (with wide-ranging imaging capability); the use of positron emission tomography (PET) in psychiatry; open source software; GRID computing; and the positive and negative impact of



Left: the opening of the IEEE Nuclear and Plasma Physics Society's combined annual Nuclear Science Symposium and Medical Imaging Conference in Lyon. Left to right: William W ("Bill") Moses of Berkeley, chairman of the IEEE Nuclear and Plasma Sciences Society; Chris Parkman of CERN, who organized the Industrial Programme for the major meeting; Stig Larsson of Stockholm's Karolinska Hospital, chairman of the Medical Imaging Conference; and overall conference chairman Patrick Le Dû of CERN. Right: micropattern detectors are widely considered to have a great future, for example in digital radiography. This image shows a small bat, 32 mm across, viewed with $50\ \mu\text{m}$ pixels using gas electron multiplier techniques. (F Sauli, CERN.)

ionizing radiation on health.

Despite the eagerness to hear about the latest developments in semiconductor detectors, the more traditional scintillation and gaseous detectors still pull in the crowds. Scintillation detectors provided early real-time particle sensors in the form of zinc sulphide screens. Throughout their long history, they have led the field for X- and gamma-ray detection.

The largest individual systems are obviously those used in the giant collider experiments for particle physics, but medical imaging provides a huge market for more than 100 tonnes of scintillator each year. The technology is evolving rapidly, as is the closely related topic of photodetectors.

Gaseous detectors started out as bulky devices (Geiger and proportional counters) with crude spatial information. The evolution through drift chambers and multiwire proportional chambers provided precise one-dimensional information and a host of application areas.

Exciting prospects

One might have imagined that, having achieved $100\ \mu\text{m}$ resolution, the pace of development would be slowing down. Not at all – micropattern detectors represent a new field with a host of exciting prospects for true two-dimensional imaging applications.

Since the invention of the planar process leading to silicon integrated circuits, the effect of semiconductor devices on detector technology has been equally dramatic. Silicon microstrip detectors have evolved in a bewildering variety of directions. They offer extremely fast tracking and can be assembled into large structures, such as the $235\ \text{m}^2$ area planned for the CMS experiment at CERN's LHC collider.

On a smaller scale, pixel-based silicon devices offer very high spatial precision as vertex detectors. Increasingly, such devices are being used in scientific imaging, as well as in more everyday equipment, such as the camcorder. For the scientific market, charge-coupled devices, hybrid and monolithic active pixel devices are being

developed, each with its own preferred areas of application. One of the high points of the parallel sessions was a talk on imaging with silicon detectors, during which a packed auditorium heard new results on applications in medicine, crystallography and high-energy physics.

In addition to the exciting progress in silicon detectors, there have been remarkable developments with other semiconductors. These included presentations on CdZnTe/CdTe-based technology, not only exploring the device physics in great depth but also detailing its real-life applications.

For other materials, too (Ge, diamond, GaAs and InP), progress has been equally spectacular. In many cases, the superb energy resolution of these devices is maintained while moving towards the spatial precision associated with silicon.

New applications of liquid xenon technology covered both gamma-ray directional reconstruction in the difficult mega-electronvolt range, and the search for weakly interacting massive particles.

Underpinning many of these developments is the continuing rapid progress in electronics and computing. Front-end electronics was the most popular of all of the parallel session topics, with eight oral sessions (every morning and afternoon) and five poster sessions.

New ideas in radiation-tolerant circuit design, signal processing and low-noise circuits were presented. The session on circuits for medical applications provided an interesting example of advanced electronics techniques applied to PET instrumentation, building more bridges between nuclear techniques and medical instrumentation.

The discussion of Novel Technologies covered very special devices, such as thermometers for cryogenic detectors, hydrophones for detecting high-energy reactions in water and imaging plates for the detection of heavy particles. It culminated in an overview of new methods and detectors for high-efficiency, high-resolution X- and gamma-ray imaging.

In the imaging domain, several new ideas are being studied, such as a multi-Compton scattering technique based on back-scattered

photons, and a method for reconstructing gamma-ray trajectories using information from segmented high-purity germanium detectors.

A new detector material made of polycrystalline films of mercuric iodide, to be coupled to thin amorphous silicon transistor arrays, is being prototyped. A number of operational devices for X- and gamma ray detectors were also presented.

The pedagogical mission of the NSS-MIC was strongly in evidence: in addition to the traditional short courses (organized this year by Fabio Sauli of CERN), an innovative series of three one-day workshops was held. More than 300 students, ranging from post-doctorate to senior level, benefited from seven courses on topics that included solid-state detectors in particle physics; particle identification and detectors for X- and gamma-ray astrophysics; analytical reconstruction; X- and gamma-ray imaging; PET; and discrete reconstruction methods.

The workshop on Advances in Electronic Portal Imaging was arranged on behalf of the European Federation of Organizations for Medical Physics by Alberto Del Guerra and designed to act as a bridge between the radiation detector community and radiotherapy professionals.

It began with a review of the Electronic Portal Imaging 2000 conference (held a few months earlier), which covered the most advanced digital detectors for portal imaging, and was followed by presentations on Monte Carlo simulation and dosimetry measurements. Finally, the image quality and image analysis of digital portal imaging

was discussed from both a physical and a clinical point of view.

The Basic Science and Entrepreneurship workshop was organized by François Bourgeois of CERN, Alan Jeavons of Oxford Positron Systems (UK), Yves Jongen of Ion Beam Applications (Belgium) and Gert Muehllehner of ADAC-UGM (US) (see March p10).

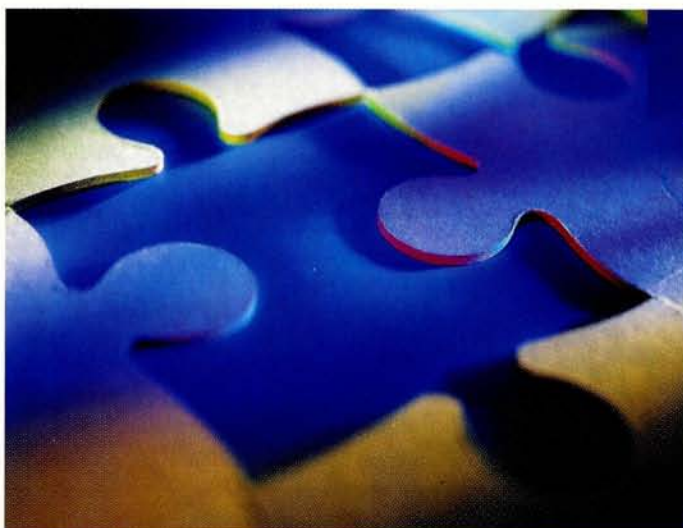
Following successful workshops held at Fermilab in 1994 and Osaka, Japan, in 1996, the workshop on Network-Based Data Acquisition and Event-Building was particularly relevant in view of the forthcoming need to choose technology for the LHC experiments' data acquisition systems, due to start work in 2005.

The state-of-the-art exhibition hall at the Palais de Congrès was used to good advantage by the Industrial Programme, chaired by Chris Parkman of CERN, allowing more than 50 exhibitors to take part. In an effort to maximize the mutual benefit to industry and the research community, exhibitors participated in a series of technical seminars, and small companies and new entrepreneurs were able to contribute to the industrial programme.

The presentations, together with all of the contributed papers, will be available on CD-ROM shortly. This will give newcomers and experts alike an up-to-date overview of developments in both nuclear science and medical imaging.

The 2001 NSS-MIC will be held on 4-10 November in San Diego, California. Full details are available at "<http://www.nss-mic.org>".

Chris Damerell (RAL) and **Chris Parkman** (CERN).



Lake Shore Temperature Sensors

**We have the
solution to fit
your needs**

LakeShore®

Lake Shore temperature sensors meet these requirements:

- Magnetic Fields
- Standard Curve
- High Sensitivity
- UltraLow Temp
- Fast Thermal Response
- High Stability
- Radiation Hard
- Wide Range

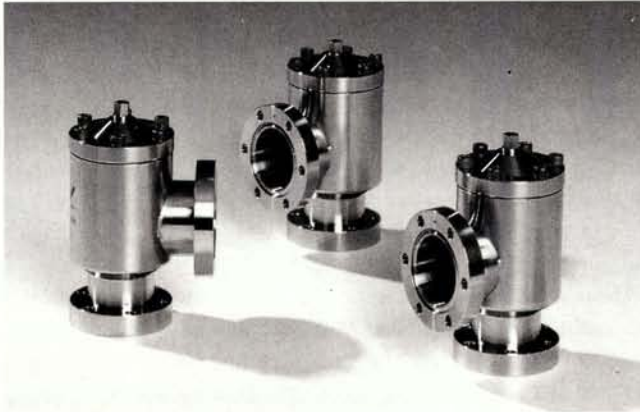
See our complete line of temperature sensors and related products at our website:

www.lakeshore.com

Lake Shore Cryotronics, Inc.
575 McCorkle Blvd.
Westerville OH 43082-8888 USA
e-mail: sales@lakeshore.com
1-800-394-2243

Series 54 «Low cost» All-metal Angle Valve

for UHV and extreme UHV



For pump and gauge isolation
under UHV conditions

- Closing to mechanical stop
- High conductance
- VATRING «hard to hard» all-metal sealing

Swiss Headquarters Tel ++41 81 771 61 61 Fax ++41 81 771 48 30 Email reception@vat.ch	VAT France Tel 01 6920 6911 Fax 01 6920 9008 Email france@vatvalve.com	VAT Germany Tel (089) 46 50 15 Fax (089) 46 37 65 Email deutschland@vatvalve.com
VAT U.K. Tel 020 8346 1999 Fax 020 8343 1104 Email uk@vatvalve.com	VAT Japan Tel (045) 333 1144 Fax (045) 333 7024 Email info@vatvalve.com	VAT USA Tel (781) 935 1446 Fax (781) 935 3940 Email usa@vatvalve.com

Ask for our catalogue «VAT Vacuum Valves 2000»
for detailed information on more than 1000 standard products.

Visit our website at www.vatvalve.com

High Voltage Power Supplies

fug

Series MCL
Series HCL

DIN EN ISO 9001

CE

NEW

Series MCL 6 Voltages / 4 Power Classes
0 - 125 ; 200 ; 350 ; 650 ; 1250 , 2000 V • 14 ; 35 ; 140 ; 350 W

Series HCL 5 Voltages / 4 Power Classes
0 - 3,5 ; 6,5 ; 12,5 ; 20 ; 35 kV • 14 ; 35 ; 140 ; 350 W

Remote controlled reversible polarity (HCL-Option)
4½dig displays for voltage and current
Operating mode indicators • Short-circuit and flashover proof
Voltage stability $\leq 1 \times 10^{-7}$ / 8h • Residual ripple <math>< 1 \times 10^{-4}</math> pp

F.u.G. Elektronik GmbH • Florianstr. 2 • D-83024 Rosenheim
GERMANY
Tel.: +49(0)8031 2851-0 • Fax: +49(0)8031 81099
Internet: www.fug-elektronik.de • Email: info@fug-elektronik.de

PLASTIC SCINTILLATOR

- Plastic Scintillators -
Thin Films, Large Sheets
- Liquid
Scintillators
- Reflective
Paints
- Optical
Cement
- Wavelength
Shifting
Plastics
- Custom Design
and Fabrication

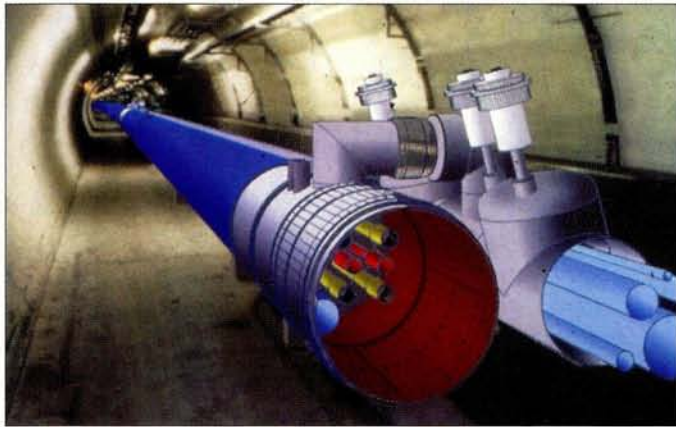
ELJEN TECHNOLOGY

PO Box 870 / 300 Crane Street
Sweetwater Texas 79556
Ph: (915) 235-1418 or (888) 800-8771
Fax: (915) 235-2872

*Organic Scintillators for
Tomorrow's Technology*

See us online
or call for our
brochure

www.eljentechnology.com



CERN's Large Hadron Collider. An estimated 2.5 million documents will be produced in its construction.

documentation related to a particular project. By 1998 this had been deployed in many particle physics research centres around Europe and was being used by about 12 000 people. It was also in 1998 that some of the original HUT people who had worked on the project at CERN started up Single Source Oy to support the software.

Meanwhile, development was still under way at CERN, and the fledgling firm worked hand in hand with the lab to add features that would be invaluable to the LHC project and marketable by the company anywhere where large teams of people had to be managed. It

was during this period that TuoviWDM evolved into the commercial product Kronodoc, which not only manages documents – keeping track of authorship and cataloguing modifications – but also provides a powerful management tool by tracking the use of documents.

Kronodoc allows project managers to see who is accessing documents and how they are using them. It distinguishes between viewing and downloading, which roughly equates to the difference between using a document and working on it. The software also builds self-organizing maps that show, at a glance, groups of closely collaborating individuals, as well as isolated groups that have little or no contact. In any large project it is natural for working partnerships to evolve, and for some groups to work closely together at one point in the project's life and not at another. Engineers, for example, may work more closely with draughtsmen at the beginning of a project than they do as the project evolves. By revealing these working relationships, Kronodoc allows project managers to take the pulse of the project at any moment and then to make sure that all of the necessary working relationships have been put in place.

