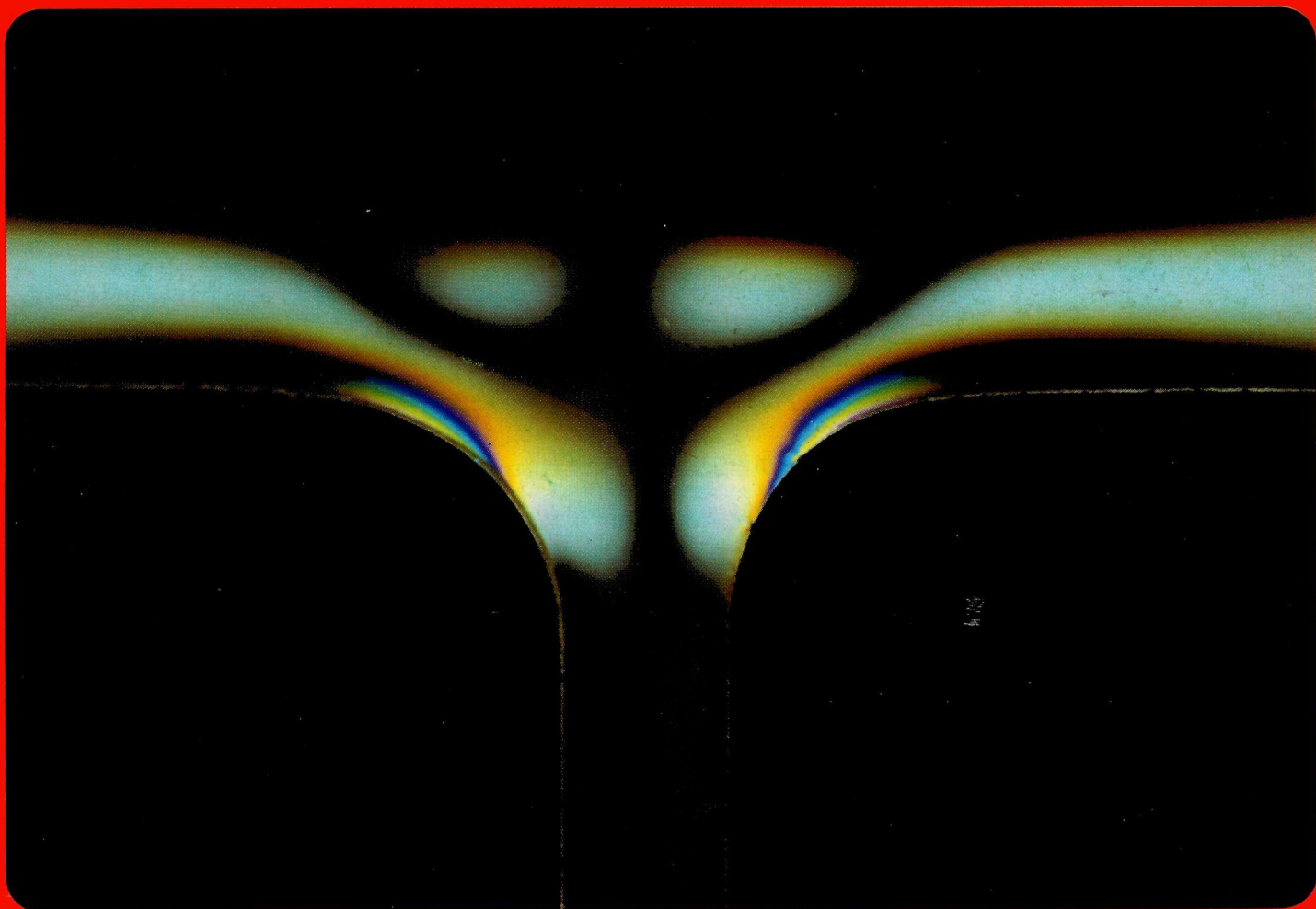


# CERN COURIER

International Journal of High Energy Physics



VOLUME 24

**2**

MARCH 1984

# CERN COURIER

International Journal of the High Energy Physics Community

Editors: Brian Southworth, Gordon Fraser, Henri-Luc Felder (French edition) /  
Advertisements: Micheline Falciola / Advisory Panel: J. Prentki (Chairman),  
J. Allaby, J. Cronin, K. Hübner, E. Lillestøl

VOLUME 24 N° 2

MARCH 1984

Around the Laboratories

KEK: TRISTAN advances . . . . . 51  
*Construction of Japan's big electron-positron machine*

DESY: HERA progress . . . . . 52  
*Working towards Germany's electron-proton collider*

CERN: Antiprotons in orbit . . . . . 53  
*Results on antiprotonic atoms from LEAR*

CORNELL: Fixing the upsilon mass . . . . . 55  
*Polarization techniques in action*

LOS ALAMOS: Winds of change . . . . . 56  
*Planning to upgrade the Meson Physics Facility*

Cosmic rays at Bangalore . . . . . 58  
*Report of international conference*

Physics monitor

Superconducting cavities looking good . . . . . 61  
*Pushing for higher energies*

Looking for oscillating neutrinos . . . . . 62  
*Searching for new neutrino behaviour*

Opening up nuclei with electrons . . . . . 64  
*Electron beams show signs of new nuclear properties*

People and things . . . . . 66

*Cover photograph: For moving material and personnel around the 27 km tunnel being built at CERN for the LEP ring, a monorail system is being planned. Seen here is the result of subjecting a model of the rail section to a photoelastic stress test using polarized light. The tests were carried out by the LEP Installation and Mechanical Engineering Group.  
(Photo CERN 590.12.83)*

Laboratory correspondents:  
Argonne National Laboratory, USA  
W. R. Ditzler  
Brookhaven National Laboratory, USA  
N. V. Baggett  
Cornell University, USA  
D. G. Cassel  
Daresbury Laboratory, UK  
V. Suller  
DESY Laboratory, Fed. Rep. of Germany  
P. Waloschek  
Fermi National Accelerator Laboratory, USA  
R. A. Carrigan  
KfK Karlsruhe, Fed. Rep. of Germany  
M. Kuntze  
GSI Darmstadt, Fed. Rep. of Germany  
H. Prange  
INFN, Italy  
M. Gliarelli Fiumi  
Institute of High Energy Physics,  
Peking, China  
Tu Tung-sheng  
JINR Dubna, USSR  
V. Sandukovsky  
KEK National Laboratory, Japan  
K. Kikuchi  
Lawrence Berkeley Laboratory, USA  
W. Carithers  
Los Alamos National Laboratory, USA  
O. B. van Dyck  
Novosibirsk Institute, USSR  
V. Balakin  
Orsay Laboratory, France  
Anne-Marie Lutz  
Rutherford Appleton Laboratory, UK  
D. Cragg  
Saclay Laboratory, France  
A. Zylberstejn  
SIN Villigen, Switzerland  
J. F. Crawford  
Stanford Linear Accelerator Center, USA  
W.W. Ash  
TRIUMF Laboratory, Canada  
M. K. Craddock

Copies are available on request from:  
Federal Republic of Germany —  
Gerda v. Schlenther  
DESY, Notkestr. 85, 2000 Hamburg 52  
Italy —  
INFN, Casella Postale 56  
00044 Frascati  
Roma  
United Kingdom —  
Elizabeth Marsh  
Rutherford Appleton Laboratory, Chilton,  
Didcot  
Oxfordshire OX11 0QX  
USA/Canada —  
Margaret Pearson  
Fermilab, P. O. Box 500, Batavia  
Illinois 60510  
General distribution —  
Monika Wilson  
CERN, 1211 Geneva 23, Switzerland

CERN COURIER is published ten times yearly  
in English and French editions. The views  
expressed in the Journal are not necessarily  
those of the CERN management.

Printed by: Presses Centrales S.A.  
1002 Lausanne, Switzerland

Published by:  
European Laboratory for Particle Physics  
CERN, 1211 Geneva 23, Switzerland  
Tel. (022) 83 61 11, Telex 23 698  
(CERN COURIER only Tel. (022) 83 41 03)  
USA: Controlled Circulation  
Postage paid at Batavia, Illinois

# Around the Laboratories

*The TRISTAN Accumulation Ring at the Japanese KEK Laboratory which accelerated electrons for the first time in November. On the left is the electron injection line.*

## KEK TRISTAN advances

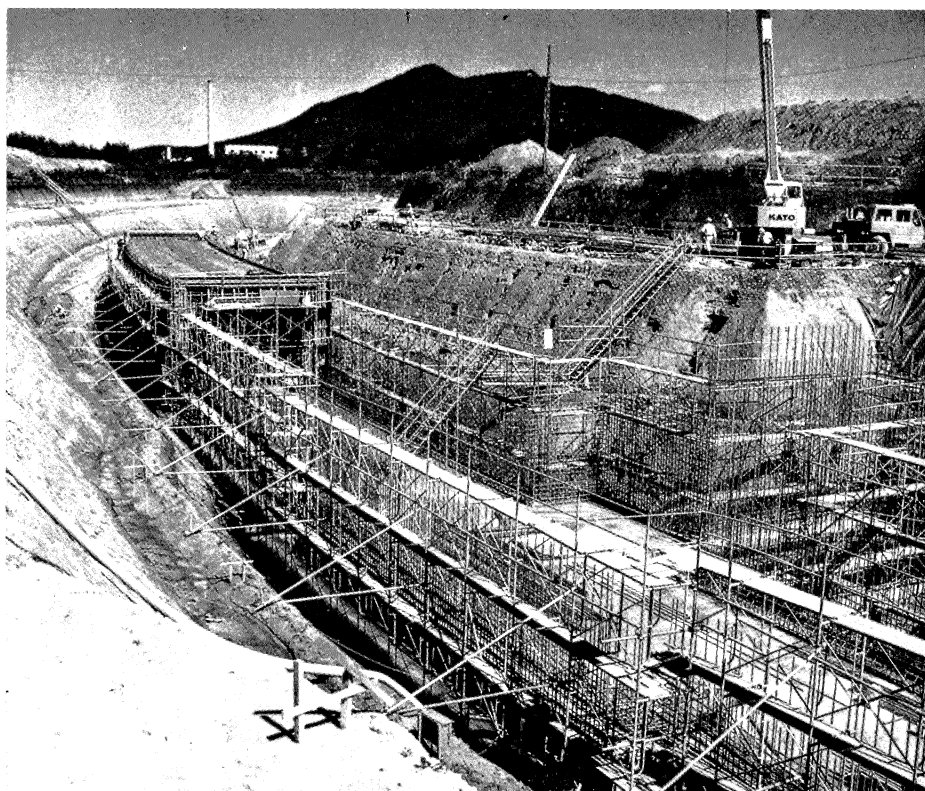
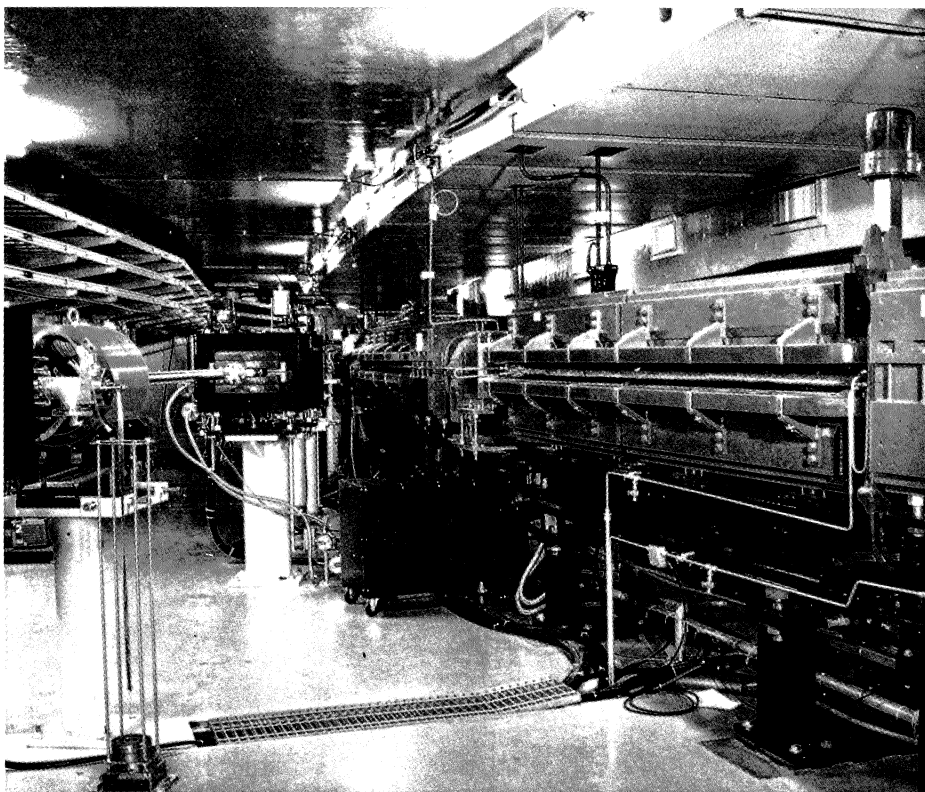
The Accumulation Ring of the TRISTAN accelerator at the Japanese KEK Laboratory accelerated electrons to 4.2 GeV on 18 November 1983, just two years after the groundbreaking ceremony on 19 November 1981. The electron energy was boosted to 4.8 GeV on 13 December and is expected to reach the design level of 6 GeV before this article appears.

For TRISTAN, the 2.5 GeV electron linac (built for the Photon Factory — the KEK synchrotron radiation research facility) supplies electrons to the Accumulation Ring. This 120 m diameter ring accelerates two bunches of electrons (or positrons) to at least 6 GeV, for injection into the 970 m diameter 30 GeV Main Ring.

The Accumulation Ring tunnel is on the same level as the linac (about 4 m below ground), while the Main Ring tunnel is 7 m lower as it goes under the present 12 GeV proton synchrotron.

Civil engineering for the Main Ring is on schedule. In the current fiscal year, two experimental halls — Fuji (South-West) and Tsukuba (North-East) — and about half the tunnel will be completed. The two general-purpose detectors VENUS and TOPAZ will be installed in the Fuji and Tsukuba areas respectively (see January/February 1983 issue, page 4).

For the third TRISTAN experiment, the AMY project has been approved recently. This compact detector will be built by a joint US/Japanese team for installation in the Oho (South-East) hall. (A proposal to move the HRS detector from SLAC to KEK has



*Construction of the TRISTAN Main Ring tunnel. In the background is Mount Tsukuba.*

More TRISTAN construction work, this time for the 'Fuji' experimental hall, so called because this hall is located in the direction of Mount Fuji when viewed from the centre of the ring. It will house the VENUS detector.

(Photos KEK)



been deferred.) Construction of the Oho and Nikko (North-West) halls and the remainder of the tunnel will shortly get under way and are scheduled for completion at the end of 1985. First beam in the Main Ring is expected by the end of 1986.

Due to the construction of the TRISTAN tunnel, the proton synchrotron will undergo a lengthy shutdown. Though a number of interesting experiments, such as studies of rare kaon decays, are scheduled at this machine, the emphasis of KEK high energy physics will naturally swing towards TRISTAN.

The proton synchrotron will concern itself more with intermediate energy nuclear physics. So far three series of such experiments have been proposed — spectroscopy of hypernuclei, experiments with a polarized proton beam, and studies with an ion beam. Technically, hypernuclear spectroscopy is the easi-

est to get under way as it requires only slight modifications of the existing beamlines.

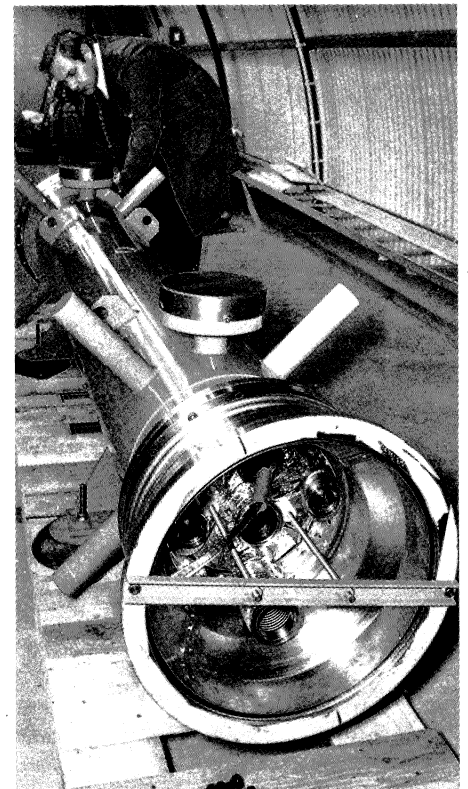
A proposal by a Tokyo/Heidelberg group has been approved and a high intensity kaon beamline is being designed, bearing in mind the possibility of using some magnets from CERN beamlines. For hypernuclear spectroscopy, more intense kaon beams are required and it is planned to increase the injector linac energy from 20 to 40 MeV by adding a new tank.

## DESY HERA progress

While formal steps towards the official approval of the HERA project continue, there have been several good reasons to celebrate at DESY. In January there was a call for tenders for the civil engineering work for

Superconducting quadrupoles for HERA, such as this one ready for testing at DESY, are being made at Saclay.

(Photos DESY)

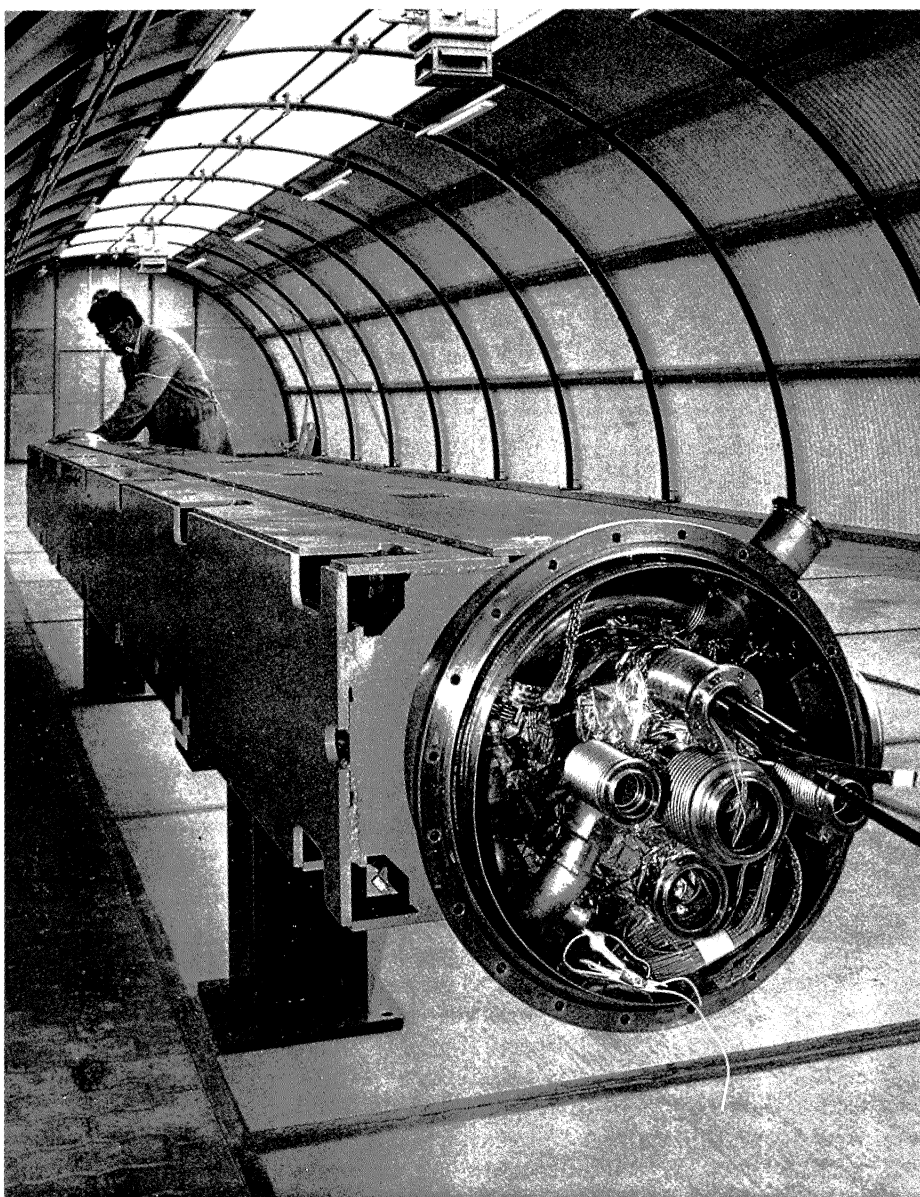


the 6.3 km HERA tunnel and for the four experimental halls. Subject to the final decision of the Federal Ministry of Research (the city of Hamburg has already agreed to the HERA plans) construction is scheduled to start in May. The buildings should then be ready in 1987, the 30 GeV electron ring in 1988 and the 820 GeV proton ring the following year. An ambitious plan, which will keep busy DESY staff and several hundred visitors from about 20 participating Laboratories.

The first superconducting quadrupole for HERA, built at Saclay, has been installed in a new test tunnel hall, alongside the first two complete 6-metre superconducting bending magnets. The first two of the quadrupoles have been tested successfully at Saclay and have reached the design field gradient of 90 Tesla/m without quenching.

