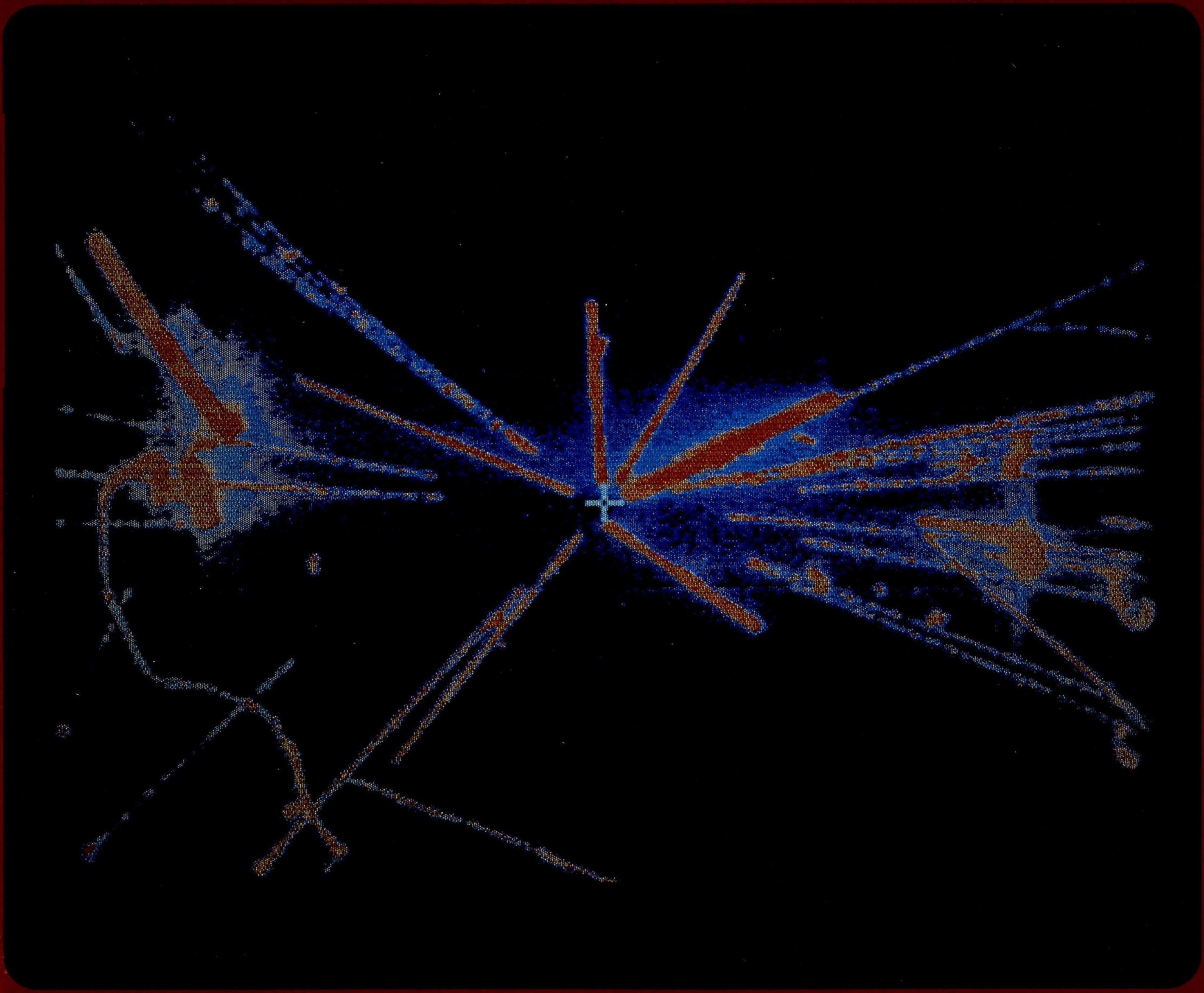
CERN COURIER

International Journal of High Energy Physics



VOLUME 25 **5** JUNE 1985

Laboratory correspondents:
Argonne National Laboratory, USA
M. Derrick
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
G. Siegert
INFN, Italy
M. Gigliarelli 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
R. Elliott
Saclay Laboratory, France
A. Zylberstejn
SIN Villigen, Switzerland
J. F. Crawford
Stanford Linear Accelerator Center, USA
W.W. Ash
Superconducting Super Collider, USA
J. Sanford
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 419 000
(CERN COURIER only Tel. (022) 83 41 03)
USA: Controlled Circulation
Postage paid at Batavia, Illinois

CERN COURIER

International Journal of the High Energy Physics Community

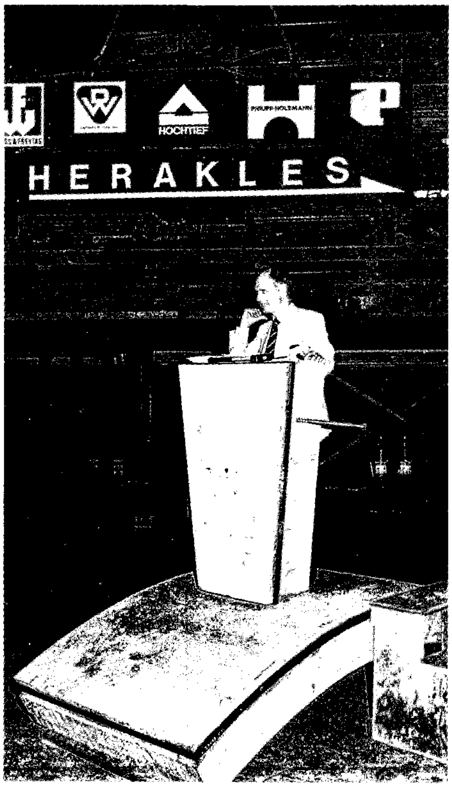
Editors: Brian Southworth, Gordon Fraser, Henri-Luc Felder (French edition) / Advertisements: Micheline Falciola / Advisory Panel: J. Prentki (Chairman), J. Allaby, H. Lengeler, E. Lillestøl

VOLUME 25 Nº 5 JUNE 1985

Around the Laboratories

Cover photograph: A 900 GeV proton-antiproton collision in the CERN SPS ring as captured by the UA5 Bonn / Brussels / Cambridge / CERN / Stockholm experiment, with the benefit of subsequent image processing by Werner Krischer at CERN of the directly-digitized data using a system developed in Cambridge, UK, by Chris Webber — see May issue, page 131 (Photo CERN X725.3.85).

Around the Laboratories



DESY Director Volker Soergel launches Herakles (Hercules) — the tunnelling machine for the HERA electron-proton collider at DESY.

(Photos DESY)

DESY HERAKLES starts its labours

On 19 April DESY Director Volker Soergel released the traditional bottle of champagne at a ceremony to launch the machine which will bore the tunnel to house the electron-proton collider, HERA. The machine actually moved off at the beginning of May from the South experimental hall where it was assembled, and is scheduled to reappear in the same location in two years after its 6.3 kilometre journey. The tunnel will lie between 10 and 20 m below ground; the inner diameter is 5 m.

Volker Soergel baptized the machine HERAKLES (Hercules) since it will be called on to display many of the qualities displayed by the Greek hero in confronting the twelve labours set for him by King Eurystheus. The machine HERAKLES will certainly need strength and, just as Hercules cleared out the Augean stables by diverting two rivers, so HERAKLES will use a flow of fluid to clear out the Hamburg sand as it makes its way around the ring. In addition Hercules (though his name means 'glory of Hera') was pursued throughout his life by the Goddess Hera (he was the son of Zeus, her husband, but his mother was Alcmene!). The intention at DESY is that HERA will pursue HERAKLES through the ring tunnel. Installation of the storage rings will follow on the heels of the tunnelling machine before the full tunnel is bored. The first quadrant will be ready for installation next year.

Other aspects of the electron-proton collider, at this early stage of the project, are also going well. The new 9 GeV electron synchrotron injector, known as DESY II (see May 1984 issue, page 151), had circulating beam in April taking electrons through eighty thousand turns to an energy of 180 MeV. Beam will not be taken to full energy until next year when the power supplies of the old synchrotron (DESY I) become available for connection to the new machine. DESY I, which has operated since 1964, will then be rebuilt to serve in the proton injection chain and DESY II will take over the role of feeding electrons and positrons to PETRA and DORIS at 7 GeV.

There is also considerable enthusiasm about progress in both superconducting radiofrequency cavities and superconducting magnets. The cavities are desirable to reduce power consumption and increase the accelerating field gradient in the 30 GeV electron ring and the magnets are needed to store beams at energies of 800 GeV in the proton ring. The cavities for the electron ring are planned to be the conventional type moved from PETRA but the existing number of these cavities would take the beam energy only to 27 GeV. It is hoped that, from the start of machine operation, a few superconducting cavities could be added to reach design energy.

After some problems, none of them fundamental, a nine-cell superconducting cavity, built in industry, has been installed and successfully operated at a frequency of 1 GHz in PETRA. It reached a gradient of 2.7 MV per m but,

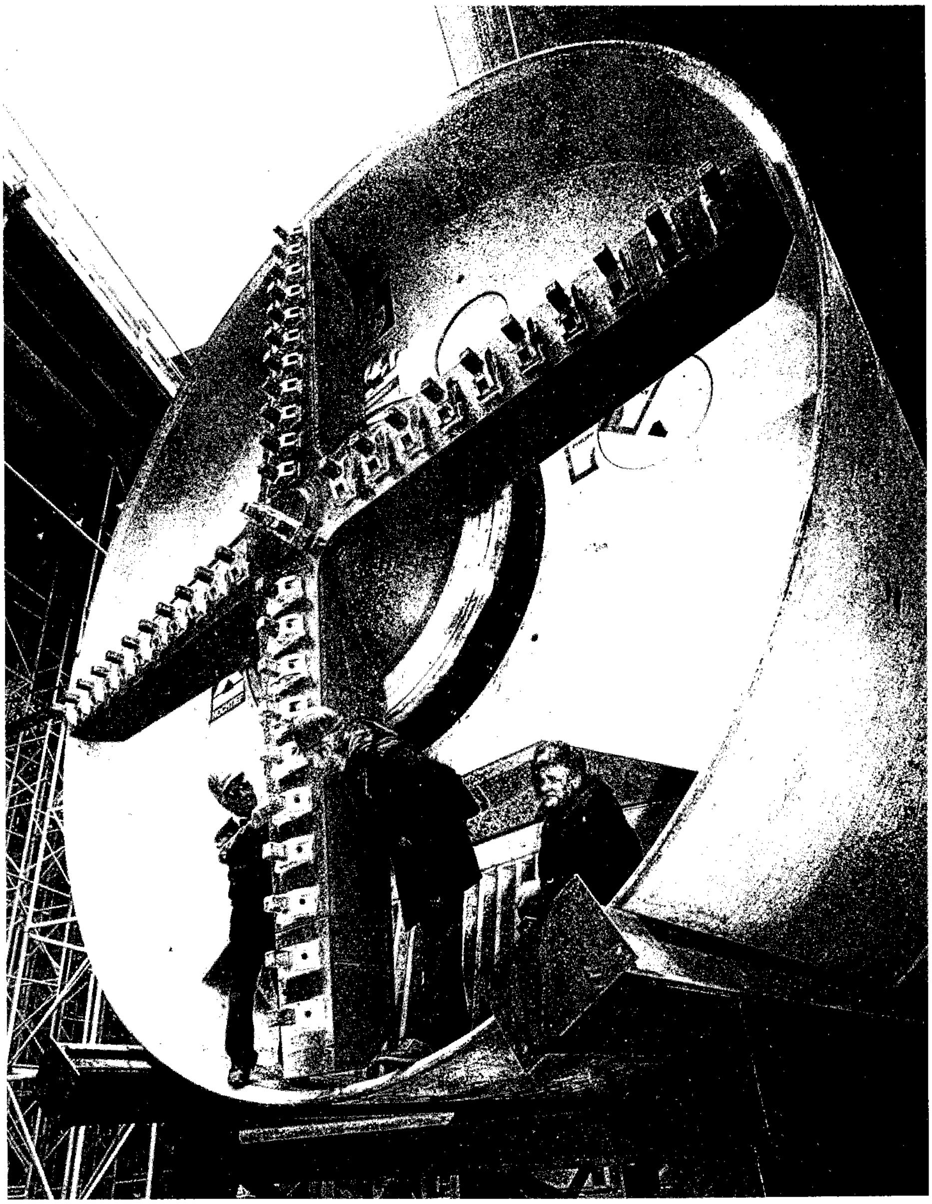
The 'palm tree' produced by etching away the copper to reveal the 2400 niobium-titanium superconducting filaments spilling out of a piece of cable for the magnets of the proton ring of the HERA electron-proton collider at DESY. Continuing developments in cable technology are making higher current densities possible.

more significantly, only some 13 W of power at liquid helium temperature were lost by the cells and their cryostat while transmitting 27 kW of r.f. power to the beam. There was no deterioration of quality after a month of operation with the beam and neither was there any deterioration after a sequence of switching the cavity on and off, indicating that intermittent operation does not cause problems.