Today, Single Source Oy is a successful company, the customers of which include a leading manufacturer of both diesel power plants and marine diesel engines, the Wärtsilä corporation. In the view of Ari-Pekka Hameri, who is still at CERN, this success would not have been possible without the close collaboration between CERN, the Finnish institutions and industry. Over the lifetime of the project, some 38 people funded from Finland worked at CERN, collaborating closely with the laboratory's personnel and making full use of their expertise. TuoviWDM produced 16 master's theses and contributed to two doctorates, as well as training 18 students on summer placement programmes. These figures alone represent a significant transfer of technology through people, given that 80% of these students have so far found jobs in industry. According to Dr Hameri, "This flexible exchange of students and researchers, which could be coordinated to the changing needs of the development work, is a unique and highly positive feature of research institutes like CERN."



Manufacturing Sciences Corporation

A BNFL Inc. Company

The Metals Processing Specialist



- Depleted Uranium (DU) Rolling and Machining Capabilities
- DU Shielding and Container Manufacture • DU Recycling and Disposal • Exotic Metals, Alloy Melting
- Counterweights, Radiographic Housings

Toll Free: (877) 481-0455
Business Development Extension 240
www.mfgsci.com

Turning inventions into companies

In Finland an invention is the property of its inventor, not of the institution where s/he works. Moreover, the country encourages institutions to support inventors who wish to turn their ideas into companies. "The recent success of Finnish high-technology industry is at least partly due to this type of supportive environment," said Dr Hameri, who intended to apply a similar approach to TuoviWDM. CERN's technology-transfer policy, while not identical to Finland's, allowed him to do so. CERN holds the intellectual property rights to the inventions of its personnel, but the lab's policy is to publish all of its results, making them available to industry. This allowed members of the TuoviWDM team to take the ideas that they had developed at CERN and seek venture capital to establish a company.

With agreements between CERN, HIP and Single Source Oy guaranteeing the transfer of technology to the new company, Single Source Oy secured the funding that it needed in 2000 and the company now employs some 21 people, 14 of whom have worked on TuoviWDM at CERN. For its part, CERN has the long-term support that it needs, and one of its member states has a tangible return on its investment in basic science. □

CERN project brings science and art together

Signatures of the Invisible, an art exhibition inspired by the work being carried out at CERN, recently showed for several weeks at the Atlantis Gallery in London. The fruit of a close collaboration between CERN and the London Institute, a premier art and design school, this exhibition was the first public showing of the results of a unique interchange of ideas between artists and physicists.

"Throughout history, science and art have had a special relationship," explained Michael Benson, director of communications at the London Institute. "Artists today are beginning to realize that science provides fertile territory for the imagination."

In spite of the differences between the two disciplines, science and art have had similarly crucial roles to play in human civilization. Throughout history, great minds have embraced both disciplines – the most famous example being Leonardo da Vinci in Renaissance Europe.

However, although modern physics impacts on all aspects of daily life, from information technology and telecommunications to energy and medical imaging, today's art world has responded little to the cultural upheavals of advancing science. No modern Leonardo has emerged as yet.

The artists involved in the Signatures of the Invisible project – Roger Ackling (UK), Jérôme Basserode (France), Sylvie Blocher (France), Richard Deacon (UK), Bartholomeu dos Santos (Portugal), Patrick Hughes (UK), Ken McMullen (UK), Tim O'Riley (UK), Paola Pivi (Italy) and Monica Sand (Sweden) – have worked with scientists and technicians at CERN to create original works of art that reflect the ideas and techniques of modern physics.

Preliminary visits to CERN, which allowed the artists to meet physicists, visit experiments and discover the potential of CERN's workshops, led to two years of exchanges and close collaboration, which resulted in Signatures of the Invisible. The exhibition will re-open at Geneva's Centre d'Art Contemporain in January 2002 before travelling to venues in Stockholm, Lisbon, Paris, Strasbourg, Brussels, Tokyo, Australia (venue to be announced) and New York. □



Above, left: Italian artist Paola Pivi and her "Moving needles". Above, top right: one of Swedish artist Monica Sands' light boxes. Above, right: artist Ken McMullen (left) and his CERN partner Ian Sexton with their "Skin Without Skin – Crumple Work" sculpture. Using CERN technology, Ian translated Ken's initial idea into a laser-cut steel structure.



Above: UK Particle Physics and Astronomy Research Council (PPARC) chief executive Ian Halliday (right) and Sir William Stubbs, rector of the London Institute, against Ken McMullen's "Roman Lead" work. The lead was mined 2000 years ago in Spain, but the ship that was transporting it to Rome sank. As a result the metal lay for almost two millennia on the seabed and was protected from any radioactive contamination due to cosmic rays. PPARC is one of the major supporters of the Signatures of the Invisible exhibition.

When the bubble chamber

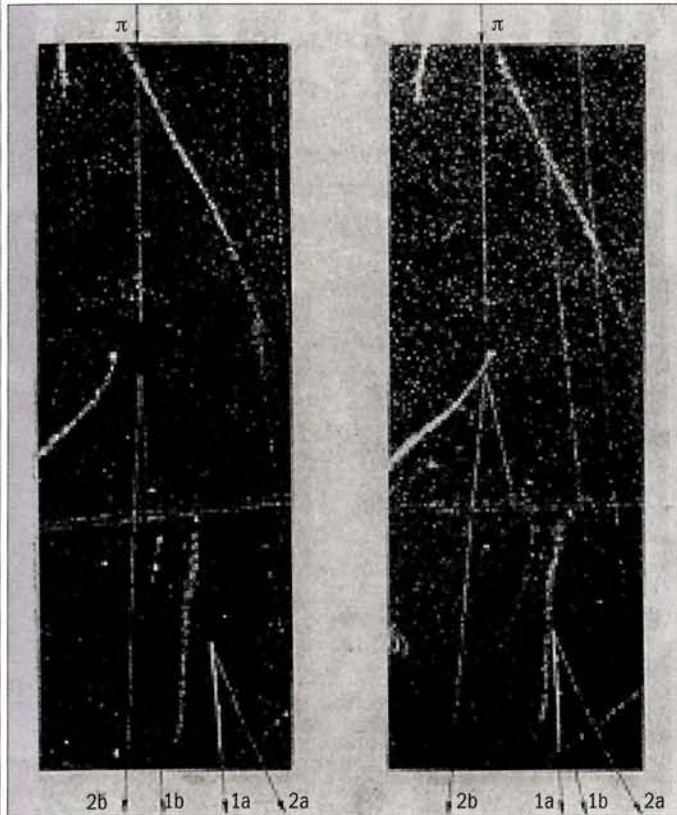


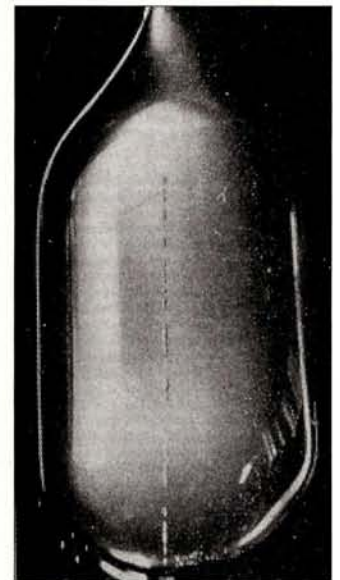
Fig. 1. Before the bubble chamber – Brookhaven Cosmotron diffusion chamber photograph of a 1.5 GeV negative pion producing two neutral V-particles, seen via their characteristic decays. Tracks 1a and 2a, believed to be a proton and a negative pion respectively, are the decay products of a Λ . A kaon is probably seen to decay into a positive and a negative pion (1b, 2b).

Strange particles were first seen in 1947 in a cloud chamber of Blackett, triggered by hadron showers produced by cosmic rays. Soon after, other strange particles, then called V particles, were also seen in nuclear emulsions. Progress in our understanding of these new particles was slow, partly because the experimental possibilities were limited to cosmic-ray observations, and partly because the phenomena were so totally outside of what was then known.

I remember in 1949, on a bulletin board at the Princeton Institute of Advanced Studies, a photomicrograph of a nuclear emulsion event, showing what is now known as a K-meson decaying to three pions. We all saw it. There could be no doubt that something interesting was going on, very different from what was then known, but it was hardly discussed because no-one knew what to do with it.

The copious production of these particles, indicative of the strong interaction, was at odds with their long lifetimes, indicative of the weak interaction. Pais noted in 1952 that this could be understood by inventing a feature of the strong interaction, a selection rule, which

On 25 May 2001, Jack Steinberger, who shared the Nobel Prize with his colleagues, reaches his 80th birthday. His memoirs, *My Years in Nuclear Science*, were published in 1997 (vol. 47, xiii). Jack is one of the great physicists of the 20th century. This article pulls together some episodes from his life.



Left: CERN stalwart Jack Steinberger. Right: Fig. 2. Track of a cosmic ray particle in Donald Glaser's first bubble chamber.

would permit their production but forbid their decay via the strong interaction. He implemented this in a mechanism that required the new heavy particles to be produced in pairs. This was extended some months later by Gell-Mann, who ingeniously combined the selection rule with the notion of isotopic spin. It required that the pair of Pairs be composed of a "strange" and an "antistrange" particle.

Enter the accelerator

The arrival of accelerators of sufficient energy facilitated the study of these new particles enormously. The Brookhaven Cosmotron accelerated protons to 3 GeV, six times the energy of the highest energy cyclotron, and sufficient to produce the new particles in collisions on nuclei, and Ralph Shutt and colleagues had developed a new type of cloud chamber. The V particles produced in cosmic-ray showers had been observed in cloud chambers, but these were very inefficient for accelerator experiments because, once made sensitive by expanding the gas, they would require 1 min of relaxation before they could be expanded again. The accelerator cycle, however, was typically 1 s. The new "diffusion" cloud chamber, in contrast, was continuously sensitive and made it possible to demonstrate the production of strange particles in pairs and verify the hypothesis of Pais and Gell-Mann (figure 1).

er first burst onto the scene

ed the Nobel prize in 1988 and is one of CERN's
s of his early life were published in *Annual Reviews*
continuing to work on his reminiscences, from which
the bubble chamber era of the 1950s and 1960s.

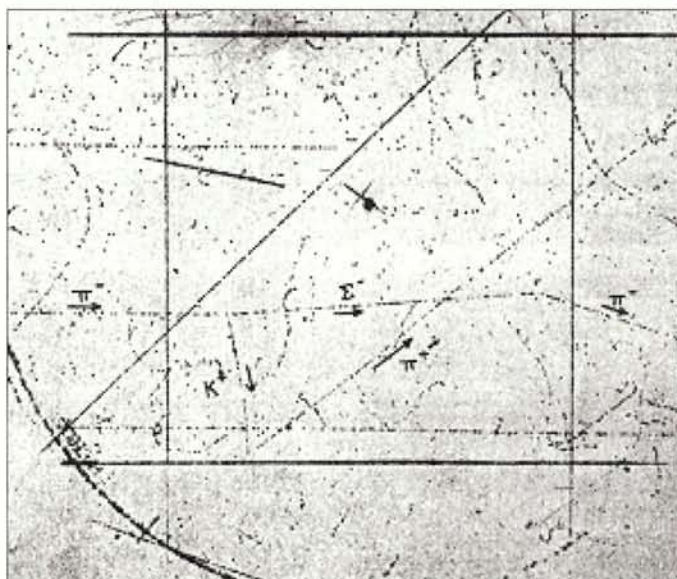


Fig. 3. An early Cosmotron bubble chamber photograph showing the associated production of two strange particles – a positive kaon and a Σ^- .

Two years later, in 1955, Gell-Mann and Pais noticed that the neutral kaon should exist in two versions, one strange and the other antistrange, one the antiparticle of the other. In addition to the known neutral kaon, there should be another one, with the same mass but with much longer lifetime and with different decays, with opposite symmetry under space inversion.

This idea, which seems obvious now, was not obvious at the time. It was not easy for me to understand or to accept this proposal when I read it, but a few days later TD Lee succeeded in explaining it to me. Once understood, the idea could not be rejected.

The experimental confirmation a year later by Lederman and Landé marked a big step forward. It was also carried out at the Cosmotron, and used what was, to my knowledge, the largest cloud chamber ever, 1 m in diameter. The large size made it more likely that the long-lived kaon, with a decay path of the order of 10 m, would decay inside. The chamber had been built at the Nevis laboratory some years before, but had never found any use. This, to my knowledge, was also the end of the long and glorious career of the cloud chamber in particle physics.

In 1953 Donald Glaser invented the bubble chamber, which went on to dominate particle physics, especially strange particle research, for the next 20 years. He showed that energetic particle trajectories



Fig. 4. A propane chamber with a magnet discovered the Σ^0 in 1956. A 1300 MeV negative pion hits a proton to produce a neutral kaon and a Σ^0 , which decays into a Λ^0 and a photon. The latter converts into an electron-positron pair.

can be made visible by photographing the bubbles that form within a few milliseconds after particles have traversed a suitably superheated liquid (figure 2).

The bubble chamber

The advantage of the bubble chamber over the cloud chamber at accelerators was two-fold: the higher density of the liquid proportionally increased the number of interactions produced in it, and it was faster to reactivate, matching the frequency of the accelerator cycle.

Within a year, John Woods, in the group of Alvarez at Berkeley, succeeded in producing tracks in liquid hydrogen. The chamber was a metal cylinder to which glass plates were attached, using indium ribbons as seals. In addition to being a major cryogenic technical achievement, this also demonstrated the crucial fact that for use with accelerators, where the expansion can be timed with respect to the accelerator cycle, the bubble chamber environment need not be as ultra-clean as was the glass vessel of Glaser, which permitted the liquid to survive in its superheated state for relatively long periods.