A series of one-metre dipole mag-

*Six-metre superconducting bending magnet for the proposed HERA electron-proton machine ready for tests at DESY.*



nets and a 6-metre coil have been tested at DESY and showed good training behaviour and field quality. They reached the so-called 'short sample design qualities' and the required field within only a few quenches. Magnet properties were well above the design values at the required field of 4.53 Tesla.

The new 70-metre tunnel-shaped test-hall has been designed to house two full-length magnet-cells for the

HERA proton ring. Each of these cells is composed of six 6-metre bending magnets and two quadrupoles, all superconducting. It will also include correction coils, monitors, full refrigeration and remote controls, and everything needed to simulate the working conditions in the HERA tunnel.

At present two types of bending magnets are being prepared for these tests. The main difference be-

tween the two designs is that in one type the iron used to return the magnetic flux is independent of the coils and is placed outside the cryostat (warm iron — DESY design). In the other type the iron is inside the cryostat and is also used to help withstand the stress caused by the current-carrying coils (Brown-Boveri design). Four magnets of each type are being prepared for comparison tests and the final decision will be made next year.

In both HERA dipole projects the beam pipe is kept at low temperature. Superconducting correction coils are wound around the vacuum tube and cooled with liquid helium. These coils are being developed in collaboration with NIKHEF in Amsterdam. A one-metre correction coil prototype, built at NIKHEF, has already been successfully tested, and the first full size correction coil is being built by Dutch industry.

In the meantime, fruitful negotiations on contributions to the HERA project are under way with both physicists and authorities from Canada, France, Italy, Israel, the Netherlands and the United Kingdom.

---

## CERN Antiprotons in orbit

The LEAR Low Energy Antiproton Ring promised to supply beams of low energy antiprotons of intensities much greater than had ever been available before. And it has. In just a few hours of beam time last year, LEAR experiments were able to log data which would have taken months or even years with conventional antiproton beams.

Already the benefits are being reaped. Some initial LEAR results on the scattering of antiprotons from nuclei were described in a previous

Comparison of X-ray spectra from antiprotonic atoms of different isotopes of oxygen, measured by the Basle / Karlsruhe / Stockholm / Strasbourg / Thessaloniki group working at CERN's LEAR Low Energy Antiproton Ring. On the left, an unperturbed (8-4) atomic transition, and next to it, a strongly attenuated and broadened line (4-3). The attenuation of this line clearly increases with the number of neutrons.

issue (December 1983, page 416). Now a Basle / Karlsruhe / Stockholm / Strasbourg / Thessaloniki (BKSST) team has some interesting results from the X-ray spectra of antiprotonic atoms.

The study of such exotic atoms, in which an atomic electron is replaced by an orbital antiproton or other negatively charged particle, has long been a speciality at CERN.

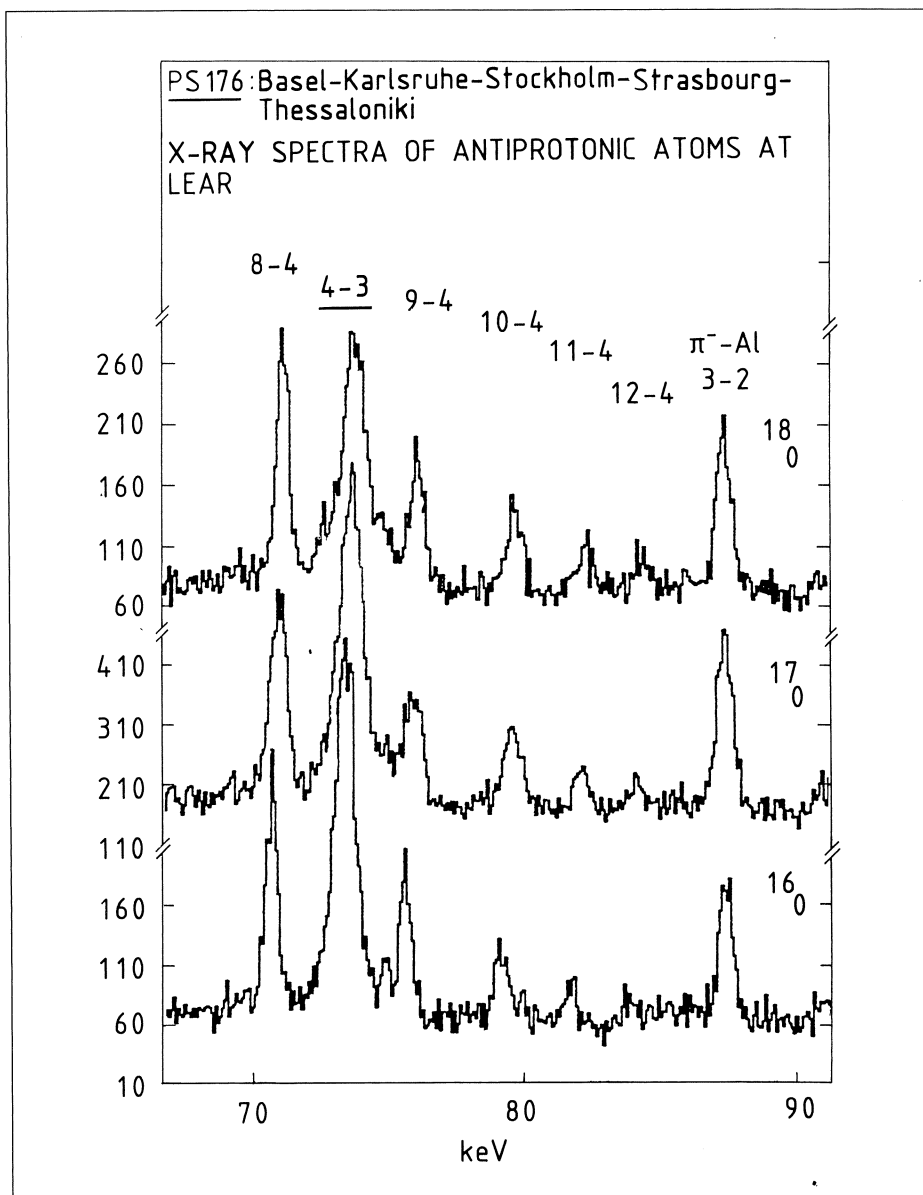
When antiprotons are brought to rest in a target, they are captured in an outer atomic energy level, but quickly fall down the rungs of the atomic energy level ladder. For each energy level transition, a quantum of radiation is emitted.

Because the antiproton is much heavier than the electron, it orbits much closer to the nucleus than the corresponding electron states. In fact when the antiproton approaches the lowest available atomic energy levels, it can be considered as orbiting inside the inner electrons. Such an atomic system can be viewed as a kind of superheavy hydrogen-like atom, with a heavy nucleus replacing the lone proton of hydrogen, and an antiproton replacing the valence electron.

But there is one big difference. As well as the electromagnetic interactions responsible for ordinary atomic structure, antiprotons also interact with nuclei through the strong force.

These strong interactions become more important as the antiproton approaches the nucleus, and should be measurable by comparing the observed behaviour with that expected from the pure electromagnetic interaction between the charged nucleus and the orbiting particle.

In highly excited states, the orbiting antiproton is still far from the nucleus, and the interaction is purely electromagnetic. However at or near the atomic ground state, the orbit is



so small that the antiproton touches, or even penetrates, the nucleus.

These nuclear interactions affect the atomic spectra calculated on the basis of a hydrogen-type atom picture, and the deviations between the observed and 'expected' values should provide important information on the antiproton-nuclear interaction.

These deviations can occur in three ways. The closer the antipro-

ton approaches the nucleus, the more the strong interaction shifts the energy level from its 'hydrogen' position. Increasing nuclear forces also mean that the inner antiproton levels have a greater chance of being annihilated in a nuclear proton or neutron. This has two consequences. When annihilation is still weak, a small fraction of the antiprotons disappear and the ensuing radiative transitions (when the antiproton falls to a lower

level) are attenuated. In the lowest level, nuclear annihilation dominates over the atomic cascade. These states are very short-lived, and this shows up as a broadening of the corresponding spectral lines.

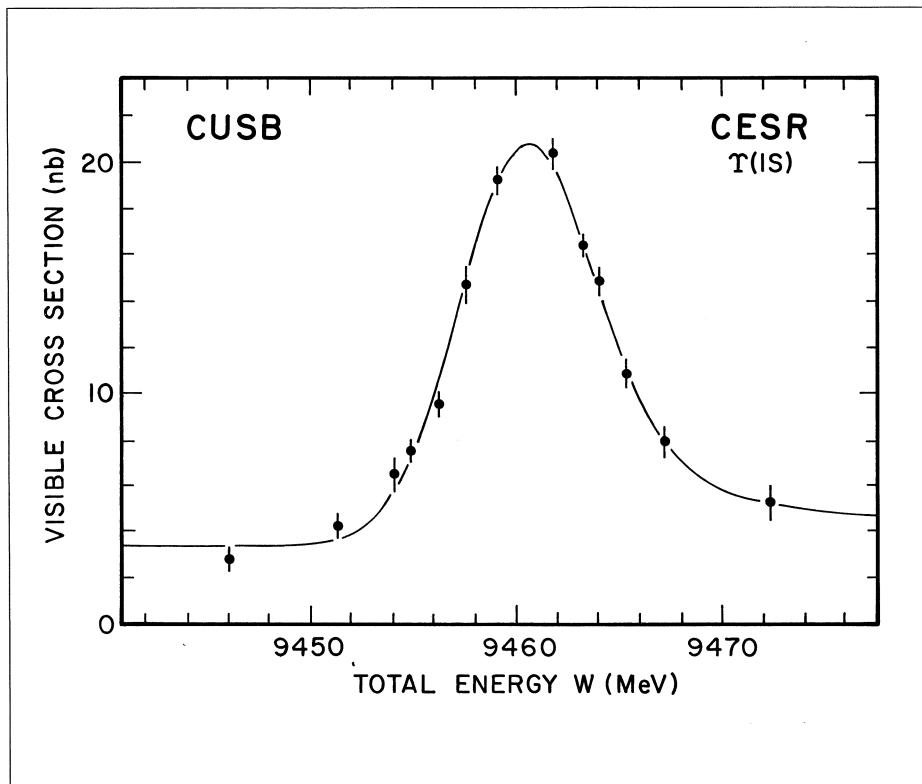
Careful measurements of all these effects should provide information on the interaction between the antiproton and the nucleons bound in the nucleus. In addition, comparison of measurements from neighbouring nuclei with the same proton number would show how the antiproton-nucleus interaction changes as one or more neutrons are added. In this way the antiproton-proton and antiproton-neutron interactions could be disentangled.

In classic antiproton experiments at CERN over the years, attempts were made to compare measurements from different nuclei, but statistics were so scanty that the resultant errors were large and conclusions were hard to draw.

But LEAR soon changed that. With LEAR, the BKSST group was able to amass sufficient data in the brief 1983 run to provide a first look at the differences in atomic antiproton spectra from several neighbouring isotopes of oxygen.

Although final results have yet to be calculated, systematic effects are already clearly visible. These measurements will surely provide important new information on nuclear interactions, and will also complement the data coming from nuclear scattering using electron beams (see page 64).

But the termination of the atomic cascade does not necessarily spell the end for the antiproton. There is a slight chance that the antiproton picks up a nucleon from the nuclear surface and produces a state deeply bound by the strong force, emitting a high energy photon. Such evidence for 'baryonium' states has been



*The upsilon production rate measured by the CUSB detector at the Cornell CESR ring, using the resonant depolarization method, giving a precise value ( $9459.97 \pm 0.11$  MeV) for the upsilon mass.*

found by the same group in previous (pre-LEAR) studies of antiprotons stopped in hydrogen and helium targets (see March 1983 issue, page 55). This time the detector was again searching for these energetic photons. As yet no evidence has been found, but the search (by a Basle / Stockholm / Thessaloniki sub-group) continues.

Other LEAR experiments are looking at antiprotonic hydrogen, and will provide the parameters of the basic antiproton-proton interaction. This will also be vital information for the heavier atomic studies.

In the months ahead, we can be sure of lots more interesting physics results from the experiments at LEAR.

## CORNELL Fixing the upsilon mass

The mass of a heavy vector (spin one) meson is one of the few quantities in high energy physics that can be measured with the precision that is routine in other areas of physics. These measurements, made in electron-positron storage rings, exploit the polarization of the beams resulting from the emission of synchrotron radiation, and the spin precession due to the anomalous magnetic moment of the electron.

This technique, called resonant depolarization, has been used at SPEAR (Stanford) to measure the psi mass, and at Novosibirsk to measure the phi, psi and upsilon masses. New measurements of the upsilon masses from Novosibirsk, DORIS

(DESY), and CESR (Cornell) were reported at conferences last year. The CESR measurement achieves a precision of 20 parts per million for the  $\epsilon$  mass — within an order of magnitude of the current errors for the electron and proton masses.

The circulating electron beam in a storage ring emits synchrotron radiation due to the acceleration produced by the magnetic guide field. A small part of this radiation process flips the electron spin. Since the total energy of the electron state is lower when its magnetic moment is parallel rather than antiparallel to the magnetic field, the radiation rate is higher for transitions from an antiparallel to a parallel state, and the beam becomes polarized. The time for the beam to polarize is proportional to the average bending radius cubed divided by the beam energy raised to the fifth power. Consequently, the technique works best when the ring is operated at its maximum energy. At Cornell, CESR's relatively large dimensions (radius 120 m) result in a polarization time of about 5 hours near the  $\epsilon$  energy. (At the same energies, polarization time at DESY's smaller DORIS-II ring is measured in minutes.)

A polarized electron precesses about the magnetic field direction with a definite precession frequency, but magnetic excitations at multiples of this frequency can destroy the polarization. Turning this statement around, resonant destruction of the electron polarization can be used to measure the beam energy in terms of the depolarizing frequency and other (known) quantities. Furthermore, typical perturbing fields require many thousands of revolutions to destroy the polarization, so the energy measured is averaged over many energy oscillations. This gives an accuracy much better than the natural energy width of the beam, which is typically

of the order of 1 to 10 MeV.

In CESR, beam polarization was measured by the technique of scattering circularly polarized light, produced by a high power argon-ion laser, from the positrons in the ring. The spin dependence of Compton scattering leads to a slight vertical shift in the distribution of the backscattered laser photons. Although the shift is small, it can be measured by comparing the vertical distributions of photons backscattered from right and left circularly polarized light. The laser and photon detection systems were built and operated by the Harvard members of the CLEO group.

The  $\epsilon$  cross-section (production rate) was measured by the CUSB group over a four-day period. Eleven measurements of the beam energy above and below the  $\epsilon$  peak were interleaved with the cross-section measurements. (The CLEO detector was not used, since its magnetic field would have destroyed the beam polarization.)

After taking account of radiative corrections and other effects, the  $\epsilon$  mass was determined to be  $9459.97 \pm 0.11$  MeV. The 110 keV statistical error is larger than the systematic error, estimated to be 70 keV. The systematic error is dominated by the uncertainties in the fitting and chromatic corrections to the luminosity. If these contributions were zero, the systematic error would be dominated by an uncertainty of 26 keV due to the present error in the electron mass!

This measurement agrees with the value of  $9460.6 \pm 0.4$  MeV obtained at the Novosibirsk VEPP-4 ring (see October 1982 issue, page 326). At the DESY DORIS-II ring, the technique has been used to measure the  $\epsilon$  prime (see December 1983 issue, page 423, July/August 1983 issue, page 224).

---

## LOS ALAMOS Winds of change

The seventeenth annual Users' Group Meeting of the Los Alamos Meson Physics Facility (LAMPF) felt the winds of change. LAMPF Director Louis Rosen noted that recent progress at the 800 MeV proton linac should not hide the fact that these are difficult times. Extra funding for operations together with good luck in sustaining 800-900  $\mu$ A beam for lengthy operating cycles have resulted in high utilization and effective running for difficult experiments such as neutrino scattering and the 'Crystal Box' measurement of rare muon decays. New impetus has been given to nuclear spectroscopy with the incorporation of a polarized target (partly from KEK) on the proton spectrometer, while the proton storage ring and beam areas will extend the LAMPF programme in 1985.

Nevertheless, sustaining scientific interest may be difficult without a major LAMPF upgrade. In Rosen's words, 'the 1990s look grim without LAMPF II'. Since the National Electron Accelerator Laboratory proposal has been funded, and the Nuclear Science Advisory Committee (NSAC) has endorsed the heavy ion collider concept, re-evaluation of LAMPF II is necessary. To involve the broadest community participation, Rosen initiated an American Physical Society session on the interface between high energy and medium energy physics for the next Washington meeting.

Closer to home, a panel discussion on LAMPF II concepts was arranged for the Users' Meeting, with NSAC representatives included. To set the stage, Arch Thiessen presented the options for LAMPF II as seen by his



At a recent users meeting at the Los Alamos Meson Physics Facility (LAMPF), a panel discussion was held on LAMPF II, the proposed major upgrade. From the left, the panelists from the Science Policy Advisory Committee: Dirk Walecka (Stanford), Peter Rosen (Los Alamos), Alan Krisch (Michigan), Leonard Kisslinger (Carnegie-Mellon), Akihiko Yokosawa

(Argonne), Sidney Meshkov (NBS), Malcolm MacFarlane (Indiana), Lee Teng (Fermilab), panel moderator Erich Vogt (TRIUMF), then panelists from the Board of Directors: George Igo (UCLA), Arch Thiessen (Los Alamos), Charles Glashausser (Rutgers), Bob Redwine (MIT), Andy Bacher (Indiana), Jim Bradbury (Los Alamos), Hal Jackson (Argonne).



planning group. With each major step in beam energy, assuming that high intensity ( $100 \mu\text{A}$ ) is maintained, new possibilities are opened. At 5 GeV, muon and muon-neutrino fluxes are enhanced, and an important energy range is opened for spin physics with polarized proton beams. A 12 GeV accelerator would make a kaon factory, and 32 GeV would make an antiproton factory. However by then the discussion is about an addition costing \$200 million. The most ambitious option is a 50 GeV accelerator providing unique energy coverage with intense beams of nearly all possible species of particle.

Erich Vogt, panel chairman and director of TRIUMF, chose a nautical metaphor, the Americas' Cup race, to illustrate his interest in seeing the best kaon factory proposal developed. He also explained that at TRIUMF 'kaon' is really a pseudonym for K-meson, antinucleon, other hadron, or neutrino.

Leonard Kisslinger reported on a subpanel discussion with Sid Meshkov, Malcolm MacFarlane, Val Fitch and Fred Reines on the 'three-star' physics accessible through more intense intermediate energy beams. High on their list was the area of strong interaction physics which has recently experienced a theoretical revolution. Expected new phenomena are glueballs, dibaryons, and scatter-

ing phenomena involving high transverse momentum, especially with spin degrees of freedom. In nuclear physics, a three-star programme is to further understanding of mesonic states in nuclei by use of strange probes; this would encompass the topical interests of a large community of nuclear scientists. Again in particle physics, there are electroweak experiments with intense beams of muons, neutrinos, and kaons.

Alan Krisch, Akihiko Yokosawa and Lee Teng reported on subpanel meetings. Access to all this physics apparently would require a very powerful and expensive facility; an attempt to reach part of the programme sooner requires careful balancing of physics, cost, and effectiveness of each stage as a component of the next. The challenge is illustrated by choice of energy stages: a synchrotron destined eventually to be a booster from 800 MeV to a 30-50 GeV ring would be cost-optimized around 3 GeV, according to Lee Teng, but as a first stage, 3 GeV does not make a kaon factory as defined by the requirement for a hundred times the kaon flux of the Brookhaven AGS.

Dirk Walecka initiated the discussion on strategy. He emphasized the connection to the nuclear physics community: 'One of the strongest arguments for LAMPF II is the variety of probes you can bring to bear on

important questions.' This was elaborated by Malcolm MacFarlane; 'What would be the use of an electron accelerator without hadron probes of as wide a variety as you can get', going on to draw attention to the complementarity of existing pion, proton, and electron spectrometers in medium energy nuclear physics. A debate followed on the likely course of large USA accelerator projects, and whether educational opportunity, preference for smaller collaborations, and better access might lead 10 to 40 per cent of the high energy experimentalists to projects like LAMPF II (or an upgraded AGS). Many comments underlined the artificial distinction between nuclear and high energy physics; Kisslinger said there is a large common area of interest in strong interactions.

The next day, Alvin Trivelpiece of the US Department of Energy pointed out that high energy physics has led to international research collaborations and a collective planning infrastructure. For the bigger facilities envisaged for the future (such as the Superconducting Super Collider, SSC), an even higher level of planning may be required. Towards this goal, a ministerial-level meeting was held recently in Williamsburg, Virginia.