A design has now been developed for a four-cell superconducting cavity for HERA, interchangeable with the five-cell conventional type from PETRA. These cavities are designed to operate at 500 MHz. Feeding liquid helium to such cavities in the HERA ring will, of course, be no big problem since helium will be running around the ring in any case for the cooling of the superconducting magnets in the proton storage rings.

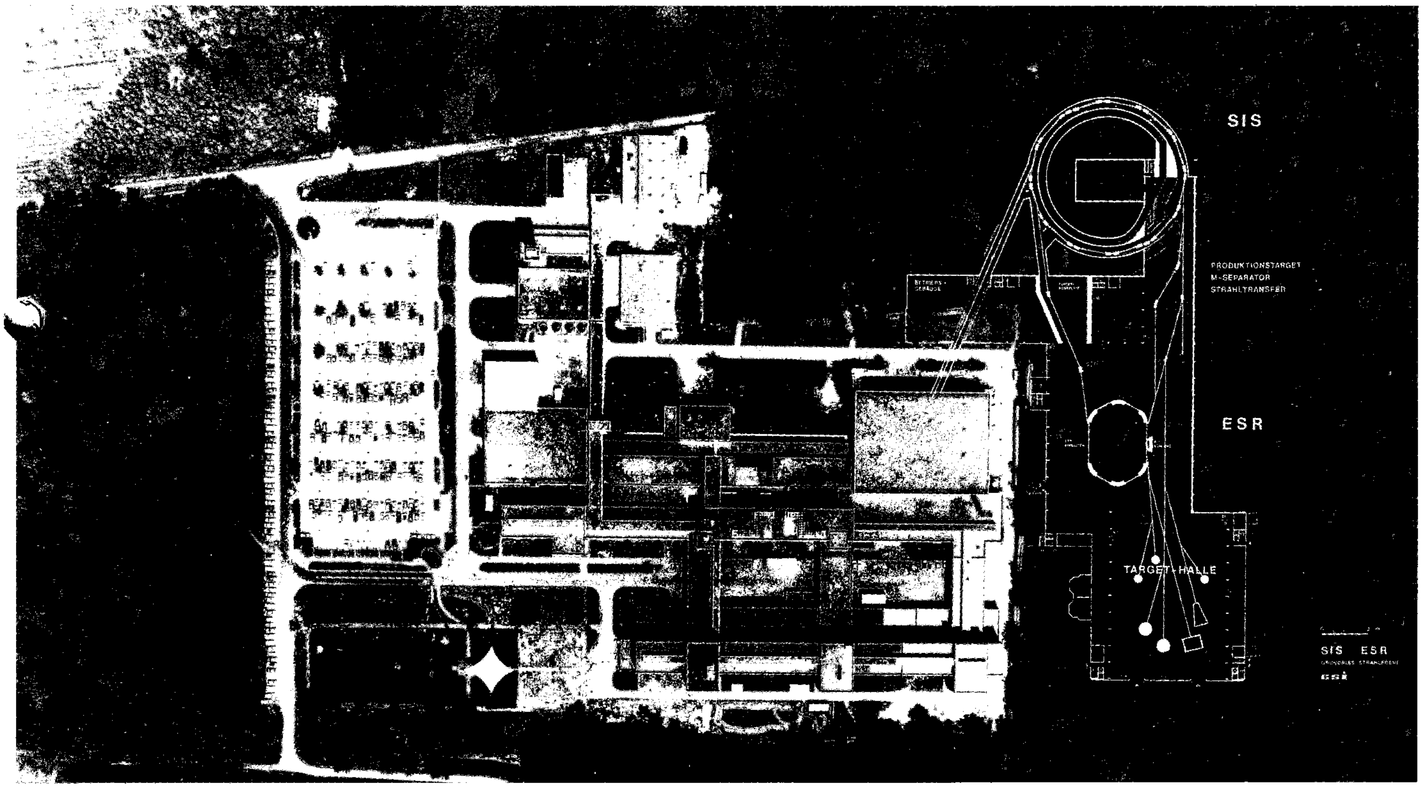
The optimism on the superconducting magnets is great. First of all there is the good news that the continuing improvements in the technology of superconducting cable production by European industry has resulted in a short sample current characteristic for the cable of the HERA magnets of 8 kA rather than the design figure of 6.3 kA to achieve 5 T. This could push the peak magnetic field, and hence the peak energy of the proton ring, higher. It indicates that field levels of the order of 7 T are now reasonably obtainable in magnet designs with niobium-titanium superconductor. The first 465 km of cable (enough to run from Hamburg to Paris) are now under production for the windings of half the HERA magnets.

In addition DESY has capitalized on the experience of the superconducting magnet pioneers at both Fermilab (cold iron design) and Brookhaven (warm iron design). Their so-called 'hybrid' magnets incorporate desirable features of both — the iron location with respect to the coil greatly reduces saturation effects while still contributing some 22 per cent to the field; construction is comparatively simple and heat losses should be low; a passive quench system can be used as in the cold iron solution. A nine metre prototype will be ready for testing in the Autumn and it will be very interesting to see if all the hoped-for advantages are achieved.



No, not another radio-telescope but the head of the tunnelling machine which has just started boring the 6.3 km tunnel for HERA. Adorning the head alongside one of the four arms carrying cutters are (left to right) Volkmer Grosse, who heads the civil engineering group, and two of the doyens of the DESY accelerator world — Gus Voss and Hermann Kumpfert.

Aerial view of the GSI Darmstadt Laboratory, showing how the recently approved heavy ion synchrotron and experimental storage ring project will be grafted onto the existing facilities. From the existing UNILAC linear accelerator building (right), the 15 MeV/nucleon heavy ion beam will be injected into the 206 m circumference SIS synchrotron. Beams will be extracted either directly onto targets or — up to energies of about half the maximum possible beam energy — to the ESR experimental storage ring. This ring will contain an electron cooling system, a slow extraction to the target area and a fast extraction for reinjection into the synchrotron.



DARMSTADT
New heavy ion project

Federal German Minister of Research and Technology Heinz Riesenhuber has announced the final approval of the heavy ion accelerator to be built behind the UNILAC heavy ion linear accelerator at GSI Darmstadt. It consists of two accelerator stages. A rapid cycling (about 10 Hz) synchrotron SIS (Schwerlonen Synchrotron) will deliver particle energies of 1.1 GeV/nucleon for the heaviest ions like uranium and up to 2 GeV/nucleon for light ions with a charge to mass ratio of 0.5. An added experimental storage ring ESR will cover an energy range of about half the values given above. From SIS a low extraction mode together with a special radiofrequency bunching procedure is foreseen to feed the target area and by a fast extraction the beam can be transferred to the ESR, which will contain an electron cooling section, a straight section for internal beam experiments, a fast extraction for reinjection into the synchrotron and a slow extraction for the transfer to the target area.

The two ring system will provide

- completely stripped heavy ion beams up to uranium
- beams of radioactive nuclei by accumulation and cooling of primary beam fragmentation products
- internal targets
- low energy experiments by merging beams
- high power density beams using a fast buncher (8 GW for 40 ns)
- 'normal' target experiments.

The possible interplay between the two rings — acceleration in SIS, transfer to and storage/accumulation in ESR, reinjection into and acceleration/deceleration in SIS — enables the whole spectrum of beam energies from the present UNILAC energy (15 MeV/nucleon) to the maximum values.

With these features a very large experimental field opens up. For example nuclear reaction und nuclear structure studies with extremely exotic projectile-target combinations will become possible as well as the probably fruitful revival of 'older' studies profiting from the high beam quality possible by the UNILAC/SIS/ESR facility. Other ideas concern low energy strangeness and antiparticle production. From the atomic physics point of view a large variety of new studies will be possible.

The total investments for SIS/ESR will be 275 Million DM, two-thirds for the synchrotron storage ring, beamlines and experimental set-ups and the rest for the tunnel, experimental halls, and support facilities.

DETECTORS

Radioactive heat

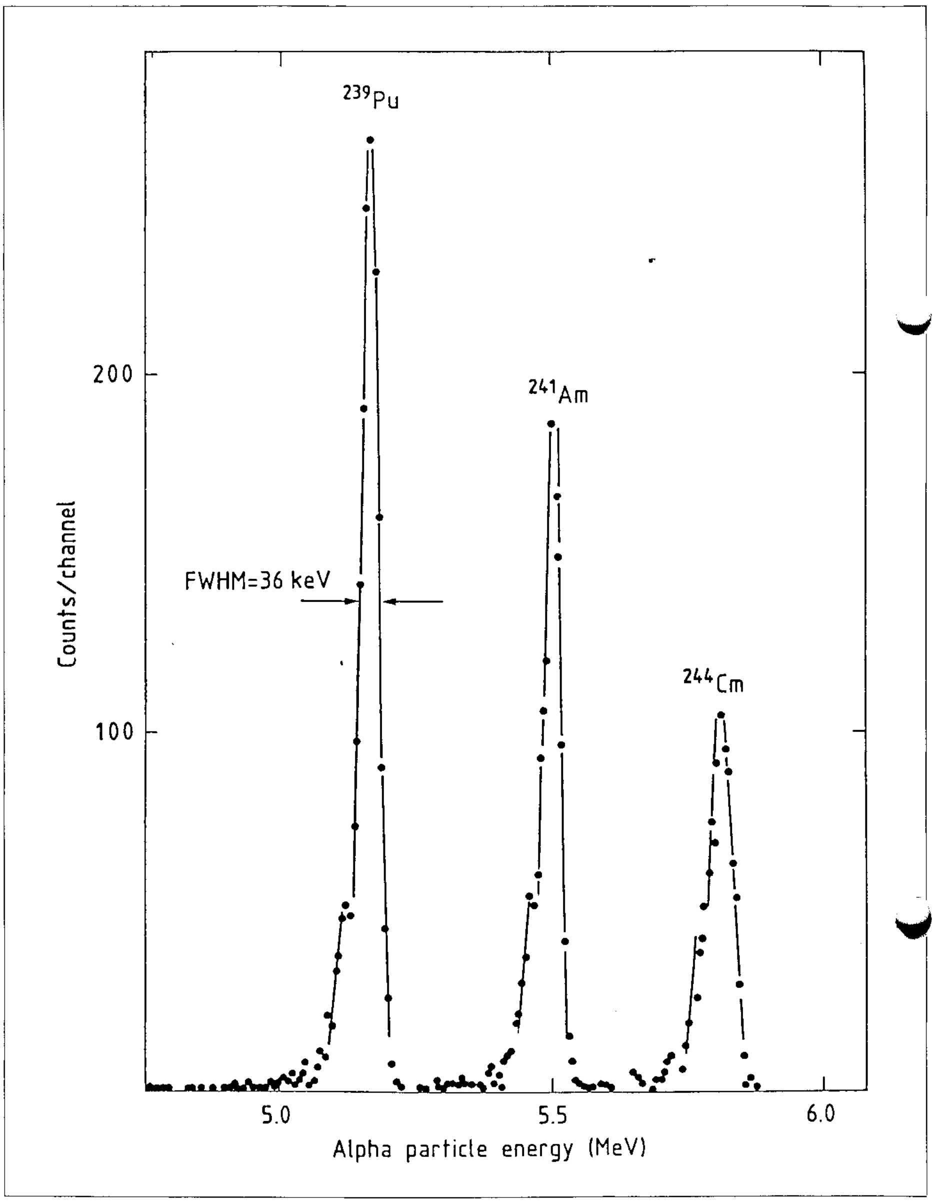
The measurement of radioactivity by the direct conversion of nuclear radiation into a temperature rise in a calorimeter is as old as nuclear physics itself. In 1903 Pierre Curie used a calorimeter to verify that the tiny amount of heat produced by a radioactive substance is due to the absorption of its radiation.

During the following years, such microcalorimetry became of great importance through the determination of the 0.337 MeV average beta energy of bismuth 210 by C.D. Ellis and A. Wooster in 1927. The difference between this value and the maximum beta decay energy of 1.17 MeV was one of the arguments which led Pauli to postulate the existence of the neutrino.

These calorimeters determined the average flux of energy due to the radioactive decays. A new kind of thermal detector, capable of resolving the energy of a single particle, was suggested by T. Niinikoski and F. Udo in 1974, based on their earlier experience in detecting cosmic ray events in ultra-low temperature thermometers.

Several groups advocated a revival of interest in this idea, mainly because the very low heat capacities of these microcalorimeters, when operated at cryogenic temperatures, suggested new kinds of spectrometer with better energy resolution than conventional solid state detectors based on charge carrier collection.

Alpha particle energy spectrum of a mixed source of plutonium, americium and curium obtained by recording the thermal pulses induced by the alphas.



The first successful detector was developed by a Wisconsin/NASA collaboration about a year ago. This is able to detect the 6 keV X-rays of an iron 55 source with an energy resolution (30 eV) comparable to, or even better than, the best semiconductor detectors based on charge collection. Their detector was specifically designed for X-ray astronomy applications. An earlier proposal by a CERN/Milan team suggested using these techniques in the search for rare processes, such as neutrinoless double-beta decay.

