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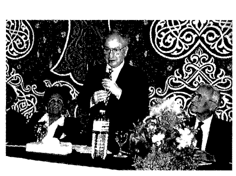


*Cover photograph : With their shared enthusiasm to push back the frontiers of knowledge, physicists can bridge political and ideological barriers. A historic meeting on high energy, condensed matter and environmental physics in Dahab, Sinai, in November brought together Egyptian, Israeli, Jordanian and Palestinian researchers. Sergio Fubini of Turin and CERN speaks at the opening ceremony, flanked by Egyptian Minister for Scientific Research Venice K. Gouda (left) and President of the Israeli Academy of Science and Humanities Jacob Ziv (See page 21 - Photo Maurice Jacob).*

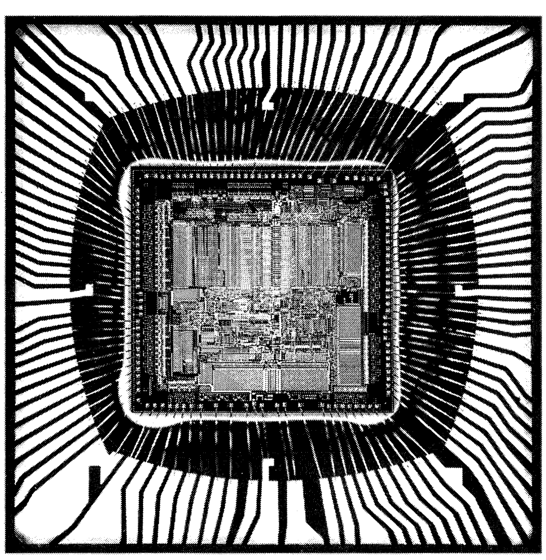
With its core business in defense and aerospace electronics, THOMSON-CSF SEMICONDUCTEURS SPECIFIQUES (TCS) has been involved for many years in radiation hardened technologies. The first one implemented at TCS was Silicon On Sapphire (SOS). However, with the need for complex radiation hardened digital IC's requiring submicron goemetries, SOS proved impractical to reach such lithographic levels due to the high defect density within the silicon layer, inherent to the sapphire/silicon interface. This is why TCS developed the SOI technology (Silicon On Insulator) based on SIMOX (Separation by IMplantation of OXygen) substrates. The materiel compatibility between the active and insulating layers yields the high quality substrates required for submicron geometries from 0,8 μm available today down to 0,5 μm and 0,35 μm in the future.

With regards to radiation performance, SOI is latch-up free by construction and, thanks to the low value of the active silicon layer thickness, it brings dramatic improvements over epi CMOS in terms of upset performance, both heavy ions and protons or prompt dose induced. On top of these intrinsic advantages, TCS' SOI technologies have been hardened to total dose effects, thus providing effective solutions for any type of radiative environment.

Achieving radiation performance goals and circuits electrical performance plus integration density is always the result of an optimization. From the starting SIMOX substrates, TCS has developed two types of SOI processes depending on the optimization factor :

- **HSOI3HD** (1,2 μm) and **HSOI4HD** (0,8 μm) for applications requiring top performance total dose and /or upset behaviour.
- **HSOI4CB** (0,8 μm) for radiation hardened complex IC's where electrical performance and integration density have to be similar to the epi CMOS ones : in that case, the process has been designed so that the physical design rules are compatible with conventional CMOS ones, thus allowing an easy hardening of an existing CMOS design by simply porting it on HSOI4CB (as an example, TCS has ported the popular 68020 32-bit microprocessor on this technology to reach more than 100 kRads total dose performance together with a 100-fold upset rate improvement over its epi CMOS counterpart).

With such an approach, TCS offers state-of-the-art solutions for all applications ranging from space, strategic and tactical defense equipments, to high energy physics (particle accelerators) or nuclear power plants electronics.



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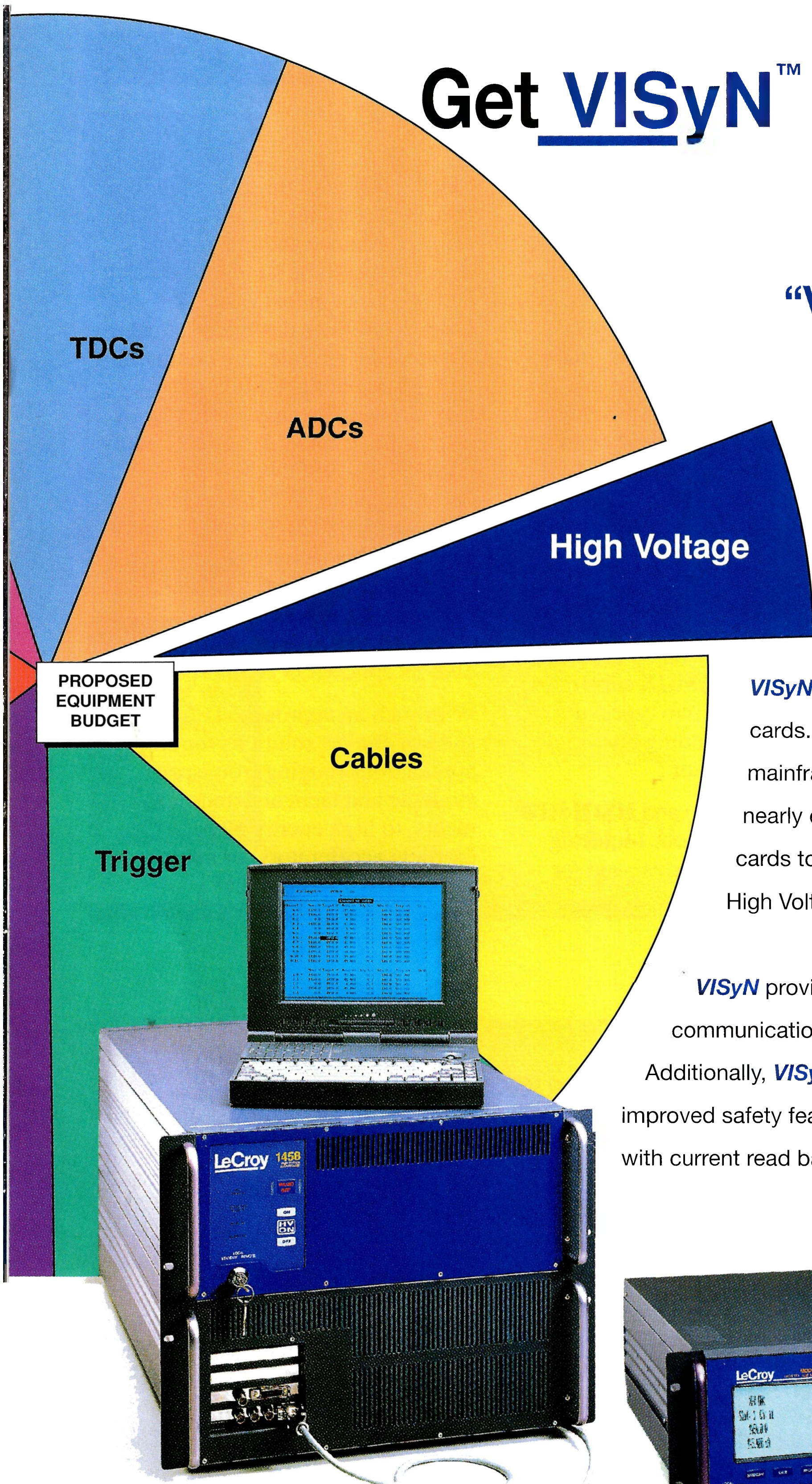


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# Around the Laboratories

## CERN
## Getting the most out of LEP

At its December meeting, CERN's governing body, Council, gave the green light for 48 superconducting accelerating cavities (32 plus 16 spares) to be added to LEP's 27-kilometre LEP electron-positron collider to push the machine's maximum collision energy from 183 to 192 GeV by May 1998. This will usefully extend the physics territory which can be explored with the machine.

With the 'Standard Model' looking in such good shape, physicists are eagerly searching for signs of the electroweak symmetry breaking ('higgs') effect which generates the observed Standard Model pattern of particle masses, and the additional LEP energy reach will enable the higgs to be hunted slightly above the mass of the Z particle (91 GeV), an area which would be uncomfortably low for CERN's new LHC proton-proton collider. By adding the new cavities, there will be no crack between LEP and LHC through which important physics could hide from view.

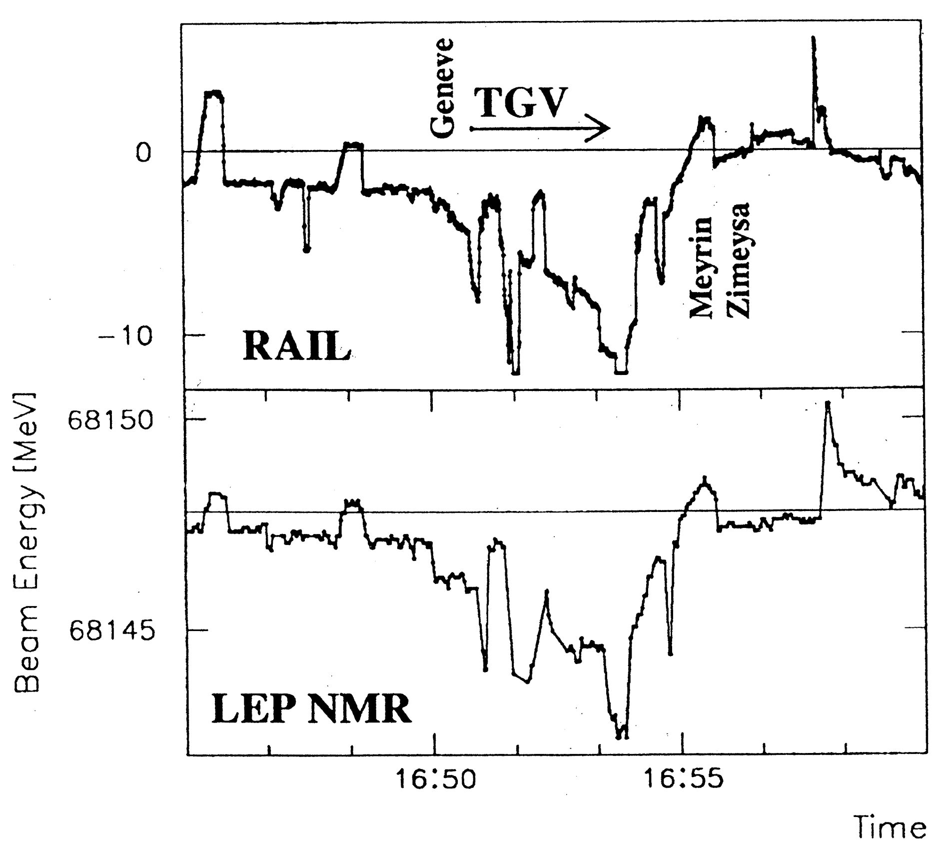
The additional LEP upgrade will be financed by 36 million Swiss francs of across-the-board economies. LEP itself has to sacrifice some running time to pay for its own energy upgrade, but the hope is that this lost time can be more than compensated by increased luminosity, so that the accumulated electron-positron score will not suffer.

Late last year (December 1995, page 1) LEP, equipped with an initial batch of superconducting accelerating cavities, made its first step up in energy to 130 - 140 GeV, beyond its traditional hunting ground at or very close to the Z resonance. Everybody was agreeably surprised how quickly the machine came on in this new regime, and how clean the physics conditions were, promising well for subsequent energy increases later this year.

No longer blinded by the Z resonance, the LEP experiments have had to dust off their 'discovery' techniques. When LEP came into operation in 1989, all eyes were open for new phenomena. With nothing unexpected turning up in itially, the experiments soon passed into a high precision physics phase, making a speciality of amassing as much data as possible and refining analyses to perfect their measurements.

While no new particles have emerged from the 1995 higher energy LEP run, in searching for them much additional territory has been ruled out. However in a flurry of excitement at the end of the year, the Aleph experiment reported an unexpected effect. Looking at LEP collisions producing four 'jets' of strongly

*Cheap day return. Last summer, precision measurements of the beams in CERN's 27-kilometre LEP electron-positron collider revealed unexplained periodic blips of the order of a few MeV (a few parts in a hundred thousand). A detailed search revealed that the blips came from high speed trains passing nearby, when some return current finds its way into the ring. The diagram shows how the track voltage due to a train leaving Geneva station leaves its mark on the LEP beam.*



interacting hadrons, and then pairing these four jets in different ways, they see a peak at around 110 GeV in a mass spectrum of jet pairs. No physics explanation is offered, and the effect is not seen by the three other experiments - Delphi, L3 and Opal.

## Lead back

One year after beams of lead ions made their first appearance at CERN (December 1994, page 15), the beams were back in a five-week spell to round off 1995 high energy physics.

After their initial acceleration in the specially-built linac, nuclei are taken further up the energy ladder by the Booster and the PS synchrotrons. The lead 53+ ions from the PS are stripped to lead 83+ for injection into CERN's SPS 'proton' synchrotron, from which ions emerge at 158 GeV per nucleon.

New modifications have ensured a smoother beam distribution around the ring, with a debunching period on a newly-introduced intermediate energy 'flat-top' prior to further acceleration to the extraction energy. Particle intensity has exceeded the design figure of 4 x $10^8$ ions per pulse, double the levels seen last year, and reaching a maximum of 4.7 x $10^8$ ions per pulse. However in December the arrival of a spell of cold weather and expensive electricity slowed progress.

The goal of the experimental programme is to see signs of the quark-gluon plasma, the state of matter which existed in the aftermath of the Big Bang and from which nuclei as we know them subsequently 'crystallized'. To recreate this quark-gluon plasma means supplying enough energy to knock quarks from their nuclear niches and 'melt' the target volume. However at such energies quark-antiquark pairs and gluons also become very plentiful.

To recreate these conditions means making a 'fireball' large enough for the plasma to be created, and this is where the high quark content of the lead ions used in the CERN experiments score. The larger the fireball, the higher the chances of seeing the long-awaited plasma.

Once the plasma is formed, the next question is how to recognize it and differentiate it from its high temperature surroundings. Several tell-tale signatures are expected, including intense 'black body' photons which with their extremely high energies would pierce easily through the surrounding nuclear material.

Another confident signature is the suppression of states, like J/psis and upsilons, formed as quark-antiquark pairs bind together. Under quark-gluon plasma conditions, the quark-antiquark pairs are more reluctant to bind together, or existing such pairs would 'dissolve' in the plasma.

The plasma would also contain more types of quarks than normal nuclei, which have only 'up' and 'down' varieties among their dominant, or 'valence', quarks. An abundance of strange quarks would also be a pointer.