Three graduate students, John Leitner, Nick Samios, Mel Schwartz, and I began work at Nevis on the design of a practical

experimental bubble chamber to study strange particle production at the Cosmotron, I think early in 1954. By 1955 we had a 6 inch (15 cm) diameter liquid propane chamber. This was used at the Cosmotron in the first experiment using this new technique. The work profited a great deal from a generous collaboration as well as friendship with the inventor, who was working on a similar project at Brookhaven with his former student, David Rahm.

Rapid action

Our main technical contribution at Nevis was the discovery of a rapid action three-way gas pressure valve, the "Barksdale" valve. This made it possible to recompress the liquid within milliseconds after the expansion, and so to reduce the undesirable thermal effects that result if the pressure remains low for longer times and greater quantities of liquid boil.

As work progressed, we were joined by R Budde from the newly established CERN laboratory, who had been sent to learn about the new technique. The chamber had a serious flaw, which we nevertheless accepted in order to get experimental results – the liquid became clouded and lost its transparency after a few hours of operation. It was then necessary to empty and to refill the chamber, with a consequent loss of time.

The experiment used a pion beam of energy 1300 MeV, only slightly more than the minimum required to produce a strange particle pair. There was no magnetic field, so the particle momenta could not be measured. However, the information from the spatial directions of the observed particles, recorded stereoscopically, sufficed to permit the identification of Λ hyperon and neutral kaon decays, to distinguish collisions on hydrogen from those on carbon, and so identify the processes we wanted to study (figure 3).

The lifetimes of most of these particles are of the order of 10^{-10} s, and consequently their path length is typically some centimetres. The several dozen events obtained gave the first quantitative measure of the production probabilities and angular distributions for negative pion on proton reactions, giving a positive kaon and a Σ^- , and a neutral kaon and a Λ . In retrospect, the most interesting result was a precocious glimpse of parity violation, soon to be at the centre of the particle physics stage.

The development of bubble chambers went on apace. Within a year the 10 inch (25 cm) hydrogen chamber of Alvarez was in operation at the Bevatron, which was then, with 5 GeV protons, the world's highest-energy accelerator, and which had permitted the discovery of the antiproton by Chamberlain, Segrè, Wiegand and Ypsilantis in 1955. In 1959 this was superseded by the 72 inch (1.8 m) chamber, the workhorse of the Bevatron for more than a decade, which led to the discovery of several meson and hyperon resonances.

At Brookhaven the Shutt group made important technical advances. In 1958 its 20 inch (50 cm) chamber came into operation, followed in 1962 by the 80 inch (2 m) chamber. This went on to take 11 million photographs, and the results included the important discovery in 1964 of the triply strange Ω^- hyperon, confirming the SU(3) symmetry proposed by Gell-Mann to account for the multiplet structure and mass regularities of the observed strange particles, and which mothered the invention of the quark (figure 6).

At CERN a 30 cm hydrogen chamber came into operation in

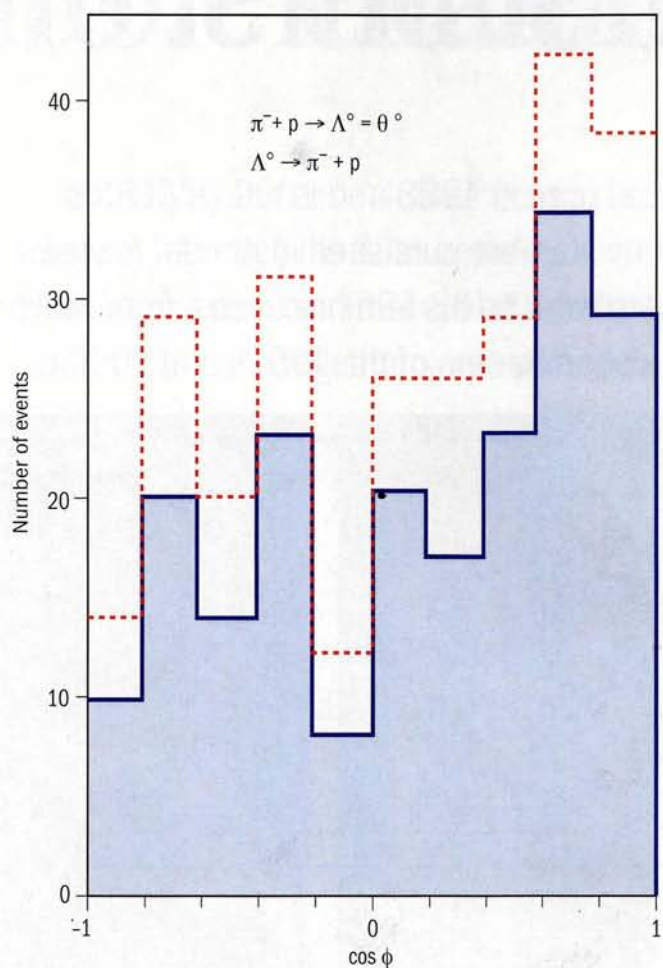


Fig. 5. 1957 – an early example of parity (left–right symmetry) violation. This shows the angular distribution in Λ decay. The shaded area contains events produced in the centre-of-mass angular region 30° – 150° . The asymmetry about 90° shows that parity is violated.

1960, and the 2 m hydrogen chamber in 1964. This became the main CERN tool for the study of resonant and strange particle physics for a decade and kept hundreds of physicists busy and happy. Gargamelle, a very large heavy-liquid (freon) chamber constructed at Ecole Polytechnique in Paris, came to CERN in 1970. It was 2 m in diameter, 4 m long and filled with freon at 20 atm. With a conventional magnet producing a field of almost 2 T, Gargamelle in 1973 was the tool that permitted the discovery of neutral currents.

These bubble chambers took pictures on film at the rate of about one per second. Many millions were produced. These had to be scanned, and the events of interest measured and reconstructed. At first we used the simple, manual techniques for scanning and measuring inherited from our cloud chamber predecessors: simple projection tables, protractors for angles, templates for the measurement of the track curvatures and manual computers.

However, just at that time commercial electronic computers were beginning to appear. We learned to construct digital measuring devices that would automatically punch the track co-ordinates onto cards, and to write increasingly sophisticated programs that utilized



Fig. 6. 1964 – the bubble chamber classic, the production and decay of the Ω^- hyperon in Brookhaven's 2 m bubble chamber. This remarkable event permitted reconstruction of all particle momenta and the determination of the mass of the Ω^- .

the rapidly evolving power of computers to reconstruct interesting physical quantities. This was an essential element in the power that the technique developed. It was one of the early challenges to the evolving computer industry, and the bubble chamber community was able to contribute to the advancement of this technology.

At Nevis, in 1956, within a few months of the first chamber, we had our first chamber with a magnetic field. It was a propane chamber, 12 inches (30 cm) in diameter. The volume had increased eight-fold and the magnetic field was 1.3 T. One of the technical innovations was the introduction of a third camera, so that the field of view was photographed from three angles rather than two. This was essential to the automatic measurement and reconstruction of tracks parallel to the plane of two of the cameras.

In the first exposure we were able to discover the Σ^0 hyperon (figure 4) and measure its mass. Together with the previously known positively and negatively charged Σ s, the three formed an isotopic triplet, the first experimental evidence supporting the flavour SU(3) symmetry, later dramatically confirmed by the Ω^- .

The same magnet as well as optics also served our first hydrogen chamber, with dimensions similar to the propane one. This began

operation at the Cosmotron in 1957. The expansion of the liquid was accomplished with the help of stainless steel bellows, with the associated risk of rupture after many cycles of operation. This would have been an interesting accident involving substantial quantities of hydrogen. Nevertheless, I don't remember ever, at the time, trying to understand the likely consequences.

Soon after, Ralph Shutt at Brookhaven demonstrated that equally effective, but safer, expansion could be achieved with a piston sealed with teflon piston rings, and this was the method generally adopted afterwards. The 12 inch hydrogen chamber was used at the Cosmotron to continue the study of strange particle production, their decays and other properties. One of the first results was the demonstration of parity non-conservation in Λ decay, now with about 10 times as many statistics as with the premature experiment of 1956 (figure 5).

This combined the results obtained in the 12 inch propane and hydrogen chambers with those obtained in a somewhat smaller propane chamber by my mentor and inventor of the bubble chamber, Don Glaser. Similar results were also obtained by the Berkeley pioneers in the hydrogen bubble chamber development at the Bevatron.

This experiment was followed by a determination of the spins of the Λ and Σ hyperons. It was natural to assume these to be 1/2, the same as those of the proton and neutron, in line with SU(3) symmetry, but this was not known experimentally.

One of the main interests of the bubble chamber community in the early 1960s was the discovery and study of meson and baryon resonances, and the determination of their properties and relationships to each other.

Resonances are excited states of hadrons that decay rapidly through the strong interaction, and therefore have poorly defined total energy or mass. The resonance "widths", or energy spread, are typically of the order of 100 MeV, corresponding to lifetimes of the order of 10^{-23} s.

Resonating properties

At the time, these resonances had the same right to be considered "elementary" as the stable hadrons. Now we understand all hadrons, stable or resonances, as bound states of quarks, and none is "elementary". The first meson resonance to be seen was the ρ , which decays into two pions, with a mass of about 750 MeV and a width of 150 MeV. It was discovered at the Cosmotron in 1962 by Erwin Walker *et al* in the 14 inch hydrogen bubble chamber of Adair-Leipuner, using beams of 1.89 GeV pions.

The first hyperon resonance was seen in Berkeley, which then had a 15 inch (38 cm) hydrogen chamber in operation at the Bevatron. Berkeley had also pioneered in the electrostatic separation of particle species, making use of the difference in velocity of particles previously selected to have the same momentum.

Using a negative kaon beam to produce $\Lambda\pi\pi$, the Berkeley group found a resonance in the $\Lambda\pi$ system with mass 1.38 GeV and width 37 MeV. The data favoured the assignment of spin 3/2. Dozens of these resonances were found in rapid succession. This knowledge contributed to our understanding of the strong interaction, which crystallized in 1973 in the form of Quantum Chromodynamics.

At Nevis, in the meantime, we constructed two more chambers, again one using propane and one hydrogen. They were 30 inches (75 cm) in diameter, substantially larger than their

predecessors, but when they came into use, late in 1961, there were already larger chambers in operation. Some 12 million pictures were taken in the 30 inch hydrogen chamber.

In tune with the times, we did some work on the production and decay properties of resonances. In one set of measurements, antiprotons of a separated beam were brought to rest in the hydrogen chamber. The antiprotons combine with protons and annihilate, with many different possible final states, of different numbers of pions and kaons, and one could try to exploit these to gain some insights. One rather particular use we made of this exposure was the first determination of the widths of the ω and ϕ resonances. These were among the more interesting meson resonances that had been observed, and distinguished by the fact that their widths, or equivalently their inverse lifetimes, were too small to be measurable in the usual experiment.

In the case of the ω we were able to select a few proton-antiproton annihilations giving $\omega K^+ K^-$. Given the masses of the particles involved, the kaons are emitted with such small kinetic energy that they typically come to rest in the chamber. This made it possible to determine their energies very precisely from their ranges, and, by energy conservation, the mass of the accompanying ω . A similar procedure was used for the ϕ .

Searching for resonances at random was not my style, and I never looked for, nor found, a new one. I preferred to focus on something specific. In one experiment, negative kaons were stopped in the

chamber in order to study the relatively rare leptonic decays of Σ hyperons. In the same kaon exposure we could measure the relative parity of the Σ^0 and Λ hyperons.

Of these 30 inch chamber experiments, this was probably the one we valued most highly. This was also the thesis of a doctoral student who, in the meantime, had become my wife, after the first one had decided to throw in the towel in 1961.

End of an era

This was pretty much the end of my bubble chamber adventure. Since my first steps in physics in 1947, particle physics had advanced and changed very much. Cosmic rays had been entirely replaced by accelerators, experiments took more time, and were carried out by larger groups, more often 10 people than one or two. Quite a bit had been learned. Four elementary particles had swollen to dozens, the weak interaction had witnessed a wave of clarification in the wake of the discovery of parity violation, and particle detectors had advanced, with the advent of the scintillation counter and the bubble chamber.

I took great pleasure not only in contributing to our understanding of the physics, but also in the design and mechanical construction of the detectors: counters, liquid hydrogen targets, bubble chambers, even the electronics, where I did not shine particularly. □

• This article, fully annotated with references, is available at "http://www.cerncourier.com/main/article/41/4/18".



Group3 Technology Ltd.
 P.O. Box 71-111, Rosebank, Auckland,
 New Zealand. Fax +64 9 828 3357
 group3tech@compuserve.com
 www.group3technology.com

Magnetic Field Measurement

Hall Effect Digital Teslometer

- Outstanding accuracy
0.01% including probe
- High resolution - 10^{-7} T
- for high precision measurements



Analog Hall Probe

- better than 0.05% accuracy
over 10-50°C, 0 to 10 kHz
- ideal sensor for closed loop
control of magnetic field



Accelerator Control Systems



Group3 Control
 The best off-the-shelf solution
 for accelerator control

- fibre optics
- 16 bit analogs
- scan to 32,000 channels/sec
- small size
- robust and fault tolerant
- designed for accelerators



Multiplexed BPMs
 Log-ratio BPMs
 Digital Analog frontends
 Variable-frequency BPMs



U.S.A./Canada:
 GMW Associates
 sales@gmw.com

Japan:
 Repic Corporation
 sales@repic.co.jp

*The Faraday Cup sponsors...
 Serving the World of Accelerators*

Workshop looks through the lattice

Faced with the difficulty of doing exact calculations, theorists are turning to approximation techniques to understand and predict what happens at the quark level.