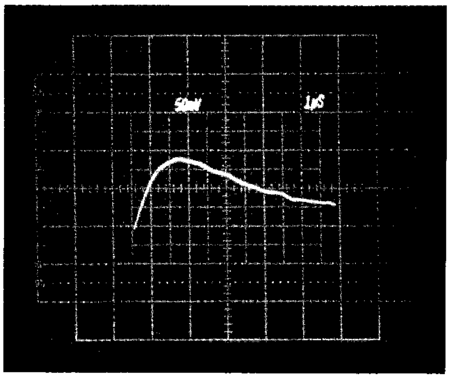
A composite bolometer was developed at the Laboratoire de Physique Stellaire et Planétaire (LPSP) near Paris with an absorber having relatively large surface area (several millimetres diameter) coupled to a small (fraction of a millimetre diameter) semiconductor thermistor (thermal resistor). In this way the absorbing and detecting functions are separated, allowing performance to be optimized. With the radioactivity collected in the absorber part, the whole instrument can also act as a total absorption spectrometer without affecting the thermometer part.

Such units are now used for measuring a wide range of radiations, achieving good resolutions. In a recent test, an Aarhus / CERN / Göteborg / LPSP / New York collaboration developed a composite bolometer which succeeded in picking up and resolving the alpha emission from a mixed source of plutonium 239, americium 241 and curium 244. Using improved electronics, an operational alpha detector with a resolution of about 3 keV is expected.

These detectors were capable of good energy resolution, but have a rate limitation because of the rather slow time structure of pulses, mainly dûe to constructional details. Recent tests at CERN show much faster responses.

The work at CERN is part of an ongoing (ISOLDE group) project at the 600 MeV synchro-cyclotron to measure any vestigial mass of the neutrino by studying the spectrum of the radiation emitted along with electron-capture beta decay (see June 1981 issue, page 208). The new type of detector could pick up signs of neutrino masses of just a few eV.

The application of these new detectors in high resolution spectroscopy opens wide fields in nuclear, atomic, solid state and astrophysics. Most fascinating of all, these instruments get away from the old straitjacket of charge collection due to ionization, and are therefore capable (in principle) of detecting particles which are weakly ionizing, or even not ionizing at all, such as slow monopoles or astrophysical neutrinos.



The time evolution of the thermal pulse of an 8 MeV alpha particle in a 3 x 4 mm^2 silicon detector at 270 mK temperature. The rise time of a few microseconds is limited by the speed of sound in the detector. The decay time of about 20 microseconds is controlled by the heat capacity of the detector and outward heat conductivity.

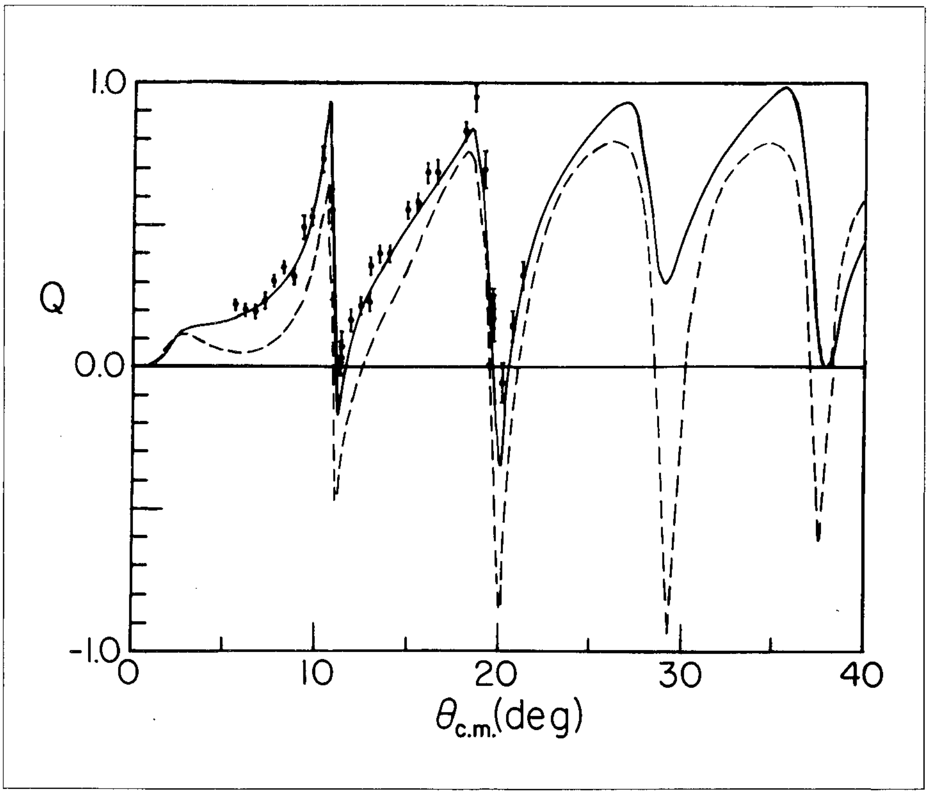
WORKSHOP
Nuclear physics

A workshop 'Dirac Approaches to Nuclear Physics' was held at Los Alamos from 31 January to 2 February, the first meeting ever on relativistic models of nuclear phenomena. The objective was to cover historical background as well as the most recent developments in the field, and communication between theorists and experimentalists was given a high priority.

The programme was opened by Dirk Walecka of Stanford who outlined an approach to nuclear matter and finite nuclei. Walecka refers to this model as quantum hadrodynamics (QHD) because it assumes that nucleonic and mesonic, not quark, degrees of freedom are the ones relevant to nuclear physics. The first formulation in 1974 provided a simple and elegant picture of the saturation of nuclear matter as a relativistic phenomenon and stands as perhaps the most important antecedent to today's formulations, which have become much more comprehensive. Walecka concluded his presentation by showing how QHD could be extended in a natural way to include the quark gluon plasma as another, high density, high temperature phase of nuclear matter.

Gerry Hoffmann of Texas then presented an experimentalist's view, emphasizing the role played by the high precision Los Alamos proton-nucleus elastic scattering data taken with the High Resolution Proton Spectrometer (HRS) in the early 1980s. As Hoffmann pointed out, spin measurements at 500 MeV were originally made to 'calibrate' the standard non-relativistic theory which was expected to work very well at that energy. Surprisingly, the standard theory described the new data quite poorly and the lack of a satisfactory explanation caused considerable despair. In the meantime, Bunny Clark of Ohio State and her co-workers had been enjoying impressive successes with a phenomenological relativistic model of proton-nucleus elastic scattering. These successes prompted others, including Steve Wallace of Maryland, to develop a relativistic picture for elastic scattering in which ad-hoc potentials were replaced by potentials from nucleon-nucleon scattering data. As emphasized by Hoffmann, and by Wallace later, the extraordinary agreement between the parameter-free calculations and the Los Alamos data is largely responsible for the upsurge of interest in relativistic models. Wallace also discussed recent refinements of the model.

Extensions to inelastic processes exciting the target nucleus were discussed by James McNeil of



First measurement of the spin-rotation parameter Q for 500 MeV elastic scattered polarized protons on calcium 40 taken with the High Resolution Spectrometer at LAMPF. The data are compared with full relativistic (solid line) and non relativistic (dashed line) calculations.

Drexel and Ernest Rost of Colorado. These formulations are in their infancy but preliminary indications are that even the simple versions describe the data as well as more refined non-relativistic models. Gary Love of Georgia discussed the similarities and differences of the relativistic and non-relativistic models. McNeil also emphasized that the relativistic model of inelastic scattering facilitates the comparison of proton data with inelastic scattering data using other probes such as the electron. Wallace Van Orden of Maryland also covered electron scattering and concluded that no striking signatures of relativity were present in electron-induced proton knockout reactions.

John McClelland of Los Alamos presented an overview of the proton scattering measurements at Los Alamos, TRIUMF (Vancouver), and the Bloomington cyclotron. All three Laboratories are trying to measure full proton spin-transfer data using high resolution spectrometers equipped with focal-plane polarimeters. It is hoped that these new spin measurements for inelastic scattering will be as great a boon to theorists as the earlier elastic measurements.

New relativistic models of nuclear structure were discussed by Franz Gross of William and Mary and, as an extension of QHD, by Brian Serot of Indiana and Richard Furnstahl of Stanford.

David Sparrow of Pennsylvania spoke about relativistic models of antiproton-nucleus scattering and antiprotonic atoms. He and his colleagues have found that their relativistic treatment of antiproton scattering fits recent data from the LEAR ring at CERN. However, in contrast to proton scattering, the description is not substantially different from non-relativistic approaches.

The programme concluded with the only non-relativistic talk of the workshop. Nathan Isgur of Toronto discussed his investigation of the nucleon-nucleon interaction as derived from a non-relativistic quark model. This calculation involves solving the quantum mechanical six-body problem. The results displayed nucleons in the six-quark system of the deuteron. In addition to the clustering of quarks into nucleons, Isgur also found that the short range repulsion and intermediate range attraction of the nucleon-nucleon interaction appear naturally. In fact, with a one-pion exchange mechanism grafted on, his model gives an excellent account of the measured properties of the deuteron.

Sceptics of relativistic models were also heard. John Negele of MIT questioned why local meson fields are needed to describe the interactions of extended nucleons in nuclei and why relativistic effects should be significant in nuclear ground states where the characteristic kinetic energy is only 20 MeV. He pointed out that the theory should reflect that it is harder to connect the distributed quarks in an extended nucleon to an anti-nucleon than to connect a point electron to a positron, and emphasized the uncertainties in relativistic many-body calculations. He cautioned against taking the successes too seriously, since corrections in the nonrelativistic approach have essentially the same effect as relativistic models, and since extra terms are crucial for spin observables. On the other hand, he acknowledged that the relativistic approaches are interesting and that nuclear physicists are now asking many new questions. The successes were acknowledged and Negele emphasized that theorists should strive to identify new experimental signatures. He expressed his pleasure, shared no doubt by all participants, in taking part in a conference where new theoretical initiatives are so clearly and strongly stimulated by experiment.

Conference proceedings will be available from the Los Alamos Meson Physics Facility.

By Jim Sheepard and Olin van Dyck

Superstring fever

Mathematics and particle physics have often gone their separate ways in an attitude of mutual 'benign neglect', diverging in both methodology and language. This uncomfortable gap was bridged to a unique degree at the Argonne-Fermilab-Chicago symposium on Anomalies, Geometry and Topology, which took place at Argonne and the University of Chicago from 28-30 March, and which highlighted the new optimism in string, and particularly superstring, theories.

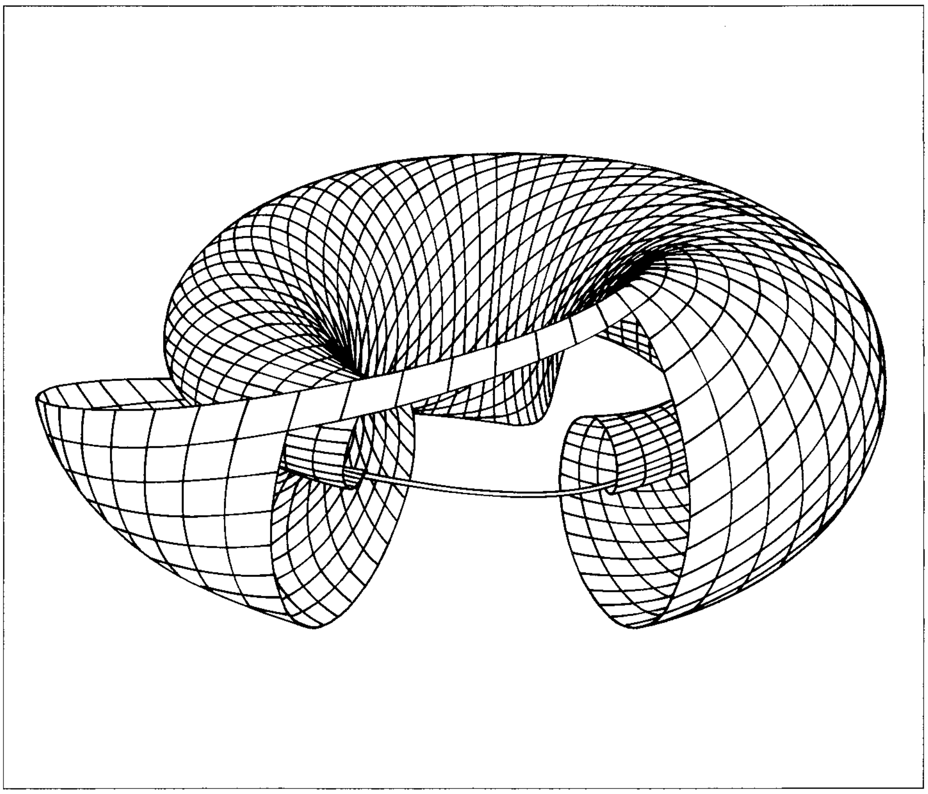
More than 300 theoretical physicists and mathematicians met together to discuss problems of current excitement and to report on recent progress in an atmosphere of remarkably unguarded optimism. In an overview, John Schwarz of Caltech described how superstring theories are now making dramatic strides towards achieving the ultimate goal of a unified quantum theory of all interactions including gravity.