With experiments bombarded by high energy lead beams and producing high particle densities, detector components have to be particularly robust to survive, at the same time being sufficiently sensitive to be able to pinpoint single particles from thousands.

Receiving beams in the North Experimental Area were:

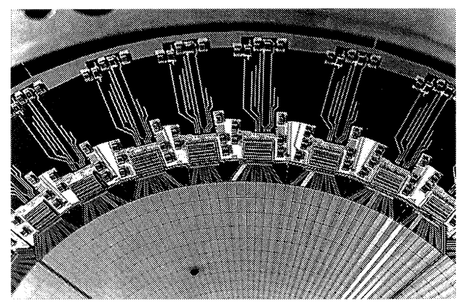
NA44, using a superconducting magnet spectrometer to identify pion and kaon pairs and investigate detailed momentum correlations of small numbers of particles within the thousands produced in these reactions, as well as measuring proton and deuteron spectra, and using a threshold-imaging Cherenkov counter (TIC) for particle identification;

NA45 (CERES), a double-layer large acceptance ring-imaging Cherenkov detector looking at electron-positron spectra and single direct photons;

NA49, a large acceptance, data-hungry multi-hadron magnetic

*Heavy ion instrumentation.*
*1) For the WA98 experiment at CERN, the upstream charged particle detector has to be very thin to ensure that photons reach downstream. Thickness is minimized by passing signals from the silicon pads to the outer edge of the wafer.*

*2) The NA50 experiment's silicon multiplicity detector has to withstand radiation levels comparable to those expected at CERN's planned LHC proton collider.*



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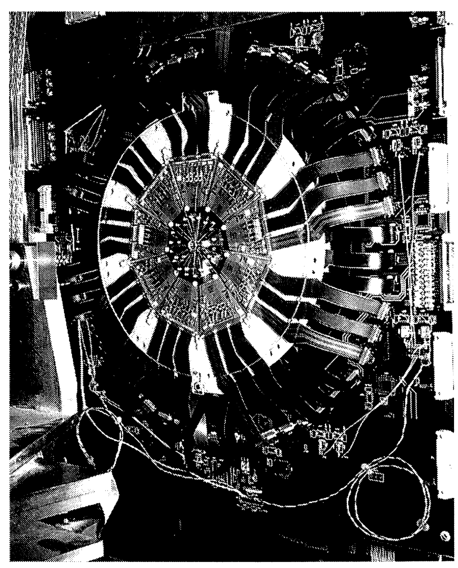

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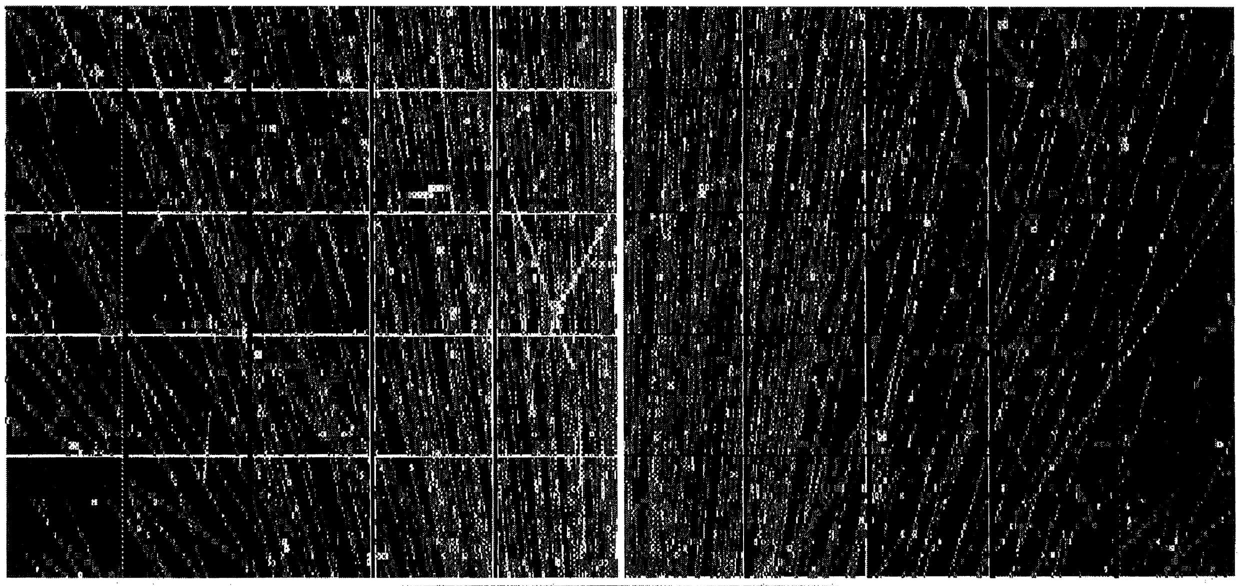
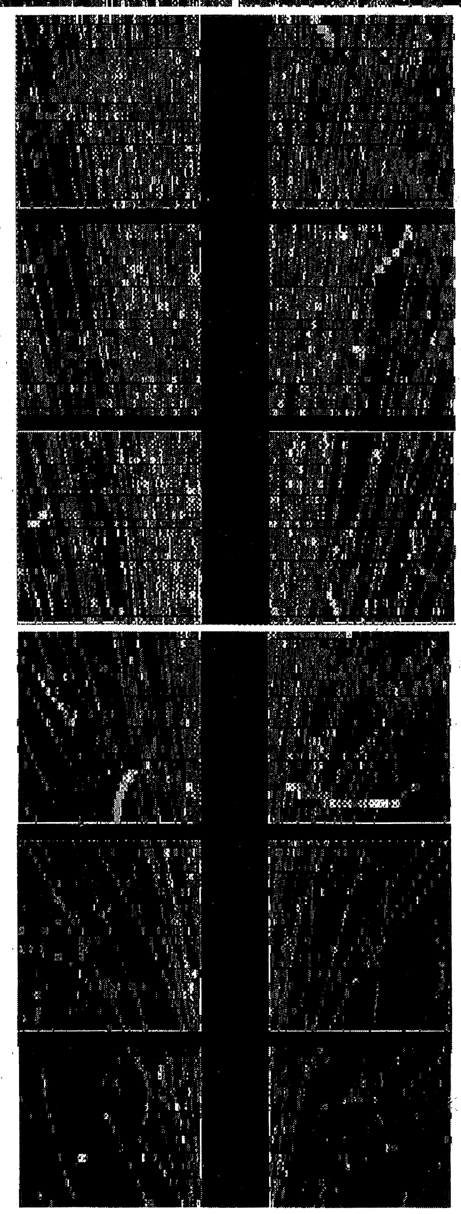



spectrometer with four large time projection chambers, time-of-flight and calorimetry identifying charged hadrons and neutral strange particles, analysing on an event-by-event basis;

NA50, a magnetic spectrometer picking up muon pairs, and equipped with a special silicon multiplicity detector, looking for possible suppression of states composed of bound quark-antiquark pairs; and

NA52, a magnetic time-of-flight spectrometer searching for unusual quark combinations ('strangelets').

Receiving beams in the West Experimental Area were:

WA97, based on the veteran Omega spectrometer and using high granularity pixels to search for unusual signs of hyperon (strange baryon) production; and

WA98, a large collaboration, including a contingent from India, with large acceptance photon-hadron coverage (in an extension of the earlier WA93 experiment) to look for photons and hadrons. The experiment includes a novel 4,000 channel silicon pad multiplicity detector complemented by highly granular photon detectors.

Digesting the complex lead-lead collisions takes the experiments a lot of time and effort, and the interpretation of the signals is very difficult. Physicists look forward to a coherent picture emerging at the next 'Quark Matter' meeting, to be held from 20-24 May in Heidelberg. The previous such meeting, held a year ago in Monterey (April 1995, page 13), caught the first hints of effects from CERN's initial run with lead ions in December 1994.

*Equipped with four large Time Projection Chambers (TPCs), NA49 records the wealth of secondary particles emerging from high energy lead-lead collisions.*

However already the suppression of J/psi particle production (NA50) seen with lead ions is more pronounced that with the earlier sulphur-32 beams. NA49 sees 1 TeV of transverse fireball energy, releasing up to 2,000 hadrons per collision, with both NA44 and NA49 seeing more transverse energy and changed particle distributions, suggesting that an expanding hadronic fireball has been created.

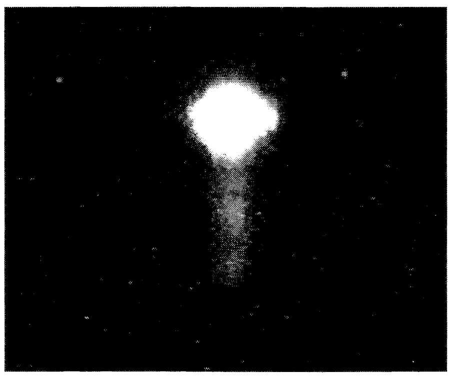
## FERMILAB
## Beam extraction by bent crystal

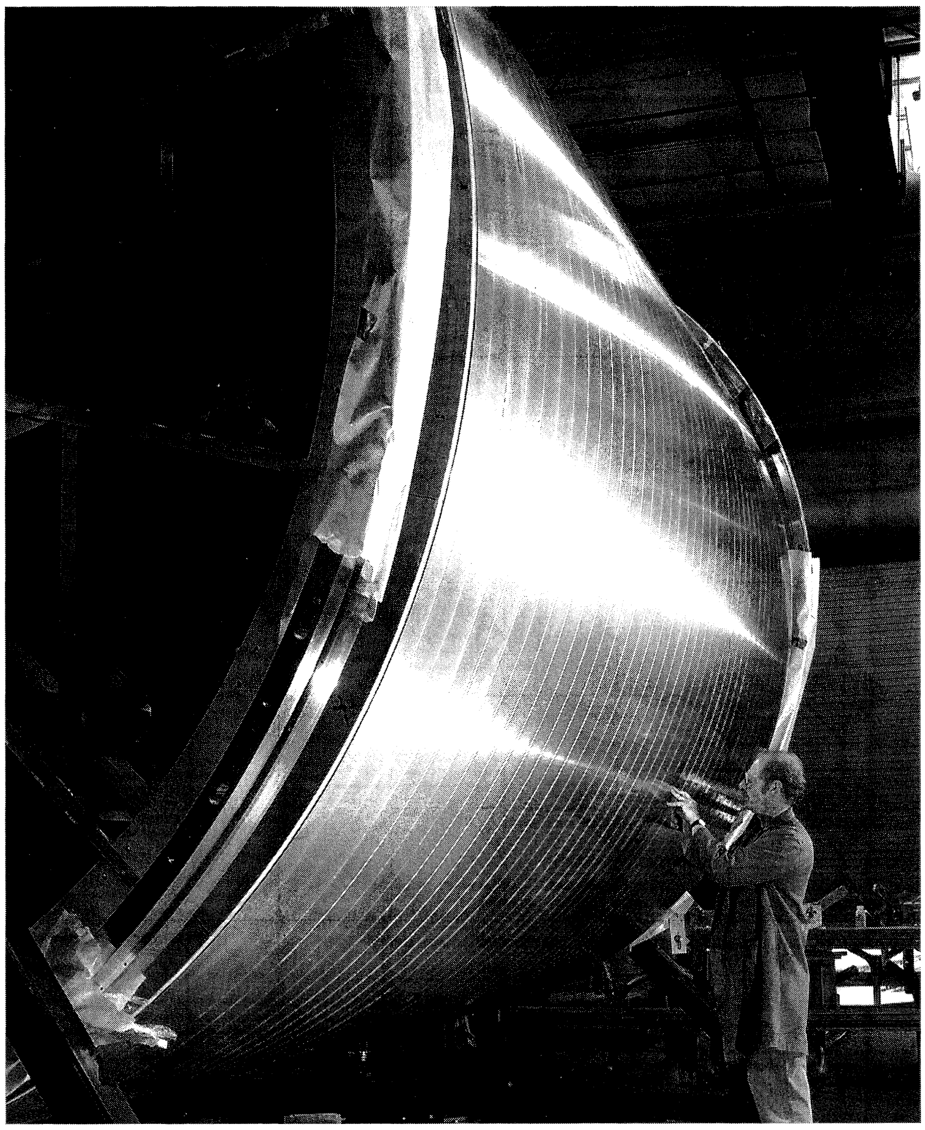
A 900 GeV beam has been extracted from the superconducting Tevatron by channeling it through a bent crystal. This is the first such extraction from a superconducting accelerator and the highest energy example of beam channeling.

For guiding high energy beams, channeling - steering a charged particle beam by the interior structure of a crystal - is an alternative to large magnets. Using a 4-cm-long crystal, the Fermilab demonstration

*The tight spot of a 900 GeV beam extracted from Fermilab's superconducting Tevatron by channeling through a bent crystal. The tail below the spot is due to particles leaving the crystal before completing the full 640 microradian bend.*

*Winding aluminium strips for the outer vessel of the Time Projection Chamber (TPC) of the STAR solenoidal tracking detector for Brookhaven's Relativistic Heavy Ion (RHIC). Collider.*





reproduces the bending effect of 8 metres of kicker magnets.

The Tevatron crystal extraction experiment (E853) began with Superconducting Supercollider (SSC) funding to investigate the possibility of extracting peripheral beam halo from the SSC. With the demise of the SSC, work on E853 continued, because of its implications for CERN's LHC proton collider and to study accelerator questions of crystal extraction.

Crystal extraction is considered particularly useful for awkward extraction directions and/or short straight sections, where conventional magnetic systems would be difficult to install. The Fermilab work has been closely coordinated with other work at CERN (450 GeV beams - May 1990, page 5) and Serpukhov (70 GeV).

In the Fermilab test, beam moves horizontally into a specially produced crystal with a vertical bend of 640 microradians.

To deflect the beam onto the crystal, two different techniques are employed - a horizontal kicker magnet pushes the beam the half millimetre to the crystal, while forced diffusion moves the beam more slowly. The channeling gives a tight beam spot, while the multi-turn extraction found earlier at CERN is also clearly seen.

## BROOKHAVEN STAR turn

A recent meeting of the STAR Collaboration (Solenoidal Tracker At RHIC) at Brookhaven highlighted progress on the large solenoidal tracking detector, scheduled to begin operation in 1999 at the Relativistic Heavy Ion Collider (RHIC).

The RHIC accelerator, currently being built at Brookhaven, will collide gold beams at a collision energy of 200 GeV per nucleon and proton beams of up 500 GeV collision energy. It will also circulate high luminosity polarized proton beams which provide an unparalleled opportunity for fundamental studies of spin physics (November, page 1).