# Cosmic rays at Bangalore

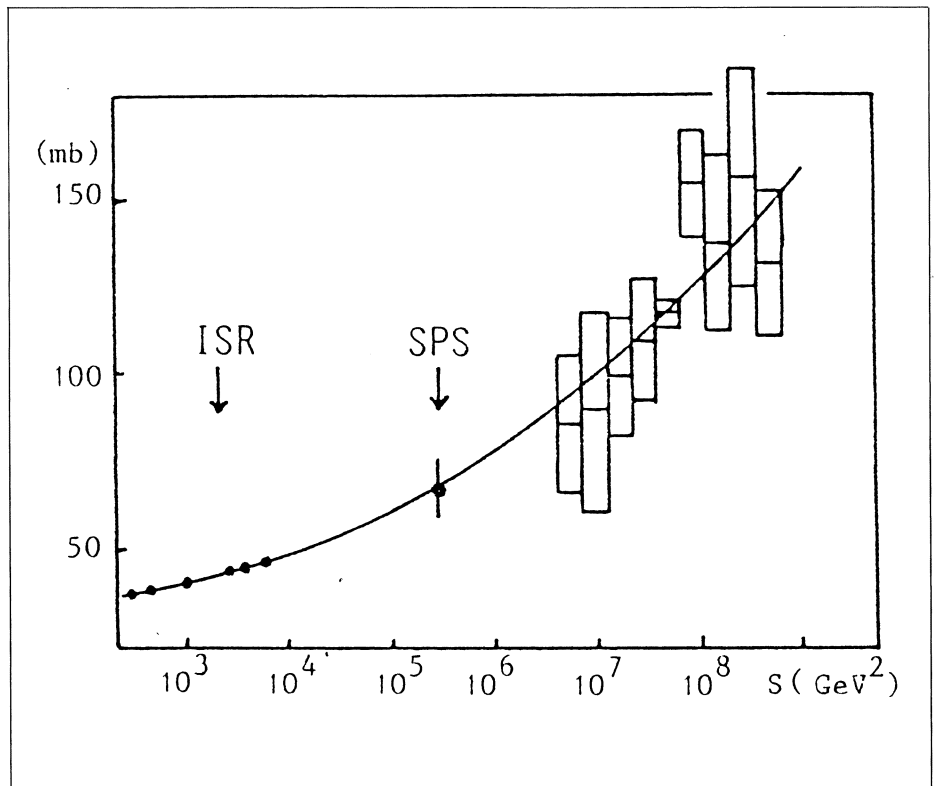
With collision energies in particle physics experiments beginning to probe the region hitherto accessible only through cosmic ray studies, there is a new impetus to the exchange of information and ideas between the two fields.

The 18th International Cosmic Ray Conference was held in Bangalore, India, from 22 August to 3 September 1983. About 425 delegates from all over the world presented over a thousand papers on various aspects of cosmic rays. A unique feature of this Conference series is that bound volumes of all contributed papers are given to the delegates at registration and the first two days are left free for digesting the papers and private discussions.

Contributed papers on the origin, acceleration, propagation, energy spectra, composition and anisotropy of primary cosmic rays, extremely energetic hadronic interactions, etc. were presented in four parallel sessions. In the plenary sessions, eight invited talks were given by experts on topics ranging from the radiation backgrounds and their cosmological implications to recent results from the CERN proton-antiproton collider and developments in particle detectors. The conference ended with 20 rapporteur talks. Apart from the main programme, several informal sessions were held in the evenings on specialized topics such as anti-proton fluxes in the primary cosmic radiation, neutrino astronomy, hadronic interactions at ultra high energies, simulations of air shower cascades, history of cosmic ray research etc.

The centenary of the birth of Victor Hess of Austria, who discovered cosmic rays in 1912, was celebrated by a special symposium.

Considerable attention was devoted to questions of origin, composition and energy spectra of the pri-



The proton-proton total cross-section rise from CERN Intersecting Storage Rings (ISR) through CERN SPS Collider to cosmic ray energies ( $s$  represents collision energy squared).

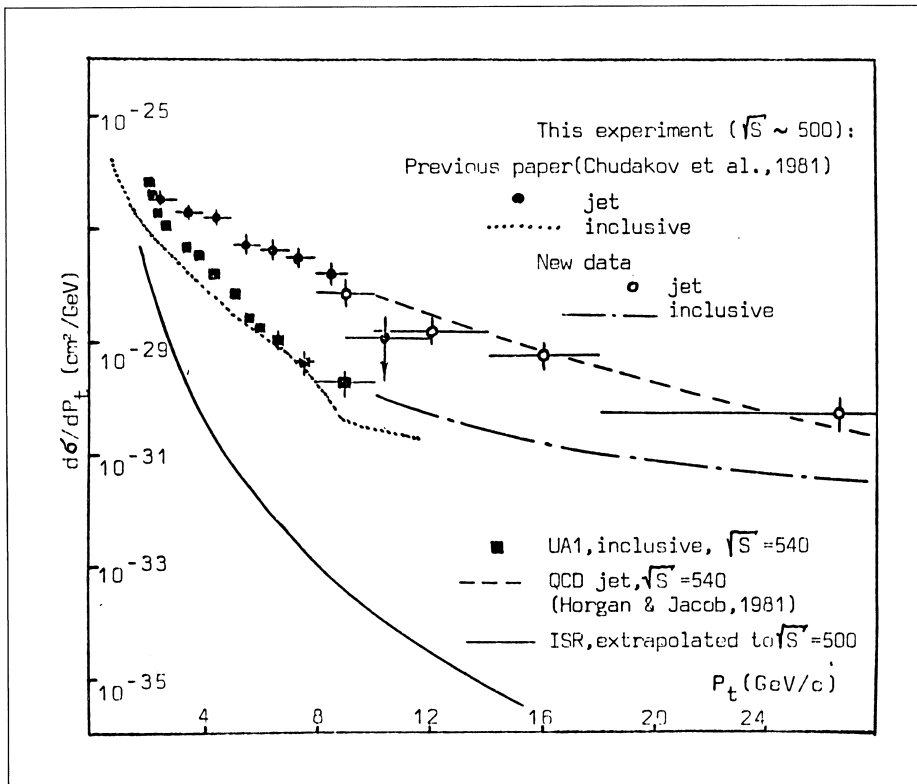
mary cosmic ray particles. In spite of more than half a century of activity in this areas, the main problem of the origin of cosmic rays still eludes solution essentially because cosmic rays, being charged particles, lose their directions due to interactions with the irregular magnetic fields in the galaxy. As Kenneth Greisen of Cornell commented long ago, it is like trying to do visible astronomy through an atmospheric haze that scatters the starlight equally in all directions.

At Bangalore, the Kiel group from West Germany reported sighting of a cosmic ray source, Cygnus X-3, beaming particles (photons?) of energy near  $10^{15}$  eV, with typical periodicity of 4.8 hours at lower energies, which was also confirmed by the Haverah Park group (UK). A puzzling result on multiple muon events was reported from the Soudan (US) proton decay experiment. Pairs of

multiple muon events (muon threshold energy about 600 GeV) separated in time by less than 5000 seconds (the average time separation in their experiment) appear to be preferentially arriving from a direction with galactic latitude  $20^\circ$  and galactic longitude  $95^\circ$ . Their primaries are unlikely to be charged particles as they would lose their directions in the interstellar magnetic fields at energies below  $10^{15}$  eV. They are not likely to be gamma rays either unless photonuclear reaction rates are unexpectedly large.

Direct measurements with balloon-borne detectors up to energies of some  $10^{14}$  eV and inferences from air shower studies beyond suggest that the cosmic ray composition is a mixture of protons and nuclei, mostly protons up to around  $10^{14}$ – $10^{15}$  eV, and few nuclei above  $10^{16}$  eV. The flattening of the cosmic ray energy spectrum at energies

Production rate of high transverse momentum jets from cosmic ray studies compared with results from colliding beam machines and theoretical calculations.



above  $10^{19}$  eV, previously seen only in experiments in the northern hemisphere, is now seen from the southern hemisphere also. No significant anisotropy is seen in this hemisphere, unlike in the northern hemisphere. This poses a puzzle since the universal 3K microwave radiation is expected to deplete the flux at these energies if it is of extragalactic origin.

A proof of the existence of antimatter in the Universe would be its detection in cosmic rays. At the previous Conference in Paris, an American group reported a finite flux of antiprotons at energies of a few hundred MeV, which is too high to be accounted for by interstellar production because of the high energy threshold for nucleon-antinucleon pair production. At Bangalore, an Indian group reported a few antiproton events in agreement with the high flux. Further investigations are nec-

essary to establish the flux and understand its origin.

Cosmic rays are still the only source of particles with extremely high energies (up to  $10^{20}$  eV) particularly for the study of hadron-nucleus and nucleus-nucleus interactions, though the energies available at colliding beam machines are rapidly increasing (the CERN Collider being equivalent to a  $10^{14}$  eV beam hitting a fixed target). Several notable discoveries in particle physics have been made with cosmic rays, including many new particles. Any massive particles existing in Nature could be produced in cosmic ray interactions. If their production rate is large enough and if they are reasonably long-lived, they could be detected in cosmic ray experiments.

Searches for various types of particles were reported at the Conference, many with negative results, including the slow-moving  $10^{16}$  GeV

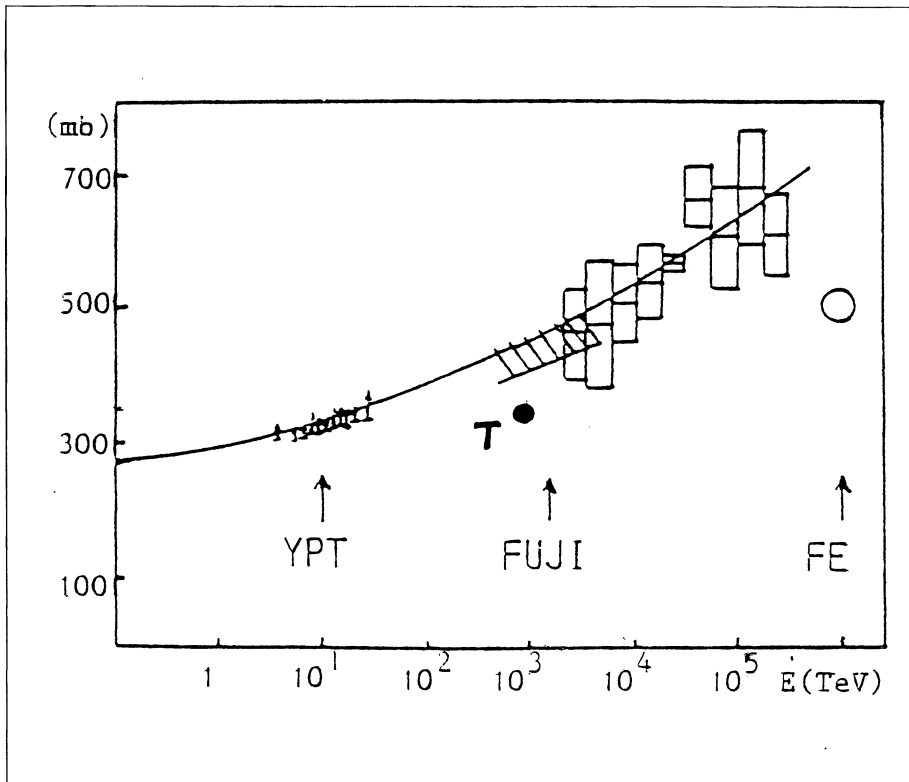
monopoles predicted by Grand Unification Theories. However there are many astrophysical constraints on the possible flux of such monopoles and these predict even a few orders of magnitudes less than the current cosmic ray experiment limit. There has been speculation on monopole-antimonopole bound states, relics from the early Universe with lifetimes of  $10^{11}$  years whose annihilations in the space near earth would generate extensive air showers (EAS) in the atmosphere.

No new results on free quark searches were reported. However McCusker proposed a limit for the free quark flux based on fluxes of 'Centauro' events, 'long flying component', EAS cores and horizontal EAS. A Japanese group reported evidence for a flux of fractional charges ( $2.5 \text{ m}^{-2} \text{ sr}^{-1} \text{ d}^{-1}$ ).

Because of low fluxes, cosmic ray data is scarce, but sometimes suggests strange phenomena, some of them persistent and lacking a convincing explanation. An example is the so-called 'long flying component' in the hadronic cascades developing in lead calorimeters at energies above 200 TeV, observed by the Tien Shan group and interpreted as due to the effect of charm mesons and baryons. An explanation for these exotic phenomena is offered by the formation and explosion of 'quark globs'. Muon pair production in the cores of EAS has been interpreted as due to a long-lived (more than  $10^{-8}$  s) particle of mass near 20 GeV.

Searches for the exotic events like Centauro, Chiron and Geminion events discovered earlier by the Brazil, Japan group at high mountain altitudes were also covered. The Centauro events, thought of as 'pizeroless' showers, a majority of which were first suggested by an Indian group to be due to fluctuations in the

Inelastic proton-air cross-sections at cosmic ray energies (YPT — Yodh, Pal and Trefil analysis, T — Tien Shan Mountain observations, FUJI — Japanese emulsion chamber results and FE — Fly's Eye detector, Utah). The rectangles are from the Akeno (Japan) Air Shower Group's deductions.



development of atmospheric showers, have not been observed in the Pamir and Fuji collaboration experiments, nor in the UA5 experiment at CERN's collider looking for pizeroless high multiplicity events. Chiron and Geminion events, which are interpreted by the Brazil-Japan group as multiparticle production events and pair production events respectively with large transverse momentum and without pion production, have been observed by other groups. Simulation of atmospheric cascades show that the Geminion events could be understood as coming from fluctuations in the usual pion production process if half the inelastic interaction leads to the production of high transverse momentum jets at energies near  $10^4$  TeV. Similar calculations are necessary for understanding the Chiron events. Estimates of production rates of high transverse momentum jets at colli-

sion energies of around 500 GeV from multicore studies of EAS by the Baksan group show excellent agreement with theoretical predictions and with results from laboratory experiments.

Estimates of the inelastic interaction level of protons on air nuclei upto  $10^{18}$  eV, from measurements on extensive air showers, were reported. The Akeno air shower group in Japan found the proton-air cross-section to be  $290 E^{0.066 \pm .005}$  mb in the energy range  $10^3$ - $10^6$  TeV from the frequency attenuation of showers with fixed number of muons and electrons, after making allowance for the possible presence of nuclei in primary cosmic rays. This is an upper limit considering the uncertainties in the details of particle production at these energies. With certain assumptions, they estimate the proton-proton cross-section to be  $38.5 + 0.46 \ln^2 (S/100)$  mb with S

(squared collision energy) in  $\text{GeV}^2$ . From the fluctuations in the depth of shower maximum, the Fly's Eye group (US) estimated the proton-air cross-section to be 500 mb at  $10^{18}$  eV. Both these measurements are consistent with the extrapolation of the dependence given by Yodh, Pal and Trefil, about a decade ago, in the few TeV energy region from unaccompanied hadron fluxes at mountain altitudes.

There is speculation that at extremely high energies, particularly in nucleus-nucleus collisions, where matter can be compressed beyond the nuclear densities, phase transition from hadronic to quark matter can occur and quark-gluon plasma may be produced. This would be characterized by very high multiplicities, direct production of gamma rays and enhanced production of strange particles and baryons. Because of the possible presence of energetic nuclei in the primary beam, this phenomenon can be looked for in cosmic ray experiments. At the Conference, a few isolated events of unusually high multiplicity (1500!) were reported from balloon-borne emulsion chamber experiments. A Japanese contribution showed that most of these and other similar events can be understood in terms of a multi-chain model of nucleus-nucleus interactions without invoking the idea of a quark-gluon plasma. Nevertheless this remains a very exciting area in which contributions can come only from cosmic ray experiments in the near future.

With indications for many new phenomena at superhigh energies, cosmic ray investigations with ambitious detector set-ups are planned and the field is still very active. The large experimental set-ups will be massive underground (or underwater) detectors, giant air shower arrays at the surface with detectors spread

# Physics monitor

*Big and little brother! Above, a 350 MHz superconducting niobium cavity of the type envisaged for LEP at CERN. Below, a small 3 GHz cavity, used for investigating the surface problems of superconducting niobium.*

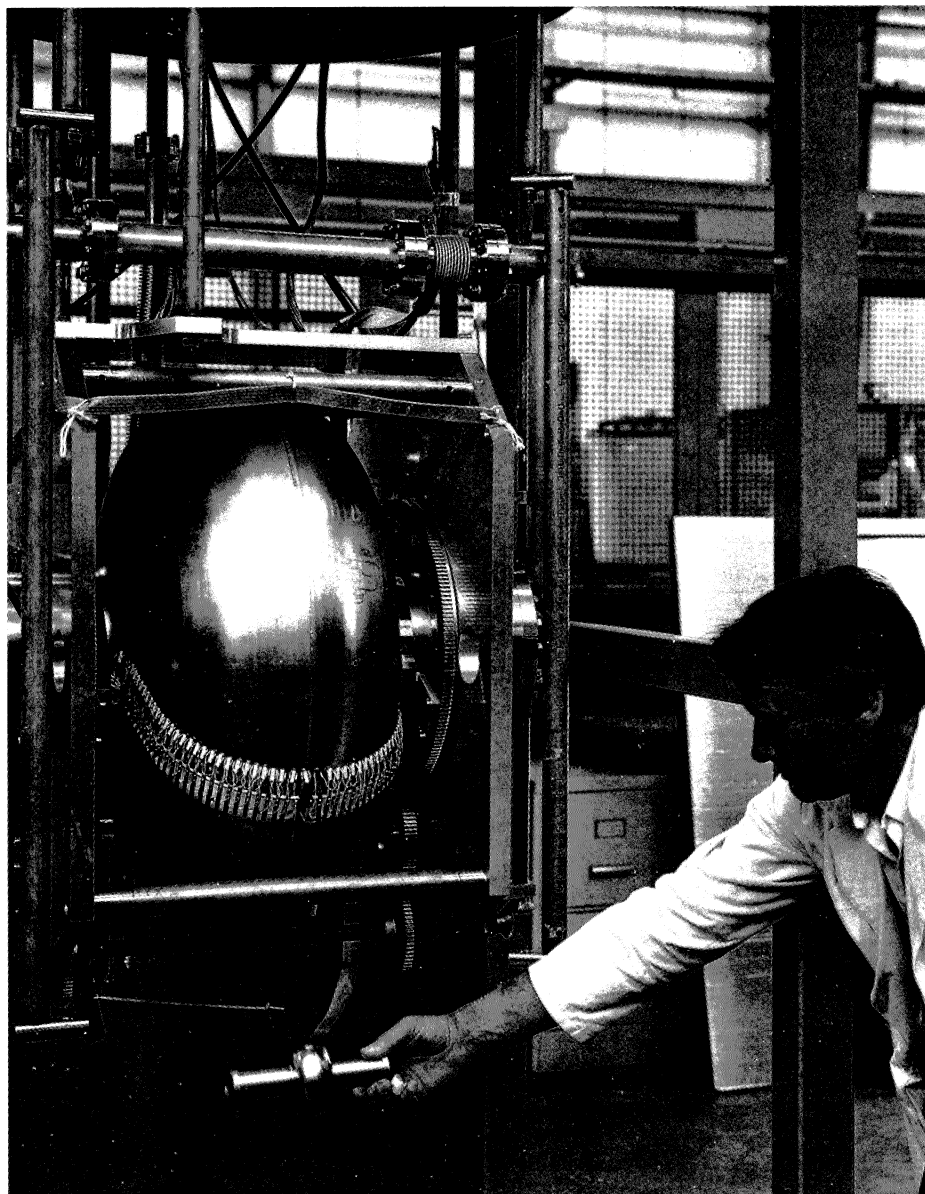
*(Photo CERN 218.7.83)*

over areas of several tens to a hundred square kilometres, some of them with hadron calorimeters of areas above  $10^3 \text{ m}^2$ . Emulsion chamber exposures at mountain altitudes hope to reach  $10^4 \text{ m}^2$  year in the near future.

*(From M. V. S. Rao and A. Subramanian)*

## Conference Papers

The Conference Papers of the 18th International Cosmic Ray Conference, held in Bangalore, India, from 22 August-4 September 1983, are now available. The Contributed, Invited and Rapporteur papers are brought out in 13 Volumes totalling to nearly 5000 pages. Topics covered in these volumes are X-rays, gamma rays, origin, composition and energy spectrum of primary cosmic rays, modulation of primary cosmic rays, solar particle production, high energy interactions, extensive air showers, muons and neutrinos and techniques. They may be obtained by mailing a cheque for US \$ 180 (Air Mail) or US \$ 120 (Surface Mail) to Prof. P. V. Ramana Murthy, Tata Institute of Fundamental Research, Colaba, Bombay-5, India. The cheque should be drawn in favour of 'Tata Institute of Fundamental Research'.



## Superconducting cavities looking good

The push for superconducting accelerating cavities to supply higher energies for large electron storage rings continues apace in Europe as well as the US and Japan.

(As electron beam energies climb beyond the 50 GeV level envisaged

for CERN's LEP Phase I, the accelerating cavities would have to compensate for the extremely high synchrotron radiation. This would incur very high r.f. losses, and in turn, immense power bills. At other machines, such as PETRA at DESY, the energy has been taken as high as conventional r.f. accelerating cavities allows — there is simply no more room to install more r.f. equipment!)

In Europe, development efforts are mainly concentrated at CERN and DESY. At DESY, a 9-cell 1 GHz niobium cavity has reached an accelerating field of 5.7 MV/m with a quality factor  $Q$  of  $8 \times 10^8$ . (The quality factor is inversely proportional to the r.f. losses in the cavity.) This cavity was produced by industry and surface treated — partly by new polishing methods — at the University of Wuppertal and at DESY. This year, the DESY group intends to install it in the PETRA ring for a long-term test. Another DESY line of approach uses cavities made from niobium sheet, with the outer surface coated with a good thermal conductor (e.g. silver) to reduce the likelihood of thermal breakdowns.