Superstrings

As their name suggests, mathematical strings are extended objects, rather than points.

Supersymmetry is the new idea of pairing particles with supersymmetric partners. The known fundamental particles are conventionally divided into two kinds. First there are the fermions (quarks, electrons, etc.) which make up matter. Then there are the bosons (photons, gluons, Ws and Zs) which carry the forces between the particles. Supersymmetry says that each matter fermion must have a supersymmetric counterpart boson, and vice versa. Superstrings are the supersymmetric partners of conventional strings, and have ten dimensions. These ten dimensions then have to be collapsed down to four by 'compactification'.

The logo of the Symposium on Anomalies, Geometry and Topology, held at Argonne Laboratory and the University of Chicago in March.



Of course, superstrings are not isolated theoretical constructs but sit naturally at the peak of a large pyramid of theoretical concepts developed during the past few years, none seeming to be the whole truth but each having elements of formal beauty and aspects of physical reality. Several speakers at the Symposium expressed the opinion that with the arrival of superstrings, winning the theoretical jackpot is no longer a dream.

A unifying theme of the Symposium was the mathematical discipline of topology, which has intrigued particle theorists for a long time. However in the last few years the general relevance of topology to the understanding and computation of so-called 'anomalies' has become much more apparent. Anomalies are subtle violations in the fundamental symmetries used to build the gauge field theories describing the forces of Nature. Arranging for these anomalies to cancel is important in quantum field theories. However anomalies have much broader implications. Most recently they have played a crucial role in developing the new versions of the quantum string model. The mathematical structure of anomalies and the new developments in superstring theories dominated discussions at the Symposium.

Anomalies were discovered 'long ago' by Jack Steinberger when he was trying to calculate the decay of the neutral pion into two photons, using the limited theoretical repertoire available at the time. Anomalies have since proceeded from protons to quarks to strings. Relatively simple calculations have led to precise theorems concerning fundamental physical processes. The original mathematical focus of anomalies concerned properties of Dirac (half-integer spin) operators and the related index ('handedness') theorems discovered by mathematicians M.F. Atiyah and M. Singer.

Very recently it has become possible to study anomalies using these powerful topological techniques. As a result, anomalies have been computed outside (as in Ed Witten's discrete gauge anomaly) the straitjacket of perturbation theory which for so long has hampered field theory; a variety of anomalies in different space-time dimensions were correlated using elegant differential geometry constructions; and several new ones, including the gravitational anomalies (the nonconservation of the energy-momentum tensor) were derived in a general context. This last development in turn proved crucial in computing a subtle gauge-gravitational anomaly cancellation in the intriguing superstring theory of J. Schwarz and M. Green. This recently discovered cancellation opened the door to the dramatic developments and intense activity which led to the new results reported at the Symposium.

While the Symposium concentrated on superstrings, there were also many other highlights. The intense level of interaction between mathematicians and physicists was certainly a notable feature. Atiyah remarked 'I used to think mathematicians and physicists were very different. Physicists were interested in four dimensions only and never in unusual cases while mathematicians were always interested in general numbers of dimensions and the unusual cases'. He noted that three branches of mathematics — index theorems, complex manifolds, and Kac-Moody algebras — are all playing a role in current string theory. He also traced the history of anomalies in relation to the index theorems, and gave a general discussion of mathematical ideas (spectral flow) needed for the new physics applications.

Mathematician I. Singer delivers his plenary talk. The Symposium succeeded in getting mathematicians and physicists to talk the same language.

A major focus of the Symposium was the mathematical structure of anomalies, which provided an interesting point-counterpoint between physicists and mathematicians.

Ed Witten presented an analysis of global (rather than local) anomalies which could provide additional restrictions on the theories. He showed that these do not apply to the superstring theory but may be important for the 'compactification' of the extra dimensions of the theory. Roman Jackiw summarized topological aspects of anomalies in defining quantum gauge field theories.

J.R. Schrieffer provided the condensed-matter physicist's viewpoint, and reported on some examples (such as the solitons of polyacetylene or the fractional charges of the quantum Hall effect) which are actually observed. His talk showed that here indeed was real physics. (Fractional charges are a characteristic fingerprint of anomalies).

In a somewhat different vein, Gerard 't Hooft presented his work on black holes and argued that a new physical picture of the 'inter-

Organizers Bill Bardeen (Fermilab) left, and Alan White (Argonne) resplendent in Symposium tee-shirts. Also on the organizing committee were P. Freund and Y. Nambu of Chicago and E. Braaten of Northwestern University.

(Photos Argonne)

ior' of a black hole may be necessary for a consistent interpretation of Hawking radiation. He also took on the role of devil's advocate in the evening panel discussion by posing the questions asked by the 'average' physicist when first exposed to string ideas.

This Symposium may well be remembered as the first meeting where superstring physics emerged as a theme for the entire physics community. Like many other successful theories, strings started on the wrong track. The electroweak gauge theory, for example, stemmed from the monumental efforts of Yang and Mills who some twelve years previously had tried to develop a formalism for strong interactions.

String theories were formulated in 1970 by Y. Nambu and others as an elegant codification of the dual resonance structure of the strong interaction mechanism. Other attempts followed, but it soon became clear that the fundamental string theory could not be regarded as a satisfactory model of strong interactions.

To compress unwanted dimensions, the work of Kaluza and Klein, carried out 65 years ago, was resurrected. Then supersymmetry appeared on the scene (see the article by Bruno Zumino in the January/February 1983 issue, page 18). But strings languished in the wilderness. They seemed to be without physical applications.

In 1974, J. Scherk and John Schwarz decided to apply strings to a totally different problem, the quantum theory of gravity. The relativistic string contained a massless, spin two excitation which was no good for strong interactions but could be identified as the graviton, the quantum of the gravitational field. The simplest terms for calculating the scattering of this massless quantum were shown to agree with those derived from Einstein's theory of gravity.

In 1976, F. Gliozzi, Scherk and D. Olive realized that fermionic strings could produce a supersymmetric theory in ten dimensional space-time. Superstrings were born. Their properties suggested that superstring theory might succeed where field theory had failed. A complete string theory is now envisaged as including all interactions of the universe — seen and unseen.

The breakthrough achieved in superstring theory and the impact of the Symposium can perhaps be summarized by the following comments. Mike Green remarked 'I feel the symmetry groups found for the superstring are very important but I am not yet convinced that one particular superstring theory is correct'. Ed Witten commented 'this was the first widely attended conference since the (superstring) revolution. Before this meeting the significance of the developments had not really sunk in for many people'. David Gross expressed the greatest optimism and said 'it is remarkable how easily recognizable features of physics emerge from superstrings. While I don't believe we have yet found the right route, there appear to be no insuperable obstacles to deriving all known physics from the E8 x E8 heterotic string'.

From A.R. White and C.K. Zachos, Argonne, and W.A. Bardeen, Fermilab.

LEAR looks ahead

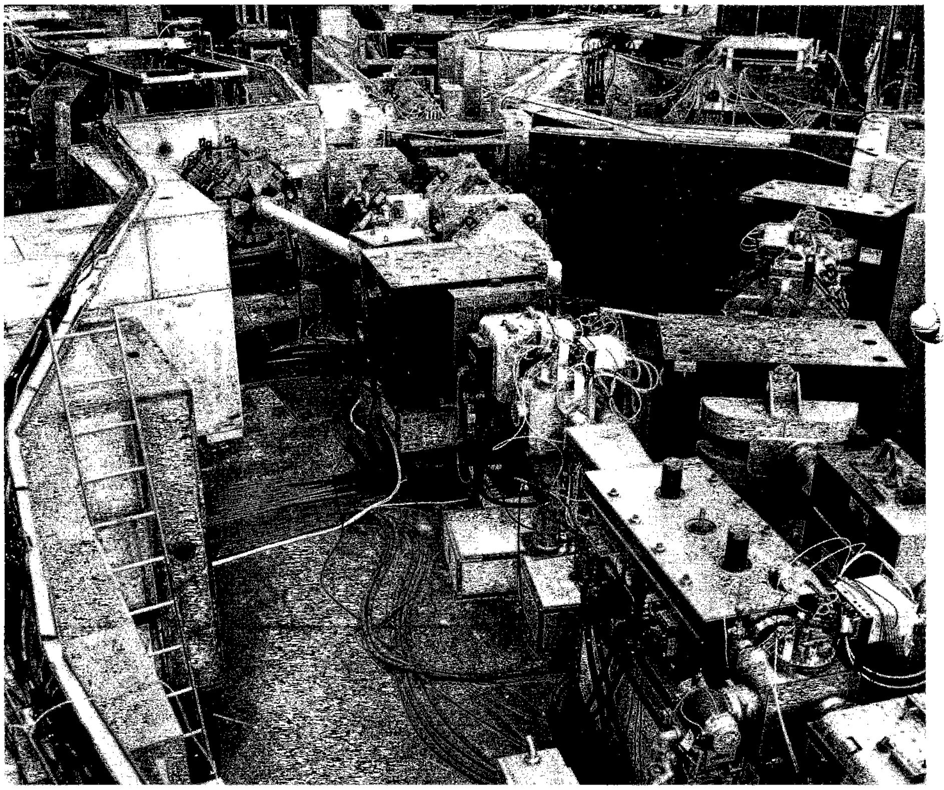
From 19 to 26 January in Tignes in the French Alps, 180 members of CERN's newest physics community met to review progress and discuss plans for the future. These physicists use the LEAR low energy antiproton ring which came into action in 1983 and whose unique low energy beams have attracted an unanticipated level of participation from all over the world.

In February 1984, construction began for CERN's new Antiproton Accumulator (ACOL), which will complement the present Antiproton Accumulator (AA) ring. ACOL is designed to provide a tenfold increase in the rate at which the precious antiprotons can be collected (6 x 10^{10} particles per hour).

The Tignes meeting included reviews of the machine status in and around LEAR. Roy Billinge kicked off with a general survey of CERN's antiproton facilities, and Eifion Jones followed up with a progress report on ACOL. Construction should take a total of 3½ years and installation a further eight months, so that the machine in scheduled to be ready in 1987.

Attention then turned to LEAR itself. Pierre Lefèvre covered the current status of the machine, while Daniel Simon dealt with the experimental areas. At the moment, LEAR experiments are confined to the South Hall at the CERN Proton Synchrotron (which decelerates the antiprotons prior to injection into LEAR). To satisfy the big interest in LEAR, additional beamlines could be provided in the South Hall, and users are hoping to gain a foothold in other experimental areas.

Dieter Möhl described the technical aspects of future LEAR options such as internal targets, co-rotating beams of negative hydrogen ions and antiprotons, colliding proton and antiproton beams, and additional antiproton deceleration, and followed up with a design for a superconducting 'Super-LEAR'.



The beam switchyard at CERN's LEAR Low Energy Antiproton Ring. Ideas for the future of the very popular LEAR project were aired recently at a meeting at Tignes in the French Alps.

(Photo CERN 457.10.83)

Other talks covered control and diagnostic systems, cooling of circulating beams (with illustrations from other cooling rings) and ideas for cooling and deceleration of the extracted beam.

After the daily ration of machine sessions, attention turned to the wide variety of physics which has attracted so many users.

The first physics session was given over to nucleon-antinucleon interactions. As well as the important and still largely unexplored area of particle-antiparticle annihilations at low energy, talks covered resonance searches, proton-antiproton atoms, spin effects, elastic scattering, and the possibility of introducing the added attraction of antineutrons.

The spectroscopy session covered the mesons expected to be accessible in proton-antiproton annihilations at LEAR and Super-LEAR energies. New effects are observed at LEAR in meson production mechanisms from annihilations at rest, but so far there is no confirmation of 'baryonium' states (narrow resonances seen only in annihilation). Experimentalists are keen to dig deeper into the rich meson gold mine of annihilation, looking for glueballs (mesons made of gluons rather than quarks), hybrid quark/gluon mesons, and baryonium, using new detectors and new approaches (comparison of different angular momentum states in annihilation at rest, jet targets, polarization experiments, etc.). The recent investigation of charmonium (charmed quark-antiquark states) at the ISR using a gas jet target gives support to Pietro Dalpiaz' push for quarkonium spectroscopy at Super-LEAR energies.

In the sessions on rare decays, results on the annihilation into an electron positron pair, and charge-parity violation and the mysteries of the neutral kaon system got plenty of coverage. Here LEAR could play a vital role in testing ambitious new theoretical ideas, especially with the high intensities expected with ACOL.

In the antiprotons and nuclei session, clear results were presented from exotic atom spectroscopy, from scattering experiments, and evidence has been seen for annihilations of antiprotons both inside and on the surface of nuclei.

In the 'new ideas' sessions, proposals were aired to test the gravitational properties of antimatter, where it is important to check whether antimatter falls down, or whether it 'falls' up! Trapping of extremely low energy (almost stationary) antiprotons in magnetic 'bottles' were discussed, together with very high precision experiments. The idea of studying proton-antiproton atoms produced in flight was aired, and imagination went as far as considering the production and storage of antihydrogen (an antiproton nucleus with an orbital positron) — which would be the first example of the production of stable neutral antimatter.