At this meeting, Tim Hallman (UCLA), interim STAR spokesman while spokesman John Harris

(Berkeley) is on sabbatical, reviewed the physics goals. STAR's primary physics goal is to search for signatures of the quark-gluon plasma - a deconfined phase of matter thought to have existed shortly after the creation of our Universe (see page 2).

By measuring most of the several thousand tracks produced in a gold-gold collision, STAR will be able to measure and correlate many global observables on both an event-by-event and an inclusive basis. An analysis of such correlations may uncover signs of the quark-gluon plasma. The ability to search for signatures of quark-gluon plasma formation (e.g. high strangeness production, critical fluctuations) on an event-by-event basis is a unique feature of STAR resulting from the large acceptance of the detector and the high particle multiplicities expected at RHIC.

The STAR baseline detector has been under construction for about two years. It includes a large Time Projection Chamber (TPC) along with front-end electronics, trigger, and data acquisition. The TPC will be in a solenoid magnet designed to produce a field of 0.5 Tesla.
The collaboration is planning several additional detectors, including a high resolution silicon vertex tracker designed to measure strange particle production, a time-of-flight detector to extend the range of momenta for particle identification, and an electromagnetic calorimeter to measure neutral transverse energy and enable the detection of hard-parton scattering (jets, high transverse momentum particles) as a penetrating probe of relativistic nuclear interactions.

Project Director Jay Marx described many recent technical highlights, such as construction of the TPC outer field cage - a cylinder 4.5m long and 2m in radius. Marx announced that the assembly team had completed all 24 outer sectors of the TPC and that the Front End Electronics group had finished the design of several custom integrated circuits which will be used to digitize and store TPC data. Tesla Engineering (UK) is fabricating the coils for the STAR magnet, while Precision Components Corporation of York, Pennsylvania (USA) is manufacturing the return steel.
At Brookhaven, construction has started on a new building for STAR assembly.

Currently STAR has 350 collaborators from 35 institutions throughout the world. Interest in this project continues to grow from the nuclear physics and high energy physics communities . At this meeting, the University of Birmingham (UK) formally joined the collaboration.

*From Howard Matis, Berkeley*

## DESY Future physics at HERA

At the HERA electron-proton collider at the DESY Laboratory, Hamburg, luminosity has been running at up to 50% of the design figure of 1.5 x $10^{31}$ per sq cm per s, with the physics programme well underway.

Initially based on the H1 and ZEUS detectors, the HERA scenario now also includes the HERMES polarized gas target experiment, whose appearance on the scene this year is seen as a major success. For the future, the HERA-B experiment is being readied, with a first physics run expected in 1998.

With a view to further exploring this unique new physics foothold, the future directions of the HERA physics programme are already under detailed study, in particular the implications of higher luminosities, polarized beams, and new beams of ions.

Chaired by Gunnar Ingelman of Uppsala and DESY, and Albert DeRoeck and Robert Klanner of DESY, the 'Future Physics at HERA' series began with a well attended meeting last September and continue with at DESY on 8-9 February, where first conclusions should emerge. The final conclusions and recommendations for the future of the HERA programme will crystallize from a final meeting at DESY on 29-31 May.

Separate working groups cover: Structure functions; Electroweak physics; Beyond the Standard Model; Heavy quark production and decay; Jets and high transverse momentum; Diffractive hard scattering; Polarized electrons and protons; Light and heavy nuclei in HERA; and HERA upgrades and impacts on experiments.

Further information from e-mail HERA-WORKSHOP95@DESY.DE or World Wide Web http://www.desy.de/conferences/hera-workshop95.html

# Physics monitor

## AMANDA at the South Pole: Antarctic neutrinos

As heralded by the observations of the 1987 supernova, neutrino astronomy is an exciting field that holds the promise of unique information on energetic processes deep inside stars and galaxies.

Most "neutrino telescopes" currently planned or in operation are based on the principle of Cherenkov detection. When a fast particle traverses an optically transparent medium, Cherenkov light propagates along a cone around the direction of travel, with a conical opening angle determined by the speed of the particle and the refraction index of the medium. The Cherenkov photons registered in photomultiplier tubes (PMTs) surrounding the volume detect the neutrino event, and in some cases the arrival direction is determined.

A problem with neutrino astronomy is that the detection rates are generally very small, so the detector volume should be as large as possible. To minimize background like radioactive decays, muons generated by cosmic ray interactions, etc, the detectors are installed as deep as possible (often in mines) and precautions are taken to minimize radioactive background. This makes the detectors quite expensive and sets a limit on the realistic size of an underground detector. On the other hand, neutrino sources of much higher energy could exist, but with flux and detection rate below the sensitivity of the present generation of water Cherenkov detectors.

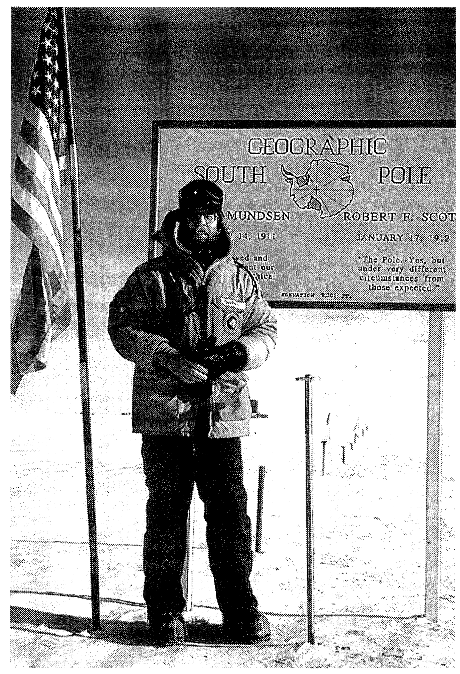
This has led to a search for alternative ways of constructing high energy neutrino detectors. One way to increase the effective area is to use large volumes of natural water as the medium and detect high energy muons generated in charged current interactions. Since muons are very penetrating, they can be detected even if they were produced far from the detector (November 1993, page 36).

One pioneering experiment of this kind is DUMAND (Deep Underwater Muon and Neutrino Detector), planned to be deployed in the Pacific Ocean near Hawaii. Strings of PMTs are lowered to a depth of several kilometres, where the atmospheric muon background is small. After a brief period of data collection in a 1993 prototype, technical problems have delayed further commissioning.

An experiment in the Baikal Lake, Siberia, deployed at a depth of 1100 m and consisting of four strings with 12 PMTs and one string with 24 PMTs, is presently taking data. However, so far no decisive neutrino signal has been demonstrated.

In Sweden, plans for a similar detector to be deployed in one of the clear natural lakes North of the Arctic Circle were investigated during 1991 and 1992. Problems with seasonal variations of water quality led, however, to the abandonment of this idea and instead the Swedish group decided to join the newly formed AMANDA experiment in late 1992.

The AMANDA (Antarctic Muon And Neutrino Detector Array) experiment is now a Berkeley/DESY (Zeuthen)/Irvine/Stockholm/Uppsala/Wisconsin collaboration which uses the clear ice deep in the ice sheet at the South Pole as the Cherenkov detection medium. Ice has several advantages: it has very low radioactivity (in contrast to ocean water which

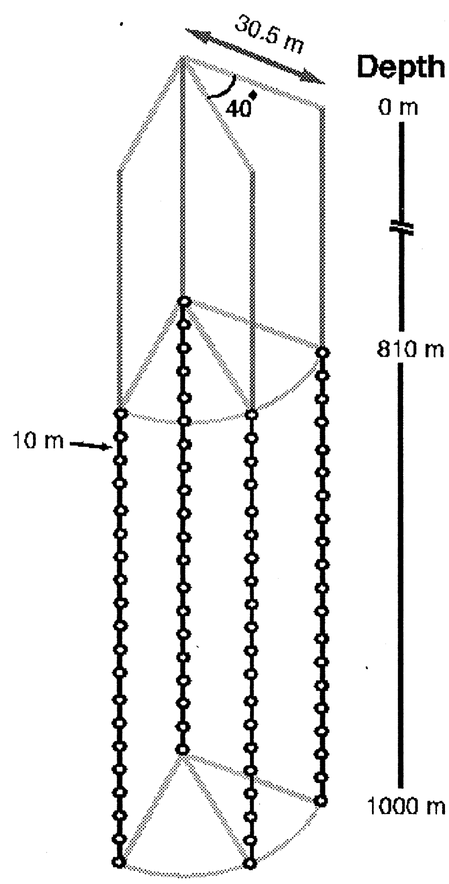



*The leader of the Swedish AMANDA group, Per Olof Hulth, at the geographic South Pole. The AMANDA array is some 800 m from the Pole.*

contains a radioactive potassium isotope) and low bioluminescence (in contrast to Baikal water), it provides mechanical support for the deployment of PMT strings, and at the South Pole there is a well-equipped base providing infrastructure (run by the American National Science Foundation).

The ice at the South Pole originates from packed snow accumulated over several hundred thousand years. The firm surface layer is transformed after a depth of a few hundred metres to ice containing air bubbles. At these depths light spread by these air bubbles makes track reconstruction very difficult. Further down an interesting transformation takes place: it becomes energetically favourable for water molecules to diffuse into the air bubbles, forming an air hydrate which is transparent and has almost the same refractive index as ice itself.

In this bubble-free medium light travels in almost straight lines,




*The present AMANDA detector, deployed in 1993-94 under the ice cap at the South Pole. The four strings, each of 20 photomultiplier modules between 800 and 1000 m depth, will be followed in 1995-96 by six strings going one kilometre deeper into the ice.*

making Cherenkov detection of muons possible. In particular, Cherenkov light from upward-going muons is of special significance since these muons must originate from neutrino interactions in or below the sensitive ice volume watched by the PMTs.

In the Antarctic summer of 1993-94, a prototype detector of four strings, each of 20 PMTs, was deployed at the Scott-Amundsen scientific station at the South Pole. The operation was very successful at the technical level, with only a few of the 80 PMTs not functioning after deployment to 800-1000 m (all the other tubes are still operational).

A laser calibration system, originally intended for exact positioning of the optical modules, enabled the optical properties of the ice at these depths to be determined. A pulsed laser beam was carried through optical fibres to diffusive nylon spheres close to the optical modules. By varying the emitting and receiving modules, large portions of the detector volume could be investigated optically.

In the 1994-95 season, the laser system was extended to permit light of several wavelengths to be used. The results of these measurements were quite unexpected. On the negative side, it was immediately clear that contrary to theoretical expectations by ice chemists, the bubble-hydrate transition was not complete at 1000 m. (Ice core data from the Russian Vostok base in Antarctica now shows that bubbles disappear at around 1200 m.) The ice thus has a milky appearance precluding track reconstruction of muons by the Cherenkov technique. On the positive side, the measurements show that between the air bubbles the ice is incredibly clear. In fact, the ice measured by AMANDA seems to be much cleaner than any purified ice sample ever prepared in laboratory. The ice at the South Pole may well be the purest solid naturally occurring on Earth. Although the present AMANDA array may be used for detection of other physics processes than singe muon reconstruction (such as cascades generated by very high energy particles), the aim for the 1995-96 season is to go deep enough so that air bubbles will no longer be a problem. A new hot-water drill will enable deployment of strings down to 2000 m. Several strings will be in place by February 1996, determining ice properties and starting to search for neutrino reactions. Although air bubbles should no longer be a problem, there may be regions of dust impurities (related to the changed climate during ice ages). Before a large-scale detector can be put into operation, a detailed investigation of the optical properties of the ice has to be made, and this is one of the main goals of the coming season. If everything goes according to plan, AMANDA could soon start searching for those precious, upward-going muons which could hold the key to many interesting phenomena.

Among the most interesting potential sources are the active galactic nuclei (AGN), among the most powerful objects known in the Universe. Although many details are still unknown, it is generally believed that AGNs are powered by massive black holes (some 108 solar masses) at the centre of galaxies. They efficiently transform gravitational energy from matter accreting onto the black hole into radiation. In the turbulent shock regions believed to surround the black hole, particles may be accelerated to enormous energies by a mechanism suggested by Enrico Fermi (December 1994, page 23). Through a random walk process, where particles pass many times through the shock region and change speed and direction through the influence of the ambient irregular magnetic fields, particles attain very high energies, perhaps several PeV (1 PeV = 1000 TeV = $10^{15}$ eV).

If protons are accelerated in this way, there will most likely be neutrinos from ultrarelativistic pion decays, since pions will be copiously produced when protons interact with the dense photon gas known to surround the AGNs. Thus, if multi-TeV neutrinos would be observed from the direction of known AGNs

(like Markarian 421, known to emit high-energy gamma rays), it would give important insight into the mechanisms of acceleration of the highest energy cosmic rays.

There is also the possibility of an isotropic, "diffuse" high-energy neutrino component arising from the result of all AGNs in the Universe. Although rate estimates are beset with large uncertainties, AMANDA could detect some tens of events per year, based on the measured gamma ray flux.

High-energy neutrinos may also give clues to the dark matter mystery. Perhaps the most promising candidate for the dark matter in galactic halos is the lightest supersymmetric particle. Since it is stable in most models, it would have survived as a relic from the Big Bang. If such particles are present in the galactic halo, they should be trapped by scattering and gravitational accumulation at the centre of the Earth or the Sun. There they would annihilate each other, creating ordinary particles which - except for the neutrinos - would never leave the region where they were formed.

Since they are so penetrating, neutrinos (whose typical energy is some fraction of the dark matter particle mass, in the 10 GeV - 1 TeV range) would leave the annihilation region and could be detected by a neutrino telescope like AMANDA. A signal of high energy neutrinos coming from the centre of the Sun or the Earth would be an unmistakable signal for such physics.

The sky has never before been surveyed in high-energy neutrino radiation. As has historically been the case when new windows have been opened to the Universe, completely unexpected findings may result. With AMANDA, the era of neutrino astrophysics could enter a new exciting phase.

*Lars Bergstrom (Stockholm and Uppsala Universities) and Hector Rubinstein (Uppsala University)*

## 'Brown dwarf' seen

Astronomers have made the first unambiguous sighting of a 'brown dwarf' star.

The evidence consists of an image from the 60-inch Mount Palomar observatory and a spectrum from the 200-inch Hale telescope on Mt. Palomar, confirmed by an image from NASA's Hubble Space Telescope. The collaborative effort involved astronomers at the California Institute of Technology, Pasadena, and the Johns Hopkins University, Baltimore.

