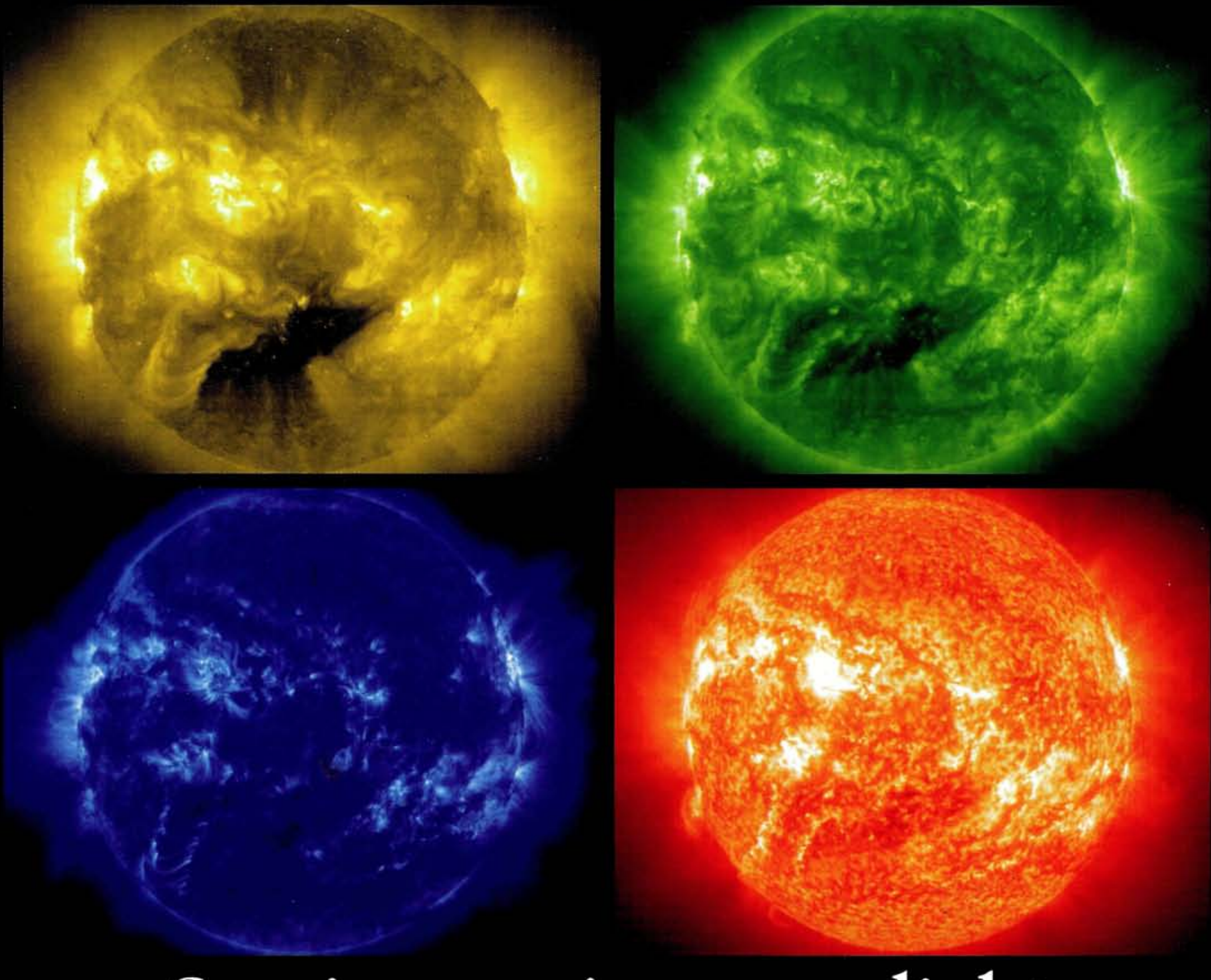
INTERNATIONAL JOURNAL OF HIGH-ENERGY PHYSICS

CERN COURIER

VOLUME 42 NUMBER 1 JANUARY/FEBRUARY 2002



Sun is seen in a new light

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INFN reaches 50 p26

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 Tranducer	± 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

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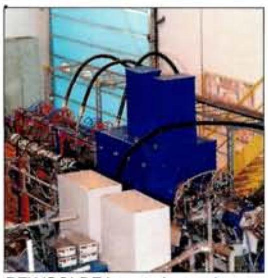

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Cover: The Sun as seen by the international Extreme Ultra-Violet Imaging Telescope aboard the ESA/NASA SOHO Solar and Heliospheric Observatory using radiation from ionized iron atoms. *Nucleus* is a new illustrated book that explains the mechanisms at work in the Sun (p46).

CERN

CERN reacts to increased LHC costs

At its December meeting, CERN's governing Council decided on new measures to react to the increased costs that emerged this year for its future Large Hadron Collider.

The collider (LHC), which is being constructed in the 27 km tunnel that was built in the 1980s for the LEP collider, will be packed with high-technology equipment and, in particular, will need 1232 superconducting dipole magnets to control its high-energy proton beams. Approval of the contract for these magnets – a final major supply item – clarified the LHC's "cost to completion".

CERN now has to look for ways of finding the extra money needed. A first proposal will be submitted to Council in March, and this will evolve into a medium- and long-term plan, which will be presented in June.

CERN has set up five Task Forces to study scientific programmes, possible areas of saving, restructuring, and improving resource management. Karl-Heinz Kissler has been appointed as CERN programme controller.

In another major move, Council approved a proposal to establish an External Review Committee (ERC) to examine two main areas: the LHC, its experimental areas and CERN's share of LHC detector construction; and CERN's scientific programme not directly related to the LHC.

Robert Aymar, Director of ITER (the International Thermonuclear Experimental Reactor), is Chairman of CERN's new External Review Committee.

The ERC's comprehensive review will be carried out in parallel with the work of the internal Task Forces. The ERC's interim report in March will be taken into consideration for the revised medium- and long-term plans. The final report will be presented in June.

Robert Aymar of France, director of the International Project for an Experimental Thermonuclear Fusion Reactor (ITER), was appointed ERC chairman. The other members of the committee are Stephan Bieri of ETH Zurich; Bjorn Brandt of the Swedish Foundation for Strategic Research; Enrique Fernández of the Universidad Autónoma de Barcelona; Italo Mannelli of the Scuola Normale Superiore, Pisa; Sigurd Lettow of the Forschungszentrum Karlsruhe; Marc Pannier of the French Ministry of Finance, Ecomony and Industry; John Peoples of Fermilab; and David Saxon of Glasgow University.

On the financial front, Council took the unusual step of stipulating that 5% (SwF 53 million) of CERN's 2002 budget would initially be frozen. Council will decide how to release this money in line with the new medium- and long-term plans.

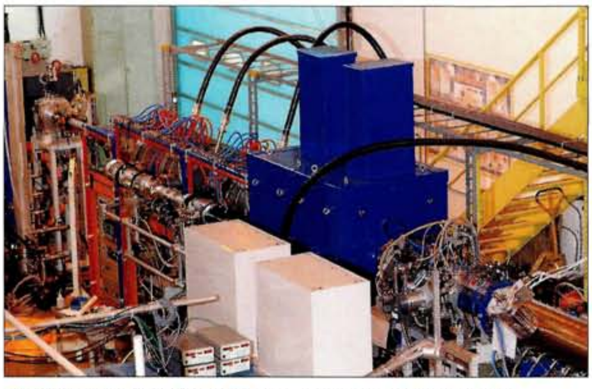
For more information, see "http://www.cern.ch/info/LHCCost/".

CERN

Radioactive beam research gets new facility

CERN's new nuclear physics facility, REX-ISOLDE, was commissioned at the end of October, opening up new horizons for the laboratory's nuclear physics community. REX-ISOLDE builds on CERN's existing radioactive beam facility, taking radioactive ions and boosting them to energies of up to 2.2 MeV per nucleon.

ISOLDE, the isotope separator on line, has a history stretching back over 30 years supporting experiments from basic nuclear physics to the life sciences. To date, these have focused on radioactive nuclei at energies of less than 60 keV – an upper limit that was starting to constrain the facility's potential. REX, the newly commissioned radioactive beam experiment, remedies this by opening up the 0.8–2.2 MeV range for exploration.



CERN's new REX-ISOLDE boosts radioactive ions to energies of up to 2.2 MeV per nucleon.

REX-ISOLDE has been built round a new linear accelerator, which was funded and constructed by a broad European collaboration. ISOLDE's 60 keV ions are accumulated in a Penning trap, charge bred in an Electron Beam Ion Source and then finally accelerated in the linac. The first beams to be accelerated consisted of neutron-rich sodium isotopes, which reached 2 MeV per nucleon on 30 October.

Researchers at the facility's main detector system – a gamma detector array known as Miniball – are now starting early experiments probing whether the magic numbers N = 20 and N = 28 of the nuclear shell model are still valid for very neutron-rich nuclei. Future experiments will address topics that include the structure of nuclei with equal numbers of protons and neutrons, proton radioactivity and nuclear astrophysics.

MOSCOW

U10 proton synchrotron reaches 40

Moscow's Institute for Theoretical and Experimental Physics recently celebrated the 40th anniversary of the commissioning of its U10 proton synchrotron.

Originally a 7 GeV machine, the proton synchrotron was constructed at the institute (ITEP) as a prototype for the 70 GeV Protvino machine – then the most powerful in the world – which was commissioned in 1967.

The ITEP machine was, along with the CERN Proton Synchrotron and Brookhaven's Alternating Gradient Synchrotron – one of the first three synchrotrons constructed using the alternating gradient focusing principle. In 1973 its output energy was upgraded to 10 GeV. In 1980 the maximum intensity – 1.5×10^{12} protons per pulse – was reached.

The ITEP U10 accelerator is used for experimental physics, proton therapy, material irradiation, and testing fast electronics and new detectors.

Four decades of strong focusing – the U10 proton synchrotron at Moscow's Institute for Theoretical and Experimental Physics.

The ITEP proton synchrotron contributed greatly to particle and relativistic nuclear physics. Experiments were performed with different bubble chambers, including the world's largest helium and xenon chambers, and magnet spectrometers with wire chambers.

Many important results have been obtained on light meson spectroscopy and CP-violation parameters in neutral kaon decay, and on non-strange baryon spectroscopy via precise measurements of pion-nucleon elastic scattering on unpolarized and polarized targets. A comprehensive study of few nucleon systems has been made using beams of light nuclei and in pion-deuteron interactions.

The ITEP TWAC TeraWatt Accumulator Project (March 2001 p7) takes the U10 ring into a new era. Complementing the proton programme, it will be used as a heavy-ion accumulator for high-energy density experiments. This work should begin this year.

US

Subpanel recommends a collision course

"We recommend that the highest priority of the US programme be a high-energy, high-luminosity, electron–positron collider, wherever it is built in the world. This facility is the next major step in the field and should be designed, built and operated as a fully international effort."

This forthright statement is one of the main recommendations of a subpanel set up by the US Department of Energy and the National Science Foundation to chart a 20 year "roadmap" for the future of fundamental physics research. The subpanel's report states that this future begins with a thorough exploration of the TeV energy scale at CERN's LHC, but that it does not end there. An electron–positron linear collider is seen as the next step after the LHC.

"We also recommend that the US take a leadership position in forming the international collaboration needed firstly to develop a final design, and then to build and operate this machine," continues the report.

Long-term international R&D for the next major international machine – the Next Linear Collider Test Accelerator at the Stanford Linear Accelerator Center, Stanford. SLAC and the Japanese KEK laboratory collaborate closely in this work.

"We recommend that the US prepare to bid to host the linear collider in a facility that is international from the inception."

Regarding where such a machine would be built, the report adds: "If it is built in the US, the linear collider should be sited to take full advantage of the resources and infrastructure available at SLAC (Stanford, California), and Fermilab (near Chicago)."

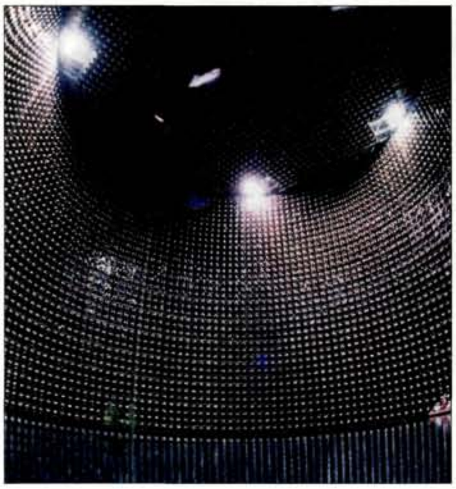
The introduction to the report concludes: "The 20th century can be characterized by an increasingly global economic interdependence, as well as by many shared problems, including the health of the human race and of the Earth itself. It is becoming increasingly important to find successful international models for solving such problems. Particle physics represents one of the most successful areas of international co-operation. From the pivotal role of CERN in postwar Europe to the global collaborations of today, particle physicists have worked together with great success on problems of common interest. The construction of a linear collider will break new ground as an international partnership and provide a useful model for other areas of human endeavour."

The full report can be found at "http://doe-hep.hep.net/home.html".

JAPAN

Accident at major detector in Japan

Debris at the bottom of the Super-Kamiokande detector. (Institute for Cosmic Ray Research, University of Tokyo.)



Super-Kamiokande as it once was.

Routine maintenance at Super-Kamiokande, showing the size of the photomultiplier.

On 12 November, as reported briefly in the December issue (p5), several thousand large photomultiplier tubes imploded in the huge Super-Kamiokande underground neutrino detector in Japan. The extent of the damage suggested some kind of chain reaction in the tubes, with one implosion setting off the next. It happened as the detector was being refilled with water after routine maintenance.

The detector began physics operation in 1996 and had produced important results, monitoring particles from the Sun, from cosmic-ray interactions in the atmosphere and from the Japanese KEK laboratory 250 km away. Recent results showed that synthetic muon-type neutrinos from KEK do not always show up as expected (September 2000 p8). The detector also provided key benchmarks for solar neutrinos (September 2001 p5). These results had been a major influence on physics thinking, and researchers were eagerly looking towards more.

A Japan–Korea–US collaboration, the Super-Kamiokande detector uses 50 000 tonnes of pure water as a neutrino target 1000 m below ground. The water target is 40 m high and monitored by 11 200, 50 cm diameter Hamamatsu R3600 photomultiplier tubes, and it is divided into a 32 000 tonne inner detector where the events are logged, and an 18 000 tonne outer volume to screen off unwanted effects. Most of the photomultipliers are deployed in the inner detector to pick up the flashes of light created when neutrinos interact with the water.

Apparently, a tube, probably near the bottom of the detector, imploded and set off a chain reaction, destroying much of the detector to a depth of about 2 m below the water level. The instrumentation at the top of the detector survived. The chain implosion caused around 8000 tubes to be destroyed, and it also wreaked havoc with the detector infrastructure.

The Hamamatsu R3600 photomultiplier tubes were first used in Kamiokande, the current detector's predecessor, which was built in the same underground mine in the early 1980s. The initial goal of that experiment was to search for signs of proton decay (the "-nde" suffix is short for "nucleon decay experiment"). This detector used 1000 photo-multipliers and a 300 tonne water target. Kamiokande's observations of the 1987 supernova marked the beginning of a new science – neutrino astronomy – and Super-Kamiokande was set to follow this tradition.

NEUTRINOS

Experiment reveals neutrino surprise

Just as physicists were getting used to the idea of all particle physics measurements agreeing with each other and with the all-embracing Standard Model, a major experiment at Fermilab has announced a surprising neutrino measurement.

The NuTeV collaboration at Fermilab's Tevatron compares the different types of neutrino interaction and finds a vital parameter to be 0.2277, not 0.2227. At the level of precision being explored in particle physics, this is a major upset and needs confirmation. However, the NuTeV experiment has now terminated, and the Fermilab Tevatron has ceased operations for fixed target studies, such as those using neutrino beams.

Over a period of 15 months in 1996 and 1997, NuTeV shone beams of neutrinos and their antiparticles at a 700 tonne target. The energy of the neutrinos was 125 GeV, and that of the antineutrinos was 115 GeV.

Neutrinos do not interact readily with matter – at NuTeV, only one in a billion neutrinos registered a hit inside the target. Together, some 2 million neutrino and antineutrino hits were patiently collected.

Neutrinos, which are electrically neutral, almost massless, particles, can interact with other matter through the weak nuclear interaction in one of two ways. In the classic form, related to nuclear beta decay, the neutrino changes a nuclear proton into a neutron (or vice versa) and an electrically charged muon (or electron) is emitted. This type of reaction shuffles round the charges of the participating particles and is therefore known as a "charged current".

In 1973, neutrinos were also discovered to be capable of interacting with matter without permuting electric charge – a "neutral current". This discovery was vital evidence in favour of the then new "electroweak" theory, which unifies weak interactions and electromagnetism. By looking to see whether neutrino interactions were accompanied by a muon, NuTeV could distinguish between charged and neutral current interactions – only the former produced an outgoing muon.

By comparing the ratio of neutral and charged current production by neutrinos and antineutrinos, the experiment finds a value for the vital mixing parameter (Weinberg angle), which dictates the weights of the electromagnetic and weak effects in the combined electroweak theory and also relates the masses of the Z boson (the particle that mediates the neutral current) and the W boson (the charged-current carrier).