The detector session began with a survey by chief detector guru Georges Charpak, who claimed 'the limitations of particle detectors are usually not solely intrinsic but are also determined by the nature of their interaction with the particles, the geometry, and the cost. Very often the advertised limits are illusory'. The unusual physics at LEAR is also acting as fertile ground for detector innovations.

Science transfer for development

by Abdus Salam

The author, who shared the Nobel Physics Prize in 1979 with Sheldon Glashow and Steven Weinberg, is founder and Director of the International Centre for Theoretical Physics in Trieste, Italy. A native of Pakistan, Abdus Salam has long advocated increased Third World participation in first rate scientific research. The article published here is extracted from a fuller text which first appeared in 'Third World Affairs 1985', published by the Third World Foundation for Social and Economic Studies, London.

Despite the recent realization that science and technology are the sustenance and major hope for economic betterment, the third world (barring a few countries — Argentina, Brazil, China, India...) has taken to science — as distinct from technology — as only a marginal activity.

This is also true of the aid-giving agencies of the richer countries, of the agencies of the United Nations and also unfortunately of the scientific communities of the developed countries which might naturally have been expected to be the third world scientists' foremost allies.

Policy makers, prestigious commissions (like the Brandt Commission), as well as aid-givers, speak uniformly of problems of technology transfer to the developing countries as if that is all that is involved. Very few within the developing world appear to stress that for *long term effectiveness, technology transfers must always be accompanied by science transfers;* that the science of today is the technology.

Science transfer is effected by and to communities of scientists. Such communities (in developing countries) need building up to a critical size in their human resources and infrastructure. This building up calls for wise science policies, with long-term commitment, generous patronage, self-governance and free international contacts. Further, in our countries, *Third World photographs by Gérard Bertin.*

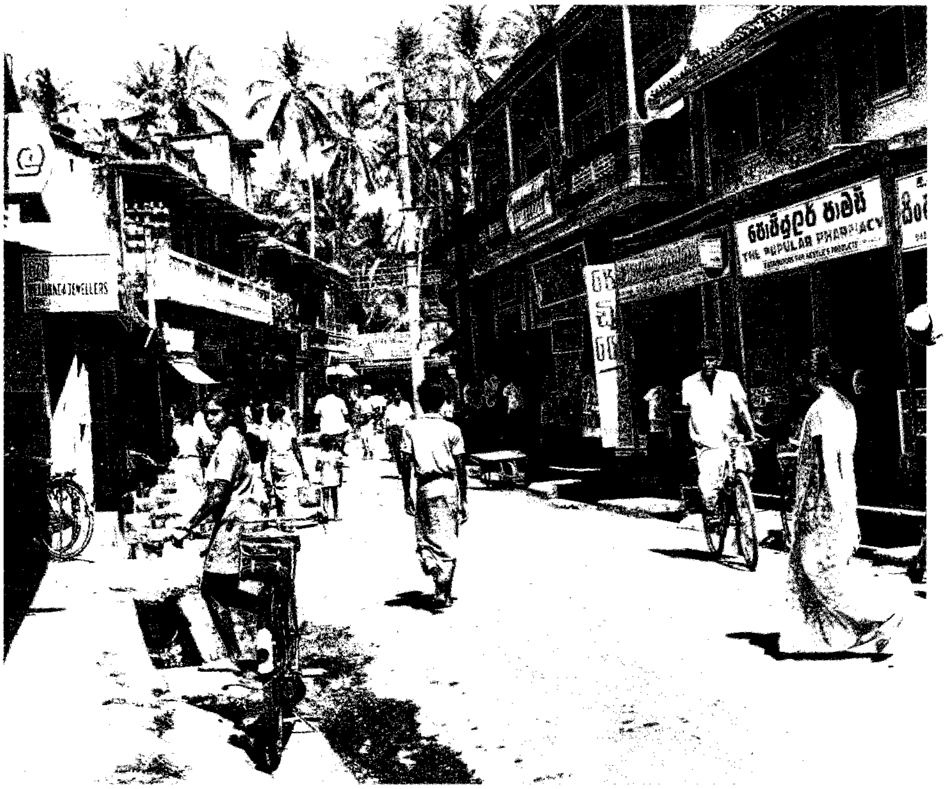
the high-level scientist must be allowed to play a role in nation-building as an equal partner to the professional planner, the economist and the technologist. Few developing countries have promulgated such policies; few aid agencies have taken it as their mandate to encourage and help with the building up of the scientific infrastructure.

Why Science Transfer?

First and foremost, we need scientific literacy and science teaching — at all levels — and particularly at the higher levels, for engineers and technologists. This calls for inspiring teachers, and no one can be an inspiring teacher of science unless he has experienced and created at least some modicum of living science during some part of his career. This calls for well-equipped teaching laboratories and (in the present era of fast moving science), the provision of the newest journals and books. This is the minimum scientific infrastructure any country needs.

Next should come demands on their own scientific communities — consisting of their own nationals — from the developing country government agencies and their nascent industries, for discriminatory advice on which technologies would be relevant and worth acquiring.

Still next, for a minority of the developing countries, there is the need for basic scientists to help their applied colleagues' research work. For any society, the problems of its agriculture, of its local pests and diseases, of its local materials base, must be solved locally. One needs an underpinning from a first-class base in basic sciences to carry through applied research in these areas. The craft of applied science, in a developing country, is much harder than the craft of basic science, simply because one does not have available expertise.



And finally, at the advanced stages of a country's development, is the need for basic scientific research for the riches it might unexpectedly yield for technology.

Consider some of the breakthroughs in physics. Faraday's unification of electricity and magnetism, accomplished in the last century, is certainly one of the most striking examples. When Faraday was carrying out his experiments — showing that while a *stationary* electric charge produces an electric force on another charge in its vicinity, a *moving* electric charge produces a magnetic force — no one could have imagined that this simple discovery would lead eventually to the whole of heavy electrical engineering.

Just to emphasise how relatively useless Faraday's work was thought to be by his contemporaries, consider the assessment by one of them, Charles Burney, of electricity versus music. 'Electricity is universally allowed to be a very entertaining and surprising phenomenon, but it has frequently been lamented that it has never yet, with much certainty, been applied to any very useful purpose... (while) it is easy to point out the humane and important purposes to which music has been applied... Many an orphan is cherished by its influence, and the pangs of child-birth are softened and rendered less dangerous...'.

After Faraday came Maxwell, Hertz, ..., leading to the marvels of radio, television and the modern communication systems, as well as X-rays.

To see how the climate has changed in developed countries since Faraday's time, when a hundred years after Maxwell, in the 1960s, my colleagues at Harvard, Glashow and Weinberg, and I independently took the next step of postulating a unification of two further forces of nature — of electromagnetism with the weak nuclear force of radioactivity — even the London 'Economist' took note and counselled perceptive businessmen not to ignore the likely economic consequences of this new development!

Last year, experiments at CERN provided direct confirmation of our theory. It did so with technical brilliance of the highest order. I am not suggesting that the developing countries should create accelerator laboratories like CERN. However, even if the 'Economist' may have been optimistic in its forecast of direct economic benefits of the new unification of forces, there is no question that these accelerator laboratories are founts of the highest technology in microelectronics, in material sciences, in superconductor as well as vacuum technology. I rejoice that Fermilab in the US has decided to set up a special Institute to make this area of science and related technology available to Latin American physicists. And CERN has made available to us — the Trieste Centre — the services of some members of their microprocessor team who have already conducted two six-week colleges on microprocessor physics and technology at Trieste at the highest level, for 250 of the developing world's physicists. During June 1984, this team held a four week microprocessor college in Sri Lanka for 62 physicists from South East Asia; to be followed in the coming years by four week colleges in China, Colombia, Kenya and Morocco.

Science in the Third World

I can illustrate the situation of scientific research in most of the third world from the example of my own country. In 1951 when I returned to teach in Pakistan after working at Cambridge and Princeton, I could call on just one physicist who had ever worked on a like subject. The most recent issues of 'Physical Review' available were dated before the Second World War. There were no grants whatsoever for attending symposia or conferences; the only time I did attend a conference in the United Kingdom I spent a year's personal savings.

After 30 years, the situation in Pakistan has improved. For a population of around 80 million now, there are some 46 research physicists, experimentalists and theoreticians in Pakistan's 19 universities. (On the US norms these numbers for this population base might have been one hundred-fold larger — i.e. five thousand!) These physicists still face the same problems regarding journals, publication dues and attendances at conferences; Pakistan is still not a member of the International Union of Pure and Applied Physics, since our science administrators do not think we can afford $1500 of dues; our physicists are still told that all basic science — even the segments necessary for 'applicable' physics — is a frightful luxury for a poor country. However, compared to Pakistan — and a privileged group of some 30 countries — the situation in the remaining 60 odd other developing countries is as stark as it was in Pakistan of 1951. First and foremost is the problem of numbers — of a critical size. The total number of research trained physicists in many of these countries can be counted on the fingers of one hand — the choice of subdisciplines in which they may have received training has been conditioned more by chance than design. They make up no communities.

The creation at Trieste of the International Centre for Theoretical Physics in the 1960s came about when some of us from the developing countries urged agencies of the United Nations, and in particular the International Atomic Energy Agency (IAEA) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), to assist in ameliorating this situation regarding theoretical physics research. We met with incomprehension even from some of the developed countries where physics flourishes.

In 1964, four years after the proposal was first mooted and after intense lobbying, the IAEA did agree to create a physics institute. UNESCO joined as equal partner with IAEA in 1970. The Centre has flourished since then, with the support of even those who doubted its validity at first. The bulk of its funds — now amounting to 4.5 million dollars — come from Italy, IAEA and UNESCO. Smaller ad-hoc grants have come from time to time from the United Nations Development Programme (UNDP), the United Nations Financing System for Science and Technology for Development, the United Nations University, the OPEC Fund, the US Department of Energy, the Ford Foundation, the Intergovernmental Bureau for Informatics (IBI), Canada, Kuwait, Libya, Qatar, Sweden, Germany, Sri Lanka, Netherlands, Japan and Denmark. Over the 20 years that the Centre has existed now, it has shifted from emphasis on pure physics towards basic disciplines on the interface of pure and applied physics — disciplines like physics of materials and microprocessors, physics of energy, physics of fusion, physics of reactors, physics of solar and other non-conventional energy, geophysics, biophysics, neurophysics, laser physics, physics of oceans and deserts, and systems analysis — this, in addition to the staples of high energy physics, quantum gravity, cosmology, atomic and nuclear physics and mathematics. Such a shift to the interface of pure and basic applied physics was made simply because there was not and still is not any other international institute responsive to the scientific hunger of developing country physicists.

Stages and Growth of Sciences in the Third World

Based on the experience gained in physics, we could divide the developing countries (other than Argentina, Brazil, China and India) into three categories. The first category would consist of nine countries — Bangladesh, Korea, Malaysia, Pakistan, Singapore and Turkey in Asia, plus Egypt in Africa and Mexico and Venezuela in Latin America. These countries have a population of physicists, currently approaching criticality, as well as a few centres of high quality for physics where teams of scientists can perform independent research. By and large, these centres are capable of awarding PhD degrees for physics within the countries themselves.

In the second category, there would be some 19 countries which consist of Iran, Iraq, Jordan, and Lebanon in the Middle East; Indonesia, Philippines, Sri Lanka, Thailand and Vietnam in South East Asia; Algeria, Ghana, Kenya, Morocco, Nigeria, Sudan, Tanzania in Africa; and Chile, Colombia and Peru in Latin America. These countries have a modest population of physicists though at any given university the numbers working are rather small. There are no research groups as such, though in some cases individuals are highly active. As a rule, PhD degrees are not awarded within the countries concerned. I mention these two categories, because with organized help from the rich world's scientific communities, these countries may take off in a short span of time.

The remaining 60 countries are below the 'poverty line' — some exceptionally bright individuals, whom we elect as associates of the Trieste Centre for the day when active research starts in their countries — but no organized physics research. I stress that these are impressions based on our experience. No other significance should be read into them.

Modalities for Growth of Sciences

In the end, the growth of science in our countries is our problem. But there is no doubt that outside help — particularly if it is organized — can make a crucial difference. First, regarding the work of individual physicists, this could take various forms: for example, the physical societies of developed countries could help by donating 200-300 copies of their journals to deserving institutions and individuals. They could waive publication and conference charges. In this context, the International Union of Pure and Applied Physics (IUPAP) has helped the Trieste Centre defray postage costs for distribution of old runs of journals; the American Physical Society has helped us with shared subscriptions for 31 physicists from 13 least developed countries.

The research laboratories and the university departments in developed countries could also help by building up links with their opposite numbers and by financing organized visits of their staffs to the institutions in developing countries. They could create schemes like the associateship scheme at the Trieste Centre (whereby a high-grade physicist working in a developing country becomes part of our staff by being accorded the right to come to us three times in six years), at least for their own ex-alumni.

Let me now come to the question of the long-term help the United Nations agencies can give in building up scientific infrastructure. I wish to emphasise the role of the modality I am personally most familiar with — international centres of research. There is no question but that the developing world needs today international research institutions, on the applied side, like the Wheat and Rice Research Institute; on the science side, centres like the International Centre for Insect Physiology (ICIPE) in Nairobi. Without internationalization, science cannot flourish; one cannot guarantee standards, guarantee keeping abreast of new ideas, guarantee a continual transfer of science by men who created it and who come to such centres, moved by their idealism.