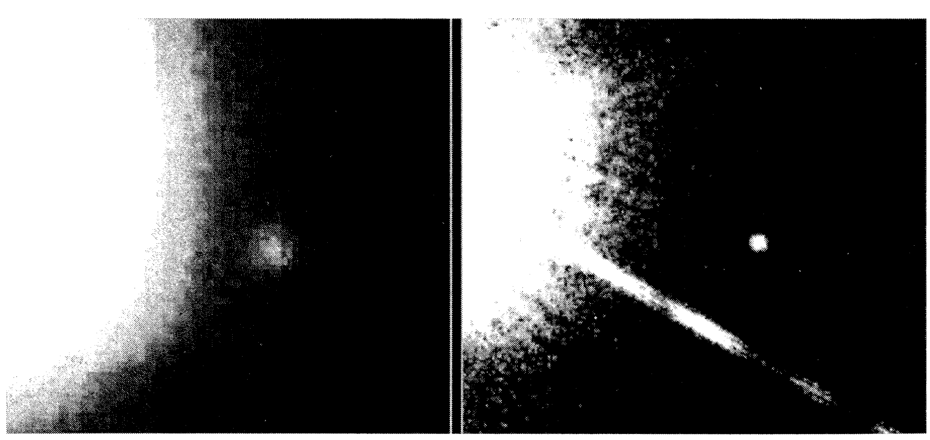
The brown dwarf, called Gliese 229B (GL229B), is a small companion to the cool red star Gliese 229, 18 light-years from Earth in the constellation Lepus. Estimated to be 20 to 50 times heavier than Jupiter, GL229B is too big and hot to be classified as a planet as we know it, but too small and cool to shine like a star. At least 250,000 times dimmer than Earth's Sun, the long-sought brown dwarf is the faintest object ever seen orbiting another star.

The infrared spectroscopic observations of GL229B, made with Palomar's 200-inch Hale telescope, show that the dwarf has the same spectral 'fingerprint' as the planet Jupiter - an abundance of methane. Methane is not seen in ordinary stars, but is present in Jupiter and other giant gaseous planets in our Solar System.

The Hubble data obtained and analysed so far show the object is far dimmer, cooler (no more than 750 degrees) and less massive than previously reported brown dwarf candidates, which are all near the theoretical limit (eight percent the mass of our Sun) where a star becomes heavy enough to sustain nuclear fusion.

Brown dwarfs form the same way stars do, condensing from a cloud of

*The first unambiguous sighting of a 'brown dwarf' star. Left, an image from the Mount Palomar observatory and, right, confirmation by an image from NASA's Hubble Space Telescope (the spike at the bottom right is a diffraction effect).*



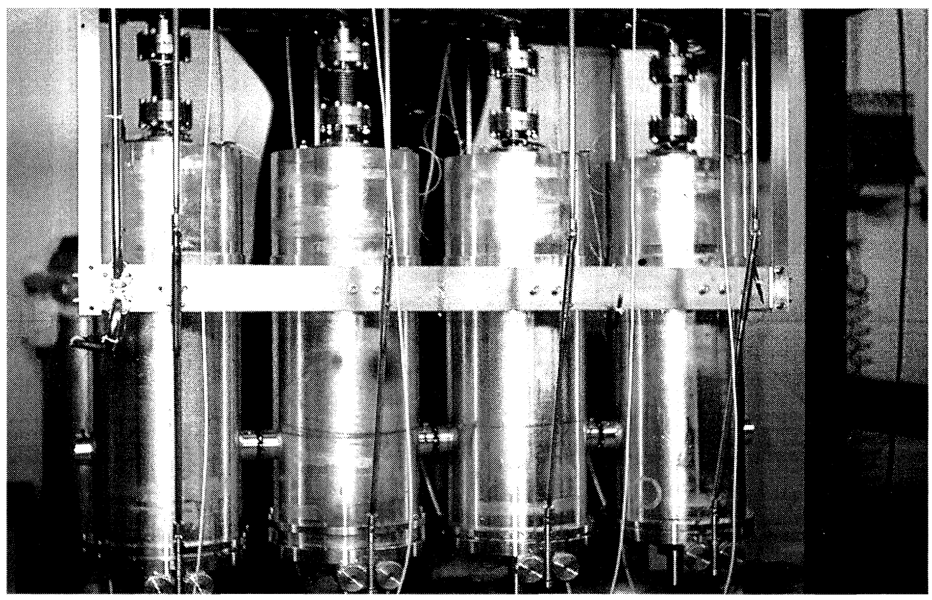
hydrogen. However, unlike stars, they do not accumulate enough mass to generate the high temperatures needed to ignite and sustain nuclear fusion at their core. Instead, brown dwarfs glow in the same way as gas giant planets like Jupiter, heating up due to gravitational contraction. In fact, the chemical composition of GL229B's atmosphere looks remarkably like that of Jupiter.

The discovery is an important first step in the search for planetary systems beyond the Solar System because it will help astronomers distinguish between massive Jupiter-like planets and brown dwarfs orbiting around other stars. Planets in the Solar System are believed to have formed out of a primeval disc of dust around the newborn Sun because all the planets' orbits are nearly circular and lie almost in the same plane. Brown dwarfs, like full-fledged stars, would have fragmented and gravitationally collapsed out of a large cloud of hydrogen.

The orbit of GL229B could eventually provide clues to its origin. If the orbit is nearly circular, then it may have formed out of a dust disc, where viscous forces would keep objects at about the same distance from their parent star. If the dwarf formed as a binary companion, its orbit probably would be far more elliptical, as seen on most binary stars.

Astronomers have been trying to detect brown dwarfs for three decades. Their lack of success is partly due to the fact that as brown dwarfs age they become cooler, fainter, and more difficult to see. TERUAn important strategy used by the researchers to search for brown dwarfs was to view stars no older than a billion years.

*Superconducting radiofrequency acceleration cavities are becoming standard tools for modern accelerators. Seen here, before installation in their cryostat, are four superconducting quarter-wave resonators for the ALPI heavy ion linac at INFN, Legnaro, Italy. Beam enters and leaves horizontally through the small tubes on each side of each resonator, the interior of which is sputter-coated with niobium. An initial test successfully accelerated chlorine-37 ions.*



## Radiofrequency superconductivity

Superconducting radiofrequency acceleration techniques are becoming increasingly standard for modern accelerators. CEBAF, the recirculating electron linac at Newport News, Virginia, with a fully superconducting 800 MV r.f. system, recently reached its design beam energy of 4 GeV, while planned machines, such as the TESLA superconducting linear collider concept, have superconducting r.f. as an integral part of the design.

With this burgeoning activity, it has become a tradition for both international experts and newcomers pressed into this field to meet every other year to hear progress reports and to discuss common problems and possible solutions.

The 7th such workshop was held from 17-20 October under the chairmanship of Bernard Bonin at Gif-sur-Yvette, jointly organized by CEA (Saclay) and IN2P3. With 170 participants it had the same attendance as the previous such meeting at CEBAF (December 1993, page 29), but still a lot more than the initial workshops, which had attendances of less than 100.

The Gif-sur-Yvette meeting began with laboratory status reports, covering both highly relativistic beam ('high beta') applications with relatively simple 'spherical' cavities (as with CERN's LEP2), using niobium as superconductor and working between 352 MHz and 3 GHz, and slower heavy ion beam ('low beta') applications with geometrically more complicated shapes, some using electro-deposited lead as superconductor and working around 100 MHz. There was increased interest for medium energy high current proton accelerators (e.g. spallation sources), where modified 'spherical' cavities were proposed.

Further operational experience with a large number of cavities in the beam comes from a number of machines - the electron ring of the

HERA electron-proton collider at DESY, Hamburg, in TRISTAN at the Japanese KEK Laboratory, the S-DALINAC (Technische Hochschule Darmstadt), at CEBAF (with 338 cavities) and in LEP2 at CERN in its push towards higher energies (September 1994, page 6).

In addition several low beta machines are also notching up good performances. ATLAS at Argonne is reliably accumulating super-conducting cavity beam hours and still holding the world cavity.hours record, while work at Stony Brook's veteran small heavy ion machine has been underway for 20 years.

Some superconducting cavities are even being pensioned off. 32 508 MHz TRISTAN cavities de-commissioned after six years of faithful service are going cheap (October, page 12).

At the workshop, operational reports alternated with lively talks and discussions on the cavities themselves and their super-conducting surfaces. The old public enemy field emission is still much alive, as shown by many studies of emitter geometries and chemical composition as well as processing mechanisms and recent experiences with both off-line (e.g. high pressure water rinsing) and on-line (e.g. in situ high peak power processing) techniques.

Cavity quenches, once considered of diminishing importance following improved fabrication and surface treatments, are back in the spotlight due to the higher performance demanded in future accelerators.

High and low beta cavities can also be made using a strong (not necessarily superconducting) support with a thin (micron) deposited superconducting film, for example the niobium-copper superconducting cavities for LEP2 at CERN. Here the film deposition technique and surface pre-cleaning are critical. For many of these films, a decrease in the resonance quality factor (Q-value) with increasing field makes future very high gradient applications more difficult. This and possible remedies are evidently under active investigation. On the other hand CERN's niobium-copper cavities or Legnaro's quarter-wave resonators, to give some examples, show that this technology can lead to successful series fabrication. A similar technique allows 'better' (higher critical temperature) superconductors than niobium, such as niobium-tin, to be 'grown' by a suitable technique inside a niobium cavity, so that cavities of, say, above 700 MHz would no longer have to be cooled below 4.2 K (involving a helium bath below atmospheric pressure and attendant difficulties). A single-cell prototype could already match CEBAF's specifications, obtained for pure niobium around 1.8 K.

High critical temperature super-conductors are finding useful applications (for example for spacecraft antennae) and commercial aspects seem promising. However these materials cannot yet provide the large defect-free surfaces required for accelerator cavities.

The tendency in these workshops to discuss nuts-and-bolts specifics was even more marked, as power couplers, cavity microphonics, window arcing or higher order mode damping for very large beam currents, and especially reliable and economic series production become more problematic. The latter, already pressing for LEP2, becomes vital for the ambitious fully superconducting linear collider TESLA scheme (October 1994, page 22).

In this context fabrication techniques such as hydroforming or explosion forming were discussed. Some have been tested on a laboratory scale, but for large scale production have been abandoned in favour of spinning (or deep drawing) and welding.

However new ideas and ongoing studies suggest that old problems might be overcome and interesting new results could be achieved for less than today's prices. These developments will be presented at the next workshop in the series, in 1997 at INFN Legnaro, Italy.

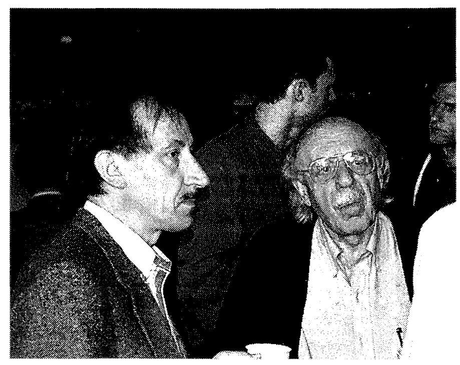
*Joachim Tückmantel, CERN*

## Polarized beams and gas targets ...

Polarized beams and targets in nuclear and high energy physics experiments are a rich source of detailed information on nuclear and particle interactions. Recent spin experiments seem to point to details of the complicated internal structure of hadrons. A recent workshop in Cologne covered the substantial progress since the previous workshop in Madison, in 1993. While polarization and intensities of polarized beams are usually sufficient in nuclear physics, in high energy machines the need for increased luminosities is always there.

Since 1993, a number of new installations, such as new polarized ion sources at COSY (Jülich), at Uppsala and at Groningen have come into operation. Besides steady progress in both beam polarization and intensity, spectacular intensity increases of polarized beams (opti-


*A privileged view of the COSY (Jülich) cooler synchrotron before it was hidden by concrete shielding. COSY will add significantly to the world stock of polarized beam data.*



*Hans-Otto Meyer (left) of Indiana with Willy Haeberli of Madison at the recent Cologne workshop on polarized beams and polarized gas targets. Haeberli, who celebrated his 70th birthday shortly thereafter, has long been a spin/polarization physics notable.*

cally-pumped DC sources such as at TRIUMF and pulsed plasma-ionizer colliding-beams sources such as at INR Moscow) were reported. Internal targets, such as HERMES at HERA (DESY), at AmPS (NIKHEF) and at IUCF (Indiana) now move towards routine data taking.

Practical experience communicated at Cologne included the handling and selection of materials for optical-pumping and storage cells to keep depolarization rates low, and (strained) photocathodes for the production of intense polarized electron beams.

The helium afterglow technique for polarized electrons (Orsay) has become competitive with other methods within the last few years. Another boon is the availability of high power, low price laser diode arrays for optical pumping. The sharp increases in polarized beam currents with certain sources means that the goal of equalling unpolarized intensities is being approached.

A number of schemes proposed at the Cologne Workshop could go on to have considerable influence, an example being the idea of combining several existing developed technologies into source designs capable of considerably higher intensities. These involve state-of-the-art polarized atomic-beam sources, existing high intensity unpolarized sources, and the storage-cell technology to be used in a new type of colliding-beams source.

Another new scheme is the MECSIS (multiple electron capture and stripping) idea to increase considerably the polarization of helium-3 ions.

The Cologne Workshop was organized by a team at the University of Cologne headed by Hans Paetzgen. Schieck and Lutz Sydow. It was sponsored and supported by the International Committee of High Energy Spin Physics Symposia, by the DFG (Deutsche Forschungsgemeinschaft), Bonn, by the Minister of Science and Research of the State of North Rhine-Westphalia, Düsseldorf, by the Forschungszentrum Jülich and by the University of Cologne.

Proceedings will be published by the World Scientific Publishing Company.

## ...Spin workshop

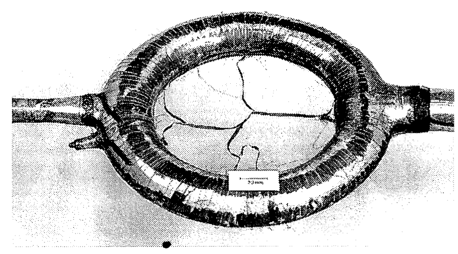
The biennial International Workshop on High Energy Spin Physics at the Institute for High Energy Physics, Protvino, Russia, alternates with the International Spin Symposium (the most recent in this series having been held at Bloomington, Indiana - March 1995, p.14). The large attendance at the recent Protvino meeting reflected the wide interest in spin physics, where most of the world's major Laboratories are either using or considering spin-oriented beams and/or targets, and the significant progress being made on both the experimental and technological fronts.

In addition, new quark spin effects invite explanation, with 'valence' proton constituents carrying only about 33% of the proton spin, and with polarization evident among the accompanying 'sea' quarks.