Beginning with high-energy neutrino studies at CERN in the late 1970s, and continuing with precision measurements of Z and W properties in proton–antiproton colliders at CERN and Fermilab and at electron–positron colliders at CERN and SLAC in the 1990s, physicists had built up a precision picture of weak interaction parameters. However, the latest NuTeV result does not fit in with this.

The history of the neutrino has been full of surprises. The prediction of such a bizarre particle was itself a surprise, and the fact that neutrinos could be observed was another. More came when physicists discovered that neutrinos come in different forms, which could even transform into each other. Is the latest NuTeV result a blip or another neutrino surprise? Only time will tell.

View of the NuTeV neutrino detector at the Fermilab Tevatron, which used a 700 tonne sandwich of steel target plates interspersed with drift chambers and scintillators.

Muon magnetism OK

A heroic reappraisal of complicated calculations means that an intriguing physics anomaly has gone away, but in an unexpected way. Last year a precision measurement of the muon's magnetism at Brookhaven reported a slight disagreement with the expected value (April 2001 p4). In some quarters, this was heralded as possible evidence for new physics. After carefully re-examining the underlying calculations, experts found that there was, in fact, a mathematical error in the predicted value. The Brookhaven team's measured value has not changed, but is no longer a puzzle. The muon's magnetism looks to be in order.

Edited by Archana Sharma

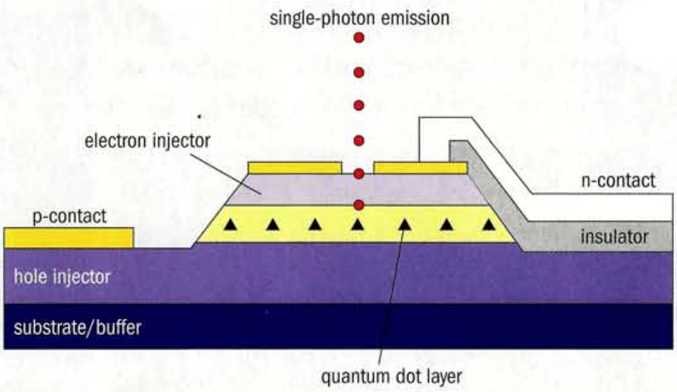
Single-photon devices get closer

The first practical, electrically driven, single-photon generator could play a key role in the emerging technologies of quantum cryptography and quantum computing.

Researchers at Cambridge and from Toshiba added a layer of "quantum dots" to a conventional light-emitting diode to create their device, which could also be used for very sensitive optical experiments.

Quantum dots are nano-sized deposits of one semiconductor embedded in another. The dot material has an energy bandgap that is smaller than that of the surrounding material. This allows it to trap charge carriers.

Scientists deposited an array of indium arsenide quantum dots in a layer of undoped gallium arsenide, which they sandwiched between layers of hole- and electron-doped gallium arsenide. They then applied voltage pulses across the structure.



Cross-section of the first practical, electrically driven, single-photon generator that could be useful in quantum cryptography and quantum computing applications.

These pulses force positive holes from the hole-doped layer and electrons from the electron-doped layer into the undoped layer, which contains the quantum dots. Owing to its low potential energy, each of the quantum dots can capture a hole and an electron, which combine to produce a single photon. A tiny aperture on top of the device allows photons from one of the quantum dots to escape.

The generator was designed to emit infrared photons, which corresponded to the sensitive region of the single-photon counter. The quantum dots can be tuned to emit light at a range of wavelengths, including 1.3 μm – the wavelength used in fibre-optic communications. Dots that generate photons with longer wavelengths are also efficient at greater than 5 K – the temperature at which the current device operates.

Until now, single-photon generators have been driven by lasers, which makes them both bulky and impractical. Previous devices that were electrically driven only worked at milliKelvin temperatures.

Reference

Zhiliang Yuan *et al.* (in press) *Science*.

physicsweb.org

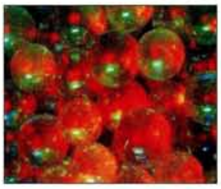
Random laser suits a range of applications

A new laser that emits different wavelengths at different temperatures could be used in fields ranging from optoelectronics to remote heat sensing.

Researchers at Florence exploited the temperature-dependent structure of liquid crystals to control the optical behaviour of their "random" laser, which need only be tens of micrometres across. Conventional lasers are based on a mirrored cavity filled with an optically active material. When the substance is excited by an electric current or another laser, it emits light, which the mirrors reflect back into the cavity, thus stimulating more light emission. This amplification step is crucial for the production of intense radiation with a single wavelength.

The laser that has been developed in Florence is a "random" laser – so-called because amplification is achieved by the random diffusion of light in a laser material. As light scatters through the structure, it excites other atoms and makes them emit light. This is a "distributed cavity", in which the material plays the role of the reflecting cavity and there are no mirrors.

In a random laser, the degree to which light can scatter through the material determines the level of gain. If the light is strongly scattered, it is trapped for longer and can stimulate greater emission, leading to higher gain and greater intensity.



"Random" laser. The spaces between the spheres of glass are filled with laser dye dissolved in a liquid crystal. (D Wiersma.)

The amount of gain can be adjusted by controlling how strongly the laser material scatters light. To do this, researchers filled a porous glass structure with laser dye dissolved in a liquid crystal. Liquid crystals are chain-like molecules that align to different degrees depending on their temperature. As the degree of alignment changes, so does the diffusion coefficient of the overall structure.

At temperatures well below 35 °C, it was found that the laser emitted extremely intense light with a very narrow range of wavelengths of around 610 nm.

As the temperature was increased, the intensity gradually fell and the range of wavelengths became broader. Laser action ceases at 42 °C, which corresponds to a phase transition in the liquid crystal. At this point the intensity dropped sharply and the emission spectrum became very flat and broad.

The range of temperatures over which the laser is sensitive can be adjusted by changing the combination of glass and liquid crystal. According to the researchers, this feature could make the device suitable for a variety of applications.

Reference

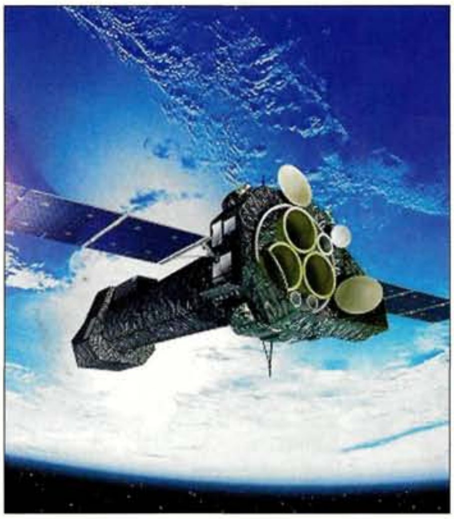
D Wiersma and S Cavalieri 2001 *Nature* **414** 708.

physicsweb.org

Edited by Emma Sanders

X-rays come under the spotlight

In 1999 two new X-ray satellites were launched – Chandra and XMM-Newton. Here we mark a few of their discoveries and show some of the X-ray images that are now available to astronomers. For the first time there is comparable resolution between X-ray and radio observations.



*Left: the XMM-Newton observatory. (*ESA.) Right: *the Chandra observatory, named after 1983 Nobel laureate Subrahmanyan Chandrasekhar (NASA).*

X-ray equipment

X-ray astronomy can only be carried out in space because X-rays are absorbed by the Earth's atmosphere. The telescopes differ from optical ones: owing to their high energy, X-rays penetrate into a mirror in much the same way as bullets slam into a wall; likewise, just as bullets ricochet when they hit a wall at a grazing angle, so too will X-rays ricochet off mirrors, allowing them to be focused.

Observations from Chandra and XMM-Newton are complementary. The latter has a larger collecting area than Chandra – better for observing faint sources – but lower resolution.

New sources shed more light on active galaxy behaviour

With the improved resolution now available to X-ray astronomers, many new sources are being discovered. This wealth of new data gives a boost to understanding the energetic processes that are at work in the heart of active galaxies. Many of the new extragalactic X-ray sources are bright and point-like, and a significant number are probably caused by material accreting round black holes.

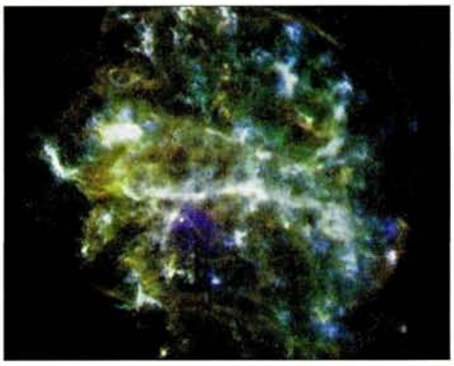
In the starburst galaxy NGC253, four black holes seem to be gravitating towards the centre of the galaxy, where they could coalesce to form a single supermassive black hole. The observers even suggest that NGC253 is undergoing a transition between starburst activity and a quasar-like galaxy. Quasars release huge amounts of energy, outshining galaxies of hundreds of billions of stars, from a space the size of our solar system. Each black hole would have a mass ten to thousands of times that of the Sun. This interpretation is a subject of great interest.

Another team surveyed 37 different galaxies suspected of containing a supermassive black hole in their centre. Some 25% contained extremely luminous sources.

For the first time the periodic variation of an X-ray source outside the Local Group of galaxies was clearly determined – proof that it originates from a binary system likely to contain a black hole of stellar mass.

Rapid X-ray flaring has been detected from the compact radio source in the Milky Way. The faintness of the associated X-ray radiation has in the past cast doubt on whether the emission really comes from matter accreting onto a supermassive black hole. Now, the rapid flaring means that the model is back on track. A factor of five change in the luminosity was detected in just 600 s. Given the finite speed of light, the emitting region could be no bigger than 20 times the black hole's event horizon.

Chandra witnesses the death of a star



Supernova remnant G292.0+1.8. (NASA.)

The death throes of a star are shown up in X-rays by the Chandra Observatory. The young, oxygen-rich supernova remnant is lit up by a central radiating pulsar. Reading the pattern of the elements that make up the remnant helps to unravel the connection between the pulsar and the star from which it formed. The expanding shell is 36 light-years across. The blue knots of emission contain material that is enriched in oxygen, neon and magnesium.

Ultraviolet camera reveals active galaxy

Active galaxy, M81. (ESA.)

This image was taken using the ultraviolet camera on XMM-Newton. Strong ultraviolet emission is a feature of star formation, supernova explosions and matter building up round black holes. The hottest regions are blue and highlight areas of intense star formation.

One of XMM Newton's strong points is that it can combine ultraviolet and X-ray data to give an idea of the processes at work across the spectrum. This helps in the case of M81, which belongs to a class of galaxy called low-ionization nuclear emission-line regions (LINERs). It is not certain what processes are at work in the centre of LINER galaxies. They could be fueled by starbursts – regions of intense star formation – or they may be a sort of mini-quasar, with a supermassive black hole round which gas and stars accrete slowly.

Astro-E2 gets thumbs up from Japanese

Astro-E2, the X-ray space observatory that is programmed for launch in February 2005, has been given the go-ahead by the Japanese government. NASA will contribute the core instrument – the high-resolution X-ray spectrometer that operates at 0.1° above absolute zero. Five X-ray telescopes will be used to focus the X-rays onto four X-ray cameras and the spectrometer. The satellite replaces the Astro-E project, which was lost in launch in February (April 2000 p11).

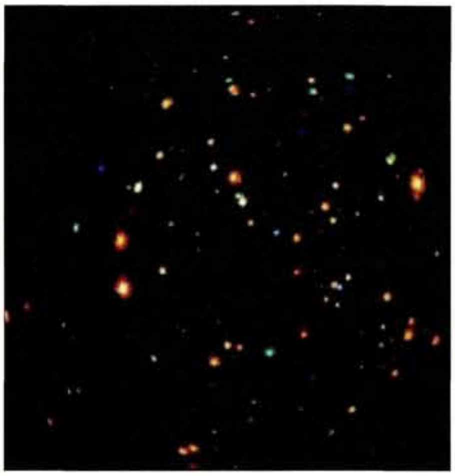
Deep field is full of surprises

The "deep field" images of the depths of outer space revealed by the Hubble Space Telescope left astronomers speechless. Here, for the first time, on a region of sky less than the size of a pinhead held at arm's length, hundreds upon hundreds of galaxies were revealed. The faintest and often the most distant objects in the universe gave an unprecedented view of the early formation of galaxies. Five years on, the image still symbolizes the power of a telescope that has revolutionized observational astronomy.

Now, Chandra and XMM-Newton have revealed X-ray versions of this famous image. What was before seen as simply a diffuse X-ray background glow on the sky can now be resolved into individual sources. The number of X-ray photons and the energy levels coming from each object can be measured.

X-rays from approximately half of the sources are probably emitted by material accreting round supermassive black holes. The other sources are weaker, and in several cases they are fairly near. In these galaxies the emission is likely to be the net result of the X-rays coming from several bright sources within the galaxy, such as stellar-sized black holes in binary systems, the hot gas within the galaxy and the remnants of supernova explosions.

One focus for research has been to observe the X-ray output from galaxies known as SCUBA sources (the Submillimetre Common User Bolometric Array first surveyed them). These luminous, dusty, star-forming galaxies radiate at infrared wavelengths and make a significant contribution to the total energy output of the universe. XMM-Newton observations show that the X-ray output is dim, suggesting that the galaxies are powered by intense bursts of star formation in the early universe, rather than by an obscured massive black hole at their centre.



XMM-Newton's X-ray deep field view. (ESA.)

In future, cross-checking the XMM-Newton and Chandra data will reveal objects with an X-ray output that varies with time. We haven't heard the last of the Hubble Deep Field.

Telescope rockets to success

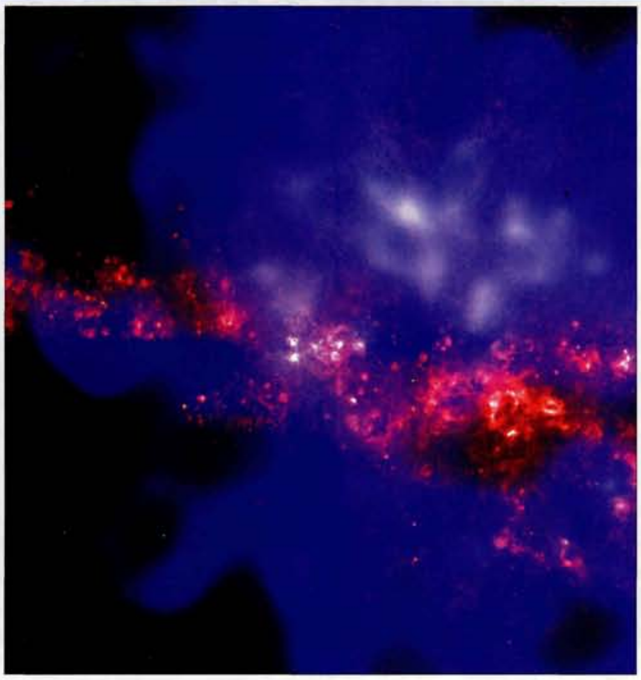
A low-cost alternative to current X-ray satellite observatories has made a promising start. Whereas traditional X-ray telescopes use grazing incidence mirrors, which are relatively inefficient (see box, p10),the new telescope, known as J-PEX, uses a multilayer coating on a normal incidence mirror, oriented as in an optical telescope. This gives greater sensitivity (because few photons are lost) and a much smaller payload.

As a comparison, J-PEX has half the effective area of the Chandra low-energy transmission spectrometer but 10 times the resolving power. The disadvantage is that multilayer mirrors only function in a very specific wavelength range.

J-PEX was flown on a NASA sounding rocket fom the White Sands Missile Range in New Mexico. It observed its target star for five minutes before parachuting back down to Earth. The experiment was carried out by astronomers from the UK and the US.

Classified pages start on p35

Picture of the month



Using Chandra and the Hubble Space Telescope, astronomers have mapped the giant halo of hot gas that extends above the disk of a spiral galaxy, much like the Milky Way. The observations of galaxy NGC4631 indicate that there must be a close correlation between the outflows of hot gas seen in X-rays and the galaxy's magnetic field revealed by radio emission. The gas radiates at almost 3 million degrees and extends some 25 000 light-years from the galactic plane. (NASA.)

Non-X-ray news: UK is set to join ESO

On 1 July the UK will become the tenth member state of the European Southern Observatory (ESO). The other member states are Belgium, Denmark, France, Germany, Italy, the Netherlands, Portugal, Sweden and Switzerland.

ESO is Europe's major astronomy organization, operating world-class telescopes in the Chilean Atacama desert. When ESO was created nearly 40 years ago, the UK then chose a different route, using new southern hemisphere facilities in Australia.