At CERN, a single cell cavity working at 350 MHz (the frequency chosen for the LEP copper cavities) has attained an accelerating field of 6 MV/m, and the excellent  $Q$  value of  $4 \times 10^9$  at 4.2 K. Powerful new computer programs for r.f. cavities have carried out cavity layout calculations for LEP, taking into account not only the fundamental r.f. mode but also the most dangerous higher order modes and the requirements of r.f. coupling.

Also at CERN, a 500 MHz single cell copper cavity, sputter-covered with a few microns of niobium, reached an accelerating field of over 8 MV/m and gave a  $Q$  value at low field of  $10^9$ . Its most encouraging feature is the absence of thermal breakdown. The high thermal conductivity of the copper wall avoided breakdowns with r.f. power dissipated inside the cavity well above 150 W. It may be possible to cool this type of cavity by tubes, instead of the usual liquid helium bath which requires both large amounts of helium and large containment vessels.

This year at CERN, the plan is to

push this promising new approach, along with a 350 MHz 3-cell niobium cavity including all ancillary equipment — r.f. power couplers, higher order mode couplers, frequency tuners and cryostats matched to LEP requirements.

In the US, the Cornell group concentrates on 1.5 GHz cavities. A 5-cell cavity has reached an accelerating field of 5.4 MV/m and a  $Q$  value of  $5 \times 10^9$  at 1.8 K. This year, it is planned to test two such cavities in the CESR storage ring.

There is also good news from the group at the Japanese KEK Laboratory. A 3-cell 500 MHz cavity, equipped with coupling ports, attained an accelerating field of 5.8 MV/m and a  $Q$  value of  $1.3 \times 10^9$  at 4.2 K. This will soon be tested in the new TRISTAN Accumulator Ring (see page 51).

All this valiant effort seems to be paying off. It is encouraging that in many cases accelerating fields now exceed 5 MV/m, and hopes are high that this year's planned tests will greatly increase our knowledge of superconducting cavities. Optimism grows that LEP can be pushed beyond the 50 GeV envisaged for initial operation.

*(From H. Lengeler)*

---

## Looking for oscillating neutrinos

The 'charged current' of the weak nuclear interaction (the part which permutes electric charges) sees definite mixtures of quarks, described by the classic Cabibbo theory (see December 1983 issue, page 418). Less clear is whether it also sees definite mixtures of the three known types of charged lepton (electron, muon and tauon) with neutrinos of different masses.

Conventional neutrino dogma used to say that neutrinos are massless, and hence travel with the speed of light, but this has never been proved. On the contrary, evidence is building up for non-zero neutrino masses. Recent experiments at IHEP, Moscow, underline earlier suggestions that the electron neutrino has a mass (at least 20 eV). Many cosmologists would like to have neutrino masses too.

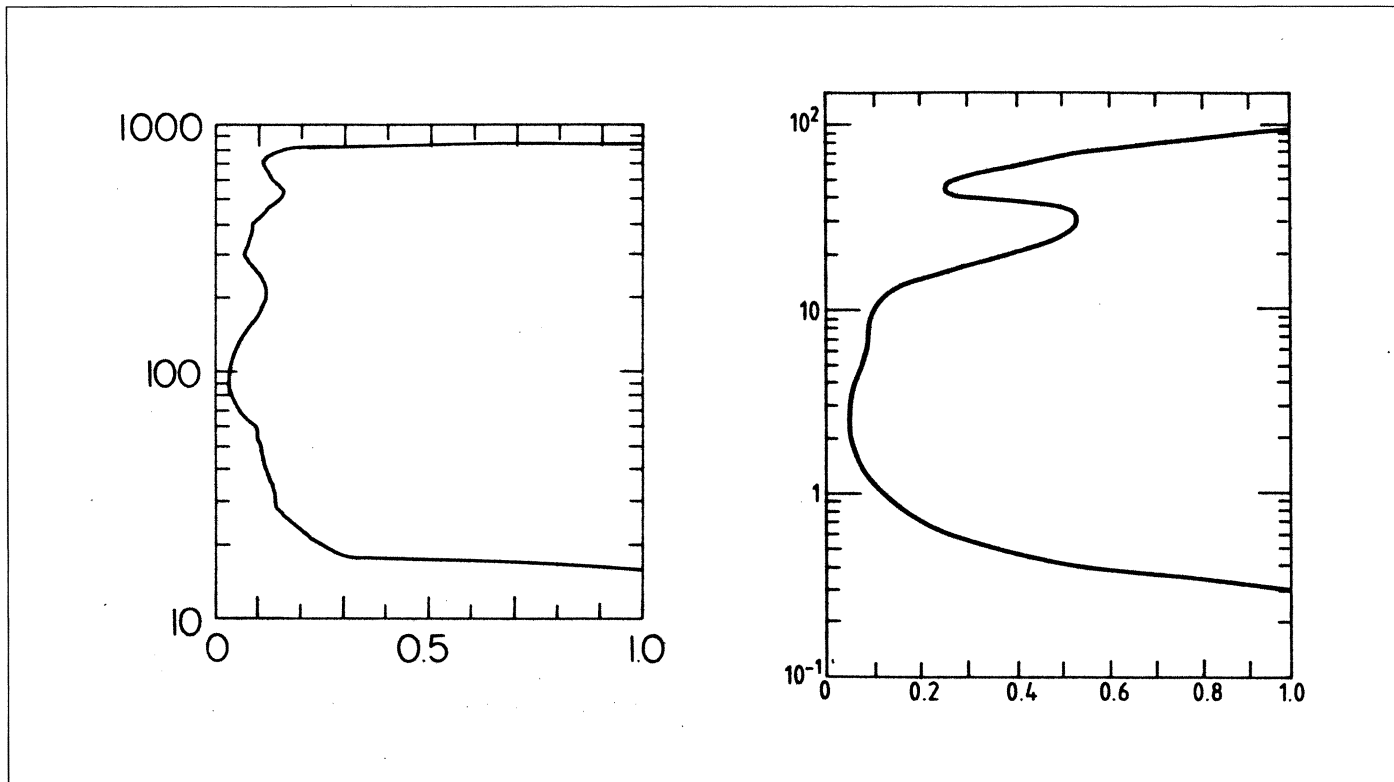
If neutrinos carry characteristic masses, and if the weak interaction does see mixtures of leptons, then a neutrino beam formed by a specific particle decay contains a mixture of neutrino types. Each of these types has its own mass and therefore travels with a different speed. Such a neutrino beam should 'oscillate' — its composition depending on where it was measured.

This possibility was first pointed out by Bruno Pontecorvo about twenty-five years ago, and ever since, controversy has oscillated. In the past few years, a major investment has been made in the search for such oscillations. Claims have been made, but the vast majority of the studies have proved negative, and these limits are gradually becoming more restrictive.

Neutrino oscillation searches can be divided into two main types: those comparing the measured flux of neutrinos at a particular place with the expected (computed) flux, and those comparing the neutrino fluxes measured by two detectors at different distances from the neutrino source. The two-detector method has the great advantage of not requiring an absolute value for the neutrino flux.

In addition, a search (of either type) can be characterized as an 'appearance' or a 'disappearance' experiment. Disappearance experiments look for anomalous variations in the

Neutrino oscillation limits from (left) the Chicago / Columbia / Fermilab / Rochester experiment and (right) the CERN / Dortmund / Heidelberg / Saclay study. The vertical axis gives the possible squared neutrino mass ( $eV^2$ ), and the horizontal axis gives the neutrino mixing parameter. Both these experiments were looking for the disappearance of muon neutrinos. The region where oscillations are not ruled out is to the left of the curve in each case.

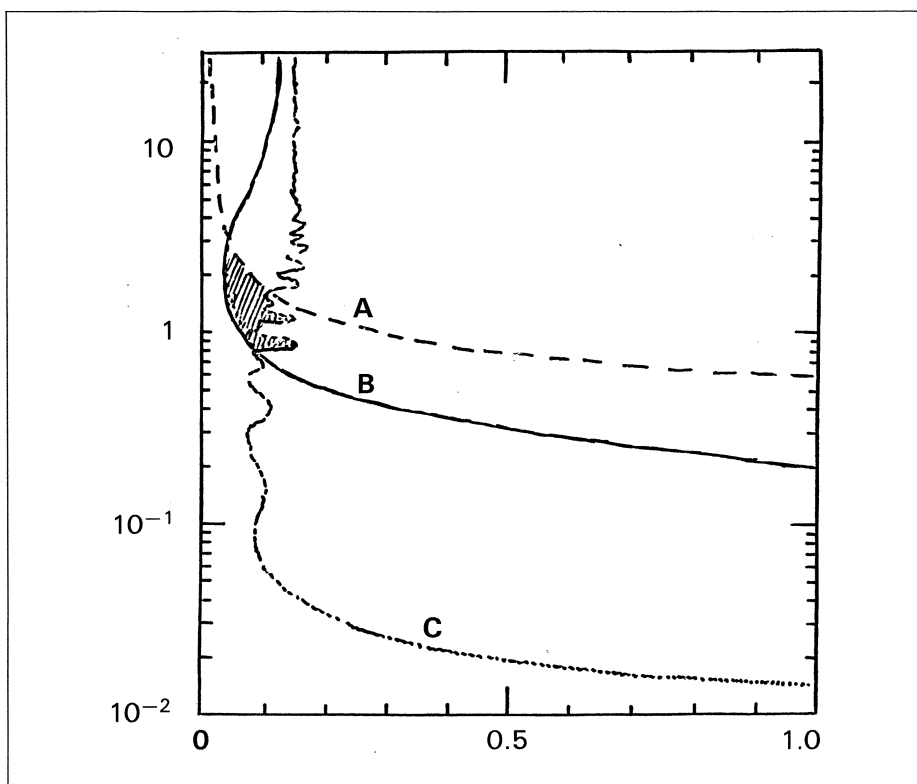


flux of neutrinos of a particular type with distance, while appearance experiments look for neutrinos of a type not present in the initial beam.

Results are now available from three counter experiments (two at CERN and one at Fermilab) which simultaneously exposed two detectors at different locations.

The two CERN experiments were based on neutrino detectors which usually use beams from the 450 GeV SPS Super Proton Synchrotron. However for the oscillation search, they used instead a special 'low' energy neutrino beam using 19 GeV

Neutrino oscillation limits from two 'appearance' experiments looking for definite neutrino transitions. Curve A is from the BEBC bubble chamber at CERN, curve B is preliminary data from the CERN / Hamburg / Amsterdam / Rome / Moscow ('CHARM') group at CERN. Curve C is from a 'disappearance' experiment by the Caltech / Munich / SIN group working at the Goesgen reactor. The units are the same as the diagrams above.



protons extracted from the Proton Synchrotron.

Modules from the big CERN / Dortmund / Heidelberg / Saclay (CDHS) and CERN / Hamburg / Amsterdam / Rome / Moscow (CHARM) experiments in the West Experimental Area of the SPS were installed upstream, just 150 m from the source of the PS neutrino beam. Data recorded in these modules and in the main detectors, several hundred metres downstream, was then compared (see December 1982 issue, page 413).

Both experiments looked for the disappearance of muon neutrinos, and their results are in broad agreement. The CDHS study benefitted from having a lot of iron and gives more stringent limits. In addition, the CHARM studies also looked for the appearance of electron neutrinos, giving useful new limits.

At Fermilab, the Chicago / Columbia / Fermilab / Rochester experiment used a high energy 'narrow band' neutrino beam. The existing 1000-ton neutrino detector, about a kilometre downstream from the neutrino source, was supplemented by a smaller detector in the 'Wonder Building', where some of the early Fermilab neutrino experiments were carried out. Because of the high energy of the beam, this study was sensitive to higher neutrino mass differences than the CERN experiments.

The CERN low energy neutrino beam has also been used in a neutrino oscillation search using the BEBC bubble chamber, however for this study only one detector position is available. Other results using artificial neutrino beams come from experiments at Brookhaven and Los Alamos.

These laboratory neutrino studies are supplemented by searches at nuclear reactors in Switzerland (Caltech / Munich / SIN group), in France (An-

necy / Grenoble) and in the US (Irvine). These experiments look for the disappearance of electron neutrinos, and are sensitive to very small neutrino mass differences, down to  $0.01 \text{ eV}^2$ . The detectors are placed at varying distances from the reactor so that signals can be compared.

More limits come from passive experiments (such as those searching for proton decay) which compare neutrino signals coming in from space with those traversing the Earth.

Measured in terms of the possible neutrino mass difference and the lepton mixing parameter (not given by any theory), the area where neutrino oscillations can confidently be ruled out is now very large. However there are plenty of unexplored corners still left, and neutrinos could still turn out to oscillate, albeit gently.

---

## Opening up nuclei with electrons

The US decision to build NEAL — Nuclear Science Electron Accelerator Laboratory — illustrates the increasing attention being paid to the use of high energy electron beams to probe nuclear structure.

Such electron probes have already produced interesting results. The energies available mean that fine details of nuclear structure can be examined, and new effects have been discovered which challenge conventional ideas of nuclear theory.

While these effects are small, this does not mean to say that they are not significant. The history of modern physics is littered with examples of precision measurements of subtle effects providing the first clues to new behaviour (Lambshift, 3K extragalactic background radiation, etc.).

Electron beams of some 700 MeV from machines at MIT and Saclay can probe below 1 fermi, while the 20 GeV SLAC beams can probe down to 0.1 fermi.

The elastic scattering of electrons on nuclei (where the electrons 'bounce' off their nuclear targets) reflect the general properties of nuclei and their collective excitations. Recent studies have revealed interesting new information on low energy nuclear structure and excitations.

Complementary information comes from deep inelastic scattering, where the incident electrons penetrate deep inside the nuclei and interact with individual nucleons, or even with the constituents of these nucleons. This provides information on the properties of nucleons in nuclear matter.

In the simplest possible picture, a single nucleon inside nuclear matter is assumed to behave like a 'Fermi gas'. This picture accounts for many of the observed general characteristics. However precision experiments soon reveal additional effects, and the picture quickly becomes more complicated. Additional mechanisms (nucleon excitations, meson exchanges, etc.) have to be introduced into the model in the hope of obtaining a more realistic description.

New observations also show that ground state charge densities of heavy nuclei such as lead (conventionally considered as a closed shell nucleus) show a smooth behaviour, without the oscillations predicted by conventional theory.

In an attempt to pin down these new effects, electron scattering experiments at Saclay looked at the adjacent nuclei of lead 206 and thallium 205. The difference between the behaviour of these two nuclei should be due to just one extra proton. Despite the high density of these nuclei, the contribution of this single



proton is clearly seen, and is in itself surprising.

In addition, the nuclear charge densities, while following the shape of the theoretical prediction, are systematically suppressed by some 35 per cent.

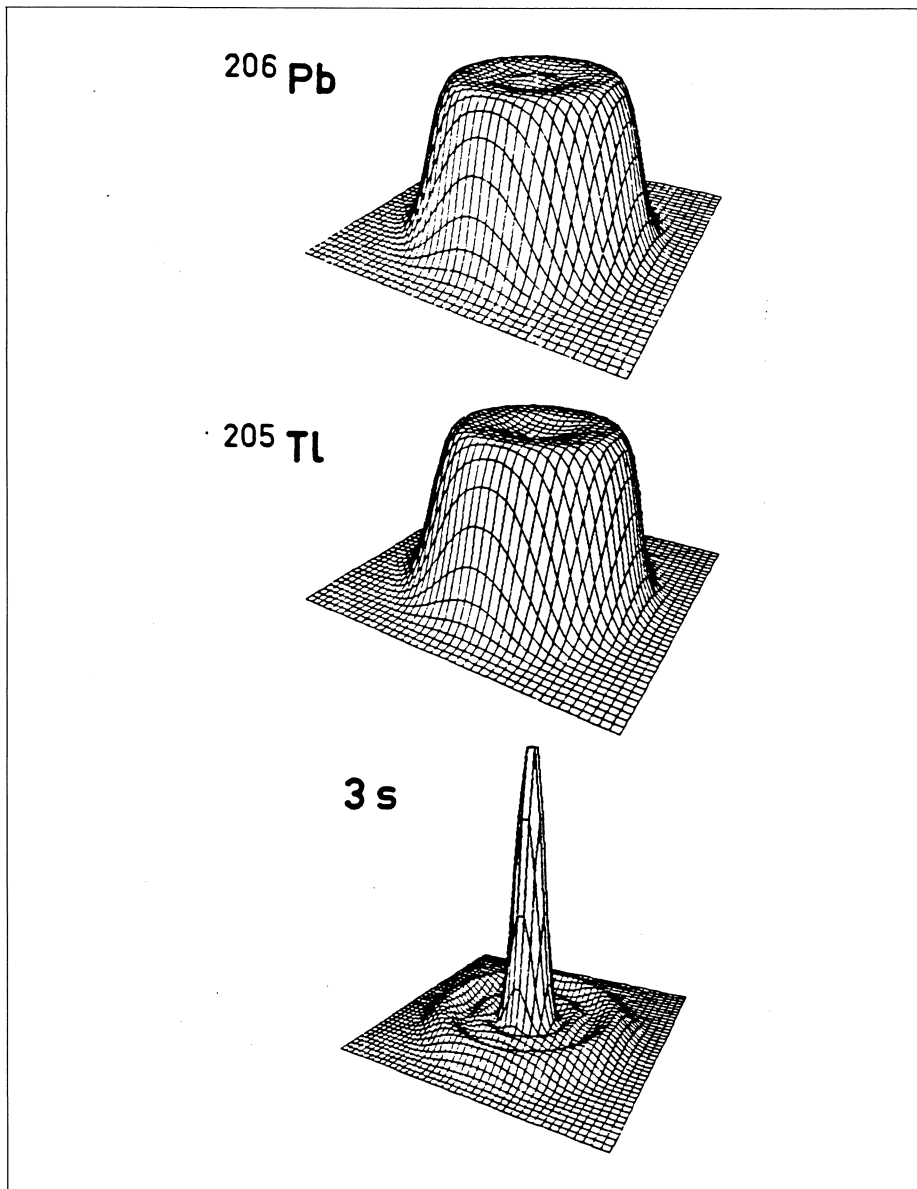
Precision electron studies of nuclear magnetic densities enable measurements to be made of the properties of neutrons as well as protons, and provide valuable additional

information to extend our knowledge of nuclear mechanisms. In some cases, it looks as though conventional ideas again have to be modified or extended.

Light nuclei provide an especially valuable means of studying few nucleon systems. New effects have been found in the observed form factors, and three-body forces and quark clusters are among the candidate mechanisms which have

received attention.

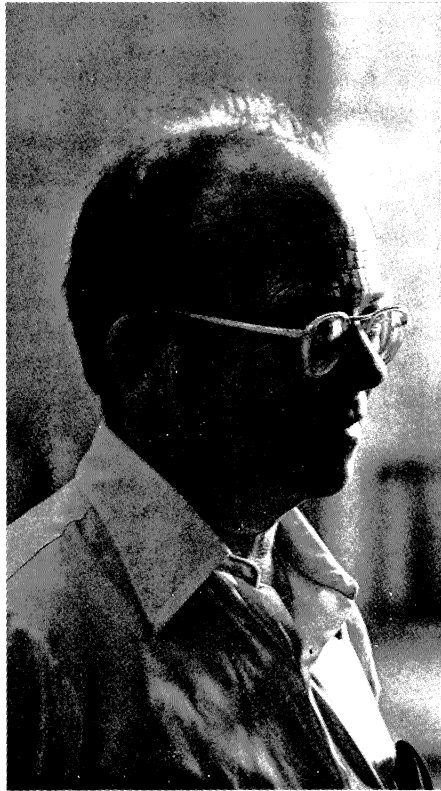
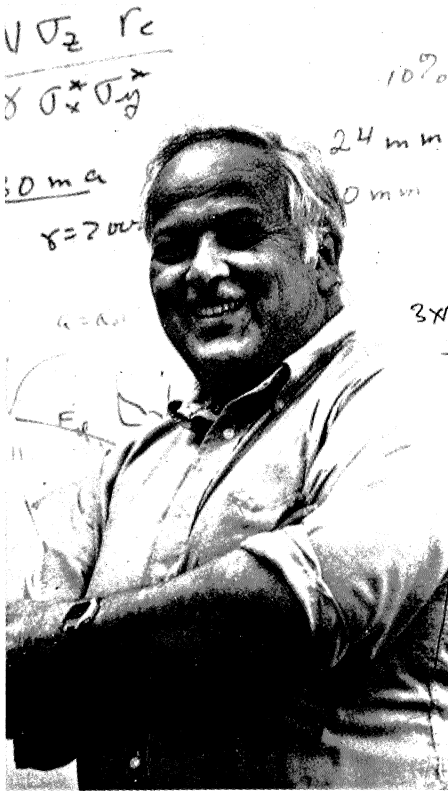
The increasing theoretical attention being paid to collective quark effects could pay off in light nuclei. Evidence for anomalous quark structure in nuclei has now been seen in a wide range of experiments (see January/February issue, page 19).