A focus for these measurements is the SMC collaboration at CERN, now

*In a spin. Participants at the recent International Workshop on High Energy Spin Physics at the Institute for High Energy Physics, Protvino, Russia.*

*What is it? Mystery torus from Oxford's Clarendon Laboratory archives.*



revealing the constituent structure of deuterons and neutrons in additional kinematic regions. Such experiments will be continued at SLAC (Stanford), while the HERMES gas target at the DESY HERA electron beam is preparing for its debut. In a standard model context, a rich polarization physics programme is underway at SLAC's SLD linear collider.

At lower energies, polarization is also being studied at the Joint Institute for Nuclear Research (JINR), Dubna, where new results show that the deuteron is a complicated system (October 1995, page 18).

Igor Ternov (Moscow) suggested that the spin radiation spectrum differs from that of ordinary synchrotron radiation, hinting that such effects had already been detected at Novosibirsk in 1983.

The meeting showed how major progress is being made in spin technology - polarized targets, intense sources of polarized ions, partial Siberian snakes, fast spin flippers, polarimeters...

The possibilities for accelerating polarized protons at the Tevatron (Fermilab), RHIC (Brookhaven) and HERA (DESY) were summarized.

The Protvino Workshop was sponsored by the Ministry of Russian Federation on Atomic Energy, the Institute for High Energy Physics and the International Committee for Spin Symposia.

## HISTORY
## What is it ?

It is a sign of maturity when a subject begins to get interested in his own history. While particle accelerators still look to the future, it is not too early for the study of high energy particle beams to learn from its past.

In the quest for high energy electrons, many unsuccessful attempts to accelerate electrons inductively were made before Don Kerst's betatron operated in 1941. These are surveyed in a historic Kerst article in *Nature* (**157**, 90, 1946), which includes a brief description of a machine designed by Jim Tuck at Oxford's Clarendon Laboratory before World War II, where Tuck was working with Leo Szilard, visiting from the US.

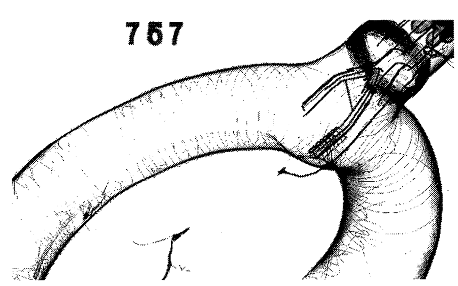
(Tuck, well-known for his wartime work at Los Alamos and subsequently in leading the controlled fusion programme there, is best known to accelerator specialists for proposing, with Teng, the regenerative extraction scheme use so successfully on the Liverpool synchro-cyclotron.)

In his paper, Kerst states that of all the pre-betatron attempts to accelerate electrons, Tuck's scheme seems to have been the most promising and technically complete - 'The investigation would surely have succeeded were it not for the war in Europe'.

Accelerator pioneer John Lawson, retired from the UK Rutherford Appleton Laboratory but now researching the early history of UK betatrons and synchrotrons, would like to discover more about Tuck's scheme, as would John Sanders, retired from the Clarendon Laboratory and interested in its history, particularly a strange torus in the Clarendon collection.

Kerst's article explains the outline of the scheme, but the historians have no record of any experiments. Was this torus ever tested? What is the purpose of the very thin winding, connected on the inside by a tape? What is the logic of the complicated electron design?

*X-rays reveal a very thin winding, connected on the inside by a tape, and a complicated electrode design.*



# Heavy ion therapy

*Fig. 1: Comparison of the depth dose distribution of different types of particle beams used in therapy. The increase in dose towards the end of the range is most effective for treating deep-seated tumours.*

## Putting particle beams to work

*The use of particle beams for medical therapy is one of the success application areas of particle accelerators, as highlighted in the special July/August 1995 'Applying the Accelerator' issue. TERUThe accompanying article by Gerhard Kraft of the Darmstadt GSI heavy ion Laboratory underlines the increasing interest in using heavy ions for this work.*

Accelerated charged particles like protons or heavier ions represent the most advanced tools of radiotherapy for the treatment of deep seated and inoperable tumours. This has been demonstrated by the successful treatment of approximately 15,000 patients with proton beams, many of them at Harvard, but also elsewhere, and by the treatment of some 500 patients with heavier ions at the Lawrence Berkeley Laboratory (LBL) and now at Chiba, Japan.

The advantage of proton therapy compared to the conventional treatment with high energy photons is the improved ballistic ratio - a higher dose can be concentrated more precisely on the tumour than is possible in conventional therapy. This is due to the small lateral scattering of the particle beam in tissue, its finite range and, most important, the increase in dose deposition with penetration depth culminating in a sharp maximum, the Bragg peak, just before the end of the range (Fig. 1).

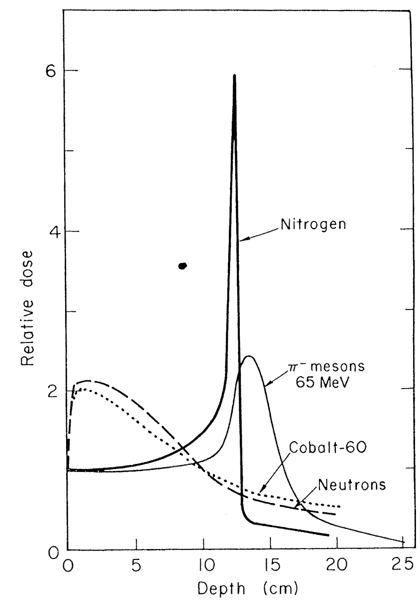
For ions heavier than protons the physical selectivity is further increased to some extent but this is not the critical issue for the use of heavier ions.

For heavier ions like carbon, the biological efficiency changes in addition to the dose during penetration in a very favourable way: in the entrance channel, at high energies, the biological damage is similar to the effects of photons and can be repaired to a large extent. But at the end of the range of the carbon beam, the high local ionization produces mainly irreparable damage.

This increase in biological efficiency, from repairable damage initially to irreparable damage at the end of range is a special feature of ions around carbon. For much heavier ions like argon and beyond, the radiation damage in the entrance channel becomes irreparable too, and saturation effects at the end of the range waste most of the energy deposited. For lighter ions like protons the range of irreparable damage is less extended. Therefore the optimal atomic numbers for tumour treatment seem to be around carbon.

To optimize the treatment efficiency, the extremely effective part of the carbon beam has to be restricted to the tumour volume and no healthy tissue should be in the range of the stopping ions. Therefore, a tumour conform irradiation system is the major prerequisite for the use of the heavy ions in therapy. For this purpose, the "intensity-controlled rasterscan system" has been developed at GSI using a fast magnetic beam deflection and an energy variation by the accelerator.

The basic idea of this method is to




split the target volume into layers of equal particle range and to "paint" each layer with a pencil beam by zig-zagging the beam spot over the area. The track along the zig-zag can be subdivided into 16,000 picture elements (pixels), for each of which the necessary particle number has been calculated. A transmission counter measures the incoming beam intensity and the beam is moved from one pixel to the next once the required particle number has been reached.

Using this technique any dose distribution in any treatment volume can be produced. It is also possible to compensate for accelerator irregularities as well as for pre-exposures for treatment of more distant layers. In experiments, target volumes of different shapes have been exposed either to homogeneous physical dose distributions (isodose) of various shapes (Fig. 2), or to an inhomogeneous physical dose which nevertheless results in a homogeneous inactivation of cells

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to whom applications, comprising a curriculum vitae, a list of publications and the names and addresses of three referees should be sent, by **Monday 25th March 1996**.

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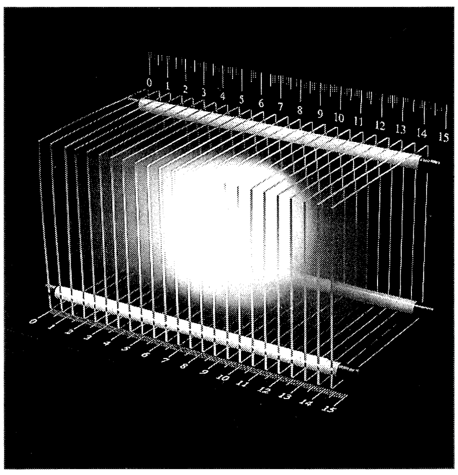
*Fig. 2: Spherical volume, 6 cm in diameter, exposed to a homogeneous physical dose distributions (isodose) of carbon ions using a beam of 3 mm half-width and 30 steps in energy.*

*(Photo Achim Zschau GSI)*



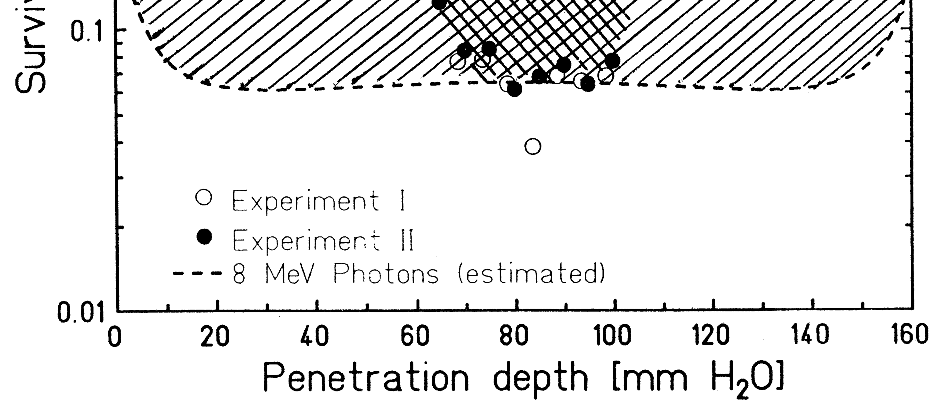
(biological isoeffect).

The concentration of the very effective track-ends to the tumour volume is of paramount importance for local tumour control. The precision of beam delivery is of the same importance for patients' safety. Two independent methods for fast beam control are used in the GSI project. First, a set of transmission detectors in front of the patient monitors the intensity and the location of the beam in 100 microsec intervals, comparing it to the required particle numbers. Any disagreement interrupts beam extraction within less than half a millisecond. Secondly, due to nuclear reactions a small fraction of the primary beam is converted to positron-emitting radioactive isotopes. These have a similar range as the coincident gamma quanta. By monitoring the gamma quanta it is possible to reconstruct the distribution of the stopping particles in the patient and calculate the dose profile.

Using the technique of tumour conform irradiation, the main problem is to translate the treatment planning into control data for the raster scan system. This requires the exact knowledge of the physical properties of the beam inside the body - energy loss, scattering, nuclear fragmentation and biological effects, i.e. the relative biological efficiency (RBE) as function of atomic number and particle energy of a complex particle field.

In both fields, physics and radiobiology, a tremendous effort has gone into solving these problems. For instance, more than 100,000 biological samples have been exposed to particle beams by GSI biophysicists at many accelerators. These experiments give a solid basis for theoretical modelling, allowing the biological response to a complex particle field to be predicted. Such a prediction includes the differences in the radiobiological response of different cell types and tissues as well as the timing of the exposure. It is the final goal of our project to provide physicians with a biology-based treatment planning system indicating the expected biological effect rather than the applied dose.

The advantages of heavy ion therapy became obvious in the first trials at LBL, Berkeley, using less sophisticated methods. There, approximately 500 patients have been treated with neon ions with great success. Because of the age of the accelerator, this therapy programme was terminated in 1993.




*The increased precision of heavy ion beams for tumour control is shown by these results, with cells in a 16 cm-diameter "phantom" (simulating a human head) exposed to carbon beams of different energies from two opposite sides. For comparison the expected cell inactivation after photon exposure is shown by a dashed line. The photon irradiation is much less selective - the hatched area (single- and cross-hatched) shows its 'reach'. The cross-hatched area shows the increased precision of carbon ions, even in a single irradiation (fraction). Adding more fractions - presently 20 are discussed - further increases this precision.*

# Bookshelf

Another heavy ion therapy opened at Chiba, Japan in 1994 where presently treatment of 50 patients has been completed in the first exploratory stage.

This summer heavy ion therapy will start at GSI in a collaboration with the Heidelberg radiological clinic and the German Cancer Research Centre. In this experimental therapy the use of the novel technique of raster scanning and the biology-based treatment planning will be tested. Although the trials in Japan and Germany are presently restricted to small patient numbers like 70 per year for GSI, the potential of particle therapy is large: according to socioeconomic studies from Heidelberg many thousands of patients per year could profit from particle therapy.

In consequence new projects have been established like the TERA initiative in Italy or the Austron project in Austria. The advantages of ion therapy are so evident that general use of protons and heavier ions for this work is only a question of time.

*by Gerhard Kraft*

*Twentieth Century Physics - three volumes, edited by Laurie M. Brown, Abraham Pais and Sir Brian Pippard, published jointly by the Institute of Physics Publishing (Bristol, UK, and Philadelphia) and the American Institute of Physics Press, New York, 2060 pages, price £250/$375. ISBN (3-volume set, 0 7503 0310 7 rest of world, 1-56396-314-0, N. America).*

Although the 20th century still has several years to go, the UK Institute of Physics Publishing and the American Institute of Physics Press boldly decided some time ago that it was time to join forces to put this history between covers - six covers, that is.

This handsome boxed three-volume set provides a valuable, if unadorned, survey of almost a hundred years of physics achievement, carefully written by scientists for a scholarly audience. Any working physicist would be proud to own the set.

The first volume covers the first half of the century and is written mainly by scientific historians, while the second two volumes deal with the increased specialization of the latter half of the century, with authoritative contributions from a 'Who's Who in Physics' array of specialists with first-hand knowledge of their respective fields. (With such authoritative contributors, it would have been informative to have had short biographies of them.) Volume 3 closes with essays by Philip Anderson (historical overview), Steven Weinberg ('Nature itself') and John Ziman (social reflections).

The emergence of the nuclear and quantum pictures are covered in Volume 1, where each of the principal editors has contributed a chapter - Sir Brian Pippard on Physics in 1990, Abraham Pais' Introduction to Atoms and Nuclei, and Laurie M. Brown on Nuclear Forces, Mesons and Isospin Symmetry. Modern particle physics is exhaustively dealt with in a 160-page mega-chapter by Val Fitch and Jonathan Rosner, including concepts like dispersion relations and Regge poles which are no longer fashionable. Malcolm Longair supplied the 115-page chapter on astrophysics and cosmology.

The editors acknowledge some gaps, notably the development of electronic circuitry from zero to a level where electronic computers now help drive research as well as benefit from it, and the post-1945 era of Big Science and its political implications. Contributors were asked to supply biographies of notable 20th-century personalities, which are scattered in boxes through the text (a quick survey of these reveals 19 Americans, 14 Britons, 9 Germans, 5 Dutchmen and 1 Frenchman).