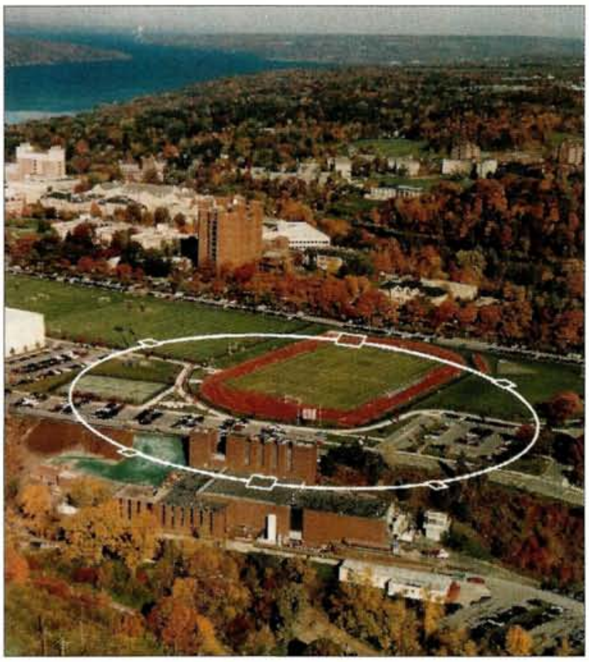
In addition to paying its ESO contributions in the normal way, the UK will be supplying the VISTA infrared survey telescope as an in-kind contribution.

Prior to taking up residence in its headquarters at Garching, near Munich, Germany, ESO was based at CERN.

Cornell's laboratory is at the crossroads

In 1979, Cornell University switched on the Cornell Electron Storage Ring, ushering in more than two decades of pre-eminence in the physics of b quarks. With the b-quark crown now passing to the B-meson factories at California's Stanford Linear Accelerator Center and Japan's KEK laboratory, Cornell is plotting a new course for its flagship facility.

The Cornell Laboratory for Nuclear Studies was established in 1946 by scientists returning from Los Alamos after the Second World War. Its given mission was "to investigate the particles of which atomic nuclei are composed and to discover more about the nature of the forces which hold these particles together". Under Robert R Wilson's guidance, a succession of electron accelerators ensued, culminating in a $10 million proposal for a 10 GeV machine to be built under the university's sports grounds. By the time this was completed, in 1968, Wilson had moved on to become the founding director of Fermilab, but during his time at Cornell he had instilled in the laboratory a "can-do" spirit that remains to this day. Wilson believed in value for money and in getting things done by being clever, no matter how tight the budget.



Football field physics: the Cornell Electron Storage Ring runs beneath the university's sports fields.

By the 1970s, following pioneering work in the early 1960s at Frascati (p27) and the Stanford Linear Accelerator Center (SLAC), colliding beam machines were gaining ground. Cornell's new director, Boyce McDaniel, decided to build an electron-positron collider at Cornell using the 10 GeV synchrotron as an injector. His first task was to convince the National Science Foundation, Cornell's main funding agency, that a synchrotron could provide the necessary positron currents for such a machine. Happily for Cornell, accelerator expertise was on hand in the form of Maury Tigner, who had built a table-top electron storage ring in 1959 while a student of Wilson's. Tigner had also been the first scientist to bring the idea of building an electron-positron collider to Cornell following conversations with Bjørn Wiik at Hamburg's DESY laboratory. It was natural for McDaniel to appoint Tigner as project leader.

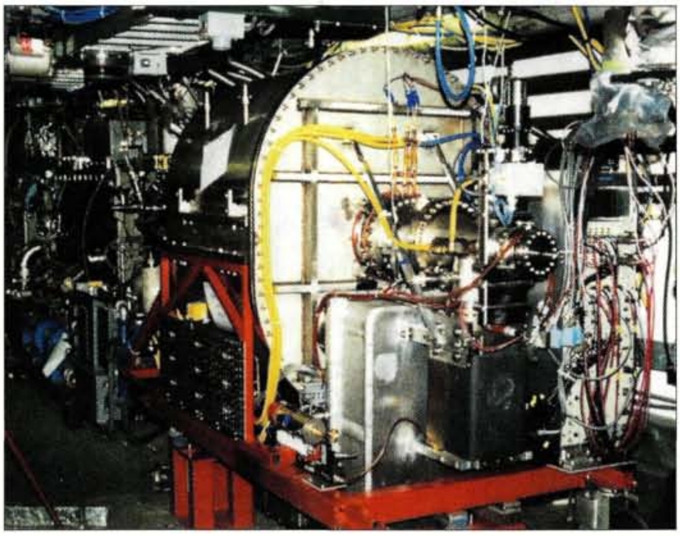
Building the storage ring

Tigner's immediate challenge was to find a way of getting an intense beam of positrons into the proposed electron-positron storage ring. With the linac that Cornell used to feed the synchrotron, the process of building up a single intense bunch of positrons by accelerating individual bunches through the accelerator chain would be a long and difficult one. Tigner's solution, which was later described as "fiendishly clever" by Karl Berkelman (the laboratory's director through much of the Cornell Electron Storage Ring era), overcame the problem by accelerating multiple bunches and then coalescing them through a sequence of particle gymnastics in the synchrotron and the storage ring.

Under Tigner's scheme the storage ring would be 61/60 of the circumference of the synchrotron and it would be filled with 60 bunches. In this way each bunch – starting with bunch number 2 – could be diverted into the synchrotron in turn. After n – 1 turns in the synchrotron, bunch n would be aligned with bunch 1 and could be reinjected into the storage ring, where it would coalesce.

The physics motivation for building a storage ring received a boost in November 1974 when the J/psi particle was discovered by Burton Richter at SLAC and by Sam Ting at Brookhaven. Six months later, Cornell submitted its proposal. It was then that the facility acquired its grand title. "For a while it was open season on creative names," ▷

Members of the CLEO collaboration in front of their detector.



Superconducting radiofrequency in CESR.

recalled Berkelman. "One of the wackiest I remember was suggested by Hywel White: CORNell COlliding Beams, or CORNCOB." Eventually McDaniel ended the debate with Cornell Electron Storage Ring (CESR).

In 1979, CESR collided its first beams using Tigner's novel coalescing scheme and the facility ran this way for several years. It was the first step in a proud tradition of Cornell particle gymnastics that would see CESR hold the world luminosity record for many years and that would be copied by other labs around the world. In the pursuit of ever-higher luminosity for CESR, Cornell physicist Rafael Littauer came up with the idea of putting more bunches in the storage ring by making the beams follow eccentric, pretzel-shaped orbits. Later on, Robert Meller's idea of colliding the beams at a small angle, thus permitting yet more bunches, allowed the luminosity to be pushed still higher. Both of these ideas have been adopted by other labs and allow CESR to run today with a total of 45 on 45 colliding bunches in the ring.

A question of serendipity

The discovery of b anti-b quark bound states – upsilon particles – by Leon Lederman's group at Fermilab in 1977 was "a fabulously serendipitous gift of nature that would guarantee the productivity of CESR for decades", said Berkelman. The resonance found by Lederman's group had a mass in the 9.4–10.4 GeV range, precisely where CESR would be looking. This was an extremely happy coincidence for Cornell, since the size of the ring, and hence its energy range, was determined by no more fundamental a parameter than the size of Cornell's sports ground.

CESR's detectors, CLEO and CUSB, soon resolved Lederman's resonance into three separate peaks and McDaniel chose to announce the lab's new facility to the world in the form of a greetings card showing these peaks (p15). The more orthodox announcement came in the form of CLEO's first paper, which was submitted to *Physical Review Letters* in February 1980. Cornell went on to play a leading role in the world of b-quark physics until 2000, when the dedicated B factories at SLAC and KEK came into operation.

Serendipity is not the only thing that has kept Cornell in the world particle physics spotlight. "We take accelerator physics and technology very seriously as a branch of physics," said Berkelman. It is this approach that has turned Cornell into a recognized centre of excellence in the field, with influence well beyond its Ithaca campus. Many innovations in accelerator physics, such as the concept of a linear collider and the innovation of an energy-recovery linac, have found fertile ground at Cornell over the years.

Superconducting radiofrequency is Cornell's forte, with a tradition going back to the 1960s. Cornell was first to apply superconducting RF technology to cyclic accelerators for particle physics, installing a superconducting cavity in the 10 GeV synchrotron as early as 1975. This presented quite a challenge, since heat-load due to synchrotron radiation could easily warm the cavities to above their critical temperature. The technology developed for the synchrotron was adopted for the Continuous Electron Beam Accelerator Facility (CEBAF) – now known as the Jefferson Laboratory – in Virginia, the construction of which began in 1987 and occupied a large part of the Cornell group.

By then, Hasan Padamsee, who chose to remain at Cornell, was promoting the idea of superconducting RF for linear colliders, and in 1990 Cornell hosted the first TESLA workshop. This time it was Bjørn Wiik's turn to take home an idea, and DESY soon became the standard bearer for the TESLA project.

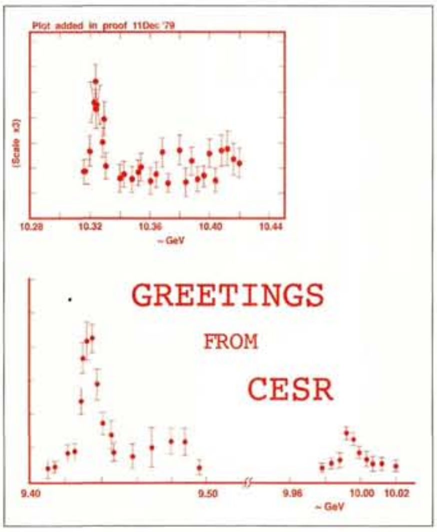
Today, Cornell remains at the forefront of accelerator R&D, and the tradition that began when CEBAF adopted Cornell technology continues. As well as being used at CEBAF and TESLA, superconducting RF technology pioneered at Cornell is now finding applications in light sources, free-electron lasers, spallation neutron sources and radioactive ion-beam facilities.

From b to c

Now that the b-quark crown has passed to SLAC and KEK, CESR has mapped out new realms to conquer. True to the Wilson spirit, the laboratory has defined a programme that will provide important contributions to the interpretation of the new B-factory data and play an important role in the future of lattice QCD.

For the first year of the new era, CESR will drop down in energy to the narrow upsilon resonances to complete unfinished b-quark business. Then, if the CESR-c/CLEO-c proposal, which was submitted in October 2000, is approved (*CERN Courier* November 2001 p22), CESR will be adapted to deliver high luminosity throughout the 3–10 GeV energy range. The lab will then focus on charm quark physics. Where it will differ from previous tau charm factory proposals is that CESR-c is not about tau and not entirely about charm either. The new proposal is just as much about B physics.

Charm-quark-containing D mesons provide a natural laboratory for learning about QCD. The number and precision of the measurements possible with CLEO-c will allow theorists to test and establish the range of validity of calculational tools for addressing QCD – such as lattice techniques. This will then determine the ultimate precision of B physics, since QCD uncertainties will be a major contribution to the errors in B-factory results and the same calculational methods are essential there. Pinning down the QCD parameters at Cornell will provide an important input to B-factory analyses and keep Cornell on the B-physics map.



Cornell's 1979 announcement to the world about its electron storage ring.

CESR-c's contribution to lattice QCD came again through serendipity – via a coincidence of meetings at Cornell in January 2000. When the experimenters were discussing ways of putting meat on the CESR-c/CLEO-c proposal, about a dozen lattice theorists from around the world were meeting at Cornell to discuss exciting plans to incorporate quark loops into their calculations. This, they believe, will allow lattice calculations to produce predictions at the few-percent level for the first time. It turned out that the parameters that CLEO-c will be measuring are those that the theorists will be calculating. So the CESR-c/CLEO-c proposal became a combination of experiment and theory, and the lattice theorists now find themselves in the unusual position of racing an experiment to get predictions out before the measurements. The CESR-c/CLEO-c programme, if approved, will keep CESR in business for another four to five years.

Developments through CHESS

It is not only in particle physics that CESR has an enviable track record. Even before CESR was operational, Neil Ashcroft and Bob Batterman proposed building the Cornell High-Energy Synchrotron Source (CHESS), which would be parasitic on CESR's beams. CHESS has notched up an impressive number of firsts, such as the structure of the common cold virus, nanosecond diffraction and work on X-ray standing waves. Developments at CHESS catalysed much of the protein crystallographic revolution that is now under way at synchrotron X-ray sources, including CCD detectors and the cryoloop freezing method. Although small, CHESS has contributed to almost a fifth of the most significant protein structures that have been solved.

For the future, CHESS director Sol Gruner is pinning his hopes on dedicating CESR to X-ray use and on a new kind of accelerator – an Energy Recovery Linac (ERL) – using TESLA-like cavities. The ERL is a next-generation light source that will produce brighter beams and shorter pulses than available at even the best synchrotrons, thereby opening up new science directions. An advantage of an ERL source is that it will also serve almost all existing X-ray synchrotron source applications, and ERLs would complement Free-Electron Laser (FEL) sources, which are also being developed as next-generation sources. By contrast, FEL sources would provide peak X-ray intensities sufficiently high that new experimental techniques will have to be developed.

Whereas synchrotrons recycle electrons, an ERL will recycle energy. The idea is to accelerate a beam in a linac, bend it round to the start of the linac and then decelerate it to extract energy that will be used to accelerate the next bunch. Synchrotron radiation will be available as the electrons are returned to the linac. The advantage over synchrotrons is that the intensity of the bunch is exploited to the full, since it makes only one pass and does not settle to an equilibrium state. This means that the beam characteristics are limited by the injector, not the lattice. An ERL would also bring timing flexibility, because bunches could be delivered with any time structure required, and that would allow the investigation of the time development of processes. Cornell is working with Jefferson Laboratory, where a small ERL has been successfully built as a proof-of-principle machine.

Cornell is a small laboratory. CESR and CLEO share a common control room, with one rack of electronics between them, and CHESS is not far off. For Maury Tigner, now the laboratory's director, this intimacy is part of Cornell's strength. "We treasure our association with the X-ray science," he said. "It is a living example of the unity of science." Tigner also draws attention to the benefits for students of having a front-line research atmosphere on campus. Cornell typically has some 50 undergraduates involved with the CESR programme each year, as well as graduate students. "One thing we see as a very important contribution is the training of students in accelerator physics and technology," said Tigner. The presence of on-campus accelerator facilities allows students in accelerator physics the same kind of hands-on training that students in other branches of experimental physics can receive.

The Cornell trustees who defined the lab's mission back in the 1940s would have good reason to be pleased with the way their lab has evolved. Cornell has maintained a position at the cutting edge of particle physics research for more than half a century – a unique achievement for a university lab.

Further reading

D Andrews *et al.* 1980 *Phys. Rev. Lett.* **44** 1108 (CLEO's first physics paper).

H Padamsee 2001 The science and technology of superconducting cavities for accelerators *Supercond. Sci. Technol.* **14** R28–R51.

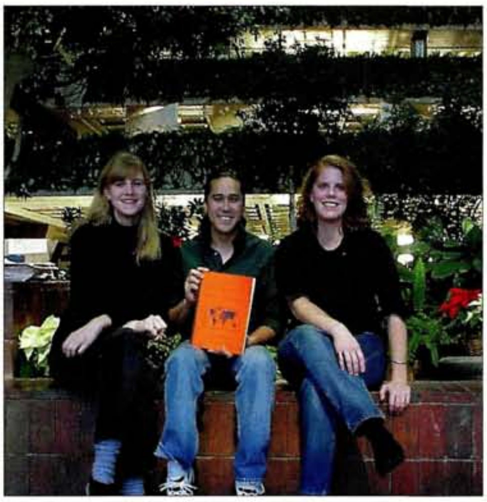
The Cornell Laboratory Web site is at "http://www.lns.cornell.edu/".

Survey helps US with long-range planning

A group of young US physicists recently conducted a survey to find out where high-energy physics is heading. The results reveal that growing internationalization makes physicists at isolated centres aim for hands-on access to research elsewhere. The survey also showed a need for more outreach to stimulate and maintain public interest, together with a lamentable lack of job opportunities.

Last year the US particle physics community mounted one of its periodic long-range planning exercises to provide a roadmap for the subject over the coming decade. The recommendations from this study, which was conducted by the High-Energy Physics Advisory Panel (HEPAP) of the US Department of Energy and the National Science Foundation, have been published (p5).

As one conduit to this review, a Young Physicists Panel (YPP) was established by Bonnie Fleming of Columbia, John Krane of Iowa State and Sam Zeller of Northwestern to provide a platform and consensus view for younger researchers. Originally the YPP hoped to provide a brief summary document. However, the survey revealed instead that most respondents did not have a single opinion to convey, making the conclusions more difficult to digest, but at the same time probably more valuable.



Young Physicists Panel members (left to right) Sam Zeller of Northwestern, John Krane of Iowa State and Bonnie Fleming of Columbia carried out a survey aimed at providing a consensus view for younger physics researchers. John Krane is holding a copy of the survey report.

A diverse range of questions

To be most useful to HEPAP, the survey, entitled "The future of high-energy physics", focused on US aspects and needs. Although initially designed for and oriented towards "young" physicists (defined as those yet to achieve a permanent position or tenure), the study was extended to all particle physicists, both inside and outside the US. There were some 1500 replies, most of which were received via the Web.