It follows from the underlying principles of quantum mechanics that the investigation of the structure of matter at progressively smaller scales demands ever-increasing effort and ingenuity in constructing new accelerators.

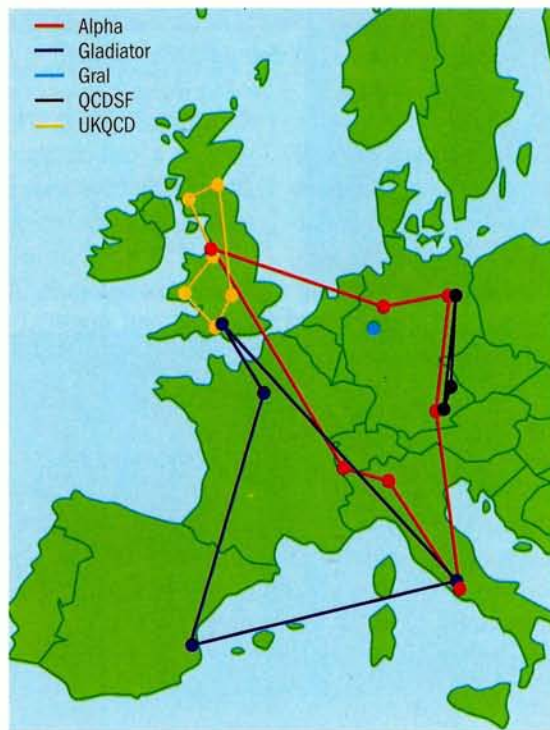
As these updated machines come into operation, it becomes more and more important to ascertain whether any deviation from theoretical predictions is the result of new physics or is due to extra (non-perturbative) effects within our current understanding – the Standard Model. Confronted with the difficulties of doing precise calculations, the lattice approach to quantum field theory attempts to provide a decisive test by simulating the continuum of nature with a discrete lattice of space-time points.

While this is necessarily an approximation, it is not as approximate as perturbation theory, which employs only selected terms from a series field theory expansion. Moreover, the lattice approximation can often be removed at the end in a controlled manner. However, despite its space-time economy, the lattice approach still needs the power of the world's largest supercomputers to perform all of the calculations that are required to solve the complicated equations describing elementary particle interactions.

Berlin workshop

A recent workshop on High Performance Computing in Lattice Field Theory held at DESY Zeuthen, near Berlin, looked at the future of high-performance computing within the European lattice community. The workshop was organized by DESY and the John von Neumann Institute for Computing (NIC).

NIC is a joint enterprise between DESY and the Jülich research



Lattice of lattices – European groups involved in lattice gauge theory calculations.

centre. Its elementary particle research group moved to Zeuthen on 1 October 2000 and will boost the already existing lattice gauge theory effort in Zeuthen. Although the lattice physics community in Europe is split into several groups, this arrangement fortunately does not prevent subsets of these groups working together on particular problems.

Physics potential

The workshop originated from a recommendation by working panel set up by the European Committee for Future Accelerators (ECFA) to examine the needs of high-performance computing for lattice quantum chromodynamics (QCD, the field theory of quarks and gluons). It found that the physics potential of lattice field theory is within the reach of multiTeraflop machines, and the panel recommended that such machines should be developed.

Another suggestion was to aim to coordinate European activities whenever possible.

Organized locally at Zeuthen by K Jansen (chair), F Jegerlehner, G Schierholz, H Simma and R Sommer, the workshop provided ample time to discuss this report. All members of the panel were present. The ECFA panel's chairman, C Sachrajda of Southampton, gave an overview of the report, emphasizing again the main results and recommendations. The members of the ECFA panel then presented updated reports on the topics discussed in the ECFA report. These presentations laid the ground for discussions (led by K Jansen and C Sachrajda) that were lively and to some extent controversial. However, the emerging sentiment was a broad overall agreement with the ECFA panel's conclusions. ▷

Interpreting all of the data that results from experiments is an increasing challenge for the physics community, but lattice methods can make this process considerably easier. During the presentations made by major European lattice groups at the workshop, it became apparent that the lattice community is meeting the challenge head-on.

On behalf of the UK QCD group, R Kenway of Edinburgh dealt with a variety of aspects of

QCD, which ranged from the particle spectrum to decay form factors.

Similar questions were addressed by G Schierholz of the QCDSF (QCD structure functions) group, located mainly in Zeuthen, who added a touch of colour by looking at structure functions on the lattice. R Sommer of the ALPHA collaboration, also based at Zeuthen, concentrated on the variation ("running") of the quark-gluon coupling strength α_s (hence the collaboration's name) and quark masses with the energy scale.

The chosen topic of the APE group (named after its computer) was weak decay amplitude, presented by F Rapuano of INFN/Rome. This difficult problem has gained fresh impetus following recent proposals and developments (*CERN Courier* July/August 2000 p23). T Lippert of the GRAL (going realistic and light) collaboration from the University of Wuppertal described the group's attempts to explore the limit of small quark masses.

The activities of these collaborations are to a large extent coordinated by the recently launched European Network on Hadron Phenomenology from Lattice QCD.

New states of matter

Another interesting subject was explored by the EU Network for Finite Temperature Phase Transitions in Particle Physics, which is now tackling questions concerning new states of matter. These calculations are key to interpreting and guiding present and future experiments at Brookhaven's RHIC heavy ion collider and at CERN. F Karsch and B Petersson, both from Bielefeld, presented the prospects.

The various presentations had one thing in common – all of the groups are starting to work with fully dynamical quarks and are thus going beyond the popular "quenched" approximation, which neglects internal mechanisms involving quarks.

Although this approximation works well in general, there are small differences between experiment and theory. To clarify whether these differences are signs of new physics or simply an artefact of the quenched approximation, lattice physicists now have to find additional computer power to simulate dynamical quarks – a quantum



Workshop participants gather at DESY Zeuthen, near Berlin.

jump for the lattice community, as dynamical quarks are at least an order of magnitude more complicated.

This means that computers with multi-Teraflop capacity will be required. All groups expressed their need for such computer resources in the coming years – only then can the European lattice community remain competitive with groups in Japan and the US.

Two projects that aim to realize this ambitious goal were presented at

the workshop: the apeNEXT project (presented by L Tripiccion, Pisa), which is a joint collaboration of INFN in Italy with DESY and NIC in Germany and the University of Paris-sud in France; and the US-based QCDOC (QCD on a chip) project.

Ambitious computer projects

QCDOC and apeNEXT rely to a significant extent on custom-designed chips and networks, with QCDOC using a link to industry (IBM) to build machines with a performance of about 10 Tflop/s. Each of these projects is based on massively parallel architectures involving thousands of processors linked via a fast network. Both are well under way and there is strong optimism that 10 Tflop machines will be built by 2003. Apart from these big machines, the capabilities of lattice gauge theory machines based on PC clusters were discussed by K Schilling of Wuppertal and Z Fodor of Eotvos University, Budapest.

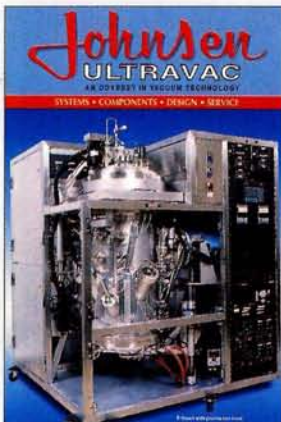
The calculations done using lattice techniques not only provide results that are interesting from a phenomenological point of view, but are also of great importance in the development of our understanding of quantum field theories in general. This aspect of lattice field theory was covered by a discussion on lattice chiral symmetry involving L Lellouch of Marseille, T Blum of Brookhaven and F Niedermayer of Bern. The structure of the QCD vacuum was covered by A DiGiacomo of Pisa.

There is great excitement in the lattice community that the coming years, with the advent of the next generation of massively parallel systems, will certainly bring new and fruitful results.

However, the proposed machines in the multiTeraflop range can only be an interim step. They will not be sufficient for generating higher-precision data for many observables. It is therefore not difficult to predict a future workshop in which lattice physicists will call for the subsequent generation of machines to reach the 100 Tflop range – a truly ambitious enterprise.

Karl Jansen, NIC/DESY Zeuthen.

FREE LITERATURE



Johnson Ultravac

Johnson Ultravac specializes in the design and manufacture of ultrahigh vacuum products including 6-axis instruments with heating/cooling stages, 1500 K to 10 K range, UHV chambers, ultralong translators, surface analysis systems, multi-technique deposition systems and a complete range of beamline components for synchrotrons such as photon/safety shutters, collimators and mask assemblies.

3470 Mainway, Burlington
Ontario, Canada L7M 1A8
Toll free: 800 268 4980
Tel. 905 335 7022
Fax 905 335 3506
Email juvinfo@ultrahivac.com
Web www.ultrahivac.com



Janis Research Co Inc

Top Loading Liquid He-3 System

The system has optical access to the sample and includes a sample probe and "vac-lock" with a gate valve, plus an external gas handling system. Typical base temperature is 400 mK with a 24 hour holding time. Contact Janis for more details today!

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
Email janis@janis.com
Web <http://www.janis.com>



Kimball Physics Inc

UHV electron and ion optics

New UHV electron and ion sources/systems and UHV components. Products include: systems with beam energies from 5 eV to 100 keV (options include focusing or flood beams, energy sweeping, rastering, fast pulsing, and emission current feedback); multi-CF fittings, vacuum chambers, Faraday cups, and eV parts. Standard and custom systems are available for a wide variety of applications. Contact technical sales for more information.

Kimball Physics Inc
311 Kimball Hill Road, Wilton, NH 03086, USA
Tel. +1 603 878 1616
Fax +1 603 878 3700
Email info@kimphys.com
Web www.kimphys.com



Atlas Technologies

Aluminum Ultra High Vacuum Components... Metal Sealed

Atlas UHV sealing technology allows you to take advantage of the many physical properties of aluminum in your vacuum system. The Atlas flange is an aluminum flange body with a 6-8mm stainless steel sealing face for robust and reliable sealing of aluminum systems using CF knife-edge seals, metal C-seals, CF chain clamp seals and crushable VAT seals.

Proven at major accelerators and synchrotron facilities worldwide, Atlas flanges are available in standard US-CF, Euro-CF, DN-CF, ISO and KF, as well as CF chain clamp and rectangular flange configurations. Atlas also fabricates custom aluminum bending magnet chambers, accelerator beam tubes and aluminum UHV chambers.

Atlas Technologies
305-B Glen Cove Road, Port Townsend, WA 98368 USA
Tel. +1 360 385 3123
Fax +1 360 379 5220
Email atlas@olympus.net
Web www.atlasbimetal.com

Get Beryllium Products as Good as Your Imagination

Need custom beryllium beam pipes for high energy particle physics accelerators? Come to us. You'll be in good company—CERN, Brookhaven, SLAC, Fermi, DESY, INFN, Cornell and KEK—have all honored us with their business.



Be Drift Chamber for BaBar Detector—Stanford Linear Accelerator.

May we craft a fine application for you? Give us a call. We will match your imagination with precision.

BRUSHWELLMAN
ELECTROFUSION PRODUCTS
Beryllium products to match your imagination

You can depend on us for: **Experience you can trust.** In each of the last two years, we made more Be beam pipes than all our competitors, put together, ever made.

Unparalleled craftsmanship. You'll get excellence whether you choose traditional or alternative methods: atmosphere brazing, electron beam welding, vacuum brazing, or seamless tube joining.

Long-lasting reliability. You've got one shot to do it right. Select the proven source. Invest in Be products designed to last for years—or decades.



Make an impact with Journal of Physics G: Nuclear and Particle Physics

Our latest impact factor is **1.62** – a leap of almost 50%. That's one reason why more and more physicists are coming to us when looking to publish their work.

Others include:

- An electronic version that received more than 100,000 hits last year
- Easy on-line submissions - we accept either your files or a LANL e-print number
- Our charity status – IoP is a learned, not-for-profit society supporting physics worldwide
- Publication online in advance of the printed issue means your work is published fast
- Free publication – no page charges

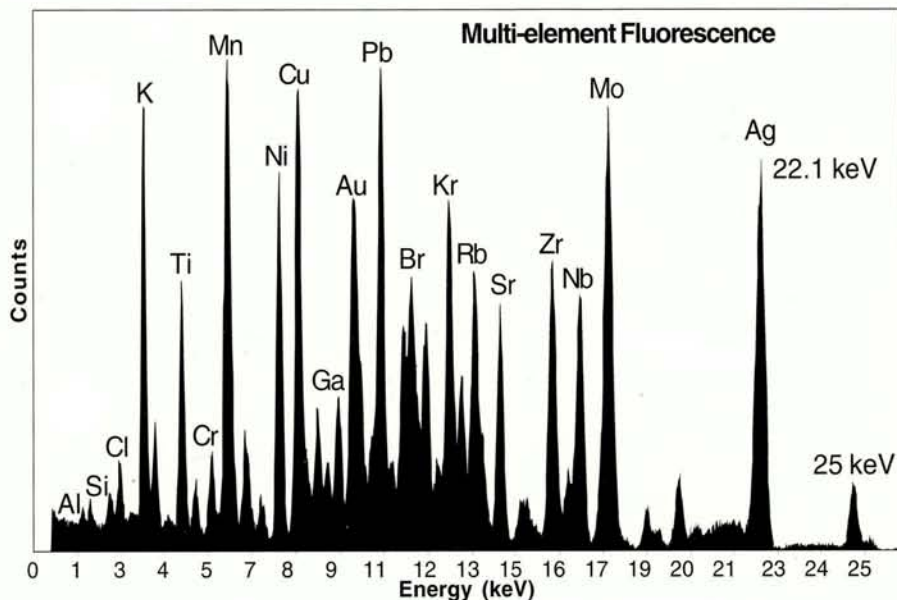
To make a submission or get further information contact us at: jphysg@iop.org or visit our website.

www.iop.org/Journals/jg

Institute of Physics PUBLISHING

X-Ray Detector

XR-100CR at 186 FWHM Resolution



No Liquid Nitrogen!!!