Recently there have been created an international centre of mathematics at Nice, an international science centre in Sri Lanka, one in Turkey and another in Venezuela. An international physics centre, directed towards Latin America, was formally inaugurated in Colombia by its President some months ago. Also the United Nations Industrial Development Organization (UNIDO) is on the way to creating two international centres in the field of biotechnology, one located in Trieste and one in India.

Besides educational planning, besides help with development of scientific agriculture, I would also wish that the World Bank could take it upon itself to emphasise to the developing countries that the fastest route to financial prosperity today lies with areas of science — based on high technology — for example, microelectronics, computer software and the like, and that the major investment needed in these areas is investment in creating scientifically highly-literate manpower.

To summarize, my feeling is that almost every developing country has a scientific and technological problem which needs scientific expertise. I strongly feel that the United Nations system must take a lead with this legitimate movement towards internationalization of science within the developing world for the developing world.

In sciences, as in other spheres, this world of ours is divided between the rich and the poor. The richer half — the industrial North and the centrally managed countries, with an income of 5 trillion dollars, spends two per cent of this — more than 100 billion dollars — on non-military science and development research. The remaining half of mankind — the poorer South, with one fifth of this income of around one trillion dollars — spends no more than 2 billion dollars on science and technology. On the percentage norms of the richer countries, they should be spending ten times more — some 20 billions. At the United Nations-run Vienna Conference on Science and Technology held in 1979 the poorer nations pleaded for international funds to increase their present annual expenditure of 2 billions to 4 billions. They obtained promises, not of two billions, not of one billion, but only one seventh of this. As we know, even this has never been realized and the United Nations Funding System for Science and Technology for Development is without adequate means. Contrast this with the situation in the military sphere. Each nuclear submarine costs 2 billion dollars and there are at least 100 of these in the world's oceans. Five hundred centres like Trieste could be funded for a year for the price of one nuclear submarine.

Let me end by quoting from a great mystic of the 17th century — John Donne — a man who believed in the moral state of man and the international ideal: 'No man is an island, entire of itself; every man is a piece of the continent, a part of the main; if a clod be washed away by the sea, Europe is the less, as well as if a promontory were, as well as if a manor of thy friends or of thine own were; any man's death diminishes me, because I am involved in mankind; and therefore never send to know for whom the bell tolls; it tolls for thee'.

Last December at the Annual General Assembly of the USSR Academy of Sciences, Abdus Salam was presented with the Lomonosov Gold Medal, the highest annual award of the Academy.

A toast to CERN

Retiring CERN Council Delegate Alexis C. Pappas of the University of Oslo was in sparkling form for his adieu speech:

From times immemorial existed the valley of Nuclear Stability. But in the beginning darkness was upon the face of the deep. And nuclei were rushing madly over the slopes of the valley.

Then it was said:

'Let the radioactive nuclei be divided into neutron-rich and neutron-poor. Let the neutron-rich gather on one side of the valley and the neutron-poor on the opposite side.'

Then a command:

'Provide a dividing line between the neutron-rich and the neutron-poor.' Thus all stable nuclei turned up along the bottom of the valley of nuclear stability.

And it was good.

Many years later the scientists were commanded:

'Build equipment, develop methods and investigate the valley of nuclear stability.'

And it was done.

And scientists were rushing up the valley of nuclear stability investigating all stable nuclei. When this was done, they started to climb the slopes of the valley, but they did not reach high up.

Then it was said:

'Build accelerators and develop new techniques, this in order to attain the top of the slopes.'

And it was done.

Scientists climbed higher and higher without falling down. But some heard the voice: 'Look at the heavens.'

Alexis C. Pappas — 'let the neutron-rich gather on one side of the valley and the neutron-poor on the other side'.

(Photo Hans Chr. Erlandsen)

They so did, and found cosmic rays.

Others were anxious to look for the entrance to the valley.

They asked:

'Where is the entrance?' Then some farsighted men with open minds heard a whispering voice: 'Since time immemorial the site of Meyrin in the land of the Swiss has been empty and dark.'
And, by listening very carefully they were able to hear:
'But unknown to mankind the keys to the secrets of nature are buried deep underground, not accessible to man.'

And these farsighted men said:

'We will create a centre for nuclear research. This shall become a temple of science, not only for Europe, but for the world as a whole.'

And they continued:

'Let us build CERN.' And scientists and engineers from all over Europe followed the call. The roads to Geneva became crowded. And these settlers started to gather at the Site of Meyrin. They built accelerators: the SC and the PS. They built ISOLDE and reached some of the peaks above the valley. They also collided in the ISR.

And all was well.

But suddenly a new command was heard:

'Go deep underground!' And it came to pass that the SPS was built. And the scientists, like bees in a hive, continued to serve their queen accelerator.

People and things

Discoveries were made, frontiers were moved:

But the people said: 'Where are the secrets of nature?' And the engineers at CERN and the scientists made a mighty noise, and with the help of the administration convinced the Council of CERN to heed their demand: 'create antiprotons.' and 'let protons and antiprotons collide, and see the fruits.'

And so they did.

And lo, there was one of the secrets of nature. And in triumph they came to Stockholm, in the land of the Swedes.

But CERN will not rest on its laurels.

They ask already:

'Where are the other keys to the secrets of nature?' and 'How to find these keys' Answers are suggested. Some may be right, Some may be wrong, but Seek and you will find!

At CERN's laboratories and accelerators you find a strange class of mortals, impelled by an almost insane impulse to seek their pleasures among protons, antiprotons, neutrinos and antineutrinos, strange particles, quarks and antiquarks, relics of creation itself.

These people will, if the CERN member states allow, dig further and further into the secrets of nature and one day find the next key to the secrets of nature.

Therefore, ladies and gentlemen; A sixfold toast to CERN and its excellent staff, to this Temple of the Future, to the wealth and welfare of fundamental research, to new successes of the international collaboration of Science, to all scientists using the CERN facilities, to the excommunication of national prestige here at CERN.

On people

CERN theoretician John Ellis, 38, has been elected a Fellow of the prestigious Royal Society of London.

Among the distinguished scientists who received the US National Medal of Science, the highest scientific honour accorded by the US Government, this year were Maurice Goldhaber of Brookhaven, Frederick Reines of the University of California at Irvine, and Bruno Rossi of MIT.

The Center for Theoretical Studies at the University of Miami has awarded its annual J. Robert Oppenheimer Prize to John A. Wheeler of the University of Texas, Austin.

The American Association of Physics Teachers' Oersted Medal goes to Sam Treiman of Princeton.

Dirac medal

To honour one of the greatest physicists of the century, who died last October, and a staunch friend, the International Centre for Theoretical Physics in Trieste has announced the Paul Adrien Dirac Gold Medal Award, to be given annually for highest achievement in theoretical physics. The 1985 Selection Committee consists of Stig Lundqvist of Goteborg, Robert Marshak of Virginia Polytechnic, Abdus Salam (Director of ICTP Trieste), Julian Schwinger of UCLA, Leon Van Hove of CERN and Steven Weinberg of Austin. The 1985 announcement will be made on 8 August.

ICFA Meeting in India

The International Committee for Future Accelerators, ICFA, held its twelfth meeting at the Tata Institute of Fundamental Research, Bombay, on 10 April. ICFA approved the programmes of the four international Panels set up at its previous meeting in Leningrad (see March issue, page 64). The Panel on Superconducting Magnets and Cryogenics will organize a Workshop on the present state of the art in March 1986, probably in the US, while the Panel on New Accelerator Schemes will participate in the organization of a Conference on this topic already planned for the Autumn of next year, also in the USA. The next meeting of ICFA itself will be held in Brussels in October this year.

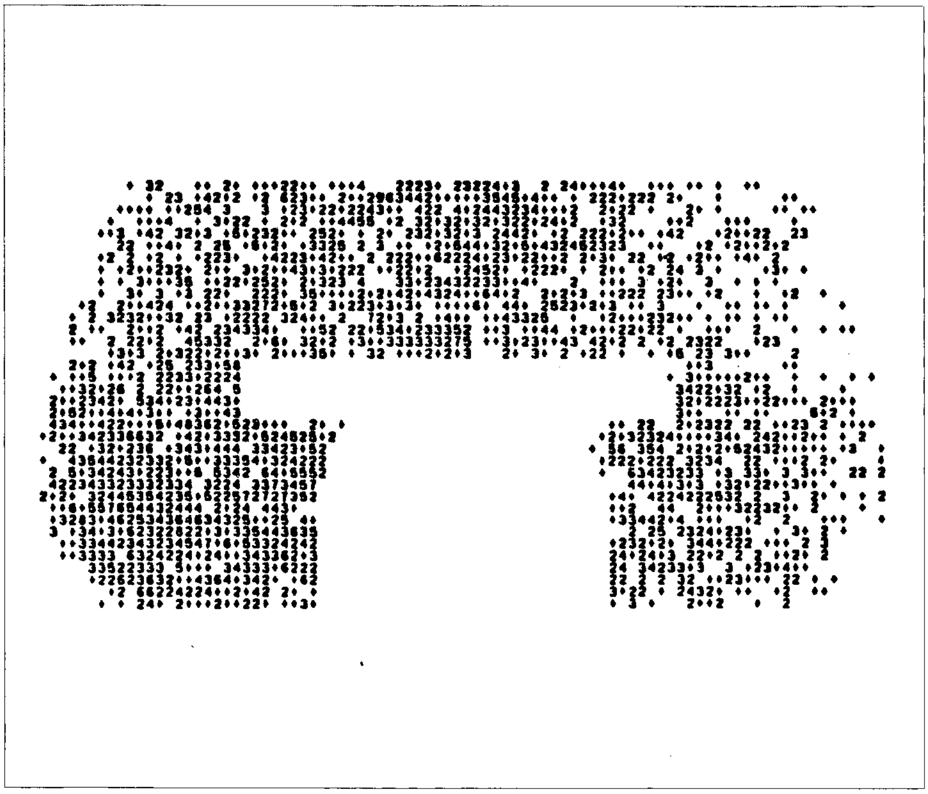
On 11 April a one-day seminar on Perspectives in High Energy Physics was held at the Tata Institute when some of the ICFA participants presented the accelerator projects of various regions of the world. In India itself, the Department of Atomic Energy has recently decided to create a Centre for Advanced Technology at Indore, Central India. The present plans are to build a 100 MeV proton linear accelerator, a synchrotron radiation source and, later, a 1 GeV proton synchrotron. In experimental high energy physics, a Tata Institute group is collaborating in the L3 LEP experiment at CERN and in an experiment at Fermilab.

Meetings

The CERN Accelerator School was greatly encouraged by the response to the General Accelerator Physics Course organized last year in collaboration with the Orsay and

Saclay Laboratories in France. This year, the School offers the Advanced Accelerator Physics course, organized jointly with the Rutherford Appleton Laboratory and the Department of Nuclear Physics, Oxford. This course, to be held in Oxford from 16-27 September, is the logical continuation of the earlier one and requires prior knowledge of accelerator physics. Further information from Mrs. S. von Wartburg, CERN Accelerator School Secretary, LEP Division, CERN, 1211 Geneva 23, Switzerland.

The next in the series of IUPAP International Conferences on Nuclear Physics will be held in Harrogate, UK, from 25-30 August 1986. Further information from Meetings Officer, Institute of Physics, 47 Belgrave Square, London SW1X 8QX, UK.



In bubble chamber experiments, neutrino interactions in the chamber walls are normally rejected. However by studying the tracks coming from these interactions, a neutrino 'tomograph' of the chamber can be obtained. The figure shows the distribution of neutrino events near the iron wall of the Fermilab 15 foot bubble chamber from an experiment by an Illinois Institute of Technology/Maryland/Stony Brook/Tohoku/Tufts group. A neutrino radiograph was obtained last year at CERN by the CERN/Dortmund/Heidelberg/Saclay neutrino experiment which clearly showed the iron walls of a liquid hydrogen target installed upstream of the detector (see July/August 1984 issue, page 239).

Trieste pays tribute to Alfred Kastler

On 11 March, the International Centre for Theoretical Physics (ICTP) in Trieste paid tribute to the memory of Alfred Kastler, Nobel Laureate for Physics 1966 and Chairman of the ICTP Scientific Council from 1970 to 1982, who died on 7 January 1984.

The ceremony took place in the context of one of the programmes initiated by him the cycle of extended courses on Atomic, Molecular and Laser Physics, this year seeing the sixth of the series. The addition of Atomic, Molecular and Laser Physics to the multidisciplinary curriculum of the ICTP was by itself an innovation; however the most striking feature had been Kastler's total intellectual and human commitment to the success of the first course. Despite all his other responsibilities, he directed the course from the first to the last day, listening to all lectures, taking part in all scientific discussions and taking an interest in young scientists from developing countries, not only in their individual difficulties relating to the course itself, but also in their day-to-day problems. Also he never missed the Italian lessons for course participants.