Top, nuclear charge distributions of lead 206 and thallium 205, measured in electron scattering experiments at Saclay. The difference between the two distributions clearly shows the contribution of the single additional proton (3s orbit), surprising in view of the high density of these nuclei.

# People and things

SLAC Directors old and new. On 1 September Burt Richter (left) takes over from 'Pief' Panofsky (right).



## Richter to head SLAC

Some time ago, Wolfgang ('Pief') Panofsky, Director of SLAC since 1961 and one of the prime movers behind both the famous two-mile electron linac and the Laboratory itself, announced his intention to step down in 1984. Immediately a search began for a worthy successor.

It is no surprise that the SLAC Director from 1 September will be Burton Richter, SLAC's Technical Director since 1982. With Sam Ting, Richter shared the Nobel Physics Prize in 1976 for their discovery of charmed particles. As well as a physicist, Richter is also a machine heavyweight. He was one of the pioneers of electron-positron storage rings, and more recently, was the main architect of the current SLAC Linear Collider

(SLC) project, which opens up a new era in accelerator design.

Underlining his preoccupation with future facilities, Richter says: 'High energy Labs have to do not only first-rate research now, but also have to look forward to the development of new research tools and accelerators so that we can continue to do research in the future. The real challenge is not so much to maintain what is going on, but to keep things moving and make sure that SLAC continues to be a first-rate institution five and ten years from now.'

## On people

Carlo Rubbia, leader of the UA1 experiment at CERN which last year discovered the W and Z particles, was named by the US science magazine 'Discover' as its 1983 'Scientist of the Year'.

Simon van der Meer, with Rubbia one of the major architects of the CERN antiproton project which made the W and Z discoveries possible, has been awarded an honorary doctorate by the University of Amsterdam.

Taiji Yamanouchi, Fermilab Assistant Director and Head of the Program Planning Office, received the 1983 Nishina Memorial Prize at a ceremony in Tokyo on 6 December. This prize is given to Japanese physicists who have performed distinguished work in the field of atomic and nuclear physics. Dr. Yamanouchi was awarded the prize for his accomplishments in high energy physics research, including his contribution to the discovery of the upsilon particle at Fermilab.

Taiji Yamanouchi



A special meeting was held at Bologna to mark the 70th birthday of Bruno Ferretti, who from 1956-58 was head of CERN's Theory Division.



A meeting 'Frontiers of Physics' was held recently at Bologna to mark the 70th birthday of Bruno Ferretti. After work at Bologna, Milan and Rome, he came to Geneva to head the CERN Theory Division in 1956. From 1958 to his retirement, he held Bologna's chair of Theoretical Physics. He has made important contributions to nuclear and particle physics, to quantum field theory, and to crystal physics. He proposed the first methods for determining the parity of the charged pions, and his ideas on baryon number conservation are particularly relevant to today's research. He is a member of the Accademia dei Lincei and of the Academies of Sciences of Bologna, Modena and Turin.

Georges Charpak of CERN has been awarded the 'Prix du Commissariat à l'énergie atomique' of

the French Academy of Sciences for his work in developing high energy particle detectors.

---

#### Vladimir Jurko Glaser

---

Vladimir Jurko Glaser died on 22 January, in his sixtieth year, after a serious illness. Born in Gorizia, Italy, on 21 April 1924, he studied at Zagreb, submitting a thesis in 1953 on work carried out in Göttingen under Heisenberg. In 1955 he became Head of Theory Division at Zagreb's Ruder Boskovic Institute, and in 1957 he came to CERN, where he was until his death one of the key figures in the Theory Division.

As a physicist he was deep, cultured and highly mathematical. His work in rigorous theory maintained a contact with reality, establishing a bridge between the abstraction of axiomatic field theory and the description of elementary particle collisions. In several basic papers, he set up the analyticity properties required for the use of dispersion relations in proton-proton and proton-antiproton collisions, the point of departure for the use of asymptotic theorems on maximum growth of cross-sections and comparison of particle-particle and particle-antiparticle collisions. He extended these results to production reactions. The recent use of antiprotons in the ISR and the SPS provides spectacular experimental proof of these results. Other work made important contributions to perturbative renormalization theory.

Jurko Glaser was interested in many fields: in quantum electrodynamics, on which he wrote one of the first modern texts; on field theory models, particularly that of Thirring; and a deep study of the

---

Vladimir Jurko Glaser, 1924-84.

Schrödinger equation, on which some of his work remains unpublished. His last work, on a 'spin glass' model, displays once more his remarkable mathematical prowess.

An exceptional teacher, some of his students became close long-time collaborators. A cultured man with widespread interests, warm-hearted and full of ideas, he had many friends. He leaves a memory not only of a great physicist, but of a man of great spirit and generosity.

---

#### Hadron collider workshop

---

A CERN-ECFA Workshop to study the feasibility of hadron colliders which it might at some time in the future be possible to install in the LEP tunnel, is to be held at the University of Lausanne from 21-24



March. This will be followed by summary talks in the CERN Auditorium on 26 and 27 March, which are open to all. The studies are in preparation for an international seminar on long-range prospects for high energy physics, organized by ICFA, to take place in Tokyo in May. Further information on the CERN-ECFA Workshop can be obtained from the Secretary of the Organizing Committee, Christine Petit-Jean-Genaz, at CERN, telephone Geneva 833275.

---

#### 1984 US Accelerator School

---

Fermilab will host the 1984 US Summer School on High Energy Particle Accelerators from 13-24 August — the fourth in this series of summer schools.

The basic objective of the School is to boost US accelerator science

in order to advance the frontiers of high energy physics. The School is intended for scientists and engineers interested in pursuing accelerator physics. A mixture of basic accelerator concepts and advanced topics will be presented. Plans for this year include extensive courses on the design principles of very high energy hadron (circular) and electron (linear) colliders.

Further information and application forms are available from M. Paul, School Secretary, Fermilab, Batavia, Illinois 60510, USA.

---

#### 1984 CERN School of Computing

---

The 1984 CERN School of Computing, the eighth in the biennial series, is being organized in collaboration with the Instituto Estudios Energeticos (Junta de Energia Nuclear, Madrid) and the Facultad de

Informatica, Barcelona, and will be held from 9-22 September at Aiguablava, Spain.

The theme of the School is 'Computing in the LEP era and beyond', reflecting the rapid evolution of technology in this area. This will be comprehensively covered in the programme, with courses covering microprocessors, data networks, underlying semiconductor technology, etc., as well as the requirements of LEP experiments.

The School is aimed at postgraduate students and research workers with a few years' experience in particle physics, computing, or related fields. Further information from Ingrid Barnett, Scientific Conference Secretariat, CERN, 1211 Geneva 23, Switzerland. Deadline for applications, 30 April.

---

#### Physics for AGS II

---

The 1984 Users' Meeting of the High Energy Discussion Group (HEDG) at Brookhaven on 29-31 March will include a Workshop on the possible physics from an improved Alternating Gradient Synchrotron. The aim is for higher quality and more intense beams, using several machine, beamline and equipment improvements, including a beam stretcher and booster. Participation from physicists and machine experts outside the US is welcomed. Those interested should contact Mrs. L. Kouchinsky, Building 510F, Brookhaven Laboratory, Upton, New York 11973, USA.

---

Earthmoving for the Stanford Linear Collider (SLC) project. The aim is to finish construction by the end of 1986 so that physics can begin early in 1987. Behind the site can be seen the buildings of Stanford campus, and beyond, the San Francisco Bay and the coastal mountains. (Photo Stanford)



**DUKE UNIVERSITY**

## ASSISTANT PROFESSOR HIGH ENERGY PHYSICS

The Physics Department at Duke University has an immediate opening in high energy physics at the **Assistant Professor** level. The position is tenure track and involves a light teaching load. It is expected that the person filling this position will participate fully in research carried on by the Duke high energy group. We currently have active experimental programs at Fermilab, Brookhaven and CERN. There is a future opportunity to participate in an approved experiment at the  $\bar{p}p$  collider at FNAL. The applicant should have both software and hardware experience in experimental particle physics. Inquiries should be sent to:

**Professor W.D. Walker,  
Physics Department,  
Duke University,  
Durham, North Carolina 27706.**

*Duke University is an  
Equal Opportunity/Affirmative Action Employer.*

## THE INSTITUTE OF PARTICLE PHYSICS OF CANADA

invites applications for several positions in experimental particle physics. Depending on experience and qualifications the applicant will be considered for appointment as Research Associate or Research Scientist. The Research Scientist appointment is normally associated with an academic position at a Canadian University participating in the program and includes the right to hold research grants and supervise graduate students. This appointment may lead to permanence after three years. Successful candidates will participate in the experimental particle physics program through association with Canadian University and National Laboratory groups. Experiments presently in operation or preparation are:

- (i)  $e^+e^-$  collisions in the Y region (ARGUS group at DESY);
- (ii) photoproduction of charmed particles in a tagged photon beam (FNAL);
- (iii) hadronic production of  $p$ -wave charmonium states and direct photons (FNAL);
- (iv)  $e^+e^-$  collisions at LEP (OPAL Group);
- (v)  $e-p$  collisions at HERA (DESY), including participation in the accelerator construction.

Interested persons are invited to apply, including c.v. and the names of three references to:



**D.G. Stairs, Chairman  
Institute of Particle Physics,  
Rutherford Physics Building,  
McGill University,  
Montreal, Quebec, H3A 2T8, Canada.**

Applications should be received before April 30, 1984.

## FELLOWS IN ACCELERATOR TECHNOLOGY

### Brookhaven National Laboratory

Applications are invited from individuals with a PhD degree and/or major training in the physical sciences or engineering who wish to launch careers in accelerator design and development.

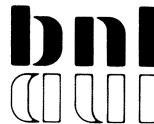
Successful candidates will be appointed Fellows in Accelerator Technology in the Accelerator Department for a period of one year, renewable for a second year. Fellows are expected to select their investigations from among the general objectives of the accelerator physics program at Brookhaven National Laboratory.

The Accelerator Department is responsible for the operation of a 200MeV proton linac, and the 30GeV Alternating Gradient Synchrotron (AGS). New initiatives are underway in: the acceleration of polarized protons, and of heavy ions in the AGS; a proposal to build a relativistic heavy ion collider; a study of a high intensity upgrade of the AGS (AGS II); and an extensive research and development effort directed towards the Super Superconducting Collider (SSC).

Scientists and engineers of any nationality are eligible to apply. Salaries begin at \$25,000 per year, and Fellows are eligible for comprehensive employee benefits, and relocation allowances. Candidates should send a detailed resume to:

**Dr. Derek I. Lowenstein  
Accelerator Department  
Brookhaven National Laboratory  
Associated Universities, Inc.  
Upton, Long Island, New York 11973**

An Equal Opportunity Employer m/f



**Brookhaven National Laboratory  
Associated Universities Inc.**

RWTH Aachen

## Lehrstuhl für Experimentalphysik

An der Mathematisch-Naturwissenschaftlichen Fakultät der RWTH Aachen ist zum Wintersemester 1985/86 die Stelle eines Professors C4 für Experimentalphysik mit dem Forschungsschwerpunkt Elementarteilchenphysik (Nachfolge Prof. Dr. M. Deutschmann) neu zu besetzen. Von dem zukünftigen Inhaber der Stelle wird erwartet, daß er sich in angemessener Weise an der Ausbildung von Physikern, Ingenieuren etc. beteiligt.

Bewerbungen mit Lebenslauf und Schriftenverzeichnis sowie Angaben über bisherige Lehrtätigkeit werden erbeten bis zum 2. April 1984 an den

**Dekan der Math.-Naturwissenschaftlichen  
Fakultät der RWTH Aachen  
Templergraben 64  
D - 5100 Aachen.**

Auch Hinweise auf geeignete Persönlichkeiten sind erwünscht.



**TRIUMF**  
**MESON RESEARCH FACILITY**  
University of Alberta  
Simon Fraser University  
University of Victoria  
University of British Columbia  
Competition No. 431-014

## BEAMLINE PHYSICIST

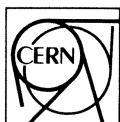
TRIUMF has an opening for an accelerator physicist to assist in the operation and development of proton beamlines for high currents and reliable beam production. Involvement in the design and construction of a new injection beamline or other development projects will also be expected. Familiarity with electric and magnetic fields, typical beamline components, beam optics, beamline diagnostics, control techniques and precision alignment methods is required. The successful applicant will have a demonstrated ability to communicate effectively with support personnel and other physicists.

Candidates should have a Ph.D. degree in physics or engineering, or equivalent, and at least three years experience in design and construction of accelerator components. Salary will depend upon qualifications and experience.

Please reply in writing as soon as possible, outlining qualifications and experience to:

**TRIUMF Personnel (competition No. 431)**  
Attn. Dr. G. DUTTO  
4004 Wesbrook Mall  
VANCOUVER, B.C.  
V6T 2A3

*We offer equal employment opportunities to qualified male and female applicants.*



**European Organization for Nuclear Research**  
**European Laboratory for Particle Physics**  
**Organisation Européenne pour la Recherche Nucléaire**  
**Laboratoire Européen pour la Physique des Particules**

The On-Line Computing Support Group in the CERN Data Handling Division has a vacancy for a young

## PROGRAMMER

to develop and maintain general purpose support software and firmware for mini and micro computers, mainly in the domain of FASTBUS, a data collection and processing system for intelligent front-end electronics in future high energy physics experiments.

Candidates, who must be nationals of the Member States of CERN\*, should have a university degree in physics, computer science or engineering, with a knowledge of programming scientific computers in both high level languages and machine code. Post-graduate experience in the latest techniques used in at least one of the following areas is desirable: real-time applications, computer interfacing, multi-processing, networking, computer simulation, scientific data management.

The ability to collaborate well with physicists and hardware designers is essential. A good knowledge of English or French and some knowledge of the other language is required.

For application forms, please write to:

**Head of Personnel,**  
**CERN, 1211 GENEVE 23, Switzerland**  
**quoting the reference: DD-OC-249.**

\* CERN Member States are: Austria, Belgium, Denmark, Fed. Republic of Germany, France, Greece, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and United Kingdom.

# STANFORD LINEAR ACCELERATOR CENTER OF STANFORD UNIVERSITY

announces an opening for the position of  
**ASSOCIATE DIRECTOR,  
TECHNICAL DIVISION**

The Stanford Linear Accelerator Center (SLAC) is a major high energy physics research laboratory operated by Stanford University under contract with the U.S. Department of Energy. SLAC's Technical Division consists of groups that are responsible for operating and maintaining the large electron accelerator and colliders; for advanced research and development in the fields of accelerator physics and engineering; and for the general provision of technical services to the rest of the laboratory. The Associate Director, Technical Division, has primary responsibility for the leadership and management of this program under the general direction of the Laboratory Director.

Candidates for the position of Associate Director, Technical Division, must have had extensive and widely recognized experience as practicing scientists in the field of accelerator physics. The laboratory is seeking a person who is willing to play a strong leadership role in the years ahead.

The intended starting date for this position is 1 October 1984; the actual date can be a matter of negotiation. Applicants should submit a curriculum vitae, together with the names of at least three references, to Professor W.K.H. Panofsky, Chairman, Associate Director Search Committee, Bin 80, SLAC, Stanford University, P.O. Box 4349, Stanford, California 94305. SLAC is an equal employment opportunity employer.

# SLAC



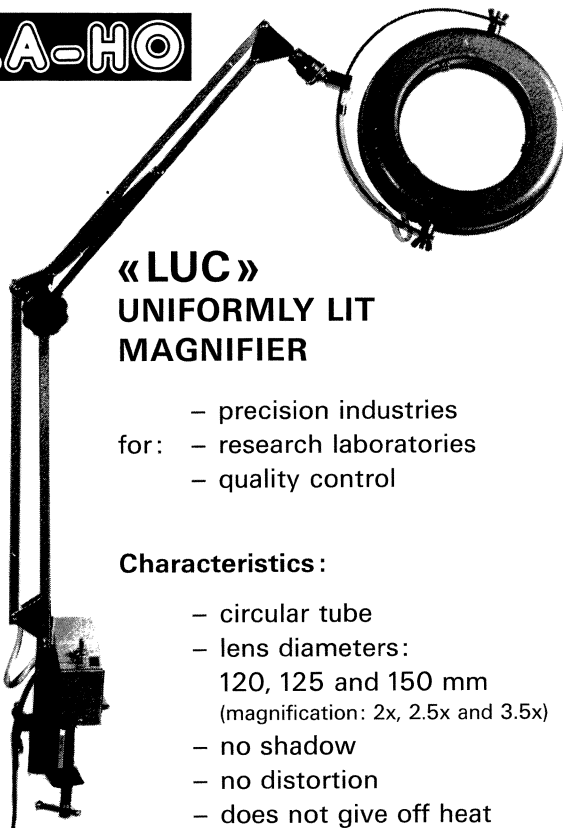
## Leader Computing Section

The Swiss Institute for Nuclear Research is searching for a leader for the recently created computing section. This section will have charge of all computing activities at SIN including on-line data acquisition for the experimental groups, computer control of the accelerators, and off-line computing. Proven leadership ability together with considerable experience in computing in an experimental environment is required. We are searching for a person able to direct present computing activities and provide a thorough assessment of future computing needs including networking and distributed intelligence. The institute has a central computing facility of three VAX-780's plus many PDP-11's used for data acquisition; we are also connected to the central ETH Zürich computing center via a broad band microwave link. The scientific working language is English but a knowledge of German is helpful.

Applications including a CV should be sent before March 31 to:

Personnel Department, SIN,  
CH-5234 Villigen/Switzerland

# LA-HO



### «LUC» UNIFORMLY LIT MAGNIFIER

- for:
- precision industries
  - research laboratories
  - quality control

#### Characteristics:

- circular tube
- lens diameters:  
120, 125 and 150 mm  
(magnification: 2x, 2.5x and 3.5x)
- no shadow
- no distortion
- does not give off heat

LA-HO, BP 53, F-94104 St. MAUR, (01) 283 77 40



# Wiley

## QUARKS AND LEPTONS An Introductory Course in Modern Particle Physics

by **F. Halzen**, *University of Wisconsin*, and **A.D. Martin**,  
*University of Durham*

This self-contained text describes breakthroughs in our understanding of the structure and interactions of elementary particles. It provides students of theoretical or experimental physics with the background material to grasp the significance of these developments.

**Contents:** A Preview of Particle Physics; Symmetries and Quarks; Antiparticles; Electrodynamics of Spinless Particles; The Dirac Equation; Electrodynamics of Spin 1/2 Particles; Loops, Renormalization, Running Coupling Constants, and all That; The Structure of Hadrons; Partons; Quantum Chromodynamics; Annihilation and QCD; Weak Interactions; Electroweak Interactions; Gauge Symmetries; The Weinberg-Salam Model and Beyond; Index.

March '84  
0471 88741 2

414pp  
\$34.00/£23.95

## GAUGE THEORIES OF STRONG AND ELECTROWEAK INTERACTIONS

by **P. Becher** and **M. Bohm**, *Wurzburg University, Germany*  
and **H. Joos**, *Hamburg University and Deutsches Elektronen  
— Synchrotron, Hamburg, Germany*

This book gives a comprehensive summary of the gauge theories of the strong and electroweak interactions which are generally considered as the basis of the theory of elementary particles. Our understanding of the basic elements of which matter is constituted has made considerable progress over the last decade and particle physics is still a field of rapid development.

The authors stress the intimate connection between the description of the experimental facts, the formulation of the theory on the basis of these facts and the application of the theory in order to derive measurable predictions. Detailed summaries of the individual sections are provided to aid the reader's understanding.

December '83  
0471 10429 9

318pp  
\$52.00/£28.00

## QUARKS, LEPTONS AND GAUGE FIELDS

by **Kerson Huang**, *M.I.T.*

The audience for which this book is written are graduate students in physics who have some knowledge of the experimental parts of particle physics, and an acquaintance with quantum field theory, including Feynman graphs, and the notion of renormalization. It might serve as a text for a one-semester course beyond quantum field theory. The material, in fact, was taken in part from such a course offered by the author at MIT and at the Institute for High Energy Physics in Beijing.

**Contents:** Introduction; Quarks; Maxwell Field; U(1) Gauge Theory; Yang-Mills Fields; Non-Abelian Gauge Theories; Topological Solitons; Weinberg-Salam Model; Method of Path Integrals; Quantization of Gauge Fields; Renormalization; Methods of Effective Potential; The Axial Anomaly; Quantum Chromodynamics.

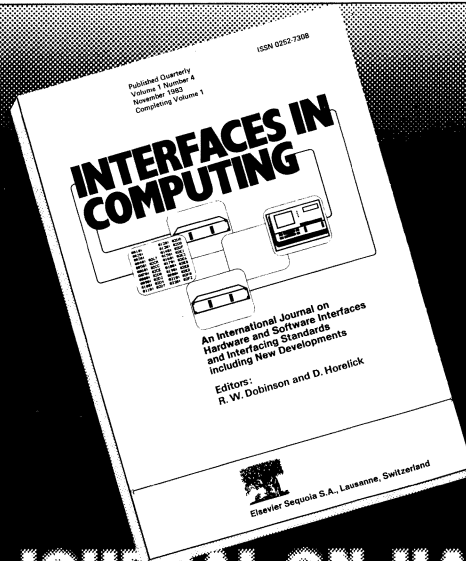
December '82  
9971 950 03 0

292pp  
\$40.00/£24.00

Published by World Scientific Publishing Company and marketed by John Wiley & Sons Ltd.