Solid State Design

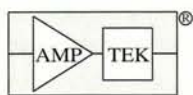
APPLICATIONS

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

Easy - simple to operate and portable

Performance - approaching that of Si(Li) detectors

Affordable - visit www.amptek.com



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



XR100CR X-Ray Detector
with Power Supply &
Amplifier



XR100CR fitted for vacuum
applications

Guest office head leaves DESY

Visitors to the DESY laboratory in Hamburg during the past 20 years have been able to rely on the help of Josephine Zilberkweit, DESY's "Mrs Guest Office", who has now left the laboratory. She managed the on-site guesthouses, helped visitors and their families to obtain visas and residence permits, arranged housing and schools for their children and ensured that medical insurance was available.

From June 1979, under her leadership, the Guest/International Office began to develop in order to serve DESY's growing visiting community. During the era of the PETRA collider, groups from the Soviet Union and China started to arrive at DESY for the first time to work alongside scientists from Europe, the US and later the German Democratic Republic and Poland.

Subsequently, the advent of the HERA collider and the expansion of HASYLAB put new demands on the Guest Office, until by 1995 it had been restructured to act as the administrative centre for all foreign guests and was renamed the International Office.

However, helping foreigners was more than a matter of office work for Zilberkweit. With the support of the Association of the Friends and Sponsors of DESY, she organized all kinds of social events – barbecues, Christmas parties, Japanese children's days, Chinese spring festivals, carnival and Thanksgiving evenings, cricket games, visits to exhibitions, gym classes and a children's group.

"DESY has always considered it important that everything possible should be done to help foreign guests to feel part of the lab," said Zilberkweit. "Dealing with people from so many different cultures and traditions is always a challenge, but getting involved with the human side of physics has been immensely rewarding. I was lucky to be able to make friends with people from all over the world, and to share



Josephine Zilberkweit – helping visitors to find their feet in Germany.

with them many important events in their lives. I even acted as a witness at two weddings!"

Despite leaving DESY, her commitment to helping foreigners continues. She is especially concerned about women accompanying their husbands. "Most of these women are highly qualified," she explained. "They have no possibility of pursuing their professions in Germany and creating a life for themselves, because they are unable to obtain work permits."

Zilberkweit is a member of a working group that includes representatives of the Hermann von Helmholtz Association of German Research Centres. "This group is examining the administrative problems encountered by foreign scientists coming to Germany. We hope to convince the authorities to make changes to the existing regulations for the benefit of all," said Zilberkweit.

With more than 3400 guest scientists from 35 nations visiting DESY each year, the role of the International Office continues to grow. Its future owes much to Zilberkweit's enthusiasm and commitment during the past 20 years.

MEETINGS

The workshop on Electron-Positron Physics at Intermediate Energies will take place on 30 April – 2 May at the Stanford Linear Accelerator Center (SLAC), Stanford, California. It is sponsored by the Budker Institute of Nuclear Physics, Instituto Nazionale di Fisica Nucleare, SLAC and the US Department of Energy. For further information see "<http://www-project.slac.stanford.edu/pep-n/>".

The purpose of the workshop is to explore the physics potential of an asymmetric high-luminosity electron-positron collider of energy between that of the phi and J/psi regions. A collaboration is forming to explore an addition to the PEP-II storage ring complex at SLAC to cover this kinematic region.

More information is available at "<http://www.slac.stanford.edu/~young/EPAC/Meeting/200011/index.html>". This is the second workshop in a series, following the meeting held at the Budker Institute of Nuclear Physics, Novosibirsk, Russia, on 1–5 March 1999. See "<http://www.inp.nsk.su/events/conf/phi1999/index.html>".

Neutrino 2002, the XXth International Conference on Neutrino Physics and Astrophysics, will be held in Munich, Germany, on 25–30 May 2002. The conference is organized jointly by the Max Planck Institut für Physik and the Technische Universität München. The programme will cover new results in the field of neutrino physics and related topics in astrophysics and cosmology. Among the subjects will be solar and atmospheric neutrinos, short- and long-baseline neutrino oscillation experiments, neutrino factories, reactor/accelerator-based experiments, double-beta decay, neutrino mass direct searches, neutrino telescopes, neutrinos in astrophysics and cosmology, dark matter searches and ultra-high energy neutrinos. For further information see "<http://neutrino2002.ph.tum.de/>".

Avakian celebrates his 70th birthday

On 28 March Robert Avakian, Academician of the National Academy of Sciences of Armenia and president of the Armenian Physical Society, marked his 70th birthday. He is well known for his experimental work in the fields of parity

violation in beta decay (ITEP, Russia), the production of polarized gamma quanta beams (Yerevan, Kharkov, Serpukhov), positron radiation (SLAC), electron-photon interactions (CERN) and nucleon spin structure (DESY).



Robert Avakian, Academician and president of the Armenian Physical Society, celebrated his 70th birthday on 28 March.



Striking architecture at Cambridge University's new Centre for Mathematical Sciences. The Cambridge mathematics department has a proud tradition in theoretical physics, encompassing the work of Newton, Dirac and Hawking. Today some 100 staff and research students work in particle physics and cosmology. Faculty members have been raising funds for new buildings on a site that they will share with the Isaac Newton Institute for Mathematical Sciences and a major new science library. The theoretical physics building is named after Måril and Hans Rausing, Swedish-born Rausing was the managing director (and later chairman) of the Tetra Laval Group for almost 37 years. The library is named after Betty and Gordon Moore. Moore, a co-founder of Intel, invented Moore's law, which predicted the growth of computing power. This picture shows the development of the half-completed centre. Construction of the remaining buildings is just starting. In two years the faculty and the library will have nearly 20 000 m² of space. For more information see "<http://www.cms.cam.ac.uk>".

Sandro Vitale 1932–2001

Sandro Vitale, professor of physics and director of medical physics at Genoa, died in Genoa on 25 January after battling against cancer for several months.

Vitale was born in Genoa on 7 November 1932. His family moved to Acqui Terme, 100 km away, to escape the bombardments of the Second World War. On his return to Genoa, he went to the local university to study physics. He graduated in 1956 under the supervision of Ettore Pancini, who had moved from the Rome group founded by Enrico Fermi.

Immediately after his graduation, Vitale became a physics assistant at Genoa, where he contributed to the birth of a local branch of the Italian Institute for Nuclear Physics, led by Pancini. He worked on experiments on parity violation in beta decay and on nuclear photo-reactions, using the then-new technique of silicon diodes. In 1963 he moved to Naples, and in 1964 to Stanford to work on positron beams and pion production with FF Liu.

From 1966, with Giuseppe di Giugno, he led a group that proposed to study the production of proton-antiproton pairs at ADONE,



US ambassador to Switzerland **Richard Frederick** (left) at CERN on 28 February with **Homer Neal** (centre, University of Michigan) and CERN director-general **Luciano Maiani**



Emmanuel Paschos (left) of Dortmund is welcomed as a corresponding member of the Academy of Athens by Academy president **N Konomes**. Paschos is well known for his work on quark-parton models with James Bjorken, and on weak interaction mechanisms, especially for neutral currents.

Frascati's 1.5 GeV electron-positron storage ring. The experiment measured the cross-section of the reaction near the threshold at 2.1 GeV for the first time. The experiments at ADONE also observed the prolific production of hadrons in electron-positron collisions.

In 1972 a second-generation ADONE experiment involved the collaboration of Naples (led by Vitale), Frascati, Pisa and the Istituto Superiore di Sanita. In November 1974, Burton Richter's group at SLAC, Stanford, and Samuel C C Ting's group at Brookhaven dramatically discovered the J/ψ at a mass of 3.1 GeV, only some 0.1 GeV above the operating energy of ADONE. The discovery earned Richter and Ting the 1976 Nobel prize.

Vitale and his collaborators, together with other teams at ADONE and the machine group, decided to push the energy higher and identified the J/ψ less than 24 hours after the official announcement by the US laboratories. Vitale sometimes recalled this episode, ironically mentioning how they were just a few hours away from the Nobel prize.

In 1978 he left Naples and ADONE to become a professor at Genoa. There he worked mainly on electronics for high-energy experiments, such as the multiprocessor for fast acquisition and data pattern recognition, and on the WA71 experiment at CERN.



Sandro Vitale 1932–2001.

A pioneering and non-conformist spirit drove Vitale's research. After his remarkable contributions to accelerators he changed his field of research. From the 1960s, discussing it first with his friend Gaetano Gallinaro in Genoa and then with Antonio Barone in Naples, he became fascinated by the idea of using low-temperature devices as particle detectors.

In 1985, after demonstrations by a US collaboration, he began a new experiment to

measure the electron antineutrino mass via the beta decay of rhenium-187 with cryogenic detectors at 0.1 K. The experiment, in which we collaborated, gave a big boost to the development of the new detectors (now known as micro-calorimeters).

Among the results that were discovered using this technique was a new effect – beta environmental fine structure – which was due to the influence of the crystalline environment on the emission rate of beta particles. The experiment also put upper limits on the electron neutrino mass and on the existence of heavy neutrinos. In 1993 Vitale joined the BOREXINO solar neutrino collaboration, for which he developed the electronics.

His career as an educator was highly productive. From 1958 he taught undergraduate physics in Genoa and Naples. In 1984 he introduced astrophysics into the physics course, and in 1995 founded and directed the School of Medical Physics. From 1978 to 1980 he was director of the physics department.

Vitale had two main passions – physics and sailing. When he was not in the laboratory he could be found cruising the Tyrrhenian Sea with his family, especially his daughter, Manuela, and friends.

Massimiliano Galeazzi, Wisconsin-Madison, and Flavio Gatti, Genoa.

Paul Falk-Vairant 1921–2001

Paul Falk-Vairant died on 9 March, just one month before his 80th birthday. He had recently lost his wife, to whom he was very close, and had suffered for many years from an illness about which he rarely spoke.

After studies at the Swiss Federal Polytechnic, Zurich, he moved to France to undertake doctoral studies at Saclay, at the time a leading European centre in nuclear physics. He swiftly became head of a group bringing together physicists from Orsay and Saclay. A rapid series of experiments using electronics techniques followed. At the same time, he set up a bubble chamber group at the University of Paris that later became the Laboratory of High Energy and Nuclear Physics (LPNHE).

With his Orsay-Saclay group, later joined by Pisa, Falk-Vairant led several experiments, culminating in a series of measurements of pion-proton charge exchange interactions at



Paul Falk-Vairant 1921–2001.

the CERN PS. He was extremely proud of having set up the first experiment at CERN that was not managed from within the organization. However, it was within the European organization that he continued his career, becoming first the director of the Physics I Department and then research director, in which capacity (from 1976 to 1978) he had to guide the experimental programme for the new SPS.

After his period at CERN he returned to France, where he remained as assistant scientific director of the IN2P3 Institute until he retired. It was there that he supervised the ever-increasing French contributions to the LEP experiments. Even after his retirement he made himself useful by organizing the refurbishment of the LPNHE premises.

Falk-Vairant was full of energy. When he was not teaching his grandchildren to sail he would be visiting modern art exhibitions, cooking or waxing enthusiastic over a horse of the Tang dynasty. He was happy to have lived through the golden age of particle physics.

He did not consider himself to be a great physicist, but he had great influence as an accomplished manager whose decisions were always guided by good sense and honesty.

He was not ambitious for recognition (he did not think he deserved the Legion of Honour), but he has left behind him in France a generation of physicists for whom he will always epitomize rigour and efficiency.

François Vannucci, LPNHE, Universités de Paris VI et VII.

Douglas R O Morrison 1929–2001

A distinguished and conscientious physicist and a popular figure at CERN, Douglas R O Morrison died on 25 February 2001. He was born in 1929 in Glasgow where, in 1944, aged just 15, he obtained the Scottish "Certificate of Fitness", which qualified him for university entry. As yet too young to take full advantage of this achievement, Morrison took a job in the research department of a dye and colour factory. Three years later he began studying physics at Glasgow.

Morrison obtained a BSc with honours in 1951, and started research under Philip Dee using a cloud chamber at the Glasgow synchrotron. He was exempted from his national military service because of his industrial research on rockets and explosives, and he formally received his PhD in 1957.

CERN had just been created when Morrison obtained a CERN fellowship in 1956. From this date until his death – a period of some 45 years – he dedicated heart and soul to the laboratory. He was one of the first to initiate and lead large international collaborations that spanned political and ideological boundaries, mainly in bubble chamber experiments but also at the ISR.

Although he was a natural recruit for a number of CERN committees, Morrison had a dread of bureaucracy and was never tempted by managerial tasks. His domain was the battlefield of science: researching, debating, attending conferences and publishing his findings. He put his name to more than 300 publications in many fields.

Noteworthy among his many activities and achievements are his founding of the journal *Nuclear Physics B*, to which he contributed over many years, and the HERA data compilations; and he must be considered the father of the Multiparticle Dynamics Conferences of which he was secretary from 1973 to 1996.

Morrison's long career at CERN was never interrupted. Even during his sabbaticals in Vienna (1963), Brookhaven (1967) and Hawaii (1988), he continued to give guidance to his collaborations.