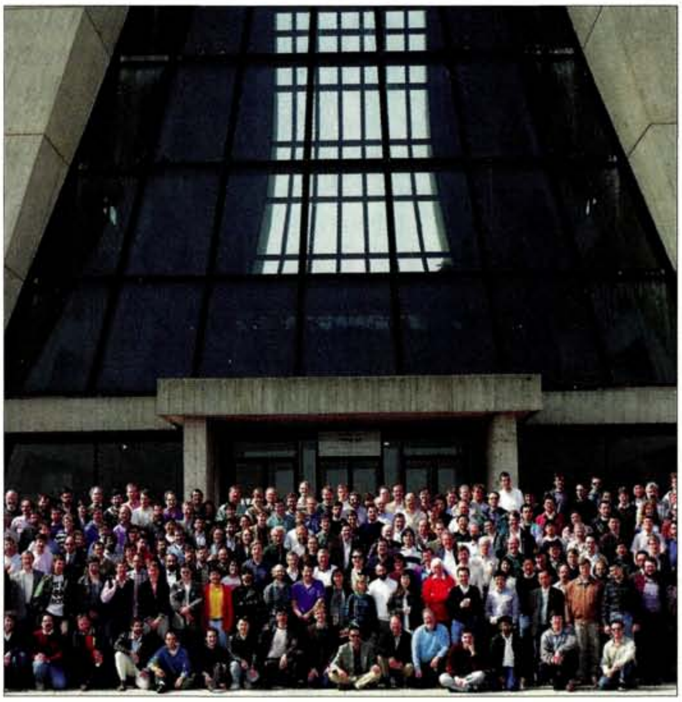
The survey began with a request for demographic and personal information – current career status, geographical origin, place of work, type of physics done and size of collaboration. The highest profiles to emerge were of a North American working in North America, or a European working in Europe, on collider physics in a team of 500–1000 people. No surprises there.

The next series of questions were aimed at "balance versus focus", asking what sort of research should be carried out at the next major physics machine to be built, how many detectors it should have and what sort of physicists it should employ.

In this section the emerging picture was of a machine supporting a diverse range of physics, with at least two detectors, employing comparable numbers of theorists, phenomenologists and experimentalists. An extra question showed that it is considered important for high-energy physics laboratories to host an astrophysics effort. Some do, some are in the process of doing so, and other laboratories have yet to satisfy this demand.

A section covering "globalization" lumped together anything to do with big science being concentrated at major centres. Most respondents admitted to seeing their detector at least weekly, so obviously they have easy access and would rather have it this way than be near their supervisor. A hands-on hardware requirement was seen as very important and, if a research centre was situated outside the US, national or regional access via a staging post was considered the best possible alternative to being centrestage.

Answers to specific questions on outreach underlined that ▷



Major physics collider collaboration: members of the Collider Detector Facility experiment at Fermilab's Tevatron.

particle physics is not doing nearly enough to communicate with either the relevant funding agencies or the general public. Half of the replies indicated that physicists were ready to dedicate more time to this important activity. (It is our opinion at *CERN Courier* that while this is very commendable, it is one thing to tick a box, but quite another to deliver. Unfortunately, few physicists have the imagination and commitment to contribute significantly to outreach activities.)

Scientific interest

The most revealing part of the survey was perhaps the one that asked participants why they had been attracted to particle physics originally and why they had remained in the field. The answers reveal that intrinsic scientific interest dominated the decision, whether for newcomers or for those further down the line. Science is clearly interesting, at least to some people, and here is a possible message for outreach.

Also very prominent was the opinion that a lack of jobs could drive young people out of the field. Another visible signal indicated that not enough talented physicists are retained. The big question that faces the field now is how to rectify this.

The remaining sections of the YPP survey focused on physics issues, and these were largely mirrored in the HEPAP recommendations. However, it was clear that opinions about the siting of future machines were polarized according to geographical base (North America or Europe). While most tenured US scientists think that it is important to have a major new facility in the US, this view is not mirrored among younger scientists.

With big issues at stake, casting a wider survey net could reveal a more global consensus within the physics community on the way to go forward.

Further reading

The YPP Web site is at "http://ypp.hep.net".

Science knows no boundaries

Physics provides a stage for international collaboration. At the opening of a recent exhibition at the Russian Duma, presented by CERN and the Joint Institute for Nuclear Research, CERN adviser for non-member state affairs, John Ellis, explained how.

First and foremost, CERN and the Joint Institute for Nuclear Research (JINR) are centres of scientific excellence. To mention just a couple of examples, at CERN, physicists discovered the massive particles that are responsible for radioactivity and made detailed measurements that established their underlying theory, resulting in two Nobel Prizes. JINR continues to play a pioneering role in both the discovery and the study of superheavy elements, one of which bears the name dubnium.

JINR and CERN are also living evidence that science knows no boundaries. CERN has 20 member states; JINR has 18. The two organizations were both founded in the years after the Second World War to enable European and other countries to contribute to fundamental physics in ways that they could not afford individually.

Now the two organizations have several member states in common, which was impossible during the Cold War. Nevertheless, CERN and JINR collaborated actively during that dark period, extending their hands to each other across the Iron Curtain. Consequently, they were able to seize the scientific and human possibilities opened up by the fall of the Berlin Wall.

JINR is now one of CERN's most valued international partners. It has joined CERN in many experiments using CERN's accelerators.

Two foundation stones

CERN and the Joint Institute for Nuclear Research, Dubna, near Moscow, were set up in 1954 and 1956 to provide a physics foundation for international collaboration. CERN set out to rebuild Western European science after the Second World War; Dubna had a similar mission for the socialist countries of Eastern Europe and further afield. Over the years, these two political spheres, isolated from each other during the Cold War, have grown closer.

Russian vice-minister of science Mikhail Kirpichnikov opens an exhibition at the Russian Duma, presented by CERN and the Joint Institute for Nuclear Research. Left to right: JINR director Vladimir Kadyshevsky, vice-director Alexei Sissakian, Alexander Olchevsky, Ivo Zvara of the Czech Academy of Sciences, Dimitry Shirkov, Nicholas Koulberg of CERN and John Ellis, CERN adviser for non-member state affairs and the author of this article.

Thousands of students have attended the advanced physics schools that have been organized jointly throughout Europe since the 1960s. Many friendships have been formed there, which have turned into international scientific collaborations that now span the world. Hundreds of JINR-affiliated scientists and engineers are now working with CERN and its other international partners on the Large Hadron Collider (LHC) project. Working together, physicists will use the LHC to study basic questions in physics, such as the origin of mass and the nature of the dark matter filling the universe.

The future

The LHC project presents unprecedented technical challenges, such as in the areas of superconducting technology, cryogenics and informatics. In the latter field, the World Wide Web was invented at CERN in the early 1990s to enable physicists around the world to share data from LEP and analyse them together. The requirements of the LHC are driving the next stage in the evolution of the Internet – the Grid – which will enable people anywhere in the world to use remote computer power, just as today the power grid enables us to use electrical energy without knowing where it was generated.

The LHC is also an unprecedented international collaboration. The accelerator is being built with important contributions from JINR, Russia, the US, Japan, India and Canada, as well as CERN and its member states. The LHC experiments are open to scientists worldwide, who currently originate from more than 80 countries. A special role is played by the International Association for the Promotion of Co-operation with Scientists from the New Independent States of the Former Soviet Union (INTAS) and the International Centre for Science and Technology (ISTC), which have facilitated the participation by many scientists and engineers from Russia in particular.

JINR is also making many important contributions to the LHC experiments, notably to CMS, ATLAS and ALICE. The JINR contibution is both direct, through its staff working at home and at CERN, and indirect, through its coordinating role for the contributions made by Dubna member states.

Fostering friendship

CERN has fostered some unique collaborations. For example, for many years it has had Indian and Pakistani physicists working together, as well as scientists from both Beijing and Taipei. Now an Iranian group is starting to work at CERN alongside Americans. In my own area – theoretical physics – CERN has had a postdoctoral fellow from Afghanistan, and another from Iran has recently written joint scientific papers with a CERN staff member from Israel.

Many of us fear that the openness of the international system is under unprecedented attack. Scientists must thus stand together to defend our common values. This joint exhibition by JINR and CERN clearly displays our common vision. We stand for scientific excellence, international understanding, dialogue to find common solutions to common problems, openness, development and progress. In the words of the Russian empress Elizabeth Petrovna, which were quoted at the exhibition, "Enlightenment of mind eradicates evil."

Fabrication at JINR Dubna of a "tile" calorimeter module for the ATLAS experiment at CERN's Large Hadron Collider. Each of the 64 modules weighs 20 tonnes. JINR also coordinates work for other major modules at both the ATLAS and CMS experiments.

John Ellis, *CERN.*

Magazine plays its part in physics history

Gordon Fraser, who has stepped down as editor of *CERN Courier*, looks at how the physics scene has changed during his time working on the magazine.

A news magazine is about developments. As scientific developments have unfolded over time, the many issues of this magazine have helped to reveal the history of particle physics.

The rate of particle physics discoveries, which was tumultuous during most of the 20th century, has slowed down. In the final years of the 20th century our knowledge and understanding reached a plateau in the Standard Model (few physicists share Murray Gell-Mann's passion for coining imaginative words where they matter).

From this plateau, the view has widened. High energy means high temperature, so that particle physics and astrophysics, and even cosmology, find themselves more and more on common ground, tracking the immediate aftermath of the Big Bang in a still-hot universe. Not that long ago it would have been inconceivable for particle physicists to be interested in what happens in the sky. Now the latest news on microwave background radiation, supernovae, black holes and gamma-ray bursters is followed enthusiastically at major particle physics meetings. Astrowatch (p10) is one of the most popular features of this magazine.

Technological stampede

The rate of pure particle physics breakthroughs may have slowed temporarily, but an accompanying rush of technological innovation continues and even accelerates. To seek the elusive particle signatures of tomorrow, large experiments involving thousands of ingenious researchers scattered across the globe are today exploiting new materials and pushing innovative techniques to achieve what seemed impossible only yesterday.

The World Wide Web is just one example. Take telecommunications, microelectronics, cryogenics etc. At no time in history has technology been advancing so rapidly. Fundamental science is the spring from which many of these developments flow. Physicswatch (p9) monitors this evolution.

Visiting CERN recently was Mike Lazaridis, the president and co-chief executive of Research in Motion of Canada. He is a leading designer and manufacturer of wireless communications equipment. As a great believer in the importance of fundamental physics for society, Lazaridis is personally funding the Perimeter Institute in Southwestern Ontario – an institute dedicated to theoretical physics.

From news editor to new editor

Starting with this issue, James Gillies takes over as editor of *CERN Courier*, succeeding Gordon Fraser, who has been a major contributor to the magazine since his arrival at CERN in 1977 and its official editor since 1986.

New editor – James Gillies.

The new editor is no newcomer to physics or physics writing. He began his career as a graduate student at Oxford working on CERN's EMC experiment in the mid-1980s. Moving on to the Rutherford Appleton Laboratory (RAL), he then became increasingly interested in communicating science, working for a summer with the BBC World Service Science Unit; setting up a regular local radio science spot; and producing public information material for RAL.

In 1993 he left research to become the head of science at the British Council in Paris. After managing the council's bilateral programme of scientific visits, exchanges, bursaries and cultural events for two years, he returned to CERN in 1995 as a science writer, and was soon installed as news editor of *CERN Courier*. He co-wrote, with Robert Cailliau of CERN, *How the Web was Born* – a history of the World Wide Web, which was published by Oxford University Press in 2000.

Lazaridis said: "Theoretical physics gave rise to virtually all of the technological advances of present-day society. From lasers to computers and from cellphones to magnetic resonance imaging, the road to today's technological developments was based on yesterday's groundbreaking theoretical physics."

A continuing theme at CERN is international collaboration. The universal culture of physics brings people and nations together, ▷

surmounting political and other barriers. CERN was the first example of scientific international collaboration in post-war Europe. As well as furthering research in its member states, CERN helped to catalyse new contacts further afield, where contact was difficult because of politics or recent history. Even in the depths of the Cold War, there was contact between scientists at CERN and their counterparts in the Soviet Union (p18).

Dwarfs and giants

The Geneva laboratory has gone on to become an even wider stage. Building the detectors for CERN's proton-antiproton collider in the late 1970s and early 1980s demanded a major international effort, mainly in Europe. However, even this is being dwarfed by the operations now under way worldwide to construct the Large Hadron Collider and its mighty detectors. While G8 powers and lesser giants naturally play an important role, being part of this effort is a source of great pride for nations that would otherwise not be able to participate in such prestigious research.

Today's Standard Model may be a plateau of understanding, but it is not the ultimate summit of knowledge. Particle physics is poised to enter the next act in a drama for which the script has yet to be written. To understand a universe of unfathomable complexity will demand fresh insight and imagination.

Describing the ultimate physics is a continual challenge. Quantum mechanics pioneer Paul Dirac pointed out: "The new theories...cannot even be explained adequately in words at all." And that was back in 1930.

Fundamental science attracts keen minds. Working with these intellects is rewarding, but demanding. Articles written for a wide audience are not always welcomed by specialists who quickly point to the verbal inadequacies anticipated by Dirac. In constructing the intellectual cathedral of science, attributing individual recognition is particularly difficult. The world's great lasting monuments may have been designed by far-sighted architects, but they were built by protracted teamwork.

Words aid comprehension. Francis Bacon (1561–1626) wrote in *Novum Organum*: "The ill and unfit choice of words wonderfully obstructs the understanding." In a field where terminology is not always adopted for its transparency (quark fragmentation means exactly the opposite of what it implies), *CERN Courier* is widely appreciated. Its decoding of physics jargon is particularly welcomed by the world's media. Above all, it delights in its use of that supremely functional instrument – the English language – which remains highly resilient to the abuse heaped upon it.

Further reading

A Courier's career published in the High-Energy Physics Libraries' Webzine at "http://library.cern.ch/HEPLW/3/papers/1/".

Gordon Fraser. Gordon Fraser has been commissioned by Cambridge University Press to be editor-in-chief of a new edition of *New Physics*, an anthology of contributions spanning the whole range of physics and its applications. The first edition of the book appeared in 1989 under the responsibility of Paul Davies.

CERN Courier travels far with publishing partner

The magazine you are reading is distributed all over the world. **So-Mui Cheung** of the Institute of Physics Publishing in Bristol, England, explains how this is achieved.

CERN Courier magazine has come a long way since it was established as CERN's house journal more than 40 years ago in 1958.

Soon after the magazine's launch, it began to reflect particle physics developments worldwide, as well as what was happening at CERN. In 1975 a major world meeting of particle physics laboratory directors underlined the importance of the journal in serving the worldwide particle physics community, and the decision was taken to "go international", with official correspondents in major research centres feeding in news, and with special arrangements for distribution in certain countries. Hence the paradox of a CERN magazine that is distributed all over the world.

Printing CERN Courier *at Warners (Midlands), England.*

This network of international correspondents is still in place and it is the lifeblood of the magazine. Another important aspect of *CERN Courier* is the distribution network that exists to get the magazine to its readers.

From printer to reader

CERN Courier is published 10 times a year in parallel English and French editions (the official languages for all important CERN documents). For each issue around 18 000 copies of the English edition and 5500 copies of the French edition are printed and distributed worldwide.

With a total of 23 500 copies, *CERN Courier* is read far beyond the particle physics community, which accounts for about half of the total. Reader surveys have shown that the additional readership is mainly scientist-administrators, scientists in other fields and students, all of whom want to keep up with developments in basic physics without wanting to get too involved with details.

In the 1990s it became clear that the magazine could not continue to evolve while being published using CERN's limited inhouse resources. In 1998, responsibility for the production and distribution of the magazine passed to the Institute of Physics Publishing (IOP), in Bristol, England, which now publishes the magazine on CERN's behalf. The editor at CERN retains responsibility for all of the editorial content, but the 1998 transition was a turning point in the magazine's development.

A complex route

The task of distributing each edition of *CERN Courier* is both complex and challenging. The total print run of each issue weighs around 3 tonnes and has to be sent all over the world. Since IOP entered into a publishing partnership with CERN, it has been improving the distribution performance to shorten the time it takes for the journal to reach its readers. The magazine is available free of charge, so this distribution also has to be as economical as possible.

Readers can receive *CERN Courier* in two ways:

- via internal distribution at major research centres – to receive the magazine regularly, please check with your local distribution centre;
- via subscription (10 900 named subscribers, normally based at more isolated locations, receive individually mailed and addressed copies) – to become a regular reader via this route, see the information under the magazine's masthead (p3).

Coming off the press, each edition of *CERN Courier* splits into three separate routes:

- within the UK, where copies leaving the printer for individual readers in Europe and the rest of the world are polythene-wrapped and labelled for onward mailing;

- onwards to the US, where it is mailed and despatched to addresses in North America. For these readers, copies travel by truck from the printer to a freight handler, who books it onto a flight to New York. From there it goes on another truck to Illinois to be either enveloped and mailed, or packed in boxes and despatched to major research centres;
- bulk deliveries to major distribution centres in Europe and further afield, including Beijing, CERN, Hamburg, Frascati, Moscow, Seoul and 16 other destinations.

CERN Courier *product manager So-Mui Cheung of IOP.*

Plans for improvement

The Rutherford Appleton Laboratory (RAL) in the UK, DESY in Hamburg and INFN in Frascati play a special role in the distribution of *CERN Courier* within their respective countries. Because of the logistics involved, RAL receives copies direct from the printer, while the other two centres currently receive their copies via Belgium. An initiative is already under way to establish closer links with these major distribution centres and to enhance the distribution performance further. CERN has a particularly heavy distribution load, sending copies all over the world as well as distributing them within the laboratory.