Another innovation of Kastler was the institution of courses in French for scientists from French-speaking African countries. This led to biennial Summer Schools on Physics Teaching and on Non-Conventional Energies. The cycle started in 1977 with the Physics Teaching School held in Trieste. The subsequent ones were held in Grenoble, France in 1979, Louvain-la-Neuve, Belgium in 1981 and Bizerte, Tunisia in 1983. Louvain-la-Neuve will again welcome the 1985 School. The schools on Non-Conventional Energy have been held at ICTP.

During the ceremony, ICTP Director Abdus Salam and S. Lundqvist, Chairman of the ICTP Scientific Council, together with some of Kastler's former collaborators, described his many contributions to science and the spread of scientific knowledge.

RUTHERFORD APPLETON LABORATORY

HIGH ENERGY PHYSICS RESEARCH ASSOCIATES

There are vacancies for Research Associates to work with experimental groups in high energy physics. Groups from the Rutherford Appleton Laboratory are working on experiments at CERN, DESY, SLAC and FERMILAB.

Candidates should normally be less than 28 years old. Appointments are made for 3 years, with possible extensions of up to 2 years. RAs are based either at the accelerator laboratory where their experiment is conducted, or at RAL depending on the requirements of the experiment. We have in addition home-based programmes on development of detectors, microprocessor systems, etc. Most experiments include UK university personnel with whom particularly close collaborations are maintained.

Please write for an application form quoting VN 303 to

Recruitment Office, R20,
Rutherford Appleton Laboratory,
Chilton, Didcot, Oxfordshire OX11 0QX,
ENGLAND.

THE UNIVERSITY OF GENEVA
has an opening for a

SENIOR RESEARCH ASSOCIATE

(Maître d'enseignement et de recherche)
in the Department
of Nuclear and Particle Physics

For this full time position experience in particle physics, data processing and experimental techniques is required.

The candidate will, for the time being, join a group performing an experiment at CERN SPS, to detect direct photon production.

The appointment may be effective as of October 1st 1986 or at any other date upon mutual agreement.

Applications should be sent before June 30, 1985, to the Director of

Département de physique nucléaire
et corpusculaire
Prof. E. Heer
24, quai Ernest-Ansermet
1211 Geneva 4,

from whom further information may be obtained.

PHYSICIST

The Medium-Energy Physics Group, Physics Division, announces an opening for a staff physicist. Must have an unusual potential for accomplishments in nuclear or particle physics as evidenced by publications, invited talks, and letters of reference. Experience in the medium-energy areas of meson or hypernuclear physics is desirable.

Applicant is expected to provide ideas, technical expertise, and leadership that will benefit both existing and future research directions of the group. Research will be based at the "Clinton P. Anderson Meson Physics Facility" (LAMPF) and other accelerator facilities which complement and extend Los Alamos capabilities.

Los Alamos, located in the mountains of northern New Mexico, provides an unparalleled technical environment. If you meet the above requirements and are interested, please submit a detailed resume, publication list, and three letters of reference to:

Joel M. Moss
DIV 85-CN Group P-2, MS D456
Los Alamos National Laboratory
Los Alamos, NM 87545

University of California
LOS ALAMOS

U.S. Citizenship Required
An Affirmative Action/Equal Opportunity Employer

KineticSystems Corporation
(KSC)
Challenges YOU

We have positions open for:

- ★ DESIGN ENGINEERS
- ★ SALES ENGINEERS
- ★ MARKETING DIRECTOR

If you are presently working in a laboratory, university, or research environment and have knowledge of CAMAC or FASTBUS, you are of particular interest to us. KSC uses the CAMAC and FASTBUS standards in designing and manufacturing computer-based data acquisition and control systems for the scientific, aerospace/defense, and industrial markets.

When you join KSC you will find yourself in a friendly, stimulating, and creative environment. If you have the background knowledge, we will help you acquire the training you might need to design, market, or sell KSC's products.

We offer you an excellent salary/benefits package.

Please send your resume in confidence to:

Laurie Pike
Administrative Vice President
KineticSystems Corporation
11 Maryknoll Drive
Lockport, IL 60441

An Equal Opportunity Employer (M/H/F)

Accelerator Physics Head

Brookhaven National Laboratory

Brookhaven National Laboratory seeks a scientist to establish and to head an Accelerator Physics Branch within High Energy Facilities. The successful candidate will be responsible for building an organization from a nucleus of accelerator physicists now on the staff. The new Branch will provide a coherent framework for theoretical and experimental studies on questions of general and long-term importance to accelerator design, as well as for answers to specific problems relating to the design of the Superconducting Super Collider (SSC), the Relativistic Heavy Ion Collider, the Alternating Gradient Synchrotron (AGS) Booster, the AGS Beam Stretcher, etc. The Head of the Accelerator Physics Branch will report to the Associate Director of High Energy Facilities.

Candidates should have a history of significant accomplishment in accelerator physics or related fields, and the demonstrated ability to organize and lead the work of experienced physicists, engineers, postdoctorals affiliated with the Accelerator Technology Fellows Program, and support staff. Applications and inquiries should be directed to: Ernest D. Courant, Chairman, Search Committee, Building 902A, Brookhaven National Laboratory, Associated Universities, Inc., Upton, Long Island, NY 11973. Equal opportunity employer m/f.

bnl
aui
BROOKHAVEN
NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES INC

The Max-Planck-Institut
für Physik und Astrophysik,
Munich,

is offering the position for a

Ph. D. Physicist in Elementary Particle Physics

We are looking for an experimental physicist with experience in high energy particle physics to participate in the analysis of an experiment on high energy muon proton scattering which will be performed with a vertex detector (streamer chamber) and a forward spectrometer at Fermilab.

The appointment will normally be for three years with a possible extension.

Applications (including curriculum vitae, list of publications and the names of two referees) should be sent as soon as possible to

Prof. N. Schmitz
Max-Planck-Institut
für Physik und Astrophysik
Föhringer Ring 6
D-8000 München 40, West Germany

---

esa

EUROPEAN SPACE AGENCY

The European Space Agency offers a

RESEARCH FELLOWSHIP IN X-RAY ASTRONOMY

in its Space Science Department (Astrophysics Division) situated at the European Space Research and Technology Centre (ESTEC), Noordwijk, the Netherlands.

Research and development of focal plane instrumentation for future generations of X-ray imaging telescopes is being undertaken, based on the Gas Scintillation Proportional Counter development pioneered within the group. Observational data from the EXOSAT mission are being analysed.

Applicants should have research experience in the development of instrumentation, either in the space field or in nuclear physics, and be conversant with associated electronic systems and data handling. Knowledge in astrophysics, while desirable, is not essential.

Applicants should also have a Ph.D. or equivalent degree. Good knowledge of English or French is required; some knowledge of the other language is desirable.

The fellowship will be for a period of one or two years.

Applications should be directed to the Head of Personnel, ESTEC, Postbus 299, 2200 AG Noordwijk, the Netherlands, including detailed curriculum vitae. For enquiries, phone 1719-83308

There's a new name in SCEMs for Mass Spectrometry...

...but it's a proven name in the world of advanced technology

In photomultipliers and discrete dynode electron multipliers we've been among the front runners since the 50s. Our expertise in solid-state technology and surface physics goes back just as far. We've been in single-channel electron multipliers since the early 60s. In glass technology our experience goes back to the turn of the century. And we have one of the largest privately funded research establishments in the world.

So we asked our research laboratories and our glass technologists to develop a range of SCEMs to meet the specific needs of Mass Spectrometry. SCEMs that would

- handle count rates up to 10^7 per second
- operate linearly in the analog mode at currents up to 5 µA and gains up to 10^7
- have a useful life in vacuum of at least 3000 µAh
- deliver 10 µA for 10 minutes without lasting gain degradation
- remain fully stable to atmospheric exposure and survive baking at up to 400 °C

That's only part of the specification we set them – and they met it in every detail.

So, if you're in Mass Spectrometry, either as an OEM or for the maintenance of existing equipment, we thought you'd be glad to know there's a new name in SCEMs. A new name for price competitive SCEMs with the quality you're entitled to expect from a proven name in advanced technology.

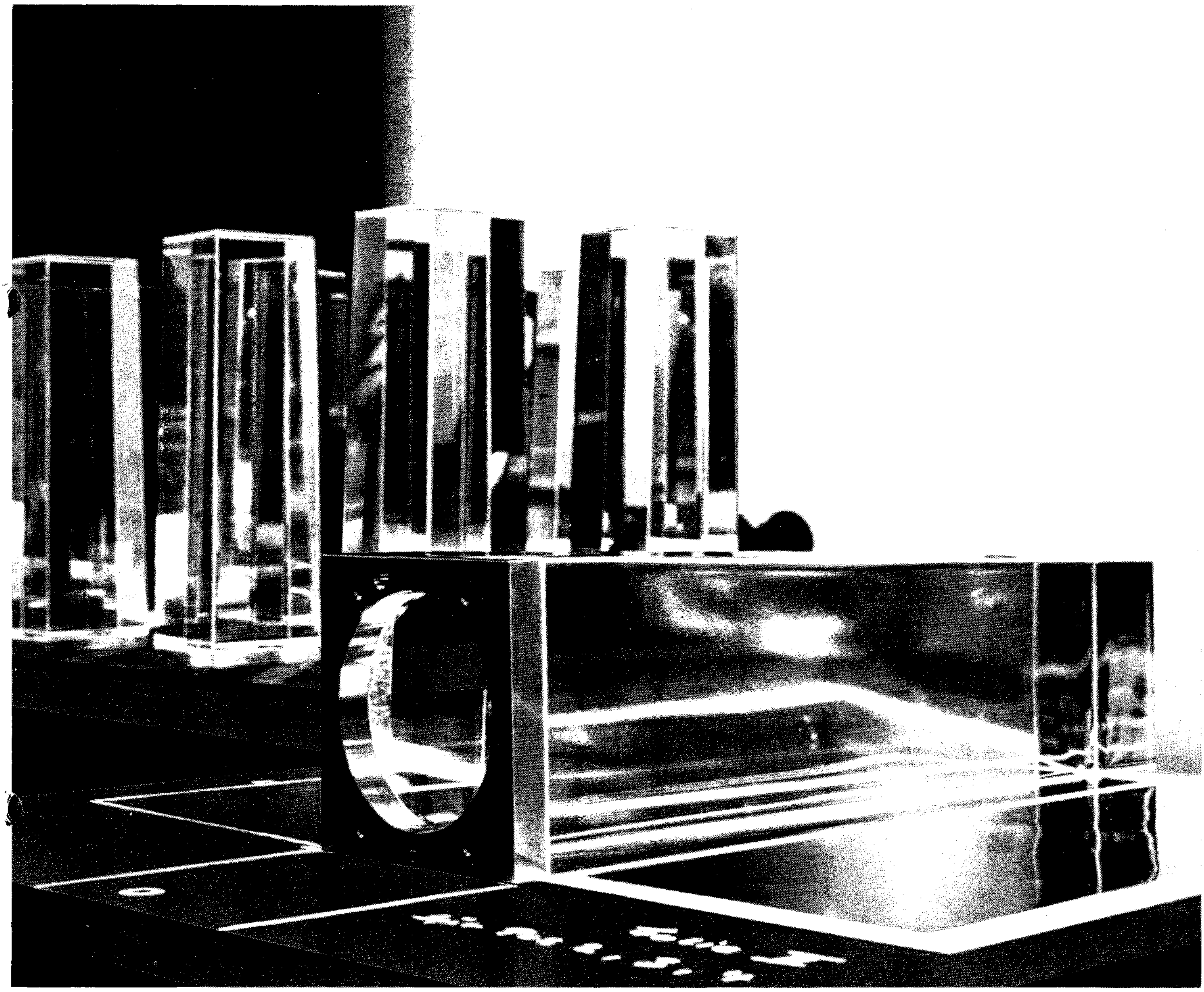
For more information, contact: Philips Electronic Components and Materials Division, 5600 MD Eindhoven, The Netherlands

Electronic
components
and materials

PHILIPS

Throughout the World of Quality Optics

SCHOTT-GLASS



In search of the structure of matter with optical glass from Schott

Schott's SF 57 glass possesses excellent properties for the detection of high energy particles in Cerenkov counters.