Beginning in 1954, Morrison's field of research encompassed the entire range of hadronic physics, from the discovery and study of resonances, peripheral reaction mechanisms, diffraction dissociation and



Douglas R O Morrison 1929–2001.

multiparticle production, to the solution of many of the questions of their translation into quantum chromodynamical terms.

After a first series of experiments with pions, protons and stopping antiprotons in hydrogen, Morrison made it his principle to work at the high-energy frontier, always using hadron beams at the highest available energies and thereby breaking new ground.

Morrison's work led to the first observation of the anti- Λ isobar resonance in 1962 and the anti- Ξ^- in 1961, the discovery of the L resonance at 1800 MeV in 1966 and the study of the Ω^- in K-p interactions in 1973. Morrison demonstrated that, with rising energy, most reactions become peripheral, leading to the rich field of t-channel exchanges, Regge poles and, in particular, diffraction dissociation.

The Gribov-Morrison rule $\Delta P = (-1)^{AJ}$ would soon become a beacon in this diffuse domain. The detailed partial wave analysis of particle systems would finally solve a number of puzzles in many reactions, in particular for the diffractively produced states in the A1 and Q regions.

With increasing energy, the mechanisms of multiparticle production became a dominant theme of Morrison's research, with many innovative analysis techniques (e.g. Van Hove

plots) and detailed comparisons with theory (e.g. first studies of the Hanbury Brown-Twiss effect in pion production).

With the arrival of a high-energy neutrino beam at the CERN SPS in 1977, Morrison and his group joined forces with the team that had discovered neutral currents at CERN. A rich programme with the Big European Bubble Chamber (BEBC), which was filled with neon or hydrogen in a series of exposures to wide- and narrow-band neutrino beams (as well as a number of beam-dump experiments), began a new chapter in quark physics.

The results obtained with BEBC, although they gave lower event statistics, were complementary to the counter experiments and quite competitive. Total neutrino cross-sections as a function of energy, neutral currents, nuclear structure functions, quark fragmentation functions and charm production were the rich harvest of this research, which provided confirmation of the Standard Model well before its apotheosis at LEP. Some pictures of these neutrino events, in particular those showing charm production, have become textbook classics.

Driven to try to detect charmed particles by observing their tracks in bubble chambers – in spite of their short lifetimes – Morrison pursued the application of holography vigorously, both at CERN and at the 15 ft bubble chamber at Fermilab. Some beautiful events could be observed in hadronic interactions at CERN. Seeing them in neutrino interactions, however, was too formidable a challenge.

Morrison maintained a keen interest in scientific questions well beyond his immediate field of research. No matter what the problem, he would critically review the evidence available and draw incisive conclusions. As more time became available to him later in his career, he drafted notes on these investigations, distributed them among his colleagues and fostered debate. Many of these investigations were described at conferences and special events, and published in scientific and popular magazines.

The mass of the neutrino and, as a consequence, neutrino oscillations was a passion for Morrison. Evidence of a 17 keV neutrino claimed by an experiment on tritium decay,

the solar neutrino problem, the solar model in general and the physics of the 1987A supernova all benefited from his attention.

Analysing the claims made by some in the scientific community that they had discovered evidence for cold fusion occupied Morrison's critical faculties over many years. Although he was initially very much impressed by this phenomenon, he quickly spotted many weak points and contradictions in the arguments of his colleagues and became a vocal and dedicated opponent of such claims.

His strong feelings on the subject led Morrison to testify in a court case that had been launched by a group of physicists against the Italian newspaper *La Repubblica*, which had been critical of the idea of cold fusion. The newspaper won the case. Taking cold fusion as a key example, Morrison expanded his criticism of "pathological science" in a series of articles and presentations.

When bovine spongiform encephalopathy (BSE) appeared in the UK, Morrison plunged into the study of this disease and, on discussing it with experts, became convinced that it was caused by wrongly folded prions. He wrote prolifically on the subject, organized a conference and, finally, analysed the epidemiological aspects of the likely transmission of the disease to humans.

Other recurring topics of study were the extinction of the dinosaurs and a survey of treatments and cure rates of prostate cancer. Having been a member of the Pugwash movement for many years, he also discussed questions of disarmament, energy supply and climatic changes.

Douglas Morrison will be remembered as an excellent and conscientious scientist, and as an enthusiast who shared his extensive knowledge and critical prowess with great pleasure and generosity. His social gatherings – like "tea" in the office at 10 p.m., wine-tasting at his house and regular excursions – contributed greatly to the dedication of his collaborators and to the amicable atmosphere in his many collaborations.

His loss is a hard blow for his family and for his numerous friends and colleagues all over the world.

Peter Schmid and Gottfried Kellner, CERN.

Explore

Absorb

Link

Digest

Browse

Search

Bookmark

cerncourier.com



Multi-pin Connectors

NEW CERAMIC SEALING TECHNOLOGY ALLOWS US TO CREATE CUSTOM DESIGNS THAT MEET YOUR SPECIFIC TECHNICAL REQUIREMENTS.



- LOW PROFILE CONFIGURATIONS
- BASEPLATE FEEDTHROUGHS
- HIGH VOLTAGE BUSHINGS
- D TYPE CONNECTORS
- ULTRA HIGH VACUUM
- EXTREME HEAT
- SEVERE COLD
- ISOLATORS
- VIEWPORTS
- THERMO COUPLES
- CRYSTAL SENSORS
- 50 OHM IMPEDENCE
- RF FEEDTHROUGHS
- HIGH DENSITY DESIGNS
- COAXIAL CONNECTORS
- CIRCULAR CONNECTORS



Ceramaseal

A Division of *CeramTec*

New Lebanon, New York
Tel: +1-518-794-7800
Fax: +1-518-794-8080

www.ceramaseal.com



New Journal of Physics

**NOW CITED
BY ISI®**

njp.org

Institute of *Physics*



DEUTSCHE PHYSIKALISCHE GESELLSCHAFT

Deutsche
Börse
Systems



Your Way to Deutsche Börse Systems

No leaflet? No problem!

If you are a physicist who is interested in a job at Deutsche Börse Systems, simply call our toll-free hotline at **00 800-21 01-34 25**. Jörg Tutas, a physicist who once worked at CERN and is now making his career at Deutsche Börse Systems, will answer your questions from May 14 to May 25. You can also send an e-mail to physiker@deutsche-boerse.com until May 31. Discover how short your way from CERN to Systems can be!

The "Neue Börse" in Frankfurt: an excellent environment for your professional future.

Deutsche Börse AG
Human Resources
D-60485 Frankfurt/Main
deutsche-boerse.com

RECRUITMENT

For advertising enquiries, contact *CERN Courier* recruitment/classified, IOP Publishing Ltd, Dirac House, Temple Back, Bristol BS1 6BE, UK.

Tel. +44 (0)117 930 1026. Fax +44 (0)117 930 1178.

Rates per single column centimetre: mono £36, single colour £38, full colour £40. Please contact us for more information on publication dates and deadlines.



GEMATRONIK

GEMATRONIK is a division of the Italian IRI-FINMECCANICA Group. We are developing, producing and maintaining radar systems since 40 years, mainly for meteorological applications. More than 130 systems are installed on airports, at research institutes and in meteorological surveillance networks all over the world.

For the development of our new generation of weather radar transmitters and for the technical support of our operational systems we have an opportunity for a

TRANSMITTER ENGINEER

You are responsible for the design, development, integration and test of

- high-precision, high-power switch mode power supplies for pulse capacitor charging applications
- MOSFET- and IGBT-based modulators for the generation of high power pulses for driving microwave tubes
- peripheral electronics of microwave tubes
- transmitter control electronics

We are seeking an engineer with a master or diploma degree in electronics, power electronics or electrical engineering and with several years design experience. You will be extensively trained on the microwave technology of our transmitters. A working knowledge of German and English language and the willingness for frequent travelling is required.

We expect motivation, reliability and team spirit. We offer an excellent working environment in a young, creative and highly motivated team, flexible working hours and a competitive, adequate salary.

Please send your resume to Human Resources or via email to h.brinkmann@gematronik.com. If you need further information please call Helena Brinkmann at + 49 - 2137/782-0

GEMATRONIK GmbH . Raiffelsenstrasse 10 . D-41470 Neuss
www.gematronik.com

Spallation Neutron Source Project

The Spallation Neutron Source Project (SNS) at Oak Ridge National Laboratory invites applications for various positions in the Accelerator Systems Division. The US Department of Energy's (DOE) Office of Science has funded the design and construction of the SNS, which will provide the world's most powerful pulsed spallation source for neutron scattering research. The SNS is a partnership between six DOE laboratories: Argonne, Brookhaven, Lawrence Berkeley, Thomas Jefferson, Los Alamos and Oak Ridge. The SNS will be based on a high-intensity front end, providing a chopped H⁻ beam, a 1-GeV pulsed normal conducting followed by superconducting RF linac, a 248-m-circumference accumulator ring, a liquid mercury target and a suite of best-in-class scientific instruments. Design and construction is underway and the project is scheduled for completion in 2006.

Staff positions are available for:

Physicists

Senior Ring Team Leader, Senior Linac Team Leader

Operations

Operations Deputy Manager, Operations Coordinator, Chief Operators

Software and Programming

Beam Physics Applications, EPICS Controls System

Mechanical Engineers

Front End, Warm Linac, Cold Linac, Cryogenics, Vacuum, Diagnostics

Electrical Engineers

Low-Level RF, High-Power RF, Power Supply, Pulsed Power, Diagnostics, Controls System

Technicians

Low-Level RF, High-Power RF, Mechanical, Vacuum, Power Supply, Pulsed Power, Ion Source, Diagnostics, Controls System

For more complete descriptions, visit our Web site at: www.sns.gov

Qualified and interested candidates should send a resume, with a list of three references, to: M.J. Fultz, Spallation Neutron Source Project, 701 Scarborough Road, MS-6477, Oak Ridge, TN 37830; e-mail: fultzmj@sns.gov. Please reference the job title when applying. Applications will be accepted until the positions are filled.

ORNL, a multiprogram research facility managed by UT-Battelle, LLC, for the US Department of Energy, is an equal opportunity employer committed to building and maintaining a diverse workforce.



University of Lausanne High Energy Physics Institute

Postdoctoral positions

We participate in fundamental and applied research in experimental particle physics. In the area of **CP violation in B decays**, we are strongly committed to the design and construction of the LHCb experiment at CERN, and newly involved in data-taking and analysis with the BELLE experiment at KEK. Our applied research includes R&D in medical imaging based on **positron emission tomography (PET)**, and the construction of a high resolution PET camera for small animals within the Crystal Clear collaboration at CERN.

Postdocs in Lausanne have teaching duties. They are expected to play important roles in the research projects of the institute and assist Ph.D. students. One of available positions will imply staying at KEK (Japan) a significant fraction of the time. The initial appointments are for one year, renewable with a limit of 5 years. Interested persons are invited to send their application (preferably via e-mail) to:

Prof. A. Bay, director Institut de Physique des Hautes Energies
Aurelio.Bay@iphe.unil.ch CH-1015 Lausanne, Switzerland

More information at the above address or <http://www.iphe.unil.ch/>

The Physics Division

of the

Illinois Institute of Technology

seeks applicants for a

tenure-track position at the Assistant or Associate Professor level in Accelerator Physics.

The position can start as early as August, 2001, and carries a joint appointment with Fermi National Accelerator Laboratory (FNAL). The successful candidate will become a member of IIT's Center for Accelerator and Particle Physics (CAPP) and will be encouraged to interact with the CAPP faculty and to collaborate with staff at FNAL. (Information about CAPP and its activities is available at <http://www.iit.edu/~bcps/hep/iit/ehp.html> on the World-Wide Web.) A competitive salary and startup package is available. A curriculum vitae, a statement of research interests, and at least three letters of recommendation should be sent to:

Prof. Daniel M. Kaplan
Chair, Physics Search Committee
Physics Division
Illinois Institute of Technology
3101 South Dearborn St.
Chicago, IL 60616, USA
email: kaplan@fnal.gov

Preference will be given to complete applications received by June 15, 2001, however, applications will be accepted until the position is filled. Illinois Institute of Technology adheres to Affirmative Action / Equal Employment Opportunity policies and strongly encourages applications from minority group members and women.

Professor in Applied Mathematics

at the

Swiss Federal Institute of Technology Lausanne (EPFL)



ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

The EPFL plans a substantial expansion in the basic sciences, including a significant reinforcement in mathematics, physics, and chemistry, and a major new effort in the life sciences.

As part of this broad program, the Mathematics Department has an opening at the full professor level. Applications for appointments at the Associate and Assistant Professor (tenure-track) levels will also be considered. We seek outstanding individuals in all areas of applied mathematics.

Applications in discrete mathematics and statistics are particularly encouraged. Successful candidates must develop an independent, internationally recognized program of scholarly research and must be willing to teach at both the undergraduate and graduate level. Substantial start-up resources will be provided.



Women candidates are strongly encouraged to apply.

More information about EPFL and its
Department of Mathematics at
<http://www.epfl.ch> and <http://dmawww.epfl.ch>.

Applications, including CV, publication list, concise statement of research interests (3 pages or less) and three letters of reference, should be sent by August 31, 2001 to:

Professor Gerard Ben Arous
Chairman of the Search Committee
Department of Mathematics
Ecole polytechnique fédérale de Lausanne (EPFL)
CH-1015 Lausanne, Switzerland

Stanford
Linear
Accelerator
Center

Accelerator Physics Faculty

SLAC invites applications for a tenured Associate Professorship in accelerator physics with specialization in the physics and technology of Radio Frequency accelerating systems. We are looking for candidates with significant accomplishments and promise for important future achievements in this science that is central to the SLAC program. SLAC offers unique opportunities

- Operating accelerators supporting research in particle physics and synchrotron radiation-based sciences.
- Accelerators, high power test stands, and extensive instrumentation and facilities for accelerator research.
- A world-class faculty and staff working towards accelerators of the future.