By the time the magazine arrives on a reader's desk or is taken from a central pick-up point, its journey will have included rides on trucks, ferries and aeroplanes. It will have been scanned by customs officials and handled by international and national shippers, not to mention being sorted and distributed within major centres.

During 2001 we were able to reduce delivery times by, on average, four days for copies sent to individually mailed addresses. In a similar way, 4–10 days have been cut for those copies travelling to the US. There is still room for improvement, not least because of the rapidly changing world scene for postal and courier services. Soon we will implement a much-needed overhaul of some of the address lists. Readers who receive copies mailed from Europe should soon expect to receive a letter and a reply coupon as well as an issue of the magazine.

There are key people at the major distribution points who ensure that you receive your copy of *CERN Courier* each month. These are low-profile yet vitally important roles that ensure that mailing lists are up to date and that centres receive enough copies.

We are in contact with most of these key people, but not all. The magazine's distribution network has in many cases developed by itself. A closer collaboration will help to improve the distribution of the magazine continuously, so if you have a role in this, please contact me.

So-Mui Cheung, *Institute of Physics Publishing.*
E-mail "somui.cheung@iop.org".

Polarized colliders key in mapping out p

Arcane complication or vital property? Opinions about particle spin differ, but those who feel strongly about it say that more spin has to come into collision.

The problem with proton spin is that it does not add up. A recent workshop, which was held at the European Centre for Theoretical Studies (ECT) in Trento, Italy, brought together 34 leading theorists and experimentalists from 12 countries to discuss the theoretical and experimental status of the "proton-spin problem", to identify the key quantities and to formulate a strategy for measuring them.

Particular emphasis was given to comparing the contributions expected from new polarized (spin-oriented) scattering experiments at CERN, DESY (Hamburg) and SLAC (Stanford), polarized proton-proton collisions at Brookhaven's new Relativistic Heavy-Ion Collider (RHIC), an electron-ion collider (EIC), also at Brookhaven and a possible new polarized HERA electron-proton collider at DESY.

For polarized HERA, the spin of the existing proton beam would be made directional. Looking further ahead, the THERA scheme plans to use electrons from the TESLA superconducting electron-positron linacs and polarized protons in HERA.

Missing spin

Polarized scattering experiments at CERN, DESY and SLAC in which the incident beams probe deep inside the target particles suggest that only about 20-30% of the proton's spin is carried by the intrinsic spin of its quark and antiquark constituents - less than half the prediction of quark models. Where is the spin coming from? This mystery has inspired vast theoretical and experimental activity to analyse and understand the spin structure of the proton.

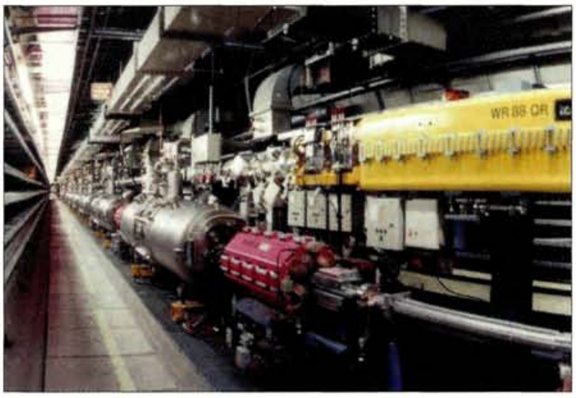
The present status of experimental data from fixed-target experiments was reviewed by Alessandra Fantoni (Frascati and HERMES) and Fabienne Kunne (Saclay and SMC/COMPASS). Detailed presentations also covered polarized deep-inelastic measurements at small parton momentum x (x is the fractional momentum of the quark; Barbara Badelek, Uppsala), hard exclusive processes (Moskov Amarian, NIKHEF) and nuclear effects (Valeria Muccifora, Frascati). Albert De Roeck (CERN) and Naohito Saito (RIKEN-Brookhaven) reviewed the new physics possibilities at polarized electron-proton colliders (HERA, THERA and EIC) and at polarized proton-proton collisions at RHIC.

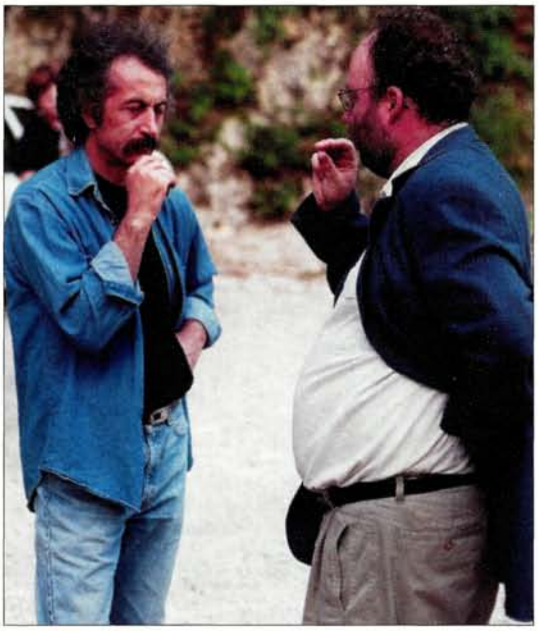
The spin decomposition of the proton was discussed in the opening talk by Robert Jaffe (MIT), who underlined the theoretical subtleties in the definition and measurability of quark orbital angular momentum and the physics prospects for measuring spin from transversely polarized targets.

The prospects for measuring the spin-flavour structure of the proton were discussed by Jechiel Lichenstadt (Tel-Aviv), Giovanni Ridolfi (Genova) and Gaby Rädel (Palaiseau), who emphasized that tightly confined sprays ("jets") of particles from quark-antiquark pairs deep inside high-energy, polarized electron-proton collisions provide a "gold-plated" measurement of gluon polarization in the proton. This mechanism is not dependent on theoretical interpretation.

Steven Bass (Trento) stressed the possible connection between the spin structure of the proton and the long-range gluon dynamics that are responsible for the unaccountably large mass of the η' meson (the famous "U(1) problem" of quantum chromodynamics). These ideas could be tested through elastic neutrino-proton scattering, which provides complementary information about the spin

may prove to be the proton spin structure





Left: Brookhaven's RHIC will soon be handling polarized protons. Electrons could also be on the menu. Above: time for spin? The HERA electron–proton collider at DESY, Hamburg. Right: Albert de Roeck (right) of CERN and Moskov Amarian (NIKHEF, Amsterdam) at the recent spin workshop in Trento.

structure of the proton. Rex Tayloe (Indiana) reported on an exciting possibility for a definitive neutrino–proton elastic experiment using the miniBooNE set-up at Fermilab.

Polarized electron–proton colliders could map out the spin-dependent structure function, g_1, down to x of about 10^{-4}, providing powerful new constraints on small x physics in addition to decisive measurements of gluon polarization in the proton. Pointing out complementary studies, Anthony Thomas (Adelaide) emphasized that polarized deep-inelastic scattering at large x (almost unity) is a sensitive probe of the valence quark structure of the nucleon. Precision measurements of the large-x region are planned at Jefferson Laboratory.

Sum rule status

In polarized photoproduction, the present status of tests of the Drell–Hearn–Gerasimov (DHG) sum rule was reported by Klaus Helbing (Erlangen) and Zein-Eddine Meziani (Temple). The DHG sum rule relates spin-dependent total cross-sections to the anomalous magnetic moment of the proton target and is derived from fundamental principles. Any violation of this sum rule would challenge our present understanding of spin in QCD.

The theory and status of spin transfer reactions, in which the spin of both the target and the outgoing particle is measured, was discussed by Jacques Soffer (Marseille). The potential of polarized colliders to probe new physics was reviewed by Jean-Marc Virey (Provence). Contributions were made on developments in QCD parton phenomenology, transverse polarization observables, single-spin asymmetries and exclusive channels, and this motivated a great deal of discussion about the physics potential of future experiments to unravel the spin structure of the proton.

The workshop ended with a presentation and comparison of the physics prospects of polarized electron–proton collider projects – polarized HERA (Albert De Roeck, CERN) and the electron–ion collider (EIC; Abahy Deshpande, RIKEN-Brookhaven and Witek Krasny, Paris), which are currently under discussion respectively at DESY and, particularly, at Brookhaven. A workshop on the EIC project is scheduled for March 2002 at Brookhaven. Possible future fixed-target programmes were also discussed by Wolf-Dieter Nowak (DESY-Zeuthen).

Polarized proton–proton and electron–proton colliders are potentially a very useful tool for the investigation of the spin and chiral structure of any new physics beyond the minimal electroweak Standard Model that might be revealed with the corresponding unpolarized colliders. Building on the programme of polarized proton–proton collisions currently under way at RHIC in the US, it is worthwhile to investigate the physics potential of future polarized proton–proton collisions in CERN's LHC. The workshop revealed considerable enthusiasm within the spin community for possible future developments with the LHC.

Steven D Bass, *ECT, Trento and* **Albert De Roeck**, *CERN.*

The INFN marks half

The Italian Istituto Nazionale di Fisica Nucleare recently celebrated its 50th anniversary. **Elisabetta Durante Romano** looks at the origins of the institute, its subsequent development and its role in today's major collaborations.

Celebrating 50 years: (front row, left to right) Luciano Maiani, Nicola Cabibbo and Carlo Rubbia at the opening ceremony of the INFN anniversary event.

Istituto Nazionale di Fisica Nucleare president Enzo Iarocci speaking at the opening ceremony of the 50th anniversary of the institute's foundation. On his left is Edoardo Vesentini, president of Accademia dei Lincei.

The Istituto Nazionale di Fisica Nucleare (INFN) is the direct heir to Enrico Fermi and Bruno Rossi's eminent pre-Second World War schools of physics. Its purpose remains the same – to investigate the innermost structure of matter, a curiosity-driven research that over the years has led to a deep exploration of nature and that today motivates physicists to "draw a picture of the Big Bang".

As Giorgio Salvini, former Italian minister for universities and research, recalled, the institute first wanted to equip itself with an accelerator – the most powerful at the time. "Fermi himself had suggested aiming high in energy...as it was new physics," said Salvini. Fermi – the last truly universal physicist – also suggested building an electronic calculating machine, the first prototype of which at Pisa soon made possible the first commercial computer in Italy.

INFN president Enzo Iarocci recalled the history of the institute and some of its most important achievements: international success linked to the names of Rubbia, Cabibbo, Maiani and Zichichi. During the celebrations, these scientists described their view of the challenges of yesterday, today and tomorrow.

Nicola Cabibbo underlined the international extent of the research. "Discoveries [in this field] do not guarantee immediately profitable applications. Nevertheless, this kind of research stimulates great industrial interest, as experimental requirements continuously force technology to move on," he said.

Fermi suggested building an electronic calculating machine, the first prototype of which made possible the first commercial computer in Italy

After recalling Fermi's foresight and farsightedness, CERN director-general Luciano Maiani highlighted the INFN commitment to his laboratory and explained the expectations of the Large Hadron Collider (LHC) and other international projects.

For Antonino Zichichi, the major physics themes to be pursued in the coming years include matter–antimatter symmetry, quark–lepton flavour mixing, supersymmetry and dark

a century of research

INFN milestones

1953 INFN actively participates in the foundation of CERN. Edoardo Amaldi is its first general secretary.
1959 The Frascati National Laboratory, equipped with a 1100 MeV electron synchrotron, is built.
1960 Led by Bruno Touschek, the first electron–positron collider is built at Frascati.
1968 The Legnaro National Laboratory, near Padua, is created for the study of nuclear physics and its applications.
1969 The Frascati National Laboratory starts operating the ADONE electron–positron collider.
1975 The Southern National Laboratory is created in Catania for nuclear physics research. Later it is equipped with a superconducting cyclotron for heavy ions.
1986 The Gran Sasso National Laboratory is established for research in astroparticle physics.
1990 The Bologna Centre of Computing is nominated to manage the Italian Research Network.
2000 the European Gravitational Observatory is created for the development of the VIRGO project.
At present, 5000 people, including employees, associated university professors, scholarship holders and postdoctoral and other students, participate in INFN activities.

matter – all of which are challenges that he views with both enthusiasm and optimism.

Nobel prizewinner Carlo Rubbia looked forward to a spectacular scenario. "The new and fundamental role of particle physics is far from being complete. Recent astronomical observations have demonstrated that 95% of the universe is made of dark and exotic matter and energy, still invisible and unknown: this necessarily implies the existence of new kinds of elementary particle and of elementary vacuum," he said. Experiments with accelerators, such as the LHC, can offer important contributions, but other avenues of research must not be neglected and they can open the way to new and promising studies. Rubbia added: "It's time to start a new and fascinating discovery game."

Stimulating students

Included in the proceedings was a meeting entitled "Building the future" at which INFN scientific perspectives in various research fields were considered – from nuclear physics to elementary particle and astroparticle physics. Among those attending were high-school student winners of the INFN contest – From atoms to quarks: a trip to the heart of matter. The aim of the contest was to stimulate students' curiosity in physics and its fundamental research.

Current research at INFN

Field	Research
Subnuclear physics	DAFNE, the electron–positron collider at Frascati for research on CP violation; a significant INFN contribution to CERN towards the Large Electron–Positron (LEP) collider and now towards the Large Hadron Collider (LHC) project; involvement in the Tevatron at Fermilab, on PEP II at SLAC and HERA at DESY.
Nuclear physics	As well as working at national laboratories, Italian physicists collaborate at DESY, the Jefferson Lab in the US, the European Synchrotron Radiation Facility and the ALICE project at the LHC.
Astroparticle physics	The Gran Sasso National Laboratory is dedicated to the study of rare phenomena and cosmic particles. This underground research centre is the most advanced in the world. From CERN it will receive a beam of neutrinos with which to study neutrino oscillation. Neutrino physics is also the goal of the NEMO submarine project, while the high-altitude ARGO laboratory in Tibet focuses on cosmic rays. The interferometer VIRGO has been established in Pisa for the observation of gravitational waves. In the search for dark matter and antimatter in space, INFN collaborates in important space missions, using technology and instrumentation from particle physics.
Applied physics	INFN applied research includes medicine (cancer diagnosis and treatment); humanitarian purposes (draining of mined territories); and culture (analysis and prevention of the deterioration of the artistic heritage).
Computing and data handling	INFN, which is now the Italian partner in the European GRID project, developed the APE computers.

The closing day, dedicated to human resources, traced INFN history through people, recalling the institute's spirit and tradition, where intellectual authority rules and where human relationships are not submerged by hierarchy. ▷

Presidential praise

During the opening ceremony of the 50th anniversary celebrations at the Accademia dei Lincei in Frascati on 12–14 November 2001, the President of Italy, Carlo Azeglio Ciampi, said: "The Istituto Nazionale di Fisica Nucleare foundation's 50th anniversary is evidence of the continuing effort of an excellent scientific tradition. The institute has contributed internationally to promote the quality and the prestige of the Italian school of physics".

> Fermi...professor of theoretical physics in Rome, [was] working with a group of brilliant young students...known as the "ragazzi di via Panisperna".

When INFN was born in 1951 it was paradoxically already 20 years old: its origins date back to Enrico Fermi and Bruno Rossi's schools of physics and to 1930s research in nuclear physics and cosmic rays. In 1926 Fermi became professor of theoretical physics in Rome, working with a group of brilliant young students who became known as the "ragazzi di via Panisperna" (the via Panispera boys).

The milestone 1931 International Congress in Nuclear Physics held in Rome was the first platform to make the new Italian physics more visible to the external world and it opened the way to an extraordinary fertility of ideas and results by Fermi's group in particular and within nuclear physics in general.

Soon, national political developments led to anti-Semitism and the disintegration of the group. On 6 December 1938 Fermi and his family left Italy for Stockholm, where he was awarded the Nobel Prize for Physics. From there he moved directly to the US and Rossi soon followed.

Despite enormous difficulties, research in Italy continued during the Second World War and it eventually led to major scientific and political achievements. It was time for both a national and an international relaunch of research via a general coordination of resources at both a local and a European level.

On 8 August 1951 INFN was created, with its first branches in Rome, Turin, Milan and Padua. Six months later, Edoardo Amaldi was designated general secretary of the institute and was also entrusted with the foundation of CERN.

Further reading

The INFN Web site is at "http://www.lnf.infn.it/50esimo/".
G Battimelli 2001 *L'Istituto Nazionale di Fisica Nucleare. Storia di una comunità di ricerca* Laterza ed. Roma-Bari.

Elisabetta Durante Romano.

APPOINTMENTS

Canada's IPP gets new director


Richard Keeler.

Richard Keeler has been appointed for a five-year term as director of the Institute of Particle Physics of Canada (IPP) after ending his term as chairman of the subatomic grant selection committee of the Natural Science and Engineering Research Council of Canada (NSERC).

The institute, which receives its funding from NSERC, is a non-profit-making organization owned by several academic and research institutions throughout the country. It is responsible for the coordination and support of Canadian involvement in subatomic physics research, both within the country and abroad. The institue hires several research scientists who work in these institutions and it has around 150 individual members.

One of the institute's major roles is to coordinate Canada's participation in subatomic physics in the world scene. The director represents Canada within such bodies as the Global Science Forum of the Organization for Economic Co-operation and Development and the international commitee for future accelerators. The institute also participates in the organization of international conferences, both at home and abroad.