**John Wiley & Sons Ltd.**  
Baffins Lane, Chichester  
Sussex PO19 1UD, England



**EDITOR**  
**R. W. Dobinson**  
 EP Division  
 CERN  
 1211 Geneva 23  
 Switzerland

## AN INTERNATIONAL JOURNAL ON HARDWARE AND SOFTWARE INTERFACES AND INTERFACING STANDARDS INCLUDING NEW DEVELOPMENTS

Interfaces in Computing is an international journal designed for production managers concerned with computing technology, system designers, electronics engineers and technicians. Its objectives are to ensure that the users of interfaces are fully aware of available techniques, to identify the needs of users

when they are not satisfied by available standards and to demonstrate interrelations between hardware and software interfaces. The journal emphasizes the value of considering hardware interfaces, communications protocols and operating systems interfaces as part of the total system design.



**ELSEVIER SEQUOIA S. A.**

P.O. Box 851  
 CH-1001 Lausanne 1, Switzerland

Please ask for a free sample copy

83425

### Measurement display, storage – simultaneous **Digital Scope Multimeter M 2050**



World first!

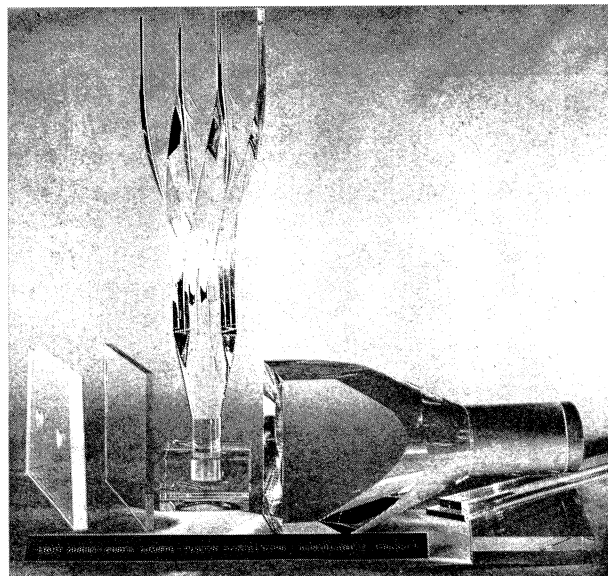
Demonstration at CERN  
 Tel. (037) 24 77 57

#### Functions

1. Multimeter: Digital readout and waveform display.
2. Oscilloscope: Digital storage oscilloscope.
3. Transient recorder: Recording and storage of transient inputs.
4. Overall concept: All functions in a single instrument; compact, handy, battery operation.

# METRAWATT

Felsenrainstrasse 1 · CH-8052 Zürich · Tel. 01-302 35 35  
 1700 Fribourg · Tel. 037-24 77 57



## POLIVAR S.p.A.

Via Naro, 72 P.O. Box 111  
 00040-POMEZIA (Roma)  
 Tel. 06/912 106 Telex 611227 PLVI

#### Product line

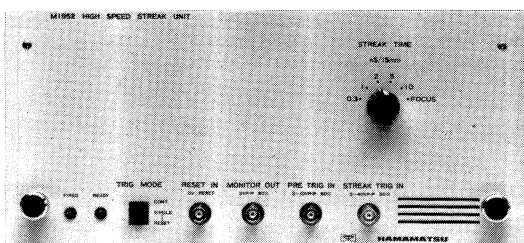
Cast acrylic sheets, bars, blocks, scintillators,  
 light guides



# Announcing the C1587 universal streak camera. The one that does it all!

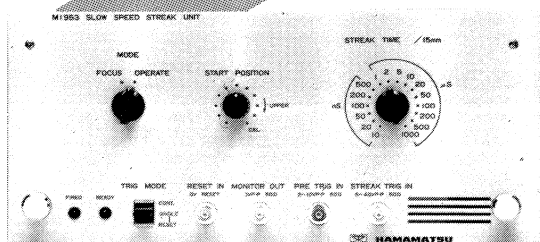
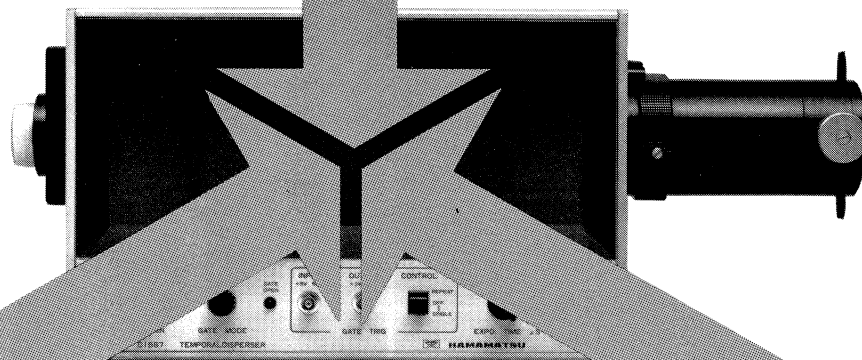
## 2 PS TIME RESOLUTION

3 plug-ins provide fast, slow and synchroscan capabilities plus shutter (framing) mode in one economical system. Fulfills the needs of almost every fast kinetics experiment.



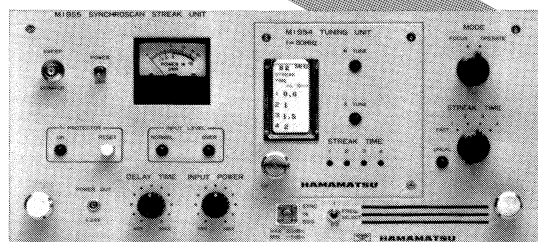
## FAST STREAK PLUG-IN

Delivers better than 2 ps temporal resolution across streak speeds 50, 15, 7.5, 3.0, 1.5 mm/ns.



## SLOW STREAK PLUG-IN

Records events that require a 100 ps time window. Select from 16 streak speeds 1.5 to 0.000025 mm/ns.



## SYNCHROSCAN

The streak sweep of this plug-in is matched to your laser frequency for high speed repetitive recording of synchronous pico-second events.

Call or write today for Universal Camera Brochure.

# HAMAMATSU

HAMAMATSU CORPORATION • 420 SOUTH AVENUE • MIDDLESEX, NEW JERSEY 08846 • PHONE: (201) 469-6640  
International Offices in Major Countries of Europe and Asia.

Hamamatsu Photonics K.K., 1126 Ichino-cho, Hamamatsu, Japan, 0534/34-3311 • Hamamatsu TV Europa GmbH, Postfach 1140, D-8031 Seefeld 1, W. Germany, 08152/7705

# ONE T? Use Vacuum Photo Triodes immune to 1 Tesla multi-directional fields

Modern solenoid-enclosed detection systems with their high operating levels of magnetic field demand a new approach to calorimeter design.

Using the experience gained from our Vacuum Photo Diode AV29\*, we have developed a new series of Photo *Triodes*. These will allow you to detect the low light levels associated, for example, with lead glass. Triode gains of  $> 10$  lift the signals out of the noise of the following preamplifiers\*\*, a requirement of Rousseau et al\*\*\*

For maximum cost effectiveness, our 2" and 3" triodes come in versions for axial fields (0 to 20°) and transverse fields (up to 70°).

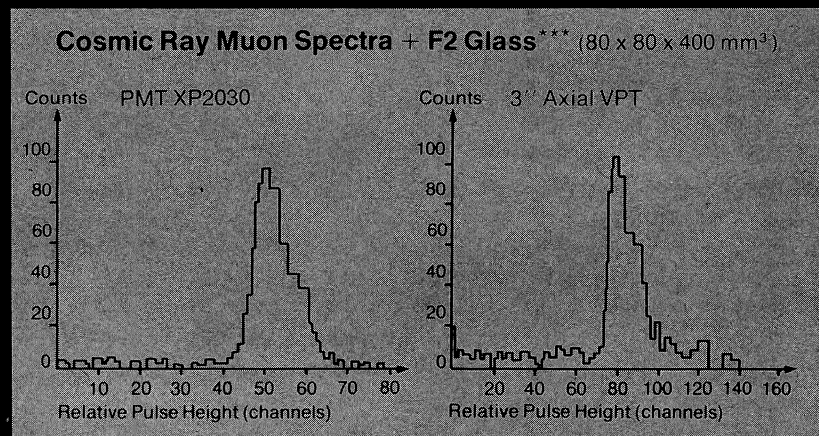
For samples and details please contact:

Philips Electronic Components and Materials Division,  
5600 MD Eindhoven, The Netherlands, Telex 35000 NLJEVO

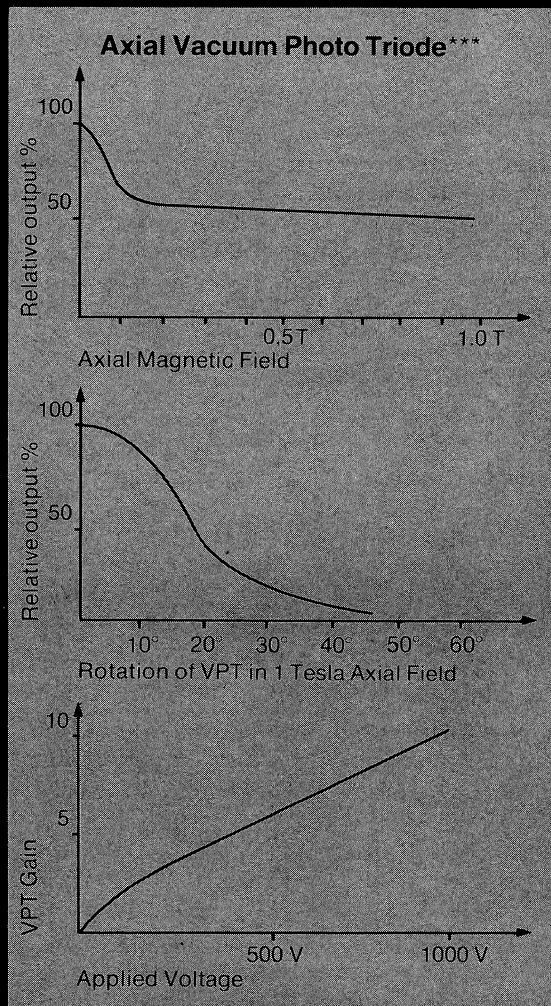
\* used in the CERN Axial Field Spectrometer where light from NaI (TI) scintillators is detected in a 0.3 T magnetic flux density at 70

\*\* Rutherford Appleton Internal Report RL82-082 by R. Stephenson

\*\*\* IEEE Transactions on Nuclear Science, 1982 Nuclear Science Symposium, Washington D.C., October 20 - 22 1982.



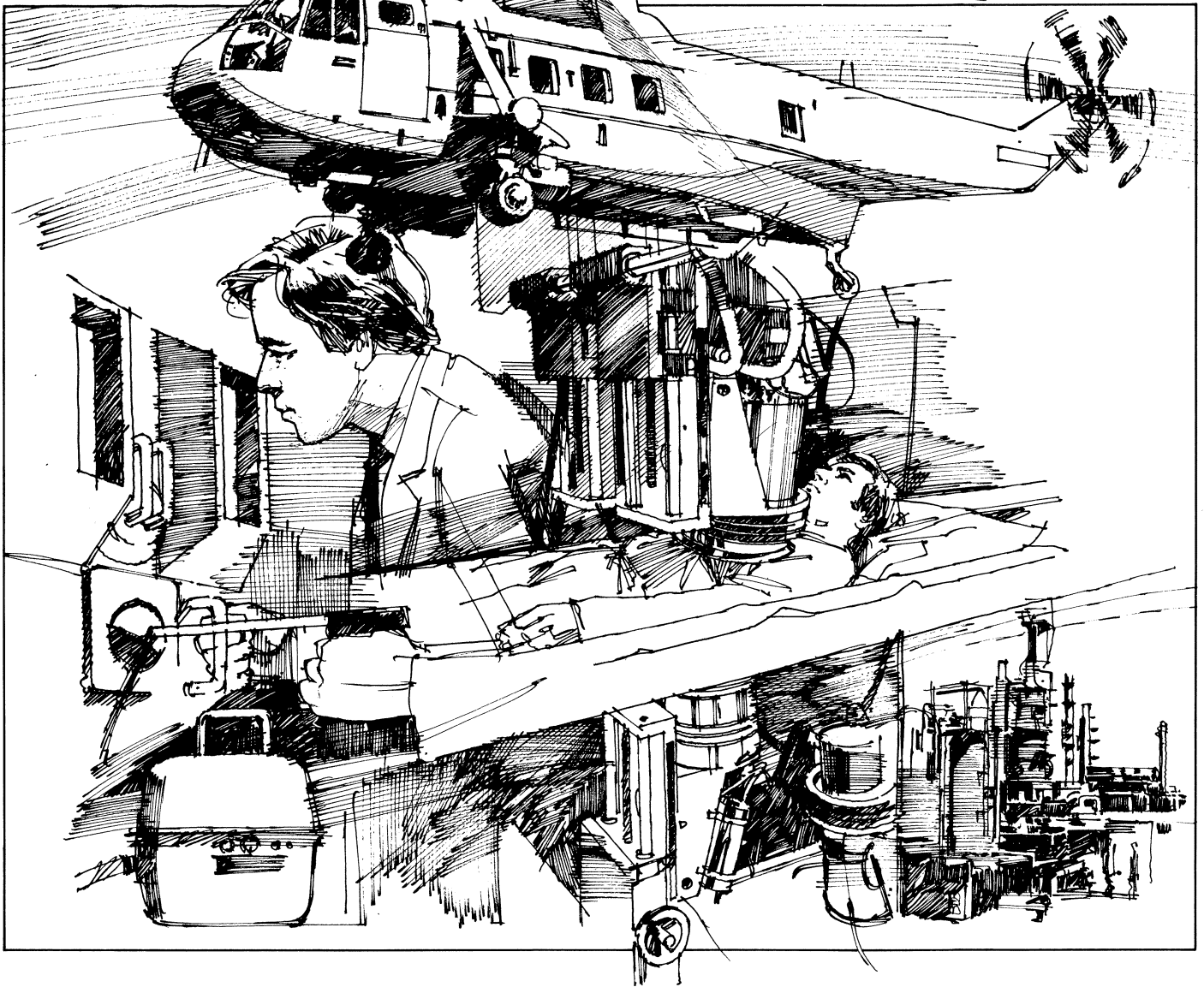
Electronic  
components  
and materials



**We've set the standard for over 20 years**

**PHILIPS**

# COMMERCIAL URANIUM. IT'S MORE THAN JUST ANOTHER METAL.



Twice as dense as lead, increasingly competitive in price, and readily available—BNFL commercial uranium could be just the other metal you've been looking for.

Currently in use for a wide range of radiological shielding and non-destructive testing applications, balance weights for aircraft, colouring

compounds for glass and ceramics and as a constituent of catalysts for the gas industry, BNFL commercial uranium is demonstrably a versatile material of great potential value to industry.

For thirty years BNFL has been fabricating commercial uranium—casting, machining, rolling, forging, extruding.

For further information write to:-  
The Commercial Manager,  
Misc. Products Business Centre,  
Room C24,  
British Nuclear Fuels Limited,  
Risley, Warrington WA3 6AS

**BNFL**

Partout où l'œil  
ne peut accéder...

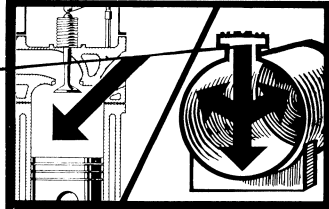
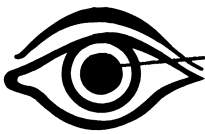


## Endoscopes flexibles à fibres de verre

pour l'inspection directe de corps creux  
non accessibles aux yeux.  $\varnothing$  3-14 mm  
longueurs utiles 0,5-12 m. Eclairage  
de l'objet par lumière halogène intégrée.  
Alimentation par pile et secteur.

For optical  
interior inspections...

## boroscopes, fiberscopes.



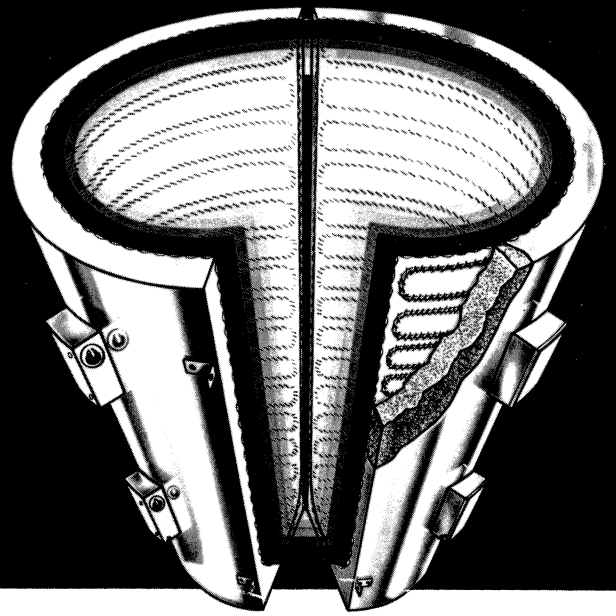
Ask for details.



**TECHNOKONTROLL AG**

8049 Zürich, Imbisbühlstr.144 Telefon 01 56 56 33

# ELECTRIC SURFACE HEATING



Custom built Heating Jackets and  
Cut to Length Heating Tapes



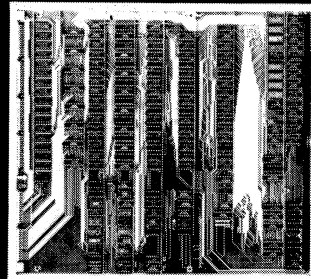
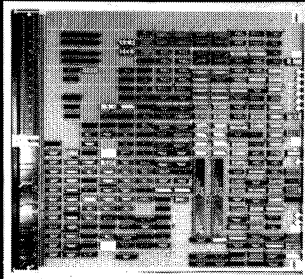
Isopad Ltd, Stirling Way, Borehamwood, Hertfordshire WD6 2AF, England. Tel: 01-953 6242. Telex: 261761

KLUGE CARD  
(CERN DD5196)

KLUGE CARD  
(CERN DD5262)

FASTBUS-MONITOR  
(CERN F6801)

FASTBUS-DISPLAY FDM  
(CERN DD5212)



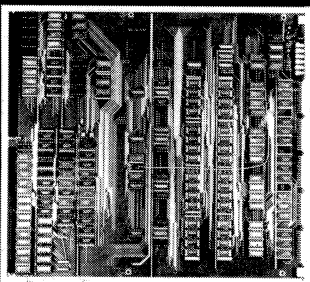
FIORI  
(CERN F6801)

ECL-IN/TTL-OUT MODULE  
(TPS-I-300)

ECL-INPUT-MODULE  
(CPS-I-300)

ECL-RAM-MODULE  
(CPS-R-300)

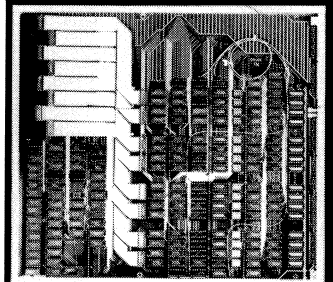
TTL-RAM-MODULE  
(TPS-R-300)



FASTBUS PRODUCTS

FASTBUS CRATE

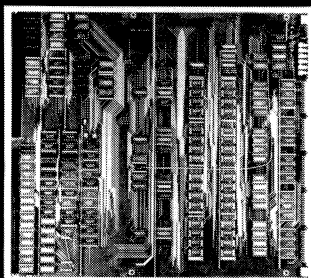
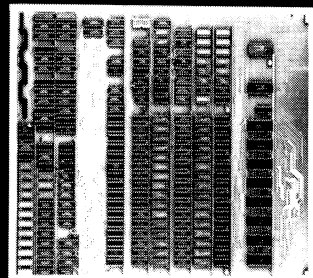
FOR LAB.-APPLICATION  
+5V/60A; -5.2V/60A;  
-2V/30A; +/-15V/4A



For additional information  
please contact:

Suisse:

ANTARES AG; Postfach;  
CH 5415 Nussbaumen;  
056-82 37 83; Telex 58 703



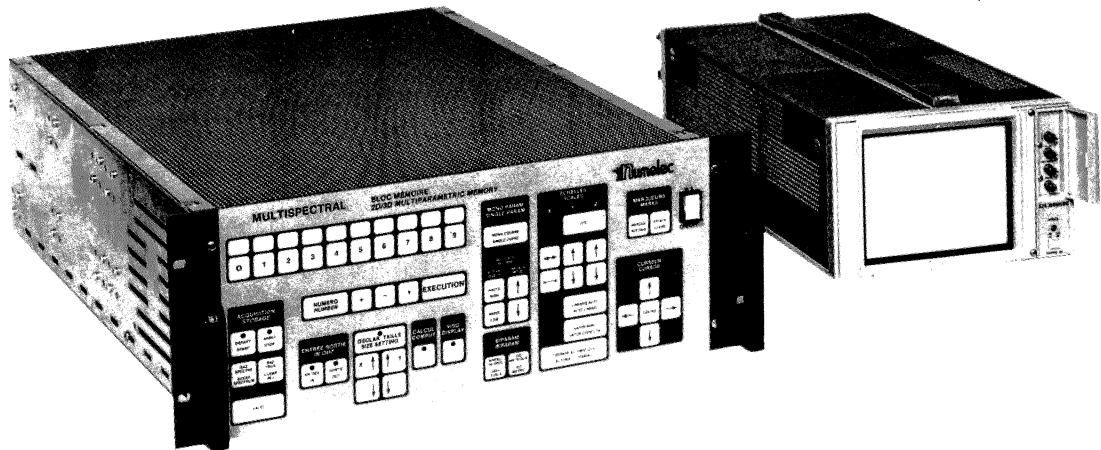
ENTWICKLUNG  
HERSTELLUNG  
VERTRIEB  
BERATUNG  
CAMAC  
INTERFACES  
DIGITALTECHNIK  
ANALOGTECHNIK

**DR. B. STRUCK**

2 TANGSTEDT / HAMBURG GERMANY  
DORFSTR. 163 · TEL. 0 41 09/62 52/62 00  
TELEX 2 180 715

# BLOC MÉMOIRE MONO-BIPARAMÉTRIQUE MULTISPECTRAL

LICENCE CNRS - IN 2 P 3 - ORSAY FRANCE



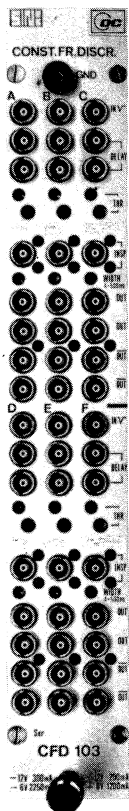
4 à 64 K canaux  
1 à 64 sous-groupes  
1,2 ou 4 voies  
+ 1 en 4  $\mu$  s PARDMI.