The successful candidate is expected to take a leadership role in the ongoing activities, in developing new initiatives, and in creative scholarship. As a member of the Academic Council of Stanford University, there will be opportunities to teach and supervise undergraduate and graduate students.

Candidates should submit a curriculum vitae, publication list, a statement of research interests, and the names of four references to **Prof. R. Siemann, SLAC - MS 07, 2575 Sand Hill Rd, Menlo Park, CA 94025**. The deadline for receipt of applications is **June 15, 2001**.

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



DEUTSCHES ELEKTRONEN SYNCHROTRON DESY

The group "Particle Physics" of the John von Neumann Institute for Computing (NIC) at DESY Zeuthen close to Berlin has a fixed term opening for a

Research Scientist (BAT-O-IIa)

The main research interest of the group is the study of the non-perturbative aspects of quantum field theories, mainly quantum chromodynamics on the lattice. The group uses the APE100 and APE1000 computers at DESY Zeuthen. In collaboration with DESY-Zeuthen and INFN-Italy the group is also active in the development of the massive parallel apeNEXT machines for multi Teraflop computing.

The applicant should have a PhD in physics or informatics, a strong interest and a good knowledge in system software of parallel computers and practical experience with numerical simulations, ideally in quantum field theory.

Starting date is the 1.10.2001 for initially 3 years. The position is to perform research using the present APE machines at Zeuthen, to serve as APE system administrator and to participate in the apeNEXT development and testing. An extension for two more years is possible.

NIC is an equal opportunity/affirmative action employer and welcomes the application of qualified women. Handicapped applicants will be given preference in case of equal qualification.

Candidates are invited to send their application including a curriculum vitae, list of publications as well as three letters of reference to

**Frau Leistkow, DESY, Personalabteilung
Platanenallee 6, D-15738 Zeuthen, Germany**

by 30. June 2001. For further information please contact K.Jansen, e-mail : Karl.Jansen@ifh.de, phone: + +49 33762 77286.

PARTICLE PHYSICS DEPARTMENT (CLRC)

Rutherford Appleton Laboratory, Oxfordshire Two Fixed Term Opportunities available

The UK BaBar collaboration has installed significant computing and data storage facilities at the Rutherford Appleton Laboratory to allow local analysis of data from the BaBar experiment. The effective focus and exploitation of this Regional Analysis centre depends upon its active use in analysing data currently being recorded by the BaBar experiment. Two three year fixed term Opportunities are now available:

VN 2084: A vacancy has arisen for the leader of the BaBar group within the Particle Physics Department. The Group Leader will be responsible directly for about five members of staff, and will develop the Group's programme, including the development of the UK computing strategy for BaBar in association with the other UK groups. The post is available for a fixed term of three years. Applicants should have a Ph.D. in Particle Physics, and a strong record of achievement, preferably with experience of B-physics, and have demonstrated leadership skills.

The appointment will be made at Band 3, salary will be in the range £30,400 to £41,800 depending upon experience.

All applications for VN2084 must be returned by 18th May 2001.

VN 1993R: There is also an opening for an experimental particle physicist to work on the BaBar experiment. The RAL BaBar group is active in CP violation and mixing studies in both the charm and bottom sectors. You will be expected to work principally on data analysis while contributing to the development of Rutherford Appleton Laboratory based data analysis facilities for the whole of the UK collaboration. The work will involve close contact with the UK University groups, and will require periodic travel to the Stanford Linear Accelerator Centre and elsewhere. The post is for a period of three years, one of which may be based at SLAC. You should have a Ph.D. in Particle Physics, or have equivalent experience.

The appointment will be made at Band 5, salary will be in the range £19,700 to £27,080 depending upon experience.

All applications for VN1993R must be returned by 22nd June 2001.

A non-contributory pension scheme, flexible working hours and a generous leave allowance are also offered. Application forms can be obtained from: HR Operations Group, Rutherford Appleton Laboratory, Chilton, Didcot, OX11 0QX. Telephone (01235) 445435 (answerphone) quoting either reference number VN2084 or

VN1993R or e-mail recruit@rl.ac.uk More information about CCLRC and application forms are available from our website <http://www.cclrc.ac.uk>

The CCLRC is committed to Equal Opportunities and to achieving the Investors In People standard.

A no smoking policy is in operation.

COUNCIL FOR THE CENTRAL LABORATORY
OF THE RESEARCH COUNCILS



NEED TO RECRUIT?

Call
**Andrew Hardie on
+44 (0)117 930 1090**

UNIVERSITY OF BERN, SWITZERLAND

One Postdoctoral and one PhD student position

are available immediately
to work on
Trigger/DAQ of the
ATLAS experiment at CERN

APPLY TO:
Prof. Dr. Klaus Pretzl
pretzl@lhep.unibe.ch



ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

The Experimental Physics Division invites applicants for a
long term position of a

PHYSICIST

in experimental particle physics research.

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

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

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

Interested candidates are asked to send an application letter, a CV including the names of three referees and a brief description of research interests as well as a list of publications to Professor G. GOGGI, EP Division Leader, CERN< CH 1211 Geneva 23, e-mail: Giorgio.Goggi@cern.ch, by 11 May 2001.

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

This position is also published under reference EP-DI-2001-43-FT, which can be consulted at www.cern.ch/jobs/.

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

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



UNIVERSITY OF
OXFORD

Mathematical and Physical Sciences Division
Department of Physics

in association with St. John's College

Temporary Lecturership in Experimental Particle Physics

The Physics Department proposes to appoint a Departmental Lecturer in the field of experimental particle physics. This is a 3-year post to start 1st October 2001 or as soon as possible thereafter, and may be associated with a tutorial appointment at St. John's College for the same period. Applications from candidates wishing to work in any area of our research programme (see <http://www2.physics.ox.ac.uk/pnp/>) are welcome, but preference may be given to candidates wishing to work on the ATLAS experiment, particularly alignment and software aspects.

Further particulars of this post are available on <http://www2.physics.ox.ac.uk/pnp/TL01-fp.htm> or from Mrs Sue Geddes, Nuclear and Astrophysics Laboratory, Keble Road, Oxford OX1 3RH, UK, e-mail: s.geddes@physics.ox.ac.uk Fax: +44 (0) 1865 273417.

Questions can be addressed to Dr Tony Weidberg, tweidberg@physics.ox.ac.uk Applications should include a description of research and teaching experience, a statement of future research interests, a list of up to ten major publications, the names of three referees and a curriculum vitae. They should be sent to Mrs Geddes at the above address to arrive no later than 20th June 2001. No more than two of the three referees should be from the same institution; they should all be asked to consider the selection criteria in the further particulars and send letters of reference directly to the above address to arrive by the closing date (a letter by e-mail or fax is sufficient). Shortlisted candidates will be invited for interview in Oxford within 1-2 months after the closing date; applicants are asked to provide an e-mail address, fax, or telephone number where they can be contacted during that time.

The University is an Equal Opportunities Employer.

Explore

Link

Digest

Browse

Search

Bookmark

cerncourier.com

SCIENTIST I

The Fermilab Technical Division designs, develops, builds and tests components for accelerators and detectors, and is a leader in R&D for future high-energy physics accelerators. The Technical Division is in the process of creating a world-class capability in RF accelerating structures and magnets for electron-positron linear colliders. The successful applicant will join a team of physicists, engineers and technicians and will play a leading role in RF structure design, fabrication and testing aimed at developing a cost-effective approach to high-performance linear colliders. Fermilab's linear R&D program presently emphasizes room temperature, copper X-band structures as part of the U.S. NLC R&D Collaboration.

A Ph.D. in Physics or Engineering (or equivalent experience and training), and at least five years experience since Ph.D. in electron linac and/or linear collider R&D is required.

Applicants or interested parties requiring more information should contact:

David Finley
Fermilab, MS 316
P.O. Box 500, Batavia, IL 60510, USA
finley@fnal.gov
630-840-4620

Applications should include a curriculum vitae, publication list, and the names of at least three references.



Fermilab

A U.S. Department of Energy National Laboratory
We are an EEO/AA Employer M/F/D/V

CORNELL UNIVERSITY

TENURE-TRACK ASSISTANT PROFESSOR OF PHYSICS

Accelerator Physics

We are seeking an outstanding individual for a tenure track faculty position in accelerator physics. The position would normally be at the Assistant

Professor level, but we will consider more senior appointments for exceptionally qualified individuals. The Cornell Laboratory of Nuclear Studies has a strong program in beam physics and accelerator technology development with many exciting prospects for the future. Currently the Laboratory operates CESR, an electron positron storage ring for both particle physics and synchrotron radiation. Continuing improvements to its capabilities offer many opportunities for advancing the basic science of accelerator physics as well as its accompanying technology. A particular strength of the Laboratory is our R&D program in rf superconductivity which both supports the continuing upgrade of CESR and opens the way for future machines in synchrotron radiation production and particle physics.

Interested parties should send an application and at least three letters of recommendation to Prof. David Rubin, Search Committee Chairman, Newman Laboratory, Cornell University, Ithaca, NY 14853. Applications should include a curriculum vitae, a publication list, and a short summary of teaching and research experience. Electronic mail inquiries may be addressed to SEARCH@LNS.CORNELL.EDU. Cornell University is an equal opportunity/affirmative action employer.



THE UNIVERSITY
of LIVERPOOL

Department of Physics

Liverpool Particle Physics Group

Research Associates in Particle Physics

Initial salaries within the range £16,775 - £25,213 pa (under review)

The group is involved in a wide ranging programme of experimentation, including ATLAS and LHCb at CERN, H1 at DESY, BABAR at SLAC, CDF at Fermilab, E-science and Detector Development at Liverpool.

You should have or be about to complete a PhD in experimental particle physics and will be expected to work in one of the above areas. The posts are funded by PPARC for three years initially. You will be expected to spend time at the overseas laboratories as appropriate. Informal enquiries to Professors Erwin Gabathuler, email: erwin@hep.ph.liv.ac.uk Paul Booth, email: booth@hep.ph.liv.ac.uk or John Dainton, email: jbd@hep.ph.liv.ac.uk **Quote Ref: B/552/CC**

The closing date is 31 May 2001 however, applications for anticipated vacancies in this area will be considered until 30 September 2001.

Further particulars and details of the application procedure should be requested from the Director of Personnel, The University of Liverpool, Liverpool L69 3BX on 0151 794 2210 (24 hr answerphone) or via email: jobs@liv.ac.uk

Web site at <http://www.liv.ac.uk>

COMMITTED TO EQUAL OPPORTUNITIES



DEUTSCHES ELEKTRONEN SYNCHROTRON DESY

DESY is one of the leading laboratories in particle physics and synchrotron radiation research with locations in Hamburg and Zeuthen. In the framework of an international collaboration DESY is coordinating the development of the superconducting electron-positron linear collider projekt TESLA with integrated free electron laser facility. The Laboratory in Zeuthen (near Berlin) invites applications for a

Postdoctoral Position

for R&D work associated with the installation, operation and optimization of a test facility for laser driven RF photo injectors.

For the operation of free electron lasers and e^+e^- linear colliders electron sources with extraordinary beam properties are required. In DESY Zeuthen a new photo injector test facility is presently under construction and in commissioning phase.

The candidate will play an important role in this project and will contribute significantly to the development, installation and optimization of the RF-gun. This includes detailed measurements as well as simulations and further developments of theoretical models.

Applicants should have a PhD in physics. Candidates with a substantial knowledge in accelerator physics and electron beam dynamics are preferred.

The position is initially limited to a duration of 3 years. The salary will be according to the German civil services BAT-O IIa.

DESY is an equal opportunity employer and welcomes the application of qualified women. Handicapped applicants will be given preference in case of equal qualification.

Contact:

Dr. Frank Stephan, phone: +49-33762-77-338, see also:
<http://desyntwww.desy.de/pitz/>

Interested scientist should send their letter of application and three names of referees and their addresses by June, 15th, 2001 to:

DESY Zeuthen, Personalabteilung
Platanenallee 6, 15738 Zeuthen, Germany

UNIVERSITÉ DE MONTRÉAL

POSTDOCTORAL RESEARCH POSITION IN ASTROPARTICLE PHYSICS

The particle physics group of the Université de Montréal is seeking a postdoctoral researcher in the field of astroparticle physics to join the ongoing PICASSO cold dark matter search experiment. PICASSO is a new approach for the detection of cold dark matter candidates based on the metastability of moderately superheated liquids. The group is presently developing a detector prototype with an active mass of 400 g which is intended to be installed this summer at the site of the Sudbury Neutrino Observatory. The successful candidate with preferably recent PhD and experience in low background counting techniques will play an important role in data taking, analysis and in the development of a future large scale experiment for dark matter search.

Candidates should submit their curriculum vitae and arrange to have three letters of recommendation sent to:

**Prof. Viktor Zacek, Laboratoire R.J.A Levesque
Université de Montréal, C.P. 6128, Succ. Centre Ville
Montreal, Quebec H3C 3J7, Canada
e-mail: zacekv@lps.umontreal.ca**

We strongly encourage all qualified persons to apply, regardless of citizenship or residential status. In accordance with Canadian immigration regulations, Canadian citizens or permanent residents will be given first consideration.

PhD-Position in Experimental Particle Physics at the Faculty of Physics of the University Freiburg

A position for experimental high energy physicists for the ZEUS experiment at the electron-proton storage ring HERA, at DESY, Hamburg is available now. The position will start with a grant and will turn after some period into a BAT IIa/2.