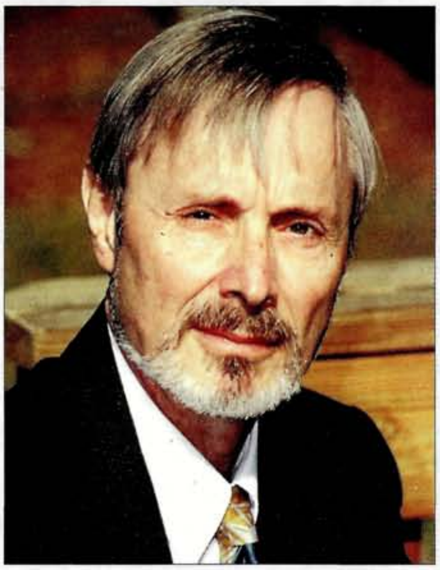
Women on top: Quinn to head APS

SLAC theorist Helen Quinn has been elected vice-president of the American Physical Society (APS) and will begin her term of office next year. She will then become APS president in 2004. She will be only the fourth woman to hold this position.

Originally from Australia, Quinn earned her PhD at Stanford in 1967 and returned to a permanent position in the SLAC theory group after serving as a postdoctorate student at Harvard. She shared the prestigious 2000 Dirac medal and prize with Howard Georgi and Jogesh Pati for her work on unified theories of fundamental particles and interactions. Quinn is also a Fellow of the American Academy of Arts and Sciences.

New CERN elections

At the December meeting of CERN's governing council (p4), Joel Feltesse of Saclay was elected chairman of CERN's scientific policy committee for one year from 1 January. New members of the committee are Ken Peach of the UK Rutherford Appleton Laboratory and Frank Wilczek of MIT. Both were elected for three years. Within CERN, Thierry Lagrange was appointed leader of the supplies, procurement and logistics division for three years.


Christoph W Leemann is the new director of the Thomas Jefferson National Accelerator Facility (Jefferson Lab) at Newport News, Virginia. He had served as interim director following the departure of the founding director, Hermann Grunder, for Argonne (*CERN Courier* November 2000 p40). Leemann has previously been Jefferson Lab's deputy director as well as its associate director for accelerators and a leader of the management team. He came to Jefferson Lab in 1985 from Lawrence Berkeley National Laboratory, where he had been involved in the design and construction of high-energy accelerators since 1970.

AWARDS

Samios wins Pontecorvo prize

Former Brookhaven director Nicholas Samios has been named as the 2001 recipient of the prestigious Bruno Pontecorvo prize by the Joint Institute for Nuclear Research (JINR) in Dubna, Moscow. The prize, which has been awarded annually since 1995, recognizes "the most significant investigations in elementary particle physics".

Samios is honoured for contributions both as a researcher and as a scientific administrator. In particular, he is noted for the discovery of the phi meson and the omega minus hyperon – both crucial in elucidating the underlying symmetry of hadrons, which ultimately led to the quark model.

The award will be made at JINR's scientific council meeting in Dubna on 18 January.

Institute of Physics makes 2002 awards

Among the 2002 awards from the UK Institute of Physics are the Glazebrook medal and prize to **George Kalmus**, who is chairman of CERN's scientific policy committee, for his leadership and promotion of particle physics in the UK and internationally; the Dirac medal and prize to **John Hannay** of Bristol for his outstanding contribution to theoretical physics in the areas of quantum mechanics, classical mechanics and optics; and the Kelvin medal and prize to **Peter Kalmus** of Queen Mary College, University of London for his contributions to the public understanding of physics through public talks, lectures and other activities.

The Rutherford medal and prize was awarded to **Peter Dornan** of Imperial College, London, **David Plane** of CERN and **Wilbur Venus** of the Rutherford Appleton Laboratory for contributions to the development of the detectors at CERN's Large Electron–Positron Collider and for their leadership of the ALEPH, OPAL and DELPHI experiments, respectively. The President's medal went to **Sir Martin Wood** of Oxford Instruments for his contributions to physics and its application, in particular for his entrepreneurial role as founder of Oxford Instruments.

Rubio gains award

On 20 November CERN education and technology transfer division leader Juan Antonio Rubio received the prestigious order of the Encomienda del Mérito Civil. The award was made for his scientific work, mainly at CIEMAT and CERN, for pioneering Spanish experimental particle physics and for strengthening the links between Spain and CERN. Rubio has also been elected president of the Association of Spanish International Civil Servants.

Research and European universities was the subject of the address by former French research minister Claude Allègre (left), at the 2001 award ceremony in Geneva for the prizes awarded by the Latsis Foundation. Allègre is seen here with 1992 Physics Nobel laureate Georges Charpak of CERN. Both men are great supporters of a hands-on approach to physics education.

SLAC scientist made fellow of the AAAS

Prof. Robert H Siemann of SLAC has been named a Fellow of the American Association for the Advancement of Science.

He has been recognized for his "outstanding contributions to the theory of particle accelerators and for pioneering service as founding editor of the electronic journal *Physical Review Special Topics – Accelerators and Beams*".

Siemann earned his PhD from Cornell in 1969 and served on its faculty from 1973 to 1990. He then moved to SLAC, where he leads a group that is involved in advanced accelerator research and development projects.

Cracow honours Hyams

Bernard Hyams (CERN 1957–1990) has received the title of Honorary Professor of the Institute of Nuclear Physics at Cracow in Poland "in recognition of his outstanding achievements in experimental particle physics, his role in introducing many scientists to the mysteries of modern physics and his great contribution to the development of the scientific collaboration between CERN and Institute of Nuclear Physics in Cracow".

Long-time collaborator Krzysztof Rybicki reviewed Hyams' contribution to methods and results. Hyams' work developed first into the CERN-Cracow-Munich team and then eventually into the long-running ACCMOR collaboration.

Bernard Hyams (right), his wife Hanna and Krzysztof Rybicki of the Cracow Institute.

Regler is recognized for his work in cancer therapy

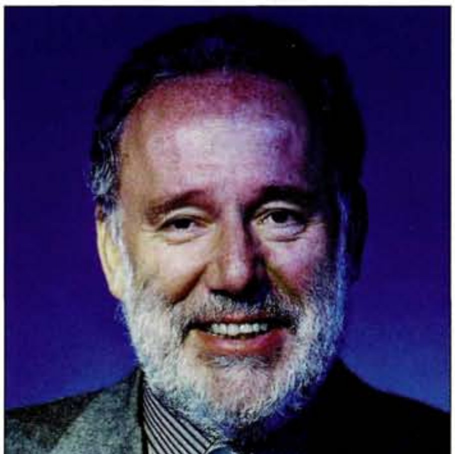
Meinhard Regler of Vienna's Institute for High-Energy Physics has been made an honorary member of the Austrian Society for Radio-oncology and Radiobiology in recognition of his contribution to the society's field of work.

After the fall of the Iron Curtain, Regler campaigned vigorously for a central European centre of physics expertise and excellence – the AUSTRON – that could help to heal political wounds. Within a decade the concept had crystallized into a neutron spallation source, but he had the foresight to include a light-ion irradiation facility for cancer therapy.

In November 1994, with the help of international partners and CERN, which hosted the accelerator study, Regler delivered the AUSTRON report, complete with its study for the cancer therapy facility, to the Austrian government . The medical facility then acquired a life of its own, becoming the Med-AUSTRON.

By 1996, Med-AUSTRON was participating in the Proton–Ion Medical Machine Study (PIMMS) – an international, in-depth study, also hosted by CERN. Within PIMMS, Regler was a strong advocate of exocentric gantry techniques and convinced the Austrian medical community of their practical advantages. In recognition of this, the PIMMS exocentric gantry has been baptized the Riesenrad after Vienna's famous ferris wheel (*CERN Courier* September 2000 p29).

With Regler's constant support and encouragement, Lower Austria has recently offered the funds needed to adapt a medical facility to serve Austria's particular needs.



Meinhard Regler – honoured for his contribution to oncology.

MEETINGS

The next **Rencontres de Moriond** workshop will be held on 16–23 March and will be devoted to the cosmological model. The event will provide an opportunity to step back and look at the journey from the beginning of modern cosmology to today and beyond.

The programme will include primordial nucleosynthesis; CMB physics; structure formation; weak lensing; galaxy clusters; galaxy surveys; the nature of dark matter; and the physics of the early universe.

Further information is available at "http://moriond.in2p3.fr/J02".

Tim Hallman (centre) of Brookhaven presided over the 16th session of the programme advisory committee (PAC) at the Joint Institute for Nuclear Research (JINR), Dubna. With him were (left to right) Vladimir Kadyshevsky, JINR director; Alexei Sissakian, JINR vice-director; Yuri Gornushkin, PAC secretary; and Igor Vasilevsky, PAC deputy secretary. Among the topics covered were the commissioning of the extracted beam from the superconducting Nuclotron for use by the international community and Nuclotron polarized beam developments. (Yu. Tumanov.)

The final Life in the Universe event, which was held at CERN on 8–10 November and was attended by hundreds of students from all over Europe, was organized by European research organizations – CERN, the European Space Agency (ESA) and the European Southern Observatory (ESO) – under the auspices of the European Science and Technology Week 2001. Present at the event were (left to right) Juan Perez-Mercader of Madrid's Centre for Astrobiology; Roger Bonnet, former ESA science director; Richard West, ESO education and public relations director; and Martin Hüber, former ESA director and one of the organizers of the event. The theme was the search for life elsewhere in the universe – are we alone, or is there life elsewhere? Participants had progressed through national competitions and had produced either a scientific project or artistic interpretations of the theme.

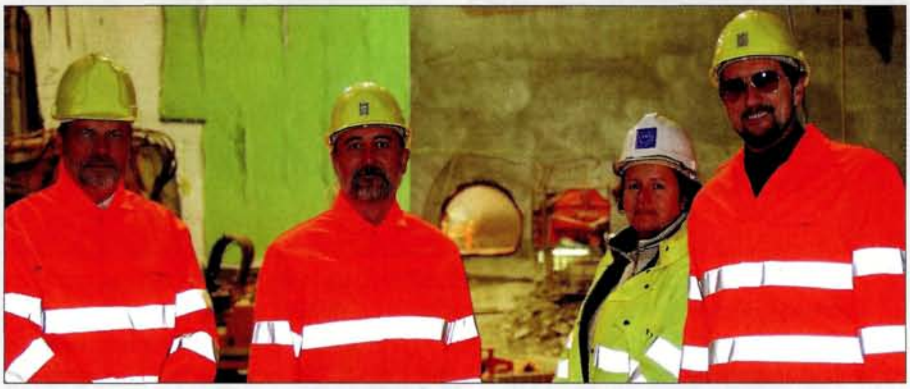
A meeting of the CERN-JINR joint scientific committee, which was held at CERN, was co-chaired by Jim Allaby of CERN and Alexei Sissakian, vice-director of the Joint Institute for Nuclear Research (JINR), Dubna, near Moscow. CERN research director Roger Cashmore expressed his gratitude to Allaby, who has chaired the committee for many years and was formally retiring from CERN. Cashmore becomes the new co-chairman. At the meeting it was announced that the general CERN-JINR agreement, which was signed in 1992 and would have formally expired this year, had been extended. In discussion are (left to right) Allaby; Cashmore; Sissakian; Alexander Olchevsky, JINR representative at CERN; Franco Bradamante of Trieste, COMPASS experiment spokesman; Igor Savin, JINR COMPASS group leader; and Nikolai Russakovitch, head of the JINR laboratory.

At the opening of the Germany at CERN trade expo, which was held at CERN on 13 November, were (left to right) Karl-Heinz Kissler, CERN supplies, procurement and logistics division leader; Bettinna Schöneseiffen, ministry of education and research (BMBF) representative; ambassador Walter Lewalter; Maximilian Metzger, ministry of education and research (BMBF) representative; and Hans Hoffmann, CERN director for technology transfer and scientific computing.

Classified pages start on p35

Attending a recent meeting of EIROFORUM at CERN were (left to right) Jerome Pamela of EFDA (the European Fusion Development Agreement) and the associate leader of JET (JET-EFDA); Colin Carlile, director-general of the Institut Laue-Langevin, Grenoble; Achilleas Mitsos, director-general of research, European Commission; Luciano Maiani, director-general of CERN; Catherine Cesarsky, director-general of the European Southern Observatory; Fotis Kafatos, director-general of the European Molecular Biology Laboratory; William G Stirling, director-general of the European Synchrotron Radiation Facility; and Jean-Pol Poncelet, director of strategy and external relations, European Space Agency. The main goal of EIROFORUM – part of the European Intergovernmental Research Organization – is to play a constructive role in promoting the quality and impact of European research.

The British ambassador to Switzerland, Basil Eastwood (left) meeting CERN director-general Luciano Maiani.



The Yugoslavian ambassador to Switzerland, Dragoljub Popovic, visited the cavern for the ATLAS experiment at CERN's Large Hadron Collider (LHC). With the ambassador (second left) were Torsten Akesson, deputy ATLAS spokesman; LHC civil engineering project engineer Simone Hajos; and Peter Adzic, chairman of the CERN–Serbia committee.

Formally retiring from CERN at the end of last year were the distinguished British physicists (left to right) Jim Allaby, John Eades and Don Cundy, all of whom began their research careers at Liverpool – at that time a leading synchrocyclotron centre.

Victor A Matveev, director of the Institute for Nuclear Research of the Russian Academy of Sciences, recently celebrated his 60th birthday. As well as having made major contributions to particle physics, he has played a significant role in the realization of projects at the Baksan and Baikal Neutrino Observatories and at the Moscow Meson Factory in Troitsk. He currently serves as chairman of the Russia and Joint Institute for Nuclear Research Dubna member states collaboration board for the Compact Muon Solenoid experiment at CERN's Large Hadron Collider.

OBITUARIES

E W D Steel 1907–2001

Lab administrators are rarely famed worldwide. One exception was E W D Steel. "Miss Steel", as she was universally called, was well known by any physicist who attended a major conference or came to CERN in the 1960s and 1970s. She arrived at CERN in 1955 after internment in France and an international career in refugee work, including settling Belsen survivors, in which she reached the rank of colonel. Within a year, she used her talents to turn the new PS group into an administratively well behaved division.

When CERN became involved in organizing international conferences, Steel was the obvious person to handle all of the invitations, the programme planning, chasing speakers who were late with their texts, helping lost Russians and making practical site and transport arrangements.

She acquired an international reputation for this work and was loaned to labs in other countries to help them with their conferences and schools.

During her time, the conference secretariat organized 39 conferences and 10 schools of physics. She was even called back after her retirement to handle the inauguration of CERN's SPS synchrotron in 1977, which was attended by 3000 participants, including the presidents of France and Switzerland and a host of ministers, ambassadors and lesser fry. The event had to be organized with the help of just one permanent assistant and local staff of varying levels of efficiency. Victor Weisskopf, at that time the director-general of CERN, described her with the words: "although not a scientist, a special member of the world community of high-energy physicists".

"Miss Steel" – a CERN pioneer.

Apart from her "duty trips", Steel travelled widely throughout Europe and Asia – to Egypt, Israel, Sinai, Kosovo, Montenegro, Cyprus, Russia, India and Pakistan. In China and along the Silk Road she reached remote places by bus and on foot – once on a camel – visiting churches and monasteries. Often on her travels she was an honoured guest of heads of labs and academies whom she had helped and taken care of at conferences. She developed an interest in Orthodox Church icons and created a significant collection, which is now in the British Museum.

Between these travels she collected and listed the corpus of 1000 reports and papers on physics carried out with the CERN bubble chambers – a task that took four years – and then spent 10 years assembling the archives of the English Church in Geneva and writing its history.

Her feeling for the needs of others was shown by her spending CERN holidays at Christmas and Easter working as a ward maid in Geneva hospitals.

To do all of this required an unusual tenacity and strength of character, which she believed came from her Wentworth family ancestry, which is symbolized in its motto "Thorough". This sums up Miss Steel very well for her friends and past colleagues.

François Zach 1970–2001

François Zach, a physicist who worked at the Institute of Nuclear Physics in Lyons and a member of the Compact Muon Solenoid (CMS) collaboration for CERN's Large Hadron Collider (LHC), died on 16 October 2001.

Following his studies at the Claude Bernard University in Lyons, where he distinguished himself as a brilliant student, Zach did his PhD at the Institute of Nuclear Physics in Lyons as a member of the DELPHI international collaboration at CERN's Large Electron-Positron collider. He defended his thesis in 1996.

With his passion for high-energy physics research, he then devoted his energies to the emerging programme for CERN's proposed LHC. He took part in the lab's LHC activities from 1996 onwards, first as a temporary teaching and research assistant at UCB Lyon-I, then as a CNRS research assistant, devoting himself to the preparation and construction of the lead tungstate crystal electromagnetic calorimeter of the CMS detector. He distinguished himself by taking up key responsibilities in prototype development and associated studies with CERN's particle beams, as well as in the construction and characterization of electronic read-out cells. His qualities as a research assistant earned him a CERN fellowship in September 2001, when he took responsibility for the calibration of the electromagnetic calorimeter.

François Zach – a gifted and competent scientist.