*GF*

*Imperial College Press*

A new imprint is that of Imperial College Press, a joint venture by Imperial College, London, and World Scientific Publishing, Singapore. Chairman of the Editorial Advisory Board is Lord Porter, of Imperial College's centre for Photomolecular Sciences, Nobel Chemistry Laureate 1967. Initially, the books will be distributed and marketed by World Scientific.

First volume to appear under the new imprint is 'Lectures on Quantum Theory, Mathematical and Structural Foundations', by Chris J. Isham

*Donald Prater - life of Thomas Mann*

(ISBN 1-86094-000-5 hardback price £35, 1-86094-001-3, paperback price £14), based on lectures given to first- and second-year undergraduates, and including worked examples. Some 12 Imperial College Press titles are scheduled to be published soon..

*Mann's world*

Not only particle physicists work at CERN. Gifted specialists from many walks of life make special contributions to the Laboratory's complex infrastructure and ensure that it ticks over smoothly. One of them was translator Donald Prater, who retired in 1983, and whose biography of the enigmatic German writer Thomas Mann, the first full-length study of Mann in English, was published last year to enthusiastic reviews.

*Thomas Mann: a life, by Donald Prater, Oxford University Press, ISBN 0-19-815861-0*

# Books received

*In the Wings of Physics, by Maurice Jacob, World Scientific, Singapore (ISBN 9810221789)*

As well as appearing centrestage as a theoretical physicist with a strong phenomenological slant, Maurice Jacob is, backstage, an accomplished scientific administrator. This volume is a collection of keynote papers and talks written during his extensive experience in two important areas of scientific administration - physics editing, where he has made a number of lasting innovations; and in learned societies, where from 1984-6 he was successively vice-president and president of the French Physical Society, and after which he served for two terms (1991-3) as President of the European Physical Society. Backstage operations in any context may be less glamorous than star roles, but are still vital to a smooth

and effective production. Maurice Jacob explains, for example, how he was able to attract US contributions to European physics journals.

*Diverse Topics in Theoretical and Mathematical Physics, by Roman Jackiw, World Scientific, Singapore (ISBN 981-02-16963 hardback, £77, 981-02-16971 paperback, price £44)*

A collection of milestone Jackiw papers: Anomalies and fractional charge; Gauge theories and gravity; Symmetry behaviour; Approaches to quantum theories following Dirac; Solitons, instantons and semi-classical quantum field theory.

*Imperial College Press is a new joint venture by Imperial College, London, and World Scientific Publishing, Singapore. Chairman of the Editorial Advisory Board is Lord Porter, Nobel Chemistry Laureate 1967, seen here (seated, left) with other members of the Editorial Advisory Board - Sir John Kendrew, Nobel Chemistry Laureate 1962 (seated, right), and standing, right to left, Maurice Jacob of CERN, Karol Sikora of the Royal Postgraduate Medical School, Sir John Mason, former Director of the UK Meteorological Office, and K.K. Phua, Managing Director of World Scientific Publishing, Singapore.*

*Early Quantum Electrodynamics: A Sourcebook, by Arthur I. Miller, Cambridge, paperpack (ISBN 0 521 43169 7, price £40)*

Paperback edition of this useful history of 1930s quantum electrodynamics. The hardback edition appeared in 1994 (for a review see April 1994, page 25)

*Particles and Nuclei - An Introduction to the Physical Concepts, by Bogdan Povh, Klaus Rith, Christoph Scholz and Frank Zetsche, Springer, Berlin (ISBN 3 540 59439 6)*

Originally published in German in 1993, this textbook (with problems) is based on sixth-semester lectures on nuclear and particle physics. It emphasizes physical concepts and achieves a good nuclear/particle balance.

*Ion Traps, by Pradip K. Gosh, Oxford University Press (ISBN 0 19 853995 9, price £55)*

In the prestigious Oxford University Press International Series of Monographs on Physics, this comprehensive volume covers the wide range of applications to which ion trap devices have been put, from high energy accelerators to molecular biology.

# MIDDLE EAST
## Bridge over troubled waters

With their shared enthusiasm to push back the frontiers of knowledge, physicists can bridge political and ideological barriers and catalyse new international contacts.

During the Cold War, the carefully nurtured dialogue and mutual respect between Soviet and Western physicists helped overcome mistrust and misunderstanding. With its modest infrastructure and funding requirements, the theoretical side of Big Science is particularly mobile, providing a useful vehicle for international dialogue.

In a new example of such a bridge, a historic meeting on high energy, condensed matter and environmental physics in Dahab, Sinai, in November brought together Egyptian, Israeli, Jordanian and Palestinian researchers. The presence of major names from Europe and the US, notably Ed Witten of Princeton, who propels much of the current boom in the mathematical framework of multidimensional string theory (October 1995, page 4), provided additional scientific focus.

The meeting was made possible thanks to the enthusiasm of Sergio Fubini of Turin and CERN, helped by Alberto Devoto of Cagliari and all the Middle East scientific authorities concerned. The meeting was sponsored by the International Centre for Theoretical Physics (ICTP) Trieste, CERN and UNESCO, with funding from Italy, ICTP and Israel.

If the peace process can be made to work, the traditional prestige of science and scientific education in Israel could hopefully seed further progress in the whole Middle East.

The event was made even more memorable when a serious earthquake, with its epicentre in the Red Sea not far from Dahab, shook the region, causing some damage and casualties. The meeting itself was unaffected.

*Princeton theorist Ed Witten (centre, right) with Jordanian students at the historic Dahab, Sinai, physics meeting in November which brought together physics researchers from all over the Middle East.*

Centre National de la Recherche Scientifique -
Université de Corse - Université de Nice-Sophia-Antipolis

## INSTITUT D'ETUDES SCIENTIFIQUES DE CARGESE

NATO ADVANCED STUDY INSTITUTE • SEPTEMBER 2 - SEPTEMBER 13, 1996

# FUNCTIONAL INTEGRATION: BASICS AND APPLICATIONS

Organized by:
**P. Cartier** (ENS Paris, F), **C. DeWitt-Morette** (Univ. of Texas, Austin, USA, Director), **A. Folacci** (Univ. of Corsica, Corte, F, Local Organizer), **C. Isham** (Imperial College, London, UK)

with the support of the NATO Scientific Affairs Division and the Collectivité Territoriale de Corse

### PROGRAMME

Basics. A new perspective on functional integration - **P. Cartier** (ENS Paris, France)
Geometry and functional integration - **C. DeWitt-Morette** (Univ. of Texas, Austin, USA)
Functional integration and wave propagation - **S.K. Foong** (Univ. of Tokyo, Japan)
Functional integration and topological quantum field theory - **M. Blau** (ENS Lyon, France)
Witten's functional integrals and their numerical proofs - **L. Rozansky** (IAS, Princeton, USA)
Introduction to the theory of knots - **L.H. Kauffman** (Univ. of Illinois, Chicago, USA)
Quantum field theory and knot theory - **J. Frölich*** (ETH Zürich, Switzerland)
Numerical path integrals techniques for long time dynamics - **N. Makri** (Univ. of Illinois, Urbana, USA)
Monte-Carlo simulations of functional integrals - **A. Sokal*** (New York Univ., New York, USA)
Applications of path integrals to polymers and membranes - **B. Duplantier** (CEA Saclay, France)
Variational perturbation expansions - **H. Kleinert** (Freie Univ. Berlin, Germany)
Heuristic uses of functional integration in quantum field theory - **B. DeWitt** (Univ. of Texas, Austin, USA)
Rigorously defined field theoretical functional integrals - **J. Magnen** (E. Polytechnique, France)

**To be confirmed*

In addition, there will be research seminars by participants of the school.

**Location**

The Summer School will be held at the Institut d'Etudes Scientifiques de Cargèse (France). Cargèse is a village of considerable charm and historic interest located 50 km north of Ajaccio, on the west coast of Corsica. The institute itself is situated by the sea, about 2 km south of the village. A group ticket at reduced cost will be arranged on scheduled flights between Paris and Ajaccio on September 1 and September 14.

**Applications**

The school will be open to approximately 65 participants. Application forms should arrive before **April 15, 1996**. Junior applicants should send a letter of recommendation from a senior scientist who has had the opportunity to judge their work. Participants are expected to cover their own travel and living expenses. Scholarships may be awarded upon specific request attached to the application form.

Application Forms should be sent to: Antoine Folacci,
Functional Integration NATO ASI,
Faculté des Sciences, B.P. 52
Université de Corse
F-20250 Corte FRANCE
Fax: 33 95 61 05 51

# Detector Instrumentation Department Head

**The Ernest Orlando Lawrence Berkeley National Laboratory (EOLBNL)** is seeking a Head for the Detector Instrumentation Department. This individual will lead a wide range of efforts in the R&D of advanced electronic instrumentation for high energy physics, nuclear sciences, medical applications and X-ray detection projects.

The department, consisting of a staff of 30-40 engineers, scientists, and technicians, serves as a resource to the Laboratory programs in High Energy and Nuclear Physics, Astrophysics, Materials, and Biosciences. The staff have competency in application specific integrated circuits (ASIC) design, high bandwidth, low noise analog and digital systems, and advanced solid-state detectors.

The Laboratory seeks a nationally or internationally recognized authority and leader in the field of instrumentation for radiation detection and measurement. This individual should have a broad interest in instrumentation development including significant experience and demonstrated competency and achievements in one or more of the following technical areas: analog signal processing, state-of-the-art microelectronics technology, solid-state detector research and development, and large systems for radiation detection. An extensive publication record, a demonstrated ability to provide effective technical leadership to large groups and complex technical projects, and good management and communication skills are required. An advanced degree in Electronics Engineering, Physics, or related field is preferred.

Reporting to the Engineering Division Director, you will provide overall technical leadership to the department, manage staff, determine and/or establish programmatic goals and requirements, assemble engineering and technical teams to meet those goals and requirements, and contribute technically to one or more of the detector R&D or construction projects underway at the Laboratory. You will also be expected to develop new technical initiatives within or from outside the Laboratory. Your own research activities may be carried out within the Engineering Division or within one of the Laboratory programmatic divisions (e.g. Physics, Nuclear Science, Materials, Life Science).

Berkeley Lab provides excellent benefits and compensation packages, and the opportunity for career growth. Please mail your resume to: **Ernest Orlando Lawrence Berkeley National Laboratory, Attn: Human Resources Dept., Bldg. 938A, JCEC3520, One Cyclotron Road, Berkeley, CA 94720.** Or fax: **(510) 486-5870.** E-mail: **jamagee@lbl.gov.** Equal opportunity employer. Women and minorities are encouraged to apply.

L•B•N•L

## UNIVERSITY OF FLORIDA EXPERIMENTAL HIGH ENERGY PHYSICS ASSISTANT PROFESSOR

The University of Florida invites applications for a tenure track Assistant or Associate Professor position in experimental high energy physics to begin August 1996 or January 1997. Requirements include a Ph.D., demonstrated accomplishments in this field of research and good teaching ability. The appointment will be made at the level of Assistant/ Associate Professor depending on qualifications and experience. The new faculty member would become part of a rapidly expanding research group that presently includes seven high energy theory faculty and four high energy experiment faculty. Several more faculty members in high energy experimental physics will be hired in the next two years. The group is presently taking an active role in the CLEO experiment at Cornell, the MINOS experiment at Fermilab and has recently joined the DZero experiment at Fermilab. The group is also leading the design and construction of the Endcap Muon System of the CMS experiment at CERN. Our work in these activities are enhanced by a powerful simulation and data analysis computer system, and the construction of a new building for the physics department which will have large and well equipped laboratory space for hardware development and will be complete in 1997.

Applicants should send curriculum vitae, bibliography and a description of research and teaching interest to Professor G. Mitselmakher, HEE Search Chair, Department of Physics, P.O. Box 118440, Gainesville, FL 32611, USA. Please arrange to have your reference letters sent or provide the names of at least three references for the Committee to contact. Applicants with questions may contact the Search Chair by mail or by email at Mitselmakher@phys.ufl.edu or by telephone at 904/392-9237. The deadline for receipt of applications is March 20, 1996.

The University of Florida is an equal employment opportunity/ affirmative action employer. Anyone requiring special accommodations to complete applications should contact the Search Committee Chair.

*SUPERCONDUCTING SUPER COLLIDER*
*Surplus Property Disposal*
*State of Texas*

The General Services Commission (GSC), as agent for the Texas National Research Laboratory Commission, announces the availability for purchase the Linear Accelerator (LINAC) system assets. The LINAC system inventory is located in Waxahachie, Texas and consists of a partially completed first stage particle accelerator, computer and network equipment, test equipment, electronic equipment, mechanical equipment, a low-conductivity water system and other support equipment.

The process for disposal of the LINAC system inventory will be completed by using various forms of competitive bidding and/or auctioneering methods. Information on the disposal process can be obtained via the GSC internet web site at **http://www.gsc.state.tx.us/**

# People and things


*The 'Poland at CERN' industrial and technological exhibition at CERN was opened on 28 November by Polish Deputy Prime Minister A. Luczak (standing just to the left of the placard). With Poland having become CERN's first Member State from Central Europe in 1991, this was a new addition to the list of member state industrial exhibitions which feature regularly at CERN.*

*(Photo CERN EM 21.11.95)*

## CERN Council

*At its meeting in December, CERN's governing body, Council, decided to create a new Engineering Support and Technologies (EST) Division at CERN grouping together activities of the present Mechanical Technologies (MT) Division plus additional support activities from both the accelerator and research sector. Its Leader is Dietrich Güsewell.*

*Council also elected Jacques Lefrançois of Orsay as Chairman of the Scientific Policy Committee for one year from 1 January 1996, succeeding Günther Wolf of DESY. Jerome I. Friedman (MIT) was appointed as a member of the Scientific Policy Committee for 3 years. Karl Gaemers (NIKHEF, Netherlands) was appointed as a member of the Scientific Policy Committee for 3 years from 1 July 1996.*

## CEBAF on line for physics

*After a decade of design, R&D, construction, and commissioning, the CEBAF superconducting radiofrequency accelerator at Newport News, Virginia, is on-line for physics. The first experiment, "Energy Dependence of Nucleon Propagation in Nuclei as Measured in the (e,e'p) Reaction," began at 03.30 on 15 November.*

*Users are delighted with the electron beam. In production running, the recirculating accelerator is delivering nearly 2 coulombs per day of two-pass, 1645 MeV continuous wave (cw) beam at experimenter-requested currents between 5 and 20 microamperes. Earlier in November, stable and reliable five-pass cw operation at 4 GeV - as originally specified - was demonstrated over several days, reaching 100 kW beam power with average currents up to 24 microamperes. Accelerating cavity gradient has averaged well above 6 MeV/m; specification is 5 MeV/m. Energy spreads have been measured at better than $10^{-4}$. With two linacs, nine recirculation arc beam lines, over 2200 magnets, and 120,000 input/output points, machine complexity is comparable to that of LEP. Up time is above 80% and getting better. A full report will appear in the next issue of the Courier.*

## Dirac memorial

*On 13 November, a plaque commemorating illustrious theorist Paul Dirac (1902-84) was dedicated in London's Westminster Abbey, near the grave of Isaac Newton. Beforehand a meeting at the Royal Society celebrated some of Dirac's contributions to physics. The speakers were President of the Royal Society Sir Michael Atiyah ('the Dirac equation and geometry'), David Olive of Swansea ('Monopoles'), Maurice Jacob of CERN ('Antimatter') and Abraham Pais of Rockefeller ('Paul Dirac: aspects of his life and work')*

*Meanwhile in St. Maurice, Valais, Switzerland, home of Dirac's ancestors, the Paul Dirac Garden is another lasting monument to the one of the greatest physicists of the century.*

## American Physical Society Awards 1996

*Among the American Physical Society Awards for 1996, Fermilab theorist William Bardeen receives the J.J. Sakurai Prize for Theoretical Particle Physics for his work in understanding the axial anomaly and his contributions to perturbative quantum chromodynamics.*

*The companion W.K.H. Panofsky Prize in Experimental Particle Physics goes to Gail Hanson of Indiana and Roy Schwitters of Austin,*

Monica Dirac (centre) and her family at the Royal Society, London, prior to the dedication of a plaque commemorating her father, Paul Dirac (1902-84) in London's Westminster Abbey.
(Photo M. Jacob)

Texas, for their pioneer observation of hadron jets in electron-positron collisions using the Mark I detector at SPEAR in the mid-1970s, and for their polarization studies which demonstrated how quarks carry spin.