- Télécommande clavier et visualisation.
- Calculs sur pics marqués.
- Calculs sur spectres avec coefficients.
- Entrées/sorties séries et parallèles.



F. Mentz  
(3) 062 43 20  
Télex 697 143 F

BP 38-78320 Le Mesnil St-Denis, France



## CFD 103

### Hex Const. Fraction Discr.

- Full automatic Walk adjustment
- Full immunity to superimposed ground loop voltages and drifts.
- CFD 103 is equipped with auto-controlled triggering point, based on a feedback loop controller principle.\*
- CFD 103 accept DC input offset of  $\pm 150$  mV and frequency interferences  $\geq 400$  Hz as well as high changes of counting rates without degradation of timing performance.
- CFD 103 is designed for signal rates up to 100 MHz and provide Walk equal to  $\pm 50$  ps over a dynamic range of 400:1.
- CFD 103 indicates the optimal autotriggering point by equal intensity of two LED's.
- CFD 103! Your old «Walk Screw-driver» will be 100% credited by buying this unit.



**ORBIT CONTROLS AG**

Zürcherstrasse 20  
CH-8952 Schlieren  
Tel.: 01 - 730 27 53, Tx: 59 834

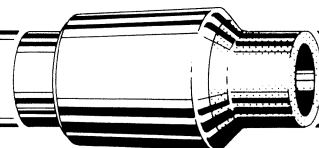
Licence

\* Patent pending

## THEVENET CLERJOUNIE TRANSITION JUNCTIONS CEA SYSTEM

FOR CRYOGENIC, VACUUM, NUCLEAR AND SPACE APPLICATIONS

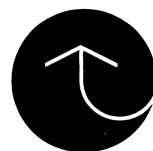
ALUMINUM  
ALLOY



STAINLESS  
STEEL

**THEY HAVE THE  
SAME MECHANICAL  
CHARACTERISTICS  
AS THE ALUMINUM  
TUBE AND CAN ALSO  
BE FABRICATED  
TO ANY MATERIAL  
SPECIFICATIONS**

TOTALLY RELIABLE BIMETALIC  
TRANSITION JUNCTIONS  
FOR TUBULAR ASSEMBLIES  
UP TO  $\varnothing$  600 MM (24")  
 $10^{-9}$  atm.  $\text{cm}^3 \cdot \text{S}^{-1}$   
10 M Pa  
0 to 573 K  
UNDER RADIATION



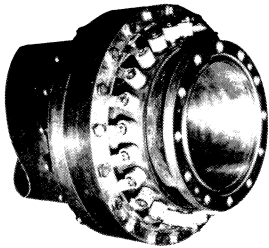
\* COMMISSARIAT A L'ENERGIE ATOMIQUE

**CALL OR WRITE FOR DOCUMENTATION**  
THEVENET CLERJOUNIE ■ DEPARTEMENT JONCTIONS TC  
CONTACT: M. ARMAND PINET, CONSULTING ENGINEER  
22, AVENUE FRANKLIN-ROOSEVELT ■ 69517 VAULX-EN-VELIN  
CEDEX FRANCE ■ TELEPHONE: (7) 849.54.64 ■ TELEX 380544F

# RF TECHNOLOGY

Components and Engineering

- Coax and Waveguide
- Pressurization Systems
- Microwave Absorbers
- Monopulse Comparators
- Waveguide Switches
- Open Wire Switches
- Coax Breakaways
- Coaxial Switches
- Phase Shifters
- Stub Tuners
- DC Breaks
- Combiners
- RF Loads



## EXEMPLARY SPECIFICATIONS DC BREAKS

(parameters are variable for each application)

Application	Coaxial DC isolation
Frequency	up to 2500 MHz
R.F. Power - peak	1.5 MW
average	20 kW
DC Voltage	20 kV
Energy absorption	5 kJ DC
R.F. leakage	60dB down
VSWR	1.1
Coax	up to 14"/35.6cm

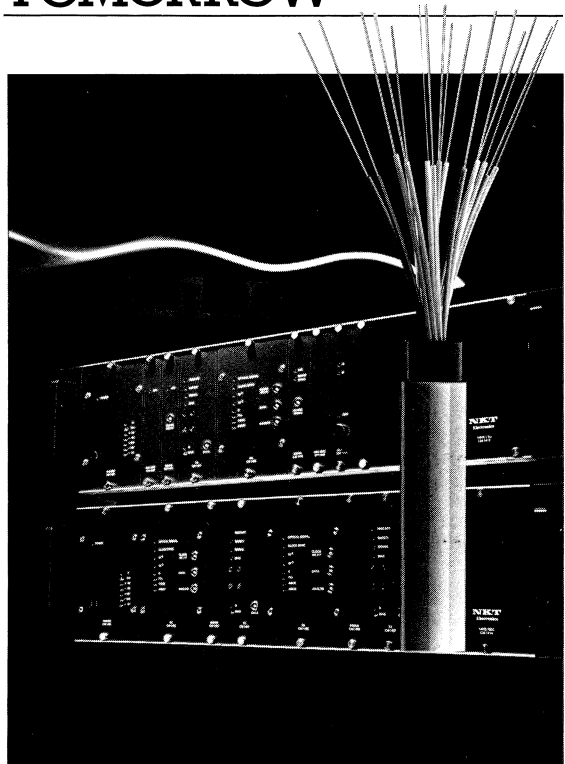
## DIELECTRIC COMMUNICATIONS

A UNIT OF GENERAL SIGNAL

A FORTUNE 250 COMPANY  
TOWER HILL ROAD, RAYMOND, MAINE USA 04071  
TEL. 207-655-4555 800-341-9678 TWX: 710-229-6890

m  
W  
t  
o  
M  
W

# NKT ELEKTRONIK CREATES THE SOLUTION OF TOMORROW



NKT Elektronik is in the forefront in digital optical tele, TV and data transmission, plus fibre optical measuring instruments and fibre optical cables — thanks to a unique cooperation between NKT, the Technical University of Denmark and the Danish Teleadministrations.

NKT Elektronik is solidly founded within the NKT Group, one of the largest in Denmark. The Group is divided into five sectors: Telecommunication, Energy, Non Ferrous Installation, Metals and Steel.

**NKT** of Copenhagen

Please contact us for further information.



Brøndbyvestervej 95, 2600 Glostrup, Denmark  
Phone: +45 2 96 26 88, Telex: 33 761 nktron dk  
Telefax: +45 2 63 13 20

# bergoz

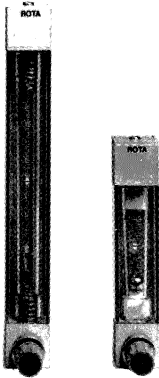


we build your  
electronic equipment

BERGOZ - CROZET - 01170 GEX, France (50) 41 00 89  
Electronic Equipment Manufacturing

# ROTAMÈTRES®

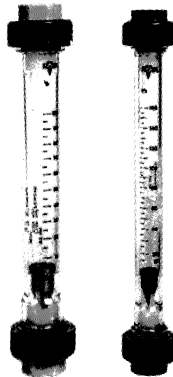
pour gaz et liquide



**ROTAMÈTRES®**  
pour faible débit  
exécution en  
PP/Alu-Elox/inox 1.4571

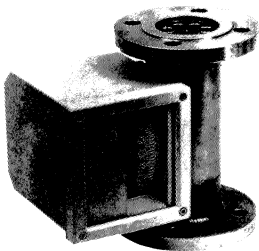
## ROTAMÈTRES®

en polyamide  
raccords en PVC/PP/acier  
inox 1.4571  
montage de contacts  
d'alarme possible



## ROTAMÈTRES®

DN 15-100/PN  
40-200  
en inox 1.4571,  
lecture locale,  
contacts d'alarme,  
transmetteur  
électrique  
0 - 20 / 4 - 20 mA



**Demandez la documentation!**

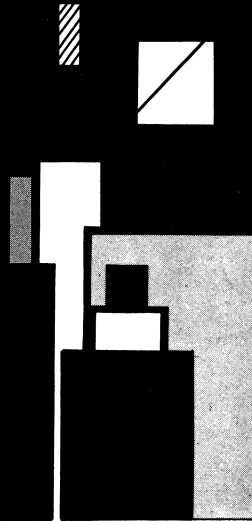
**ZIMMERLI MESSTECHNIK AG**

Schlossgasse 10  
4125 Riehen 1

Telefon  
061 67 54 54

## une gamme complète de câbles électriques isolés

- Câbles d'énergie de 1 à 400 kV
- Câbles pour installations domestiques et industrielles
- Câbles de téléphonie, signalisation et de télécommande
- Câbles souples de manutention, soudage
- Appareillages pour câbles électriques isolés



*treficable*  
**TIRELLI**

groupe énergie

agence de grenoble - 15, boulevard des alpes  
z.a.c. buclos grand pré - 38240 meylan  
tél. : (76) 90.72.54 - télex : 980195 F

**2 years development + know-how =  
our NITRONIC success !**

## HVS 132 - 32 channels high voltage power supply

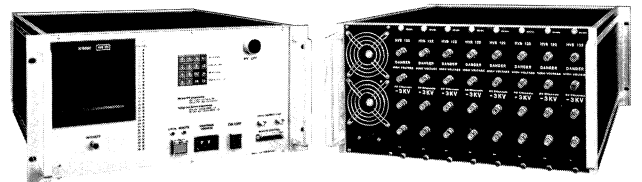
*Specifications :*

- 3kV or 7kV
- 0,5V steps
- 0,002% °C
- 10µA to 3mA progr.
- 30 mV RMS ripple
- very easy local or remote controls (RS 232)

*our NIM products :*

- Quad AND/OR
- Logic delay
- Scaler 250MHz
- Fan-out
- Discriminator

All data for all channels as displayed !

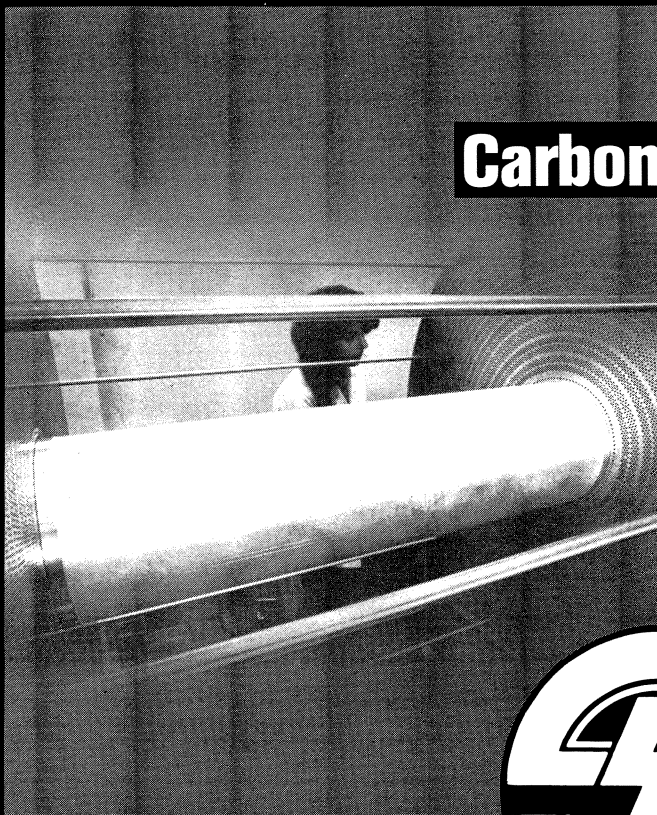


SWISS MADE

Please write or phone  
for information or for demonstration:

**NITRONIC Weyernweg 35**  
CH - 2560 Nidau, tel. (032) 51 68 10





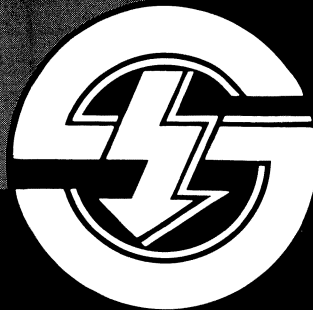
## Carbon fiber construction elements

Well-founded informations give you a personal lead in any project management. Take for example

for specific use in experimental physics, for panels, pipes, shaped parts and combination products.

Please request detailed information. Mr H. Mauch will be glad to advise you personally.

We offer a range that is based on 25 years' experience and know how through successful collaboration with field specialists.



**Stesalit AG**  
**Kunststoffwerk**

CH-4249 Zullwil/SO  
Telefon 061/80 06 01, Telex 63182

W&amp;P

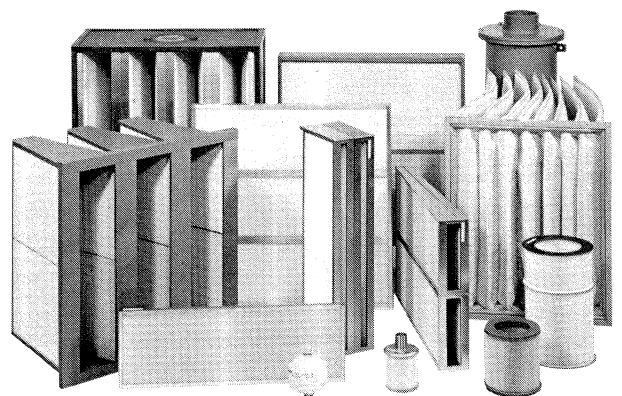
We provide easily built-in safety in Know-how.

**HEINZINGER**  
Regel- und Meßtechnik  
8200 Rosenheim · Happinger Str. 71  
Tel.: 080 31/6 41 41 · Telex: 05 25777

HIGH VOLTAGE POWER SUPPLY  
0 TO 300 kV DC  
0 TO 10 mA  
CURRENT AND VOLTAGE  
STABILITY  $1 \cdot 10^{-4}$   
OUTPUT RIPPLE AND NOISE  
 $1 \cdot 10^{-4}$ pp  
POWER INPUT 380 V  $\pm$  10% PHASE

REMOTE CONTROL UNIT

***Poussière fine, particules  
en suspension peuvent  
être retenues par les fil-  
tres Luwa. Nous en  
avons une gamme com-  
plète à votre disposition.***



Succursales, licenciés et représentations dans plus de 60 pays.

**Luwa**

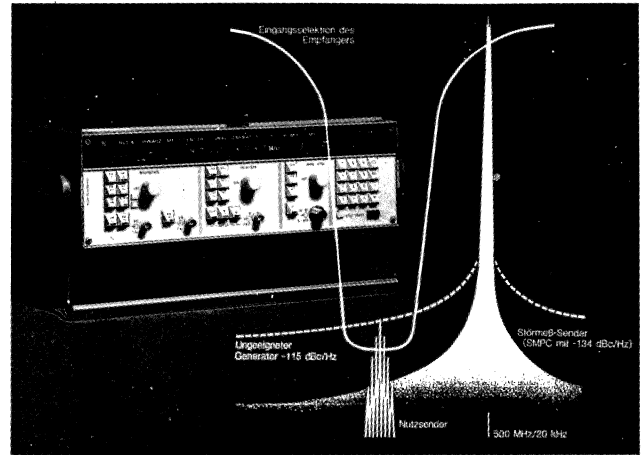
Luwa SA  
Filtres + Equipement de Protection  
Kanalstrasse 5, 8152 Glattbrugg, Téléphone 01/810 1010

# GÉNÉRATEUR SYNTHÉTISEUR SMPC

- Grande pureté spectrale
- Résolution 0,1/1 Hz
- Balayage digital
- Modulation AM, FM, PM, stéréo compatible
- Facteur de distorsion de modulation très faible
- Déviation FM jusqu'à 1600 kHz
- Synthétiseur BF de 10 Hz – 100 kHz servant de générateur de modulation
- Programmation de toutes les fonctions par Bus IEC 625-1 ou IEEE 488
- Temps de commutation de fréquence: 18 ms



**ROHDE & SCHWARZ**



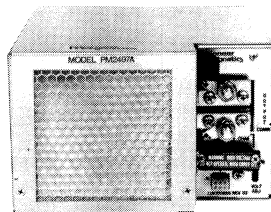
Représentation générale  
et service  
pour la Suisse



**ROSCHI**

**Télécommunication SA**

3000 Berne 31  
Case postale 63  
Télex 32 137  
Téléphone 031 44 27 11



## Alimentation de 400 à 1500 Watts

**AC/DC, DC/DC**  
**Simple ou multitension**

**Options:**

- Power Fail Signal
- Logic Inhibit
- True Inhibit
- OV Crowbar
- Remote Program/Margin
- OV Secondary Channels
- Local Margin Check
- Paralleling
- Reverse Input Protection (DC-Input Units)
- Output Out-of-Tolerance
- Output Power Good

Nous attendons vos demandes!

Täferstrasse 15  
CH-5405 Baden-Dättwil  
Telex 54070  
Tel. 056 84 01 51

**STOLZ  
AG**

Av. Louis Casai 81  
CH-1216 Genève  
Tél. 022 98 78 77

## Advertisements in CERN COURIER

Format A4

Monthly publication

All advertisements are published in both English and French editions. Second language versions accepted without extra charge.

Space (page)	Actual size (mm) width by height	Cost per insertion (Swiss Francs)			
		1 insertion	3 insertions	5 insertions	10 insertions
1/1	185 x 265	1630	1580	1530	1430
1/2	185 x 130	900	870	850	800
1/4	90 x 265	510	480	460	440
	90 x 130	510	480	460	440

Supplement for:

— each additional colour 1500 SwF

— Covers:

Cover 3 (one colour) 1930 SwF

Cover 4 (one colour) 2570 SwF

Publication date

Closing date for

positive films and copy

1st of month of cover date:

1st of month preceding cover date  
The cost of making films and of translation for advertisements are charged in addition.

Screen (offset)

60 or 54 Swiss (150 English)  
Advertisements cancelled after 1st of month preceding cover date will be invoiced.

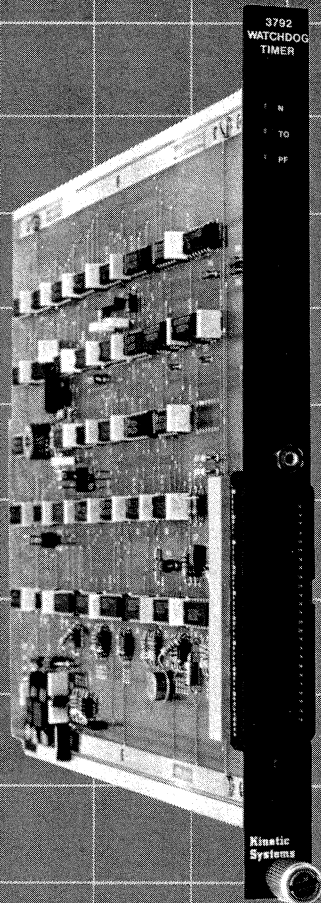
Advertising space is limited to 50% of contents and insertions are selected on a strict first-come first-served basis. These rates are effective for the year 1984.

All enquiries to:

Micheline FALCIOLA / CERN COURIER – CERN

CH-1211 Geneva 23 Switzerland

Tel. (022) 83 41 03 Telex 2 36 98



## Increase CAMAC System Safety And Reliability With New 3792 Watchdog Timer/Power Monitor

A must for every CAMAC-automated laboratory process . . .

- Generates an alarm upon failure of a power source, host or remote computer, or network node.
- Provides relay outputs for use in safety interlock chains.
- Guarantees a known, well-defined shutdown state when modules can be disabled by Dataway Inhibit.