Zach always demonstrated exceptional courage and fierce determination in his long fight against leukaemia – an illness that struck him down many times.

A gifted, competent and efficient scientist, a warm-hearted man with great human qualities, François Zach was appreciated and respected by all at the institute and who came into contact with him in his work, both at CERN and in the many labs with which he collaborated. His loss was a terrible shock to us all and has left us with a great feeling of emptiness.

He will always remain in our thoughts.

Pierre Depasse, Institute of Nuclear Physics, Lyons.

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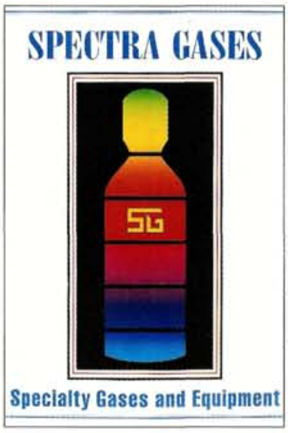

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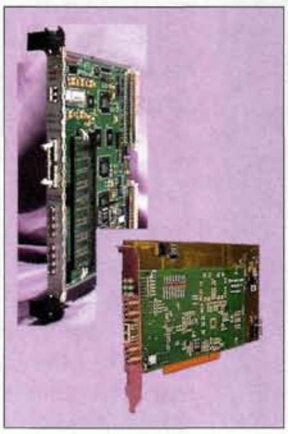

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RECRUITMENT

POSTDOCTORAL POSITIONS IN EXPERIMENTAL PARTICLE PHYSICS

The Fermi National Accelerator Laboratory (Fermilab) has openings for postdoctoral Research Associates in experimental particle physics. The Fermilab research program includes experiments with the 2 TeV proton – antiproton collider, neutrino oscillation experiments, fixed target experiments and astroparticle physics experiments. There are several positions for recent Ph.D.s to join the collider program which has completed its upgrade and begun data taking. There are also opportunities to join the neutrino oscillation experiments MiniBooNE and MINOS, the Cryogenic Dark Matter Search, the Pierre Auger Observatory (cosmic ray) project and data analysis of completed fixed target experiments. Opportunities also exist to participate in detector R&D for the future BTeV, CKM and LHC-CMS experiments. Positions associated with the experimental program are also available in the Computing Division for candidates interested in modern computing techniques applicable to HEP data acquisition and analysis.

Successful candidates are offered their choice among interested Fermilab experiments, and typically have the opportunity to participate in detector development and commissioning in addition to experiment operation and data analysis. Appointments are normally for three years with one-year renewals possible thereafter. Every effort will be made to maintain support for a Fermilab RA until she or he has the opportunity to produce physics results.

Applications and requests for information should be directed to **Dr. Michael Albrow, Head – Experimental Physics Projects Department, Particle Physics Division {Albrow@fnal.gov}, Fermi National Accelerator Laboratory, MS 122, P.O. Box 500, Batavia, IL 60510-0500.** Applications should include a curriculum vita, publication list and the names of at least three references. EOE M/F/D/V

Fermilab

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Theoretical and Experimental Postdoctoral Positions — RHIC spin physics

The RIKEN BNL Research Center (RBRC) at Brookhaven National Laboratory invites applications for theoretical and experimental postdoctoral positions for research to be carried out in RHIC spin physics. RBRC is a research center focusing on the physics program of the Relativistic Heavy Ion Collider (RHIC), hard QCD/spin physics, lattice QCD and relativistic heavy ion physics. The RBRC experimental spin physics program makes use of the RHIC collider's polarized proton capability. Members of the center include postdoctoral Research Associates (two-year appointments) and RIKEN BNL Fellows (up to five-year appointments). One theoretical postdoctoral position and one experimental postdoctoral position are expected to be offered for 2002. Members of the Center work closely with existing high energy and nuclear physics groups at BNL. Scientists with appropriate backgrounds who are interested in applying should send a curriculum vitae and have three letters of reference sent to Prof. T.D. Lee, Building 510A, Brookhaven National Laboratory, P.O. Box 5000, Upton, NY, 11973-5000, before February 5, 2002. BNL is an equal opportunity employer committed to workforce diversity.

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OHIO UNIVERSITY

POST-DOCTORAL RESEARCH ASSOCIATE IN EXPERIMENTAL NUCLEAR PHYSICS

The Department of Physics at Ohio University invites applications for a postdoctoral researcher in experimental nuclear physics. The position is renewable for up to two years with the starting date preferably in early 2002. The position will support new and ongoing physics initiatives at Jefferson Lab. Research activities will include significant involvement in detector design and development for the Hall D meson spectroscopy project, as well as studies of electromagnetic production of strangeness using the Hall B CLAS spectrometer. The researcher will be stationed at Jefferson Lab.

Applicants must have a Ph.D. in experimental nuclear or high-energy physics and experience working with hardware and software for accelerator-based experiments. Qualified candidates should send their CV, a description of research interests, details of hardware and design experience, and three letters of reference to:

**Prof. Daniel S. Carman, Department of Physics,
Ohio University, Athens, OH 45701,
Phone: (740)-593-2964 email: carman@ohio.edu**

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Northeastern UNIVERSITY

FACULTY POSITION in EXPERIMENTAL PARTICLE PHYSICS

The Department of Physics at Northeastern University invites applications for a tenure-track faculty position in Experimental Particle Physics. This position will begin in September 2002 and is contingent upon availability of funding. The Experimental Particle Physics group at Northeastern is currently a funded participant in the CMS experiment at CERN and seeks candidates who will play a major role in this project. Applicants must have a Ph.D. in Experimental Particle Physics and are expected to have advanced skills in either hardware or software. In addition, they must have an outstanding research record and show promise to excel in teaching physics at the undergraduate and graduate level. Interested candidates should submit a curriculum vitae, a list of publications, a description of research interests and skills, and the names of three colleagues who have each agreed, upon request, to write a letter of recommendation to the following:

EPP Faculty Search Committee, Northeastern University, Department of Physics, 110 Forsyth Street, Boston, MA 02115.
Information may also be sent by email to **eppsearch@neu.edu**

Northeastern University is an Affirmative Action/Equal Opportunity/Title IX Employer and particularly welcomes applications from minorities, women and persons with disabilities.

POSITIONS IN ACCELERATOR PHYSICS AT

MICHIGAN STATE UNIVERSITY

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University is seeking several highly qualified accelerator physicists or engineers with a strong background in areas related to beam dynamics and superconducting RF technology.

The successful candidates would join the ongoing design effort for an advanced Rare Isotope Accelerator (RIA) facility recommended by the DOE/NSF Nuclear Science Advisory Committee (NSAC) as the highest priority for new construction. Career opportunities exist in several areas, including:

Particle Beam Dynamics: Of particular interest are the areas of beam transport design and linac lattice evaluation.

Radio-Frequency Quadrupole (RFQ): Of particular interest are RFQ designs appropriate for heavy-ion acceleration systems.

RF Systems: Candidates familiar with several facets of RF Systems design are required, e.g., superconducting cavity characterization by utilization of computer codes such as MAFIA and RF system design including appropriate coupling and stabilizing feedback systems appropriate for superconducting cavities.

Depending on the successful applicants' qualifications, appointments will be made at the Research Associate level or at one of three ranks in the NSCL Continuing Appointment System
(see: **http://www.msu.edu/unit/facrecds/policy/nscl01.htm**).

Interested individuals should send a CV and arrange for three letters of reference to be sent directly to

Professor Richard York,
Associate Director for Accelerators,
National Superconducting Cyclotron Laboratory,
Michigan State University,
East Lansing, MI 48824-1321.

For more information, see our website at
http://www.nscl.msu.edu

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FACULTY POSITIONS IN ACCELERATOR PHYSICS AT

MICHIGAN STATE UNIVERSITY

The National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University (MSU) is seeking outstanding candidates to fill a tenure-track position in accelerator physics. Applicants with strong interests in contributing to the ongoing RIA design efforts and similar accelerator-based projects will be given the greatest priority. RIA is the highest priority recommendation for new construction in the new Long Range Plan for Nuclear Science prepared by the DOE/NSF Nuclear Science Advisory Committee (NSAC).

The successful candidate should provide a significant increase in the scope and depth of the accelerator physics program, play a leadership role in developing future facility upgrade options, and contribute to the accelerator physics graduate education program at MSU.

The NSCL is the premier rare isotope facility in the U.S. for the next decade having recently completed a facility upgrade that will increase the intensity of rare isotopes by several orders of magnitude. The NSCL has the tradition of close interaction between groups providing an ideal mix of cutting-edge technical infrastructure and an intellectually stimulating open academic environment.

The accelerator physics group is comprised of 3 tenured faculty and 7 professional scientific staff. Accelerator physics R&D has strong infrastructure support from experienced design and manufacturing groups. A program of R&D in superconducting rf technology has been initiated with requisite facilities in place.

Depending upon the qualifications of the successful applicant, the position can be filled at the assistant, associate, or full professor level. Applicants please send a resume, including a list of publications, and the names and addresses of at least three references directly to

Professor Richard York,
Associate Director for Accelerators,
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UNIL UNIVERSITE DE LAUSANNE — The University of Lausanne (UNIL) and the Swiss Federal Institute of Technology Lausanne (EPFL) — EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Professorship in the area of Observational Cosmology

A substantial expansion in the basic sciences is planned at the Lausanne site, including a significant reinforcement of physics, chemistry and mathematics and a major new effort in biological sciences and engineering. As part of this broad program, the UNIL, in close collaboration with the EPFL, anticipates the appointment of a full professor in the area of Observational Cosmology. Depending on the age and qualifications of the selected candidate, the appointment could also be made at the tenure-track assistant professor level. In 2003, he/she will become a faculty member at the EPFL, with research activities based at the Geneva Observatory in Sauverny (http://obswww.unige.ch), a well-known institution with a historical tradition of excellence.

We seek outstanding individuals with an excellent academic record and research achievements. The successful applicant will initiate independent, creative research programs and participate in both undergraduate and graduate teaching.

Starting date: October 1st, 2002 or as agreed. Applications from women candidates are highly welcomed.

For further information, please contact: professor W.-D. Schneider (wolf-dieter.schneider@ipmc.unil.ch) or professor G. Margaritondo (giorgio.margaritondo@epfl.ch) and look at http://www-sphys.unil.ch/ and http://dpwww.epfl.ch/

Applications, including curriculum vitæ with publication list, brief statement of research interests and the names and addresses (including e-mail) of at least five references, must be sent before **February 28, 2002** to the Dean of the Faculty of Sciences, Université de Lausanne, Collège Propédeutique, CH-1015 Lausanne, Switzerland.

Physics at Colliders

POSTDOCTORAL RESEARCH POSITIONS

The European Union Research Training Network *Particle Physics Phenomenology at High Energy Colliders* (HPRN-CT-2000-00149) has five open positions to work on Precision Electroweak Physics, Higgs and Top Physics, and SUSY and Alternative New Physics Scenarios, at the Universities of Granada, Karlsruhe, Nijmegen, Turin and Freiburg, starting not later than fall 2002.

Candidates should send a CV and arrange for three letters of reference to be sent to

Prof. Francisco del Aguila
Departamento de Física Teórica y del Cosmos
Universidad de Granada
E-18002 Granada, Spain

or directly to the address specified for each position at

http://www-ftae.ugr.es/network/research.html,

where further information is available.

The **Deutsche Elektronen-Synchrotron DESY** in Hamburg, member of the association of national research centers Hermann von Helmholtz-Gemeinschaft Deutscher Forschungszentren, is a national center of basic research in physics with app. 1,400 employees and more than 3,000 scientific guests from Germany and foreign countries per year. The accelerators in operation are dedicated to particle physics and research with synchrotron radiation.

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The successful candidate should have a PhD in physics. We expect good knowledge in accelerator physics and accelerator technology or a comparable qualification. Knowledge of at least one of the major programming languages is desirable. We also expect the willingness to participate in shift operations.

Payment and social benefits correspond to those in public services (BAT Ib).

Deadline for applications: 31.01.2002

Handicapped applicants will be given preference to other applicants with the same qualifications.

DESY supports the careers of women and encourages especially women to apply.

Please send your application documents to:

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email: personal.abteilung@desy.de

Bergische Universität Wuppertal

The High-Energy Physics group at the University of Wuppertal is involved in the D0 experiment and plays an important role in building the pixel detector for ATLAS. We intend to strengthen our activities in the area of detector development and are looking for a physicist to

Set up and lead an electronics lab

The position requires several years of experience in detector development, in particular in the field of electronic or optoelectronic read-out. We also expect the person to integrate into the existing projects and to have the ability to lead a group in the area of detector R&D.

The position is paid according to the German BatIb and, depending on the qualifications of the candidate can be tenured. Interested candidates should send their CV, list of publications and the names of three references until February 15, 2002 to

Prof. Dr. Peter Mättig, Fachbereich Physik,
Universität Wuppertal, Gaußstr. 20, D 42097 Wuppertal
peter.mattig@cern.ch

The University of Wuppertal intends to increase the fraction of women in research. We therefore particularly encourage women to apply.

ACCELERATOR PHYSICIST
Beam Electrodynamics Group

The Lawrence Berkeley National Laboratory is seeking an Accelerator Physicist to join the Beam Electrodynamics Group of the Center for Beam Physics, Accelerator and Fusion Research Division. The group is involved in the design, testing, and commissioning of radiofrequency (RF) and microwave devices and systems for acceleration, control, and diagnostics of charged particle beams, and in the analytical, computational, and experimental study of beam impedance and collective effects. In this position you will work on R&D in the analysis of beam impedance and collective effects, including analytical and computational studies; operation of laboratory test and experimental equipment; and planning and performing of beam-based experiments for a variety of projects and applications in particle accelerators. You will also participate in the design and development of devices and systems to control charged particle beams.

To qualify, you must have knowledge of and experience with impedance of particle accelerators, including theoretical techniques and calculation methods, and test-laboratory measurements of components. Knowledge of and experience with beam-environment interactions and collective effects, including theoretical analysis and experimental measurements on operational electron storage rings; familiarity with accelerator hardware devices and systems; and experience with RF cavities design and operations and impedance reduction of higher-order modes are also necessary. Successful candidates will demonstrate experimental skills in working with microwave and RF test and measurement equipment and a working knowledge of accelerator physics.

For immediate consideration, please complete our online application at http://cjo.lbl.gov/. Alternatively, email one copy of your resume to **afnsemployment@lbl.gov** (no attachments, please), or mail to Lawrence Berkeley National Laboratory, One Cyclotron Road, MS 937-0600, Berkeley, CA 94720, or fax to (510) 486-5870. Reference job number AF/014375/JCERN in your cover letter. Berkeley Lab is an AA/EEO.

BERKELEY LAB

UNIVERSITY OF FLORIDA

PROJECT COORDINATOR NEEDED FOR US-iVDGL PROJECT

The International Virtual Data Grid Laboratory, (http://www.ivdgl.org/), an exciting five-year technology deployment initiative funded by the National Science Foundation, is looking for an outstanding individual to act as Project Coordinator for the U.S. portion of the project, to be located at the University of Florida. iVDGL will deploy a global Grid laboratory together with US and international partners, that will be utilized by advanced scientific experiments, including those in high-energy physics at the Large Hadron Collider, nuclear physics, gravitational wave searches (LIGO), virtual observatories (NVO, SDSS) and other disciplines. The iVDGL will be based on Globus and Condor Toolkits and draw on Grid technologies from GriPhyN, Particle Physics Data Grid (PPDG) and the European Union DataGrid projects.

The position is being offered at the Assistant or Associate Scientist level (non-tenure accruing), to begin April 1, 2002 and continuing for the lifetime of the project, contingent on Federal funding. The successful candidate will co-ordinate and manage a wide variety of iVDGL activities, including the development and deployment of the laboratory infrastructure and applications, integration of the Grid toolkits and necessary further development as needed, testbed experiments, and outreach efforts. Additionally, he or she will assess progress and resources, ensure that milestones and schedules are met and work closely with the Project Directors, experiment leaders, funding agencies and other national and international Grid projects. The salary for the position depends on experience and qualifications.

For further details visit
http://www.phys.ufl.edu/~avery/ivdgl/jobs/coordinator_cern_courier.html

Applications to **Prof. Paul Avery, P.O. Box 118440, Department of Physics, University of Florida, Gainesville, FL 32611-8440, USA**
Questions by e-mail to **avery@phys.ufl.edu** or **foster@mcs.anl.gov** or phone **352-392-9264**.

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

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Faculty Positions in Communication Systems

at the Swiss Federal Institute of Technology Lausanne (EPFL)

The EPFL plans a substantial expansion in the Information and Communication Sciences. In this context, the EPFL invites applications for a "Tenure-track" assistant professor position in wireless communication systems".

The ideal candidate has demonstrated excellence in research and teaching and has a background in communication theory, physical layer communications, signal processing for communications and related areas (e.g. detection and estimation, coding, information theory, software radios and adaptive signal processing). He/she is expected to participate in EPFL's research initiatives in communication systems, and in particular in the new national research center on mobile information and communication systems (see www.terminodes.org), where issues related to ad hoc networking and self organized communication systems are studied. His/her teaching duties will typically include basic communication and signal processing courses, as well as graduate level courses on his/her field of research.