The Tom W. Bonner Prize in Nuclear Physics goes to John Dirk Walecka of CEBAF and the College of William and Mary for his theoretical guidance in exploiting weak and electromagnetic nuclear probes and for his contributions to nuclear physics.

The Nicholson Medal for Humanitarian Service goes to Yuri Orlov of Cornell for uniting his love of physics with an intense dedication to human rights. With the late Andrei Sakharov, Orlov was a strong opponent of political oppression.

The George E. Pake Prize goes to Charles Shank, currently Director of the Lawrence Berkeley National Laboratory.

The Julius Edgar Lilienfeld Prize goes to Kip Thorne of Caltech for his work in quantum cosmology and for conveying the excitement of this work to wider audiences.

The Dissertation in Beam Physics Award goes to Daniel Abell of Maryland his contributions in applying mathematical principles to tracking in accelerators.

The Robert R. Wilson Prize goes to Albert Hofmann of CERN (see page 30).

## 'Retirements': Torleif Ericson...

Formally retired from CERN since the end of November is nuclear theorist Torleif Ericson, one of the last pioneer members of CERN's Theory Division to reach this career milestone. One of the few specialists at CERN in nuclear, rather than particle, matters, he has ensured that mainstream nuclear physics has always had a place at CERN, while profiting from it to apply to his subject new ideas emerging from the particle side.

Beginning his career as a nuclear theorist under Ben Mottelson at Nordita in Copenhagen, he completed his research degree at Lund in Sweden, going then to MIT, where he made his first classic contribution, on statistical fluctuations in nuclear behaviour, a forerunner of what is now fashionably termed quantum chaos.

Many notable contributions followed, sometimes with his wife, Magda, including the famous 'Ericson-Ericson-Lorentz-Lorenz' effect on the behaviour of pions in nuclear matter.

He instigated the first 'PANIC' (Particles and Nuclei International Conference) at CERN. These meetings went on to become a regular feature of the international physics scene, providing a valuable bridge between the adjacent intellectual continents of particle and nuclear physics.

In an example of continental drift, the nuclear and particle physics sectors were once indistinguishable, but as time passed started to move apart. However in recent years this drift has been stopped, if not even reversed, with quark nuclear effects discovered at CERN using muon beams, the CERN heavy ion programme and with the LEAR low energy antiproton ring. Torlief Ericson has carried out, and will continue to carry out, an important role as custodian of the bridge linking the particle and nuclear physics continents.

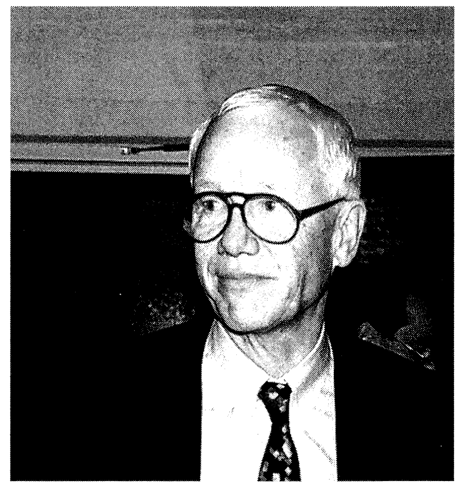
As honorary professor in Sweden, he has spent part of his time at Uppsala, a practice which he plans to continue, while remaining most of the time at CERN.

## ...and Klaus Winter

A characteristically thoughtful symposium at CERN on 6 December marked the formal retirement of distinguished experimentalist Klaus Winter, whose careful appraisals are much in demand for resolving

Nuclear resonance -
Torleif and Magda Ericson

Klaus Winter - chorus of approval



controversy in neutrino rapporteur talks.

Arriving at CERN in 1958, he was involved in initial weak interaction experiments at the synchro-cyclotron and the PS proton synchrotron. After a strong interaction interlude from 1971-76 at the Intersecting Storage Rings, he moved back to weak interactions as spokesman of a series of landmark neutrino physics experiments at the SPS proton synchrotron - CHARM, its successor, CHARM2, and now Chorus. The careful CHARM experiments have provided definitive measurements of key electroweak parameters, nicely complementing results from other sectors to provide today's precision Standard Model numbers. Meanwhile the Chorus experiment, with its innovative approach and wide international participation, is poised to add further to our knowledge of neutrinos.

After an introduction from CERN Director General Chris Llewellyn Smith, the symposium opened with memorable multilingual poetry from H.M. Enzensberger. Turning to physics, Ettore Fiorini spoke on thermal detectors, Sam Ting on precision electroweak tests, Lev Okun dreamt of an unorthodox lepton-photon picture, Val Telegdi ('The Inverse Billionaires' Club') spoke on precision physics experiments, and Walter Schmidt-Parzefall looked forward to the HERA-B experiment.

## 1996 UK Institute of Physics awards

Among the winners of this year's awards by the UK Institute of Physics is Sir William Mitchell, who receives the Glazebrook Prize 'in recognition of his outstanding contributions to the organization of science as head of the Physics Department at Reading and of the Clarendon Laboratory, Oxford, Chairman of the UK Science and Engineering Research Council, and as President of CERN Council (1991 - 3). In this latter role he oversaw much of the valuable groundwork for the subsequent approval of the LHC.

Theorist Frank Close of the Rutherford Appleton Laboratory receives the Kelvin Prize for the public understanding of physics for his memorable public presentations and well known books ('The Cosmic Onion', 'End', 'The Particle Explosion',..)

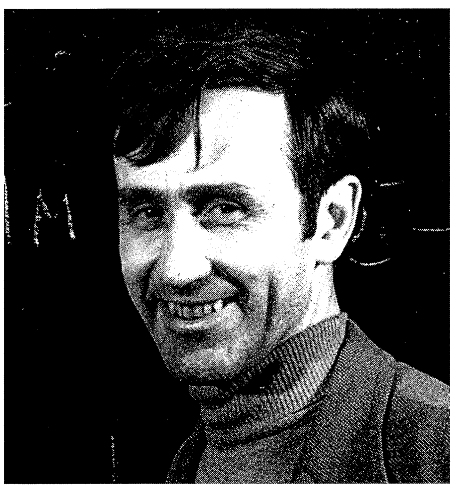
David Bugg of Queen Mary and Westfield College, London, receives the Rutherford Prize for his contributions to particle physics, particularly hadron spectroscopy. He has worked on several experiments at CERN, most recently at the LEAR low energy antiproton ring.

## Distinguished Berkeley scientists

Three notable Berkeley researchers, David Nygren, Arthur Poskanzer and Frank Stephens, well-known for their accomplishments in designing innovative detectors, become Distinguished Scientists at the Lawrence Berkeley National Laboratory.

Nygren's invention of the Time Projection Chamber (TPC) has had a profound effect on both particle and nuclear physics, while his groundwork on pixel detectors, as well as other ideas, have been extremely fruitful.

Poskanzer is a pioneer in the use of high energy reactions to produce nuclei far from stability. He has led a group effort in the field of relativistic heavy ion reactions, and was co-leader of the Plastic Ball project



Alexander ('Sasha') Skrinsky - 60

which discovered the collective flow of nuclear matter. He is spending this year at CERN, where he is deputy spokesman of the NA49 experiment.

Stephens, the originator of the Gammasphere project, is one of the foremost authorities on the structure of nuclei and the relationship of that structure to phenomena in other branches of physics.

## Alexander Skrinsky 60

Alexander Skrinsky, or Sasha as friends and colleagues call him, is 60 on 15 January. An outstanding member of Gersh Budker's Siberian school, after graduating from Moscow University in 1959 his life has been closely linked to Novosibirsk's Budker Institute of Nuclear Physics, where he has progressed from graduate student to Director.

Under first Budker and then Skrinsky, Novosibirsk's successful commissioning of pioneering electron colliders earned the Lenin Prize, and a bid to extend this work to heavy particles stimulated the famous development of electron cooling, a technique now exploited all over the world.

Skrinsky's early fascination in spin dynamics resulted in major developments for polarized beams in colliders. Their logical continuation was the discovery and subsequent development by Skrinsky (who had become the youngest Soviet Academician, elected in 1970) of resonance depolarization for high precision measurements of particle masses. For this, Skrinsky and other Novosibirsk physicists were awarded the State Prize of the USSR.

While the rest of the community focused on circular supercolliders, Siberian scientists, already dreaming of new frontiers, conceived the linear collider idea - now an acknowledged future avenue.

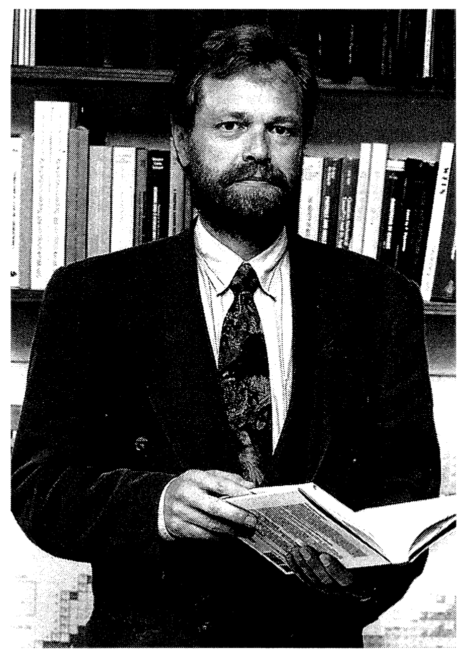
Skrinsky's wide physics interests are a continual source of fresh ideas, including the optical klystron - a special free electron laser.

As leader of a major Russian physics centre and as head of the Nuclear Physics Department of the Russian Academy of Sciences, he actively contributes to the scientific programme of major accelerator laboratories and in particular furthers the interests of Russian physicists in international collaboration.

Physically fit, he spends rare free moments in the forest: jogging in summer and skiing in winter.

## Meetings

The CERN Accelerator School and the European Synchrotron Radiation Facility (ESRF, Grenoble) are jointly organizing a course on Synchrotron Radiation and Free-Electron Lasers, to be held from 22-27 April in Grenoble, France, and mainly aimed at staff in laboratories, universities and companies manufacturing appropriate equipment. Further



Thomas Weiland of Darmstadt's Technische Hochschule received one of the prestigious 1995 Max Planck research awards for his contributions to accelerator physics.

information from Mrs. S. von Wartburg, CERN Accelerator School, CH-1211 Geneva 23, e-mail casgren@cernvm.cern.ch fax +41 22 767 5460

A meeting "Quark confinement and the hadron spectrum II", sponsored by the EEC's Human capital and mobility programme, will be held in Como, Italy from 26-29 June 1996. Information: N. Brambilla, Dipartimento di Fisica, Via Celoria 16, 20133 Milano, phone: +39 2 2392 723, fax: +39 2 2392 480; email: N.Brambilla@mi.infn.it or quarkconfin@mi.infn.it

A Summer School on Physics with Neutrinos will be held at Zuoz (Engadin) Switzerland from 4 - 10 August, organized by the Paul Scherrer Institute (PSI), Villigen. Scientific secretaries are M.P. Locher and R. Rosenfelder. Requests for registration should be sent to Mrs. Christine Kunz (secretary), WHGA-C59, CH-5232 Villigen-PSI, *South African President Nelson Mandela opened the International Conference on Cyclotrons and their Applications in Cape Town in October.*

*(Photo National Accelerator Centre, Faure, South Africa)*

*Switzerland, Telephone +41-56-310 42 23, Fax +41-56-310 36 36, e-mail: Christine.Kunz@psi.ch*

## *CERN-JINR European School*

*The 1996 CERN-JINR European School of High Energy Physics will be held at Carry-le-Rouet, near Marseille, France, from 1-14 September.*

*Organized jointly by CERN and the Joint Institute for Nuclear Research (JINR), Dubna, Russia, together with institutes from this year's host country, France, the school's basic aim is to teach various aspects of high energy physics, but especially theoretical physics, to young experimentalists, drawn mainly from CERN and JINR Member States.*

*All enquiries and correspondence related to the School of Physics should be addressed either to:*

*Miss Susannah Tracy, School of Physics, CERN/DSU; CH-1211 Geneva 23, Switzerland. Telephone +41 22 767 2724; Telex 419 000 CER CH; Telefax +41 22 767 6760; E-mail Susannah_Tracy@macmail.cern.ch*

*or to Mrs Tatyana Donskova, International Department, Joint Institute for Nuclear Research, CIS-141980 Dubna, Moscow Region, Russia. Telephone +7 095 926 2252/ 7 096 21 63448; Telex 911621 dubna su; Telefax +7 095 975 2381/7 096 21 65 891; E-mail donskova@ypr.jinr.dubna.su*

*Latest information on the school and the application form can be found on the World Wide Web http:// www.cern.ch/PhysicSchool/*

*Completed applications should be received by 31 March.*

## *Physics and detectors for a linear collider - Joint ECFA/DESY study*

*The European Committee for Future Accelerators, ECFA, is setting up joint working groups with DESY to study both the physics potential of an electron-positron linear collider with a collision energy of 500 GeV or more, and the conceptual design of the required detectors. The groups will be formed at a first workshop in Frascati on 5-6 February. There will be a second workshop in early July, and the results will be gathered together at a final workshop in November.*