The field of activity is the participation in the running of the ZEUS detector, the participation in its upgrade program, and the analysis of data from the ZEUS detector. Some teaching at the University is required, the residence will be in Hamburg, however.

For the position a Diploma thesis or equivalent degree in experimental particle physics is required.

Interested candidates should send the usual information (cover letter, curriculum vitae, examination grades, and more than one name of referees) to

**Prof. Dr. A. Bamberger
Universitaet Freiburg
Fakultaet fuer Physik
Hermann-Herder-Str. 3 D-79104 Freiburg
Tel. +49 761 203-5714**

More information via: bamberger@physik.uni-freiburg.de
See also: <http://frzsun.physik.uni-freiburg.de:8080/>

CERN COURIER RECRUITMENT BOOKING DEADLINE

June issue: 11 May

Contact Andrew Hardie:

Tel. +44 (0)117 930 1090 Fax +44 (0)117 930 1178

**E-mail andrew.hardie@iop.org
cerncourier.com**



Max-Planck-Institut für Physik (Werner-Heisenberg-Institut)

We invite applications from recent
Ph.D. graduates for
two post-doctoral positions in

Experimental High Energy Physics

The appointments are made for two years and the positions are available now.

With this year's upgrade of the HERA collider, with prospects for a five-fold increase in luminosity as well as running with a polarized lepton beam, and the upgrade of the H1-Experiment, we are entering a new and exciting phase of physics with ep-collisions.

Our group has been engaged in the H1-Experiment at HERA and is actively participating in upgrading the detector for data taking with HERA II. Our main new projects are the liquid argon calorimeter jet trigger, a fast first level trigger delivering jet-like energy clusters, and new sophisticated preprocessing of the input data for the existing second level neural network trigger.

Our group is involved in various aspects of H1 Physics analysis such as structure functions, heavy quark and jet production, heavy vector meson production and search for instantons in QCD. The substantial increase in luminosity will emphasize the physics at high Q^2 . We expect the successful candidates to become engaged in one of our upgrade projects and to participate in one of our physics programs.

Our Institute is seeking to increase the number of women in high energy physics. Therefore qualified women are especially encouraged to apply. Applicants with a physical handicap will be given preference, if equally well qualified.

Applications with full CV, statement of research interests, publication list, and names and addresses of three referees, or any inquiries should be made as soon as possible to:

**Prof. G. Buschhorn,
Max-Planck-Institut für Physik (Werner-Heisenberg-Institut)
Föhringer Ring 6, D-80805 München
(email: gwb@mppmu.mpg.de)**



ALBERT-LUDWIGS- UNIVERSITÄT FREIBURG

The Faculty of Physics invites applications for a

Full Professorship in Experimental Physics (C4)

as successor to Prof. Dr. K. Runge. The appointment will be made in the field of experimental physics with emphasis on experimental particle physics.

Prerequisites are the Habilitation or an equivalent scientific qualification. The successful applicant will participate in teaching and administrative duties of the department. The university is seeking to increase the number of female faculty members and therefore especially encourages suitably qualified women to apply. Applicants with a physical handicap will be given preference over other candidates with equal qualifications. The professorship is available as a permanent position. In case this is a first appointment to a professorship. This appointment will be temporary, with a possibility for a later promotion to a permanent position. Exemptions from this rule are possible.

Applications (including a curriculum vitae, copies of certificates, list of publications and teaching records) should be sent by **30 June 2001** to the

**Dekan der Fakultät für Physik, Hermann-Herder-Str. 3,
D-79104 Freiburg.**



International Conference on Accelerator & Large Experimental Physics Control Systems

**November 27-30, 2001
San Jose, California, USA**

For Abstract submittal, complete prospectus,
registration and commercial exhibit info, visit:

<http://icalepcs2001.slac.stanford.edu>

**Chairman: J.W. (Rusty) Humphrey
Program Chairman: Hamid Shoaee**

Be There for ICALEPCS 2001, A Unique Opportunity!

Staff Scientist Position

at the
**LIGO Laboratory,
California Institute of Technology (Caltech)**

The Laser Interferometer Gravitational-Wave Observatory (LIGO) Laboratory is seeking to fill a three-year term position for a staff scientist at its Livingston, Louisiana site.

The position may be converted at a later date to a long-term appointment subject to available funding.

The **successful candidate** will become a member of the observatory staff with primary responsibility to participate locally in the LIGO Laboratory Data and Computing Group activities. Primary responsibilities will include: site support for LIGO Data Analysis System hardware and software and participation in the scientific data analysis for astrophysical signatures from gravitational waves associated with compact relativistic objects.

Skills we are seeking include: Linux/Solaris administration background; MPI-based parallel computational background; training in astronomy, astrophysics, or physics; programming experience in C or C++ and/or tcl/tk; and knowledge of computer hardware systems including the ability to repair, install, and maintain computer equipment.

Letters of interest must include a resume with a minimum of three references listed and where the applicant saw the advertisement and should be sent to: Dr. Albert Lazzarini, California Institute of Technology, LIGO 18-34, Pasadena, CA 91125. Electronic materials may be submitted either as a pdf attachment or as ascii-only text; please no MS WORD documents.

Further information may be obtained from Dr. Lazzarini at
lazz@ligo.caltech.edu.

*Caltech is an Affirmative Action/Equal Opportunity Employer.
Women, Minorities, Veterans, and Disabled Persons
are encouraged to apply.*

INDEX TO DISPLAY ADVERTISERS

Amptek Inc	32	Hitec Power Protection	16
Atlas Technologies	31	HiTek Power	14
Bergoz	28	IOPP Journals	32
Ceramaseal	37	Janis Research Company Inc	31
CFME ACTIM	47	Johnsen Ultravac	31
Danfysik A/S	4	Kimball Physics Inc	31
Deutsche Boerse AG	39	Lake Shore Cryotronics Inc	18
Eljen Technology	20	Manufacturing Sciences Corporation	22
Elsevier Science BV	48	Pantechnik	16
F.u.G. Elektronik GmbH	20	VAT Vacuum Products Limited	5 & 20
GMW Associates	2		
Goodfellow Cambridge Ltd	16	The index is provided as a service and, while every effort is made to ensure its accuracy, <i>CERN Courier</i> accepts no liability for error	
Group 3 Technology Ltd	28		

BOOKSHELF

BOOK OF THE MONTH

The Legacy of Léon Van Hove,

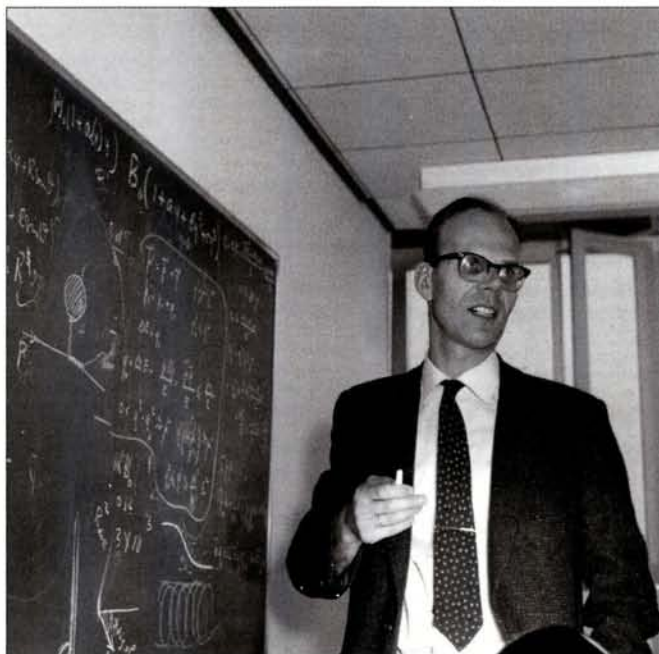
edited by A Giovannini, World Scientific Series in 20th Century Physics, Vol. 28, ISBN 98102243308, 570pp, £55.

The publication of this volume on Léon Van Hove provides a welcome global view of his multifaceted contributions to science. He was CERN's research director-general from 1976 to 1980, but some of his most important contributions date from his time outside CERN and are little known to the particle physics community. This book consists of reprints of his major scientific papers together with skilful presentations of their significance, as well as discussions of his impact as teacher and scientific statesman.

Léon Van Hove started his career with three years of underground university studies in wartime Brussels. His training and earliest research was in the field of mathematics. In the late 1940s, however, he turned to theoretical physics.

His first papers on statistical mechanics and quantum field theory were mathematically orientated. His rigorous and important papers in statistical mechanics in 1949 prepared the ground for the advances by Ruelle and by Fisher in the 1960s (R Balescu, T Petrosky and I Prigogine); he initiated the perturbation description of large quantum systems in two fundamental papers in 1955 and 1956 (N M Hugenholtz).

In the period 1951–1954 he turned, surprisingly and under the influence of Placzek, to phenomenological work on slow neutron scattering, and demonstrated how the space-time correlation function could be measured directly. His papers were a major



Léon Van Hove – multifaceted contributions to science.

stimulus to this field and had enormous influence on experiments and applications as well as on theory (N Gidopoulos and S W Lovesey). The experimental work by Brockhouse and Shull that used his approach was awarded the Nobel prize in 1994, four years after Van Hove's death in 1990.

Van Hove's remarkable scientific change of direction and contributions to particle physics on being invited to head the CERN Theory Division in 1960 are described by several close collaborators: M Jacob on ultrarelativistic heavy-ion collisions, A Giovannini on multihadron production and J J J Kokkedee, W Kittel and A Bialas on high-energy collisions and internal hadron structure.

Van Hove was also an outstanding teacher, scientific administrator and policy maker. Close associates describe his activities in these diverse areas.

Of his Utrecht PhD students in the 1950s, we learn that several became outstanding

physicists, for example the Nobel prizewinner M Veltman. (N M Hugenholtz and Th W Ruijgrok). His activities as leader of the CERN Theory Division and as research director-general of CERN are described by F Bonaudi, M Jacob, E Gabathuler and V Soergel, while his period as director at the Max-Planck Institute at Munich is covered by N Schmitz. M Bonnet describes his time as advisor to the European Space Agency and the special role he played in developing the Solar-Terrestrial Programme.

The fact that Léon Van Hove came from a field outside particle physics made him particularly sensitive to the potential of high-energy physics in non-traditional areas. For instance, he realized the scientific significance

of ultrarelativistic heavy-ion physics at a time when it was still unpopular at CERN. He threw his scientific weight behind this initiative and even focused his own scientific research on it. His intuition has recently been vindicated by the discovery of quark-gluon plasma effects.

This scientific intuition also showed itself in the bold decisions – described both by colleagues and by Van Hove – leading to the construction of the antiproton-proton collider and the discovery of the W and Z particles. Further, it is an excellent initiative to include an autobiography.

The book closes with a documentation of Van Hove's opinions and attitudes on various issues, compiled in his own words from his speeches and private papers by his son Michel.

This volume gives a fascinating account of the scientific life of a multifaceted physicist with many talents and is highly recommended. *Torleif Ericson, CERN.*

cerncourier.com

Explore Absorb Search Discover Browse Digest Surf Link Bookmark



FRANCE AT CERN
19-22 June 2001

The French exhibitors welcome you to 'France at CERN' :

AGENCE DE DEVELOPPEMENT ECONOMIQUE DU PAYS DE GEX - AIR LIQUIDE - ALCATEL VACUUM TECHNOLOGY ALLIANCE TECHNIQUE INDUSTRIELLE - ALSTOM INDUSTRIE - ALSTOM MAGNETS & SUPERCONDUCTORS - ATOS AXON/CABLE SAS - CEDRAT RECHERCHE - CEFILAC - CNB ELECTRONIQUE - ELC CEFIVAL- EUROTHERM AUTOMATION FARNELL - JEHIER - P.M.B. - REXEL ISNARD - SAMSON REGULATION SCHNEIDER ELECTRIC INDUSTRIE - SENSOREX S.I.C.N. - SOCIETE DES CERAMIQUES TECHNIQUES - STAUBLI FAVERGES - TECHNICATOME - THALES ELECTRON DEVICES THERMOCOAX SAS - VELAN

For information please contact :

CFME ACTIM : AGENCY FOR THE INTERNATIONAL PROMOTION OF FRENCH TECHNOLOGY AND TRADE

Mrs Florence COUSQUER Mrs Marie-Josiane FOURNIER

e mail: fcousquer@cfme-actim.com jfournier@cfme-actim.com

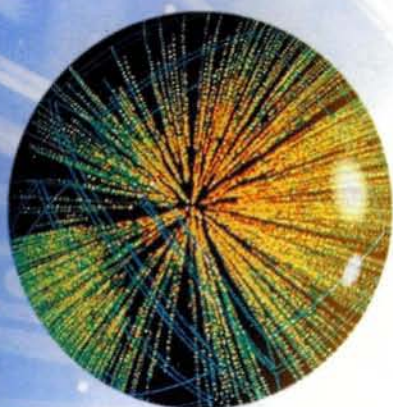
Tel: (33) 1 40 73 34 89/30 96 - Fax: (33) 1 53 70 25 77

CERN : Mrs C.L. JULLIEN WORINGER e mail: claire-lyse.jullien-woringer@cern.ch

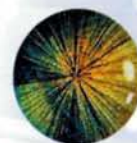
Tel: (41) 22 767 37 22 - Fax: (41) 22 767 74 50

introduces

The Paperless Publishing Process



- Easy submission of your manuscript via your personal web page within Nuclear Physics B
- Your personal information is stored on a secured server, only accessible with protected username & password
- Full insight in the status of your manuscript throughout the submission, refereeing and production process



- Online publication of your accepted article on Nuclear Physics Electronic (www.elsevier.nl/locate/npe) within 5 days



more information at the secure site:

<https://ppp.elsevier.nl/npb>