Assistant professors with "tenure-track" are part of the faculty, benefit of full independence, have a competitive salary and receive support from the EPFL in terms of start-up packages (research assistants, lab equipment, running costs and secretarial support).

More information about EPFL and its Department of Communication Systems at http://www.epfl.ch and http://dscwww.epfl.ch.

Applications, including curriculum vitae with publication list, concise statement of research interests (three pages or less) and the names and addresses (including e-mail) of at least five references, should be sent as soon as possible, but not later than February 28, 2002 to:

Professor Jean-Yves le Boudec - EPFL
Chairman of the search committee
CH-1015 Lausanne, Switzerland

For any information, please contact Mr. Jacques Bovay:
+41.21.693.56.38 or jacques.bovay@epfl.ch

Foundation FOM

The Foundation for Fundamental Research of Matter (FOM) stimulates and coördinates fundamental physics research in the Netherlands. For that, she is enabled by grants from the Dutch government through the Dutch Organisation for Scientific Research (NWO). FOM receives funds from NWO, Euratom, EU and several companies. The 1000 employees approximately, mainly scientists (including PhD students) and technicians, are divided over five laboratories and approximately 100 departments at general and technical universities. FOM - founded in 1946 - is a foundation recognized by NWO.

FOM

The Kernfysisch Versneller Instituut is a university institute funded jointly by the University of Groningen (RuG) and the Dutch Foundation for Fundamental Research on Matter (FOM). The KVI operates the superconducting cyclotron AGOR (K=600) for research in nuclear physics. The AGOR cyclotron, with its very advanced ancillary equipment, has a wide appeal to the international nuclear physics community. The AGOR facility has been recognized together with the partner institutes TSL Uppsala and IKP/Forschungszentrum Jülich as the large-scale facility LIFE (Light-Ion Facility Europe). The KVI is looking for a

Staff Physicist accelerator group (f/m)

The accelerator group is responsible for operating, maintaining and developing the AGOR cyclotron facility.
The group consists of three staff physicists and ten technicians for operation and maintenance. Expert technical support is provided by the technical departments of the KVI. The tasks of the staff physicist are
- Theoretical and experimental study of the beam dynamics in the cyclotron.
- Provide expert level support to the operators and users of the facility.
- Responsibility for projects to improve the performance of the facility.
- Assist in the operation and maintenance of the facility.
- Contribute to the education program of the KVI and the physics department of the University of Groningen.

Profile
- A recently completed university education in (technical) physics or a related subject.
- First job experience, equivalent to PhD level, required.
- Experience with and interest in computational physics.
- A broad interest in relevant fields, such as accelerator physics, control systems, cryogenics, RF techniques and electronics.
- Team worker.

Information
For further information on this position contact dr. S. Brandenburg, phone +31-50-363 25 73/ +31-50-363 36 00, email brandenburg@kvi.nl
Information on the facility is found on our website www.kvi.nl

Terms of employment
Initial appointment for two years followed by tenure in case of good performance.
For candidates with a suitable experience in accelerator physics and technology direct tenure will be considered. Salary up to a maximum of € 49,351 gross per year, depending on education and experience. Career perspective in case of excellent performance: annual salary up to € 55,117 gross. The employee is admitted to the ABP Pension Scheme.

Application
Applicants are requested to submit a curriculum vitae addressing specifically scientific and technical qualifications, a list of publications with an indication of the most relevant for the application and the names and addresses of three references before 1 March 2002 to Kernfysisch Versneller Instituut, attn. Mrs. A.M. van der Woude (Personnel Dept.), Zernikelaan 25, 9747 AA Groningen, The Netherlands, or by email landstra@kvi.nl

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Faculty positions in transmission and technologies for telecommunications

at the Swiss Federal Institute of Technology Lausanne (EPFL)

The EPFL invites applications for a tenure track Assistant Professor position at its School of engineering. We seek an outstanding individual with an interdisciplinary vision and a strong record of research accomplishments.

The new professor will develop a first rate research and teaching program in one or more areas related to telecommunication technology (physical layer), for instance novel optical communications techniques, satellite communications, wireless local loop, component-system issue. Interdisciplinary vision and industrial experience are assets.

The position requires teaching talents and the capacity to guide students, Ph.D. students and young researchers. Please contact Prof. Philippe Robert for more information (+41.21.693.26.07, philippe.robert@epfl.ch).

The EPFL is a top, internationally oriented Institute of Technology which offers competitive salaries, substantial start-up packages and excellent research and teaching facilities. The EPFL invites women to apply.

Applications, including a curriculum vitae with publication list, brief statement of research interests (three pages or less) and the names and addresses (including e-mail) of at least five references should be sent before March 15, 2002 by writing to:

Professor Michel Declercq, Dean
EPFL
CH-1015 Lausanne, Switzerland.
More information on EPFL: http://www.epfl.ch

GSI Darmstadt

the German National Laboratory for Heavy-Ion Research, a member institute of the Helmholtz-Society of German Research Centers, invites applications for

Postdoctoral positions in Electronics and Computing

in the Department of Data Processing and Experiment Electronics

- **Subdivision: Computer Systems and Networks - Code: 2300-02.1**
  to join a team extending and further developing network-based PC systems running Windows NT and 2000. The migration to Windows XP including Terminal Server Edition and IIS will be a major task.
- **Subdivision: Digital Electronics - Code: 2300-02.2**
  to join a team designing, developing, and maintaining hardware-oriented software and test systems for data acquisition hardware of nuclear experiments at GSI. The use and programming of DSPs, JTAG, and FPGA will be the main task.
- **Subdivision: Digital Electronics - Code: 2300-02.3**
  to join a team designing, developing, and maintaining digital systems and circuits for the data acquisition of nuclear and high energy physics experiments. The development of discrete and integrated circuits will be the main task.
- **Subdivision: Experimental Data Processing - Code: 2300-02.4**
  to join a team designing, developing, and maintaining an object oriented software system to be used for data analysis of nuclear experiments at GSI. The development of class libraries focused on applications will be the main task.

In all cases a PhD in Nuclear or Particle Physics or Electronics or Information Technology is required. Practical experience in PC technologies or digital electronics or data analysis, software development, and object-oriented programming would be preferred. This is an opportunity to develop state-of-the-art hardware and software for one of the outstanding sites of heavy-ion physics.

All appointments will be limited to 3 years. Applicants should not be older than 32 years. Women are especially encouraged to apply for the position. Handicapped applicants will be given preference to other applicants with the same qualification.

For more information please contact: M.Richter@gsi.de

Applications including the appropriate code should be submitted not later than February 15, 2002 to:

GESELLSCHAFT FÜR SCHWERIONENFORSCHUNG MBH
PERSONALABTEILUNG
POSTFACH 11 05 52
D-64220 DARMSTADT

Cosmic Rays at Earth by Peter K F Grieder, Elsevier Science, ISBN 0444507108, €190.59/$207.

This book is a remarkable collection of graphs, tables, data and relevant discussions about cosmic-ray physics. As the subtitle, *Researcher's Reference Manual and Data Book*, suggests, this is neither a text nor a tutorial, but a valuable resource for scientists in cosmic-ray research and related fields of physics and astrophysics.

In 1984 Peter Grieder of Bern co-wrote, with O C Allkofer of Kiel, a 379-page reference manuscript in the *Physics Data* series of the Karlsruhe Fach-informations-zentrum (*Cosmic Rays on Earth* ISBN 03448401) which contained much useful data and has been widely used. Following the death of his co-writer, Grieder has undertaken the daunting task of revising, updating and expanding the work by himself. In view of the significant quantity of new data appearing over the past two decades, this is most appropriate. The result is a comprehensive 1112-page, hardcover volume.

Over the past two decades there has been a significant migration of physicists away from traditional accelerator-based particle physics into particle astrophysics (the current, more erudite, term for cosmic-ray physics). This is perhaps nowhere more apparent than in the formation and direction of major cosmic-ray collaborations by Jim Cronin and Sam Ting, both of whom are Nobel laureates in accelerator-based particle physics.

Mature physicists moving into cosmic-ray-related research from other areas should find this book a particularly valuable source of cosmic-ray knowledge. Of course, it is not intended to replace the role of classic texts such as Thomas Gaisser's *Cosmic Rays and Particle Physics*. It covers cosmic rays in the atmosphere, at sea level, underground, underwater and under ice; the primary radiation; solar phenomena; and cosmic-ray history.

In view of the current lively interest in neutrino oscillations and the interpretation of data from Kamioka, Gran Sasso, Homestake, Soudan, Lake Baikal, Antarctica, the Mediterranean Sea and elsewhere, these detailed discussions are highly useful. They may also reflect Grieder's close connections with the DUMAND and NESTOR underwater detector programmes.

There is a substantive discussion of, and data compilation related to, neutrinos,

Cosmic-ray array at an international symposium on very-high-energy cosmic rays, which was held in Campinas, Brazil, in 2000: (left to right) Gaurang Yodh, Jim Cronin and Peter Grieder.

including both atmospheric and solar neutrinos, the latter as part of the chapter on heliospheric phenomena.

There are also comprehensive chapters in each section devoted to protons, neutrons, heavier nuclei, electrons, positrons and gamma rays (as well as muons and neutrinos). The existing data relevant to major problems and projects currently in progress are well presented. This includes such issues as the primary cosmic-ray spectrum and composition above the GZK cut-off; the confusion concerning the elemental composition in the neighbourhood of the "knee"; questions surrounding the primary antiproton flux; and the limits on primordial antimatter cosmic rays. The author presents this vast accumulation of data without editorial prejudice, so he resists noting which data should be regarded as most reliable and which should be accepted with scepticism.

The latter portion of the book includes useful reference material, such as the "optical, etc properties of water and ice"; parameters of the atmosphere (pressure and temperature versus height above sea level); the "solar elemental abundances"; and tables and graphs of muon dE/dx versus energy in various substances. There is even a full-page table of the many cosmic-ray observing stations around the globe - past and present - together with the altitude and atmospheric overburden of each.

This book is certain to become a standard reference for scholars in the cosmic-ray community, as well as for students and for other physicists and astrophysicists whose activities interface with cosmic-ray issues. Certainly, many of this book's graphs and tables will be superseded by more precise, forthcoming data from Superkamiokande, Kascade, ACCESS, IceCube, the Pierre Auger project and the many other ongoing and future cosmic-ray research activities, but its value as a reference will surely continue well into the 21st century - until someone else with Grieder's breadth of comprehension and boundless energy steps forward to undertake another revision.

Lawrence Jones, University of Michigan.

An Introduction to Particle Accelerators by Edmund Wilson, 2001 Oxford University Press, ISBN 0198508298 (pbk), ISBN 0198520549 (hbk).

Having designed real accelerators himself and having spent the last nine years at the helm of the CERN Accelerator School, Edmund (Ted) Wilson is well placed to write this book, which is an excellent introduction to a fascinating field of activity.

The book provides students with an understanding of the basic physics of particle accelerators and conveys the flavour of their technology and applications. As such it fills a useful gap between journalistic descriptive works and landmark reference books, in that it treats the reader as an intelligent scientist or engineer, willing to invest some time in the understanding of the principles invoked, yet presents the information in an attractive and digestible form.

In this respect the introduction to the subject via the history of accelerators is certainly a good way to keep the reader interested while nevertheless introducing essential concepts. But, as we all know, to understand does not necessarily mean to learn, and the inclusion of a small set of exercises at the end of each chapter is an effective way of encouraging those who really want to learn about, rather than become simply acquainted with, the subject. Having the answers at the end of the book is a real encouragement to try the exercises.

After the historical introduction to the subject, the main body of the book is devoted to the behaviour of beams of particles and the methods that are used to focus, bend, accelerate and control them. In addition to classical linear theory, the mechanisms and problems associated with nonlinearities, resonances, space charge, instabilities and synchrotron radiation are all introduced.

There follows a well balanced description of the increasingly varied applications of these devices. The final chapter, giving an outline of promising ideas for accelerating beams of particles that have not yet resulted in practical machines, should stimulate students who are interested in pursuing this path into adopting or inventing new techniques to achieve ever-more efficient machines.

This is not the only book on the subject, but it does serve as a well written and well balanced introduction – not only for students, but also for anyone drawn into the field in a related scientific, engineering or administrative capacity. The layout of the book is clear and the text is backed up with a wealth of good illustrations. Readers requiring a deeper insight into one aspect or another of the subject are invited to consult more specialized works, all of which are cited in the excellent bibliography.
Tom Taylor, CERN.

Nucleus – a Trip into the Heart of Matter by Ray Mackintosh, Jim Al-Khalili, Björn Jonson and Teresa Peña, Canopus Publishing, ISBN 0953786838, £14.95.

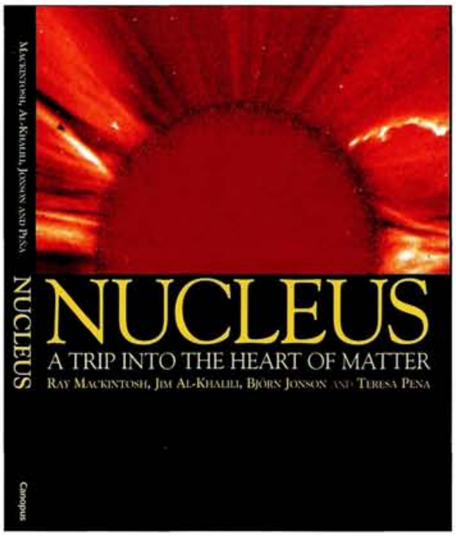
A lot of care and attention have gone into this attractive book. The authors are all eminent nuclear physicists who have developed an interest in outreach and public awareness of science, and it shows. Around their text, the book has been tastefully designed and illustrated, depicting the quest to unravel the ultramicroscopic structure of matter, particularly during the 20th century.

The keynote is the book's nuclear physics standpoint. Fundamental particles and their constituent quarks and gluons are only mentioned in passing, but this is no obstacle.

Physics is a collection of natural phenomena, but it needs physicists to interpret it and to make it understandable, and the book continually underlines the role played by pioneers like Rutherford, Hofstadter and Mottelson. After introducing the nuclear structure of our everyday world, it goes on to point out a wider nuclear landscape – the wealth of synthetic unstable isotopes and their production, behaviour and properties.

As well as its ominous implications for warfare and its still-considerable contribution to power supply, nuclear physics has a range of applications in medicine, industry, the environment and even the home, essentially through the manufacture of radioisotopes, which again are well documented and illustrated in this book.

Nuclear physics provides a prolific source of power on many different scales. At the



beginning of the 20th century, physicists did not even understand what made the Sun shine. The subsequent understanding of the role of nuclear mechanisms in astrophysics evolved slowly through the work of major figures, like Hans Bethe and William Fowler. At this point of history the book strangely deviates from its policy of presenting cameo portraits of key researchers.

Modern cosmologists try to work out what happened in the first tiny fraction of a second after the Big Bang. The universe had reached the ripe old age of one second before any nuclei appeared on the scene. Having carefully traced the role of nuclei back to this entry point, the book ironically ends.

There are a few minor errors – Rutherford is introduced twice and a bubble chamber photograph of the discovery of the positron is upside down. Perhaps the advertised selling price is another error. How can such an attractive book be made available so cheaply? *Nucleus* is one of the first books to be produced by Canopus, a new force in popular science publishing. Buy it while stocks last.

Practical Applications of Radioactivity and Nuclear Radiations by G C Lowenthal and P L Airey, Cambridge University Press, ISBN 0521553059.

At a time when applications of nuclear and particle physics are gaining ground in environmental sciences, life sciences, nuclear energy and materials research, this book is a welcome new arrival. Mainly it addresses practical applications in industry, but it also covers medical and energy sciences. The development of novel concepts in radiation detection and particle accelerators for basic subatomic physics, with potential for future applied use, make it particularly timely.

The first half of the book is dedicated to the basics of nuclear physics for non-expert readers. For this reason, some of the latest phenomena are not covered and the terminology is not always in line with that of the most recent literature of nuclear science. The book provides information for practical work with radionuclides, including the basics of radioactive decays, interaction of radiation with matter and radiation detectors. The guiding principles for working with radioactive sources in both industrial and laboratory environments are well covered. Procedures for estimating dose rates in different environments are also discussed. Measurements and results receive attention, with the book providing guidance for data analysis from radiation measurements.

Applications in industry and the environment are covered in the second half of the book. There is a detailed description of techniques based on the interaction of radiation with matter, using examples covering transmission, scattering, absorption and activation by beta particles, protons, alpha particles, photons and neutrons. Applications discussed include paper analysis, moisture meters, neutron radiography, multi-element analysis, sterilization and polymerization. Radiotracer techniques are also broadly covered, with detailed formulation in flow measurements with radioactive tracer isotopes. Radionuclides in the environment are covered, both for naturally occurring and for man-made radioisotopes.

In short, this book is a sound addition to the limited literature dealing with applications of radioactivity and radionuclides. It also serves as a useful reference source for those working professionally with accelerators and radioisotopes.
Juha Äystö, NuPECC.

Forward Physics and Luminosity Determination at the LHC edited by Katri Huitu, Valery Khoze, Risto Orava and Stefan Tapprogge, World Scientific, ISBN 9810247346, £48.

These are the proceedings of a workshop held in Helsinki, in 2000, which covered both theoretical and experimental aspects of the topic.