*Four working groups will cover:*

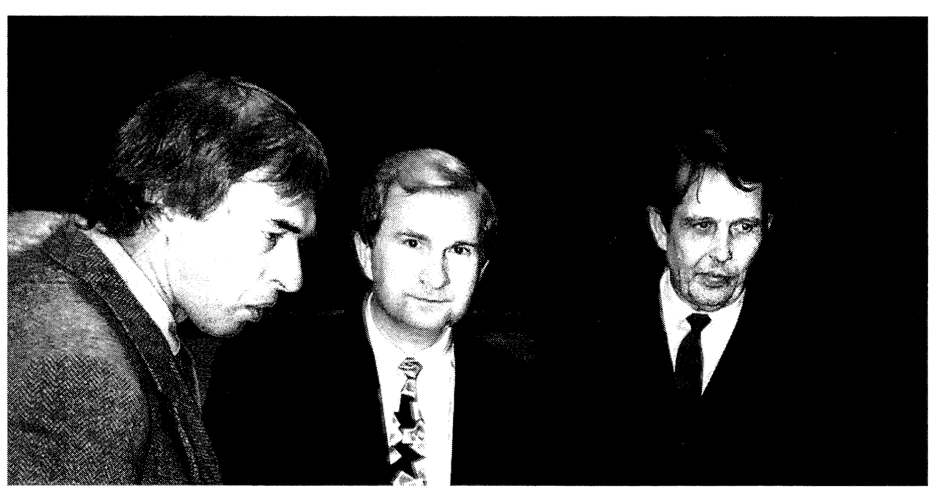
*- Physics (including electron-positron, real gamma-gamma and electron-gamma interactions), benchmark processes and generators;*

*- Detector concepts - B field, hermeticity, tools, simulation etc;*

*- Detector subsystems; vertexing, calorimetry, triggers etc;*

*- Collider-experiment interface; backgrounds, masking etc.*

*Updated details of the workshops will be available on the World Wide*



*Visiting CERN recently was Deputy Minister of Industry and Trade of the Czech Republic Miroslav Somol (centre). On his left is Jiri Niederle, President of the Council for International Affairs of the Czech Academy of Sciences and Vice-Chairman of CERN Council, with Delphi experiment physicist Jan Ridky of Prague on his right.*

## Lawrence Berkeley Laboratory
## Postdoctoral Position in Particle Physics

The Physics Division at LBL has an opening for a postdoctoral physicist in the D0 Group. LBL built a calorimeter and vertex chamber for the D0 Detector at the Fermilab Tevatron Collider, is deeply involved in electroweak and top quark physics analyses, and is collaborating on the new silicon tracker for the upgraded detector. We seek candidates who are exceptionally talented and deeply interested in analyzing present D0 data and in upgrading the D0 detector for its highest luminosity run.

Applicants should have a Ph.D. in particle physics and demonstrate strong potential for outstanding achievement as an independent researcher. This is a two-year appointment with the possibility of renewal. Salary range is \$3135-\$3820/month.

Please submit a letter of application, resume, publication list and three letters of reference to:

Dr. Ronald J. Madaras
c/o Personnel Administrator, Job PHY/3911
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**1996 LNF Spring School in Nuclear and Subnuclear Physics**

## INFN National Laboratories in Frascati

**15-20th April 1996**

The 1996 LNF Spring School in Nuclear and Subnuclear Physics will take place in INFN National Laboratories, in Frascati, Italy, from 15th to 20th of April. The School is directed to graduate students, postgraduate and postdoctoral fellows and will be dedicated to DAΦNE physics, in particular to studies of CP and CPT violation in $\phi$-decays, hadron spectroscopy at the $\phi$, hypernuclear physics, hadronic contributions to g-2 of the muon, and Chiral Perturbation Theory.

For information, contact Giulia Pancheri at Frascati National Laboratories: **e-mail pancheri@lnf.infn.it** or **tel n. 0039-6-94032885, 2427fax** or consult www at the address **http://hpteor.lnf.infn.it/.**

**Research Physicist - High Energy Physics**
University of California Santa Barbara

The high energy physics group of UCSB has one or more positions available starting in the fall of 1996. The appointments would be at the post-doctoral research physicist or assistant research physicist level, depending on qualifications. The positions are for research with the CLEO or BABAR collaborations on heavy quark physics. A Ph.D. in experimental particle physics is required, with evidence of experience in hardware development and data analysis.
Interested candidates should submit a letter of application, statement of research interests, vita, and a list of publications to:

Professors Campagnari and Morrison
Department of Physics, University of California
Santa Barbara, CA 93106-9530
email : morrison@charm.physics.ucsb.edu
claudio@ucsb2.physics.ucsb.edu

They should also arrange to have at least three letters of recommendation sent to the same address. For primary consideration, applications should be received by March 15, 1996; positions will remain open until filled. We encourage applications from minority and women candidates. The University of California is an EO/AA employer.

Web, linked under Conferences Schools and Workshops via the CERN and DESY homepages.

The physics programme of such a collider would complement the ongoing LHC programme at CERN. As a result of an intercontinental collaboration towards the realization of the linear collider, conceptual design reports are in preparation in the USA and in Japan, and are expected to appear at the end of 1998.

The joint ECFA/DESY workshops aim to match the intensive work on the conceptual designs for the TESLA and S-band accelerators with a conceptual detector design. This study will draw on the results of previous physics studies done in Europe and elsewhere in preparation for the workshops in Finland, in Hawaii and at Morioka, Japan, last September.

The organizing committee for the study is L. Mandelli (Milano, chair), G. Coignet (LAPP, Annecy), M. Danilov (ITEP, Moscow), E. Fernandez (Barcelona, new chair of ECFA), K. Gaemers (NIKHEF), L. Jønsson (Lund), M. Leenen (DESY), D.J. Miller (UC, London), A. Wagner (DESY).

## Robert R. Wilson Prize 1996

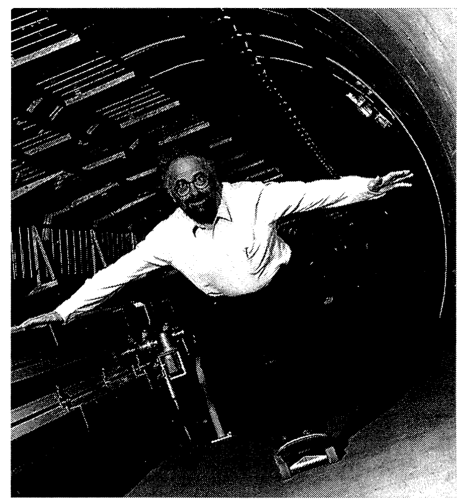
This year Albert Hofmann of CERN wins the prestigious Robert R. Wilson Prize of the American Physical Society*, an award established in 1986 to recognize and encourage outstanding achievement in the physics of particle accelerators, and which has established itself as the major world honour in this vital sector, without which particle physicists would not be able to make their experimental discoveries.

The dry official citation says Hofmann's award is 'for his numerous experimental techniques developed to elucidate collective phenomena in accelerators and storage rings; in particular the experimental determination of beam impedances and methods for controlling the instabilities that limit beam intensities. His theoretical insights and experimental innovations have led directly to high intensities in many circular accelerators and storage rings both for particle physics and synchrotron radiation production. As a superb teacher and mentor, he has been unfailingly generous in conveying his knowledge and insight to others, especially younger physicists and engineers.'

He learnt his trade first at Zurich, and then as one of a small band of dedicated pioneers at the Cambridge (US) Electron Accelerator, a complicated machine which in the late 60s and early 70s blazed a trail for electron-positron colliders to come. At CERN, his elegant work on the understanding, measurement and suppression of beam instabilities in the Intersecting Storage Rings (ISR) opened the door to higher beam intensities in that machine and its successors.

His next major responsibility at CERN was (and still is) in the LEP electron-positron collider. Along with Steve Myers, he was responsible for the commissioning of this, the world's largest accelerator, where he has played a vital role in coaxing this complex machine towards and beyond its design performance.

His genius and insight have consistently led to unexpected machine refinements, examples



Albert Hofmann - Robert R. Wilson Prize

being the first detection of synchrotron radiation from a high energy proton beam (at the CERN SPS), and the uncannily accurate prediction of the effect of earth tides on beam energy in LEP (in collaboration with the late Gerry Fischer). His exceptional talent is also well integrated into coherent teamwork, with many of his contributions have been made in collaboration with colleagues.

Away from CERN, he has spent several years at SLAC (Stanford), where he helped convert the SPEAR and PEP electron rings for synchrotron radiation use, as well as working on the damping rings for the SLC linear collider. As a world authority on synchrotron radiation, he has contributed to several major world machines.

Always eager to share his deep knowledge and understanding with his colleagues, he is much in demand as a lecturer on accelerator topics.

* For details of other 1996 American Physical Society awards, see page 23.

A recent symposium at Argonne to mark the 65th birthday of Tom Fields attracted a number of scientific celebrities, including a bevy of Directors of Argonne's High Energy Physics Division. In chronological order (right to left ) they are Roger Hildebrand, Tom Fields, Malcolm Derrick, Bob Diebold and present Director Larry Price. Missing is Tom Kirk who served as Director before Price. The one-day symposium covered the scientific and technical contributions Tom has made over a 40-year career, as well as institutional and planning questions. The range of contributions that physicists of Tom's generation made is staggering considering that today a young physicist might work on only two experiments in a lifetime!

*Juan Jose Giambiagi*

*A guiding light of Latin American physics, Juan Jose Giambiagi, died in Rio de Janiero on 8 January. A tribute will appear in a forthcoming issue.*

*Antihydrogen*

*As CERN scientists returned to the Laboratory after the end-year break, they were surprised to learn via media announcements that an experiment at CERN had discovered the first signs of antimatter. Last summer, an experiment at CERN's LEAR low energy antiproton ring using a xenon gas jet target in the circulating antiproton beam found nine atoms of antihydrogen. Such neutral atoms each consist of a lone positron (antielectron)circulating round an antiproton nucleus.*

*Antiparticles are well understood and were first seen in 1932. Scientifically, the fact that neutral antiatoms can exist is no surprise - the challenge is to synthesize and detect them. Having done this, the next, and more difficult, question is to determine whether these atoms behave in the same way as their ordinary matter counterparts. Story in the next issue.*

## CERN Courier contributions

**The Editor welcomes contributions. These should be sent via electronic mail to courier@cernvm.cern.ch**

**Plain text (ASCII) is preferred. Illustrations should follow by mail (CERN Courier, 1211 Geneva 23, Switzerland).**

**Contributors, particularly conference organizers, contemplating lengthy efforts (more than about 500 words) should contact the Editor (by e-mail, or fax +41 22 782 1906) beforehand.**

# *Experimental Research Associates*

The Stanford Linear Accelerator Center (SLAC) is one of the world's leading laboratories supporting research in high-energy physics. The laboratory's program includes the physics of high-energy electron-positron collisions, high-luminosity storage rings, high-energy linear colliders and particle astrophysics.

Post-doctoral Research Associate positions are currently available with research opportunities in the following areas:

- $Z^0$ physics at the Stanford Linear Collider, with highly polarized electron beams and the upgraded SLD detector with its new vertex detector
- Preparing for B physics with the BaBar detector at the PEP II Asymmetric B Factory, helping design and build the detector subsystems and get ready for physics
- Participating in a Particle Astrophysics program studying time-dependent x-ray sources with the USA (1996 launch) and R&D for a high-energy gamma ray astronomy experiment in space (GLAST)

These positions are highly competitive and require a background of research in high-energy physics and a recent PhD or equivalent. The term for these positions is two years and may be renewed.

Applicants should send a letter stating their physics research interests along with a CV, three references, and a list of publications to Jean Lee, jeanlee@slac.stanford.edu, Research Division, M/S 80, P.O. Box 4349, Stanford, CA 94309. Equal opportunity through affirmative action.

*Stanford Linear*
*Accelerator Center*

**SLAC**

DESY

DESY announces several

## 'DESY Fellowships'

for young scientists in experimental particle physics to participate in the research mainly with the HERA collider experiments H1 and ZEUS or with the fixed target experiments HERA-B and HERMES. New fellows are selected twice a year in April and October.

DESY fellowships in experimental particle physics are awarded for a duration of two years with the possibility for prolongation by one additional year.

The salary for the fellowship is determined according to tarifs applicable for public service work (BAT II a).

Interested persons, who have recently completed their Ph.D. and who should be younger than 32 years are invited to send their application including a résumé and the usual documents (curriculum vitae, list of publications, copies of university degrees) until 31 of march 1996 to **DESY, Personalabteilung - V2 -, Notkestraße 85, D-22607 Hamburg.** They should also arrange for three letters of reference to be sent until the same date to the address given above.

Handicapped applicants with equal qualifications will be prefered.

DESY encourages especially women to apply.

As DESY has laboratories at two sites in Hamburg and in Zeuthen near Berlin, applicants may indicate at which location they would prefer to work.

**TRIUMF**

**MESON RESEARCH FACILITY**
University of Alberta
Simon Fraser University
University of Victoria
University of British Columbia

## Research Associates Subatomic Physics

Applications are invited for two Research Associate positions in subatomic physics with the HERMES group from TRIUMF, the University of Alberta, and Simon Fraser University. The HERMES experiment measures the spin dependent structure functions of the proton and the neutron using deep inelastic scattering of polarized positrons from polarized gas targets at HERA. The Canadian group is responsible for the transition radiation detector used to distinguish between positrons and hadrons and the second level trigger. The group is also involved in the slow control systems for the experiment. HERMES has taken its first data in 1995 and the focus of the group is moving from hardware to software and physics analysis.

Applicants must have a PhD. in Nuclear or Particle Physics. Relevant skills and experience in wire chambers and nucleon structure would be an asset. There will be two positions available, subject to funding. Successful candidates will spend half of their time on hardware support upgrades, half on physics analysis. The candidate will also be expected to spend a significant amount of time at DESY in Hamburg, Germany.

Salary is competitive and depends on experience. Applicants should send a curriculum vitae and the names of three referees **before February 15, 1996 to: TRIUMF Personnel (Comp. #693-105), 4004 Wesbrook Mall, Vancouver, B.C. CANADA V6T 2A3.**

**For further information contact Dr. M. Vetterli (vetm@triumf.ca).** We offer equal employment opportunities to qualified male and female applicants. In accordance with Canadian immigration requirements, this advertisement is directed first to Canadian citizens and permanent residents. However, all qualified persons are encouraged to apply.