### — FEATURES —

- Timeout activates selectable LAM and Form C relay contacts
- Each CAMAC crate voltage is monitored
- Connection available for AC mains monitor
- Watchdog timeout period is switch-selectable
- Dataway Inhibit is switch-selectable
- Timeout periods range from 0.01 to 10.0 seconds in four decade increments

Meeting your  
CAMAC needs

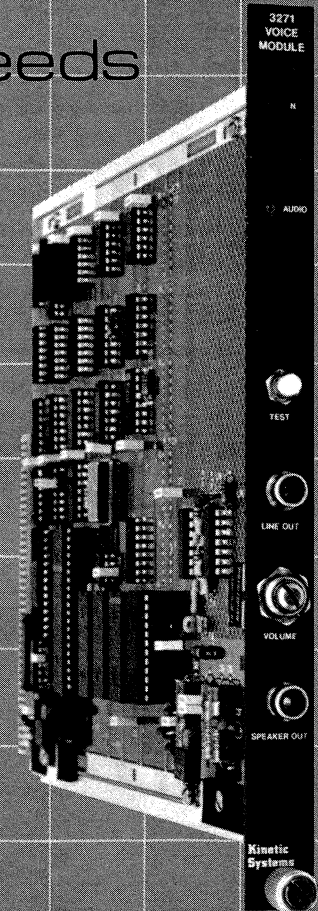
## New 3271 Voice Module Brings Powerful Speech Synthesis to Your CAMAC System

Verbal reinforcement for a variety of laboratory functions . . .

- Attract an operator's attention when an alarm condition occurs.
- Report the progress of an experiment.
- Confirm your data entry with spoken feedback.
- Direct and guide movements of laboratory personnel.

### — FEATURES —

- Speech processor and associated vocabulary ROMs for word storage
- 274-word DIGITALKER™ vocabulary
- 128-word FIFO buffer for fast, easy phrase generation
- LAM interrupt when last word in buffer is spoken
- Power amplifier for direct loudspeaker drive
- External loudspeaker for high-quality, natural speech output



Contact us  
for more information

# KINETIC SYSTEMS

#### U.S.A.

11 Maryknoll Drive  
Lockport, Illinois 60441  
Phone: (815) 838 0005  
TWX: 910 638 2831

#### West Coast Office

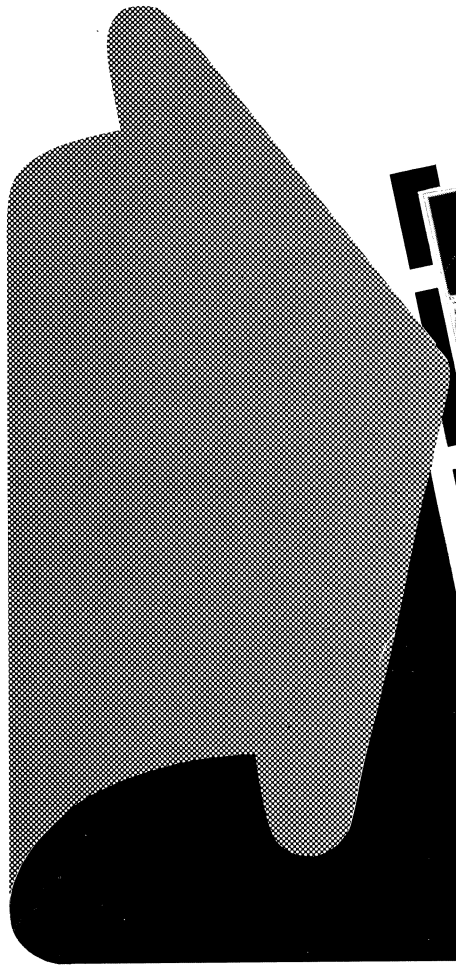
39175 Liberty Street, Suite 245  
Fremont, California 94538  
Phone: (415) 797 2351  
TWX: 910 997 0544

#### Europe (Service)

3 Chemin de Tavernay  
1218 Geneva, Switzerland  
Phone: (022) 98 44 45  
Telex: 28 96 22

#### Europe (Marketing)

Gewerbestrasse 13  
CH-4528 Zuchwil, Switzerland  
Phone: (065) 25 29 25  
Telex: 845/934648



**Testing problems?  
Wiring checks?  
Function simulation?**

**KENNARD, the micro-computer-controlled wiring tester and function simulator will solve your problems.**

- Simultaneous connection of eight crates.
- 6144 test points per crate, with facilities for extensions to 8192 points.
- Wire-wrap feed-in via keyboard or model crate.
- Direct connection via plug-in cards.
- Data storage on diskette.
- Automatic connection testing before making the next connection.
- Inherent and final test for superfluous and/or missing intermediate connections.
- Fault list print-out.

**O. ALGE ELEKTRONIK KG**  
Höchststraße 5 · A-6890 Lustenau

graphic art studio, Lustenau

## SCINTILLATORS

- Polyvinyltoluene
- Acrylic
- Liquid
- Custom Fabrication
- Light Guides
- Wavelength Shifters
- Accessories

FOR A COMPLETE CATALOG  
AND SPECIFIC DETAILS  
CONTACT

**national  
diagnostics**

198 RTE. 206 SOUTH SOMERVILLE, N.J. 08876  
TELEX 6858083 (201) 874-8696

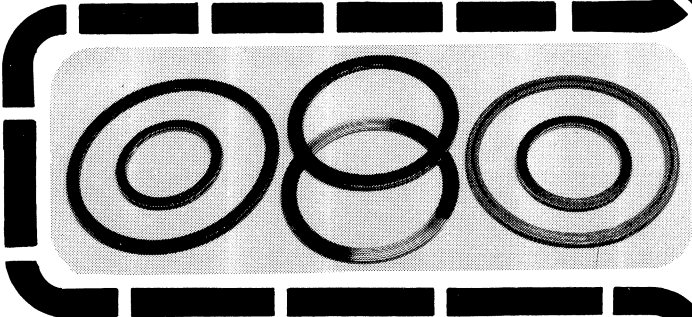
## Rivaflex Gaskets

with Rivatherm foil

**New!**

## Grooved Gaskets

with covering layer of Rivatherm foil



**Kempchen may deliver to you.**

We are specialized in all gasketing problems. Our laboratorones are always in charge of finding new solutions for your gasketing problems.

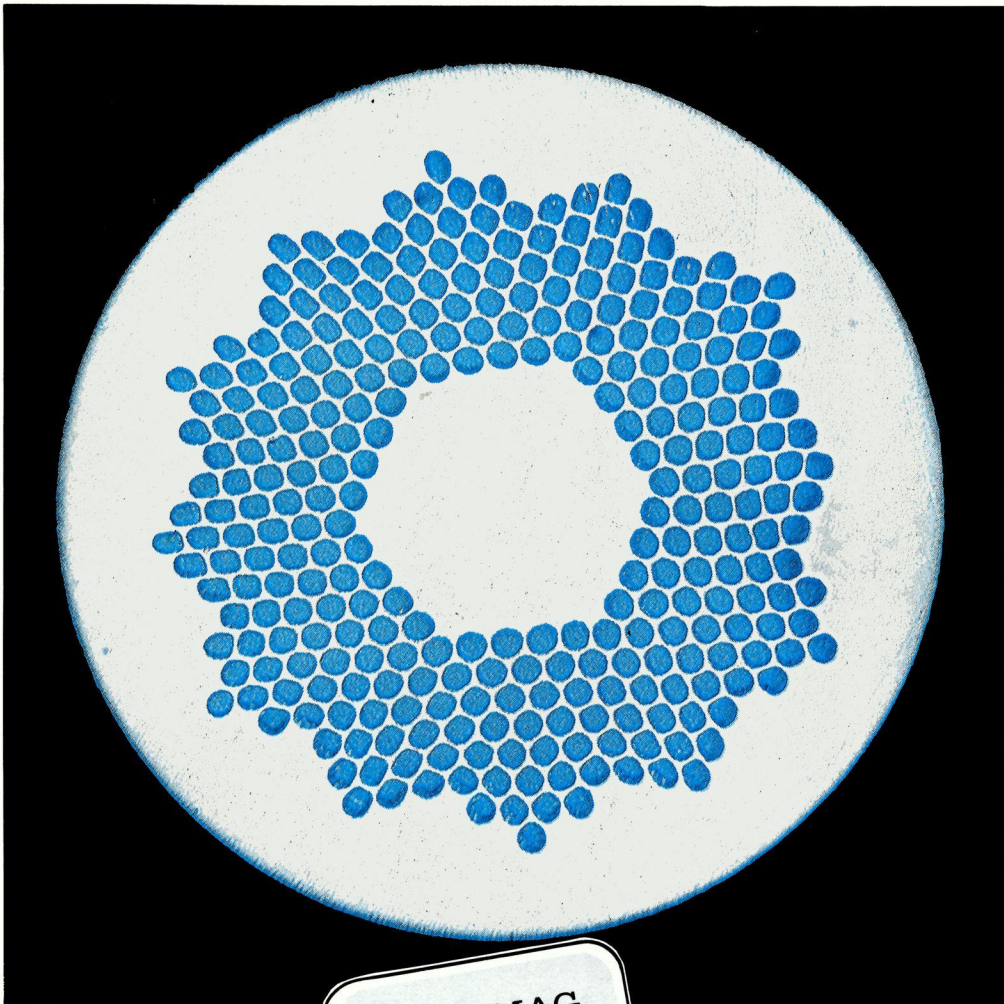
Our engineers shall be pleased to consult you; please contact them.

**Kempchen: optimum solutions for gaskets, packings and compensators.**

**kempchen-WeberAG**

CH - 4349 RHEINSULZ  
Telefon 064 64 1751 · Telex 982 265 kwa ch

# OUTOKUMPU, THE COMPANY WITH MAGNETISM



Superconductors and hollow conductors for magnet windings are made of the same high-grade copper for which Outokumpu is world famous.

Our expertise and integrated production methods meet all the challenges of today.

Let us handle your challenge.

References: SPS, Fermilab  
JET, TORE SUPRA



**OUTOKUMPU OY**  
COPPER PRODUCTS DIVISION

P.O.Box 60, SF-28101 PORI 10 FINLAND  
Phone int. +358-39-2611, Telex 26-111 okm sf

**INTERMAG  
CONFERENCE**  
April 10-13,  
1984 HAMBURG  
**STAND 19**

Mausen Oy  
Cern Courier

Use this coupon to obtain more information

- Please contact me  
 Please send me more information on your products

Name \_\_\_\_\_

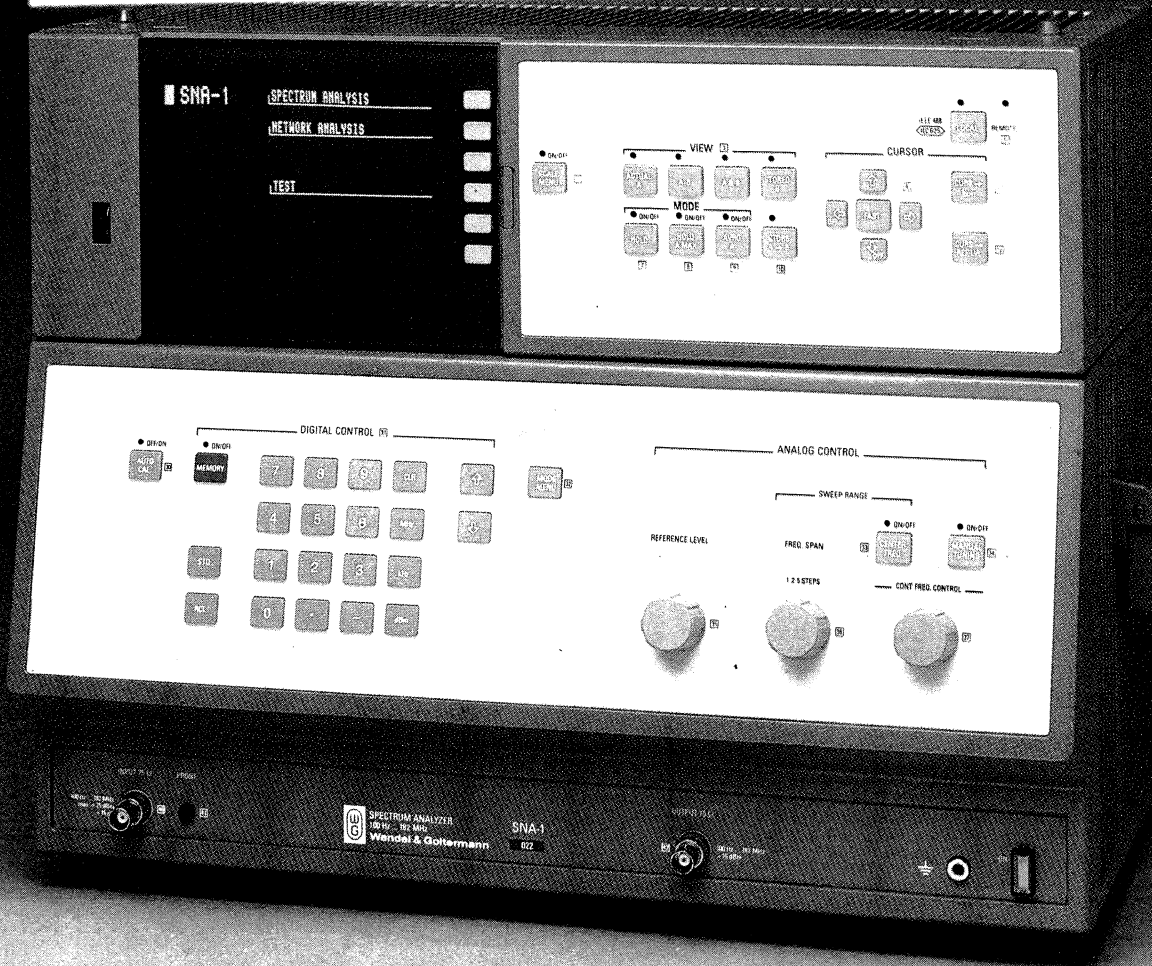
Address \_\_\_\_\_

Telephone \_\_\_\_\_

**OUTOKUMPU OY, COPPER PRODUCTS DIVISION**  
SUPERCONDUCTOR DEPARTMENT  
P.O.Box 60, SF-28101 PORI 10 FINLAND  
Phone int. +358-39-2611, Telex 26-111 okm sf

# SPECTRUM ANALYSIS

# NETWORK ANALYSIS



## Spectrum and Network Analysis Simpler and greater accuracy, at last!

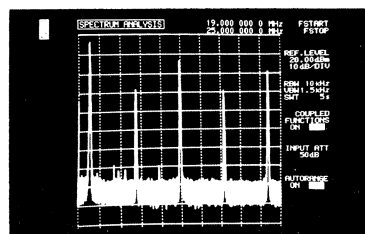
Precision, even with simpler operation? The SNA-1 Spectrum and Network Analyzer, 100 Hz to 180 MHz, offers both at the optimum.

### Simple operation:

For overview measurements, the "analog" settings with three knobs for center frequency, sweep width, and level range are obviously useful. On the other hand, known parameters are best entered exactly and easily via the keypad. Thanks to the "soft-keys", the rest is easy. Complete standard setups can be stored, or else setting and evaluation are taken care of by computer via the IEC 625/IEEE 488 Interface.

### Accurate measurements:

The SNA-1 offers the stability of a synthesizer and the high accuracy of our classical level measuring setups, with which we have achieved such worldwide success. Indeed, bandwidths starting at 3 Hz and a level measuring range down to -130 dBm speak for themselves.



The evaluation? Very easy: calibrated electronic graticule, parallax-free readings, two digital measurement curve stores (measurement, reference/difference), superimposed measuring traces and tolerance limits as well as alphanumeric display of all important parameters.

For easy documentation, the complete formatted measurement results are shown on the video screen and are available as hardcopies from a graphics/video plotter or by photographic recording. Are you looking for such an instrument? Then just request detailed information about the SNA-1 and its interesting price.



Please send me:  
 Information about the SNA-1  
 An applications engineer to advise me

Name .....

Firm .....

Address .....

Tel. No. ....

**Wandel & Goltermann**

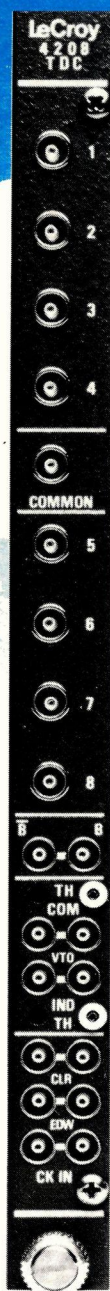
(Schweiz) AG  
 Postfach 254  
 CH-3000 Bern 25  
 Tel. (031) 42.66.44  
 Telex 32 112 wago ch



E 3271 K

# "TIMING TWINS"

## NEW MULTICHANNEL WIDE RANGE Time Digitizer



For Time-of-Flight Detectors and Mass Spectrometers

### CAMAC Model 4208 Time-to-Digital Converter

- 8 Time Digitizers
- 1 nsec resolution
- 24-bit dynamic range
- Real-time technique minimizes dead time
- Common start or stop
- Flexible operation

Designed for applications requiring wide dynamic range with high resolution and minimum dead time, the Model 4208 offers several configurations: eight independent channels, single channel multi-stop (8), dual channel multi-stop (4), and more. The design provides for a common start or stop mode to be used. Logic circuits and an external clock expand the time range beyond 16.6 msec. A fast clear is used to clear the unit in less than 50 nsec.

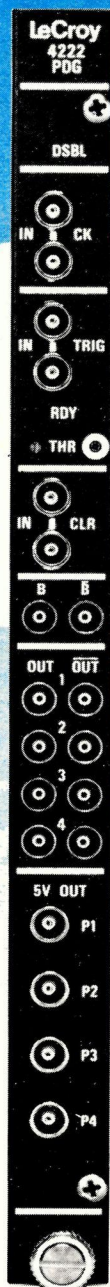
Whether your application is time-of-flight, mass spectroscopy, astronomy, laser ranging, synchrotron radiation, fusion or high energy physics, LeCroy provides the answer to your experimental problems.

For details call or write your nearest LeCroy sales office.

# LeCroy

Rue Cardinal-Journet 27, 1217 Meyrin 1-Geneva, Switzerland, 82 33 55. Offices: USA, (914) 425-2000; Heidelberg, W. Germany, (06221) 28192; Les Ulis, France, (6) 907.38.97; Botley, Oxford, England, (0865) 72 72 75. Representatives throughout the world.

## NEW 4 CHANNEL, WIDE RANGE PROGRAMMABLE Gate and Delay Generator



For: Process Control  
Time-of-Flight Experiments  
Drift Chamber Simulation  
Precision Pulse Sampling  
Test and Measurement  
Calibration

### CAMAC Model 4222 Wide Range, Gate and Delay Generator

- 170 nsec to 16.7 msec (24 bits) dynamic range
- Programmable in 1 nsec steps
- 4 channels of delay or 2 channels of gate
- Minimum dead time with real-time technique
- Single width CAMAC Module

Designed for applications requiring long, accurate, time delays or precise time windows, the LeCroy Model 4222 replaces rack size units with a compact, easy to use, remotely programmable modular instrument.

The Gate and Delay Generator provides four delayed positive and negative outputs triggered by a common start or trigger. Delays may be programmed in 1 nsec steps over a 170 nsec to 16.7 msec range.

The unit may also be set to produce two precision time gates synchronized to a common trigger. Leading edge and trailing edge times may be independently programmed.

Whether your application is simulation, test and measurement, real-time industrial control, or physical and chemical research, LeCroy can provide the answers to your time generation problems.

For details call or write your nearest LeCroy Sales Office.

# LeCroy

Rue Cardinal-Journet 27, 1217 Meyrin 1-Geneva, Switzerland, 82 33 55. Offices: USA, (914) 425-2000; Heidelberg, W. Germany, (06221) 28192; Les Ulis, France, (6) 907.38.97; Botley, Oxford, England, (0865) 72 72 75. Representatives throughout the world.

40



# The world's best power tubes are used in the world's most important scientific programs.

Since 1971, when Varian EIMAC introduced the one megawatt X-2159/8974, we have been the world leader in design and manufacture of high power tubes for scientific and communication applications.

Among the many users of EIMAC tubes in high technology fusion research, particle acceleration and other state-of-the-art investigations are:

- European Organizations for Nuclear Research (CERN) ▪ Fermi National Accelerator Laboratory ▪ Stanford Linear Accelerator Center ▪ Lawrence Berkeley Laboratory ▪ Los Alamos National Laboratory (LAMPF and FMIT programs) ▪

- Oakridge National Laboratory ▪ Princeton Plasma Physics Laboratory ▪ TRIUMF Laboratory (University of British Columbia) ▪ GSI Darmstadt (FRG) ▪ Culham Laboratory (England) ▪ CEA Foutenay-au-Rose (France) ▪ Textor-KFA Julich (FRG) ▪ GA Technology (Doublet-3).

Power tubes developed and manufactured by Varian EIMAC used in the facilities mentioned include the 8973, 8974, X-2062K/9009 and Y676A/9013. These tube types will be joined by others in development to meet new program requirements.

More information is available from Varian EIMAC. Or the nearest Varian Electron Device

Group sales office. Call or write today.

Varian EIMAC  
301 Industrial Way  
San Carlos, CA 94070  
415 • 592-1221

VARIAN AG  
Steinhauserstrasse  
CH-6300 Zug, Switzerland  
Tel: (042) 23 25 75  
Telex: 868-841