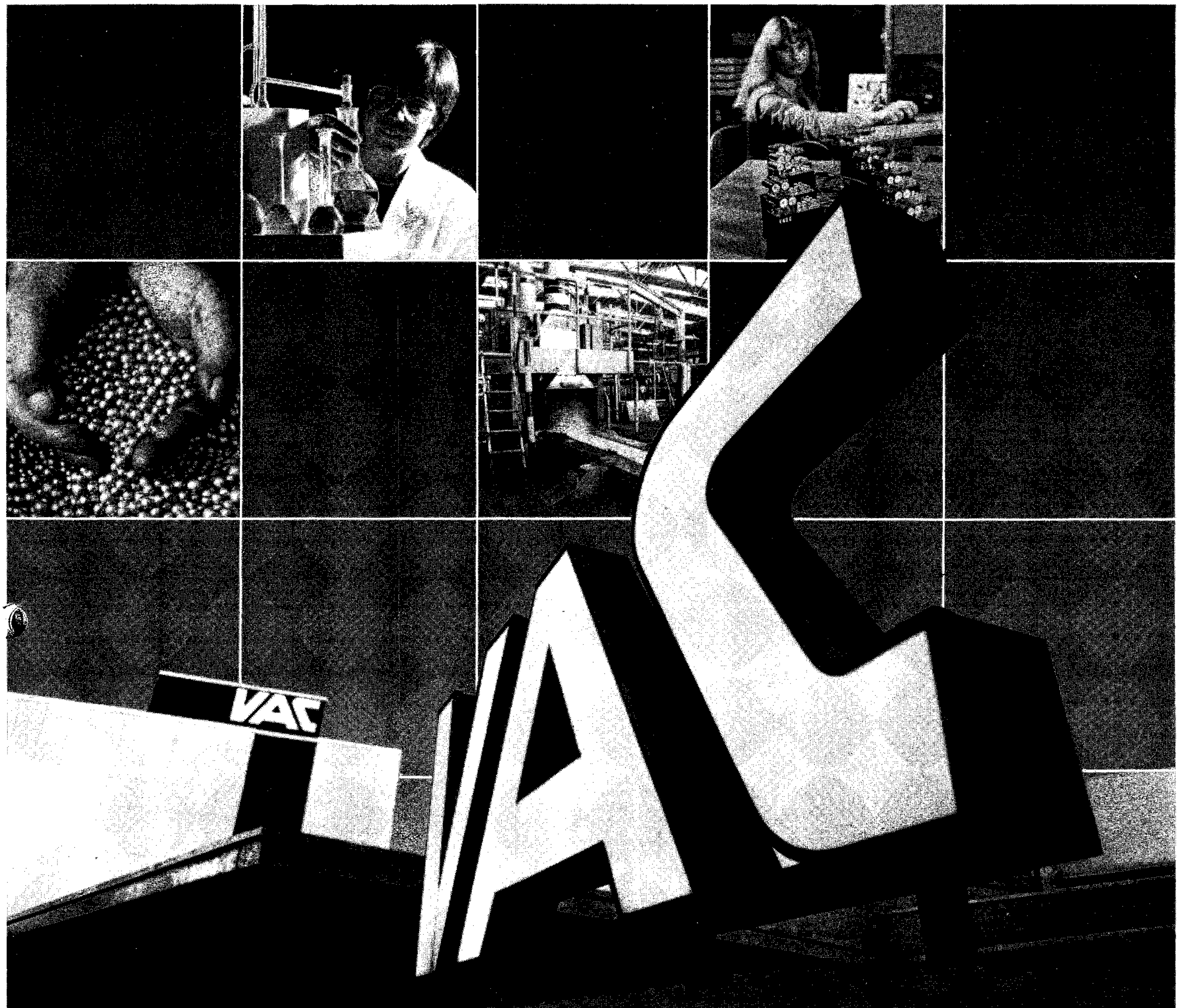
- The high internal transmittance in the blue-violet spectral regions – τ_i (400 nm) 0.30, τ_i (440 nm) $\geqq$ 0.80 at 100 mm thickness – permits evaluation of the more intensive portion of the Cerenkov continous spectrum at 400 nm.
- In addition to offering good transmission the high refractive index of 1.85 guarantees a low threshold energy for the detectable particles.
- The high density of $\rho = 5.51$ g/cm^3 results in a short radiation length of 15.4 mm which allows the glass block to be smaller thereby lowering costs.
- Tight dimensional tolerances and angular accuracy allow for simplified assembly.

We also supply scintillating glasses, fiberoptic products and optical filters.

SCHOTT

SCHOTT GLASWERKE
Optics Division
Product Group "Optical Glass"
Hattenbergstraße 10
D-6500 Mainz
Telephone (0 61 31) 66-0


borer
GPIB INTERFACE
N
LAM
SRQ
ATN
REN
BUSY
CONTR
TALK
LISTEN
IEEE-488
TRIGGER
TYPE 1124



THE RIGHT MATERIAL ENSURES PROGRESS

The foundation of all VAC alloys is base metal. A laboratory employing over 200 scientists, engineers and technicians provides the stimulus required for innovation. All our efforts are aimed at creating certain properties in the material, such as thermal, magnetic and/or electrical behaviour. These ensure the optimum function of a part, which naturally contributes to the effectivity of the end product.

The development of materials extends its influence beyond the field of technology. For example — high permeability magnetic materials, and the knowledge of how to handle them, have put VAC in a position to build a "walk-about" shielded room for the Physikalisch-Technische Bundesanstalt in Berlin, which to date has the highest shielding factor in the world. It provides facilities for research work on new diagnostic methods for heart and brain disease.

As a producer of materials working on the initial stages of development, VAC not only plan fo the immediate but also for the distant future. Our superconductors are one such product. Following successful participation in several major research projects our superconductor VACRYFLUX® is increasingly being used for more practical applications, e.g. in medical technology, and modern analytical techniques.

By comparison our amorphous metal VITROVAC® is a relatively new product combining the different properties of crystalline metals in an ideal manner. Today it represents a novelty, in a few years it will be accepted as the norm, as are superconductors and other special materials. In future these materials will all contribute to the slogan "The right material ensures progress" — VAC is already working on it.

VAC
VACUUMSCHMELZE

VACUUMSCHMELZE GMBH

Grüner Weg 37 · D-6450 Hanau 1 · West-Germany
Phone: (0 61 81) 362-1 · Telefax: (0 61 81) 362 645
Telex: 4 184 863

A-5e

WORLD
SCIENTIFIC
PUBLISHING

Superstrings: The First 15 Years of Superstrings Theories (2 Volume Set)
J.H. SCHWARTZ (Caltech)
Superstring unification is a fast developing field new to almost all theoretical physicists. This collection of basic pre-1985 references should be very valuable, the two volumes containing over 900 pages of reprints plus some introductory comments by J. Schwarz.
9971978660 (cloth) 950pp due Sept'85 £78.00/$89.70
9971978679 (paper) 950pp due Sept'85 £36.00/$41.40

Anomalies, Geometry and Topology: Proceedings of the Symposium on Anomalies, Geometry and Topology, Argonne, USA, March 1985
Edited by A. WHITE (Argonne)
These proceedings review the most important developments in Anomalies, Geometry and Topology. Perhaps this symposium may well be remembered as the first meeting where superstring physics has emerged as a dominant theme for the entire physics community. This book is a must for all theoretical physicists and mathematicians.
9971978695 540pp due Sept'85 £56.00/$64.40

Quantum Theory of Many Variable Systems and Fields
B. SAKITA (CUNY)
Based on lectures given for graduate students at City College, this is an ideal text for a one-semester course for Quantum Field Theory.
World Scientific Lecture Notes on Physics — Vol. 1
9971978555 (cloth) due Summer'85 £28.00/$32.20
9971978571 (paper) due Summer'85 £16.00/$18.40

Quarks: Frontiers in Elementary Particle Physics
Y. NAMBU (Chicago)
A historical perspective of Elementary Particle Physics, containing some of the most recent topics in this exciting field. Although aimed at people without knowledge of Elementary Particle Physics, experts will find it most stimulating.
9971966654 (cloth) 250pp due June'85 £32.20/$37.00
9971966662 (paper) 250pp due June'85 £18.40/$21.15

Supersymmetry and Supergravity: Collected Articles from 'Physics Report'
Edited by M. JACOB (CERN)
This new volume presents a detailed survey of supersymmetry and supergravity theory that covers important research and endeavour in this field over the past decade.
Contents: This volume consists of selected articles from the 'Physics Report' by M. Sohnius (1985); P. Fayet and S. Ferrara (1977); J. Ellis et al (1984); M. Haber and G. Kane (1985); P. Van Nieuwenhuizen (1981); H. Nilles (1984).
9971978741 (cloth) 600pp due Sept'85 £58.00/$66.70
997197875X (paper) 600pp due Sept'85 £26.00/$29.90

Marketed by
John Wiley & Sons Ltd
Baffins Lane, Chichester, Sussex PO19 1UD, England

CERN COURIER

A unique advertising medium for scientific and technical equipment

CERN COURIER is the internationally recognized news magazine of high energy physics. Distributed to all the major Laboratories of the world active in this dynamic field of fundamental research, it is compulsive reading for scientists, engineers, administrators, information media and buyers. Written in simple language and published simultaneously in English and French it has become the natural communication medium for particle physicists in Europe, the USA, the Soviet Union, Japan — everywhere where the fundamental nature of matter is studied.

Published from CERN, Switzerland, it also has correspondents in the Laboratories of Argonne, Berkeley, Brookhaven, Cornell, Fermi, Los Alamos and Stanford in the USA, Darmstadt, DESY and Karlsruhe in Germany, Orsay and Saclay in France, Frascati in Italy, Daresbury and Rutherford in the U.K., SIN in Switzerland, Dubna and Novosibirsk in the USSR, KEK in Japan, TRIUMF in Canada and Peking in China.

The annual expenditure on high energy physics in Europe is about 1000 million Swiss francs. The expenditure in the USA is about $ 400 million. There is similar expenditure in the Soviet Union.

CERN COURIER is the way into all high energy physics research Laboratories. If you have a market in this field, there is no surer way to make your products known than by advertising in CERN COURIER.

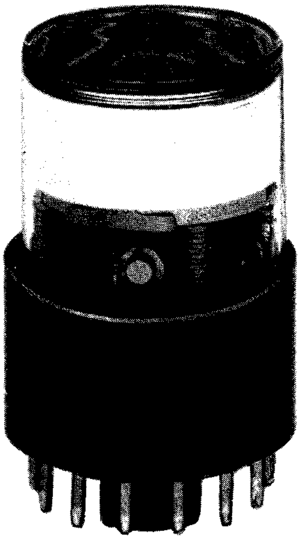
All enquiries to:
Advertising Manager
Micheline Falciola
CERN COURIER
CERN
CH - 1211 GENEVA 23
Tel. (022) 83 41 03
Telex 236 98

FOR HIGH ENERGY PHYSICS

UP TO 1 x 10^4 GAIN IN VERY HIGH MAGNETIC FIELDS

NEW FINE MESH TYPE
10 STAGE PMT

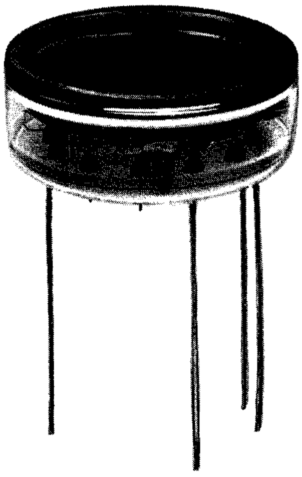
The new R2063 fine mesh tube performs very well in high magnetic fields to about 10K gauss. This unique 2" tube is the first high quality detector for High Energy Physics to overcome the gain killing effect of magnetic environments.



UP TO 15 GAIN IN HIGH MAGNETIC FIELDS

NEW MESH TYPE,
FLAT TRIODE PMT

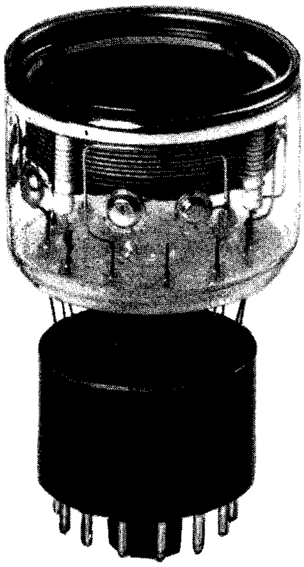
The R2046 mesh type tube provides enough gain (about 15) to preserve your signal while operating in magnetic fields of up to 10K gauss. The compact flat geometry with 3" diameter permits stacking large numbers of detectors with good volumetric efficiency.



HIGH PULSE LINEARITY AT HIGH COUNT RATES IN MAGNETIC ENVIRONMENTS

MESH DYNODE PMT

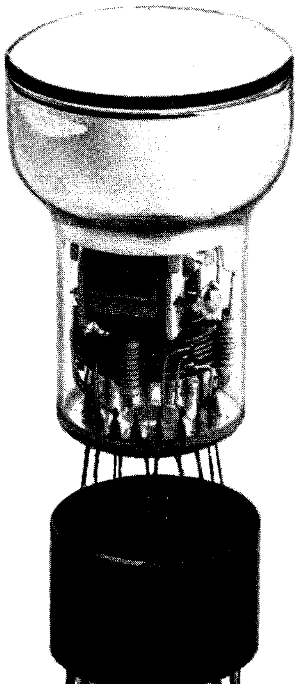
The R1652 combines superior performance in magnetic fields, good gain and high count rate linearity. This 3 inch diameter, head on tube with 9-stage mesh-dynodes uses a new proximity focus design for operation in magnetic fields up to a few hundred gauss.



HIGH ENERGY RESOLUTION AND GOOD PULSE LINEARITY

HYBRID MESH/BOX
AND GRID PMT

The R1911-01 uses box and grid dynodes at the front end for high energy resolution and new mesh type dynodes in the final stages for excellent pulse linearity. Pulse linearity of less than 2% deviation at 50 mA 1500 V is significantly better than standard PMT's. This 3" tube is ideal for physics and medical diagnostic applications because of its reduced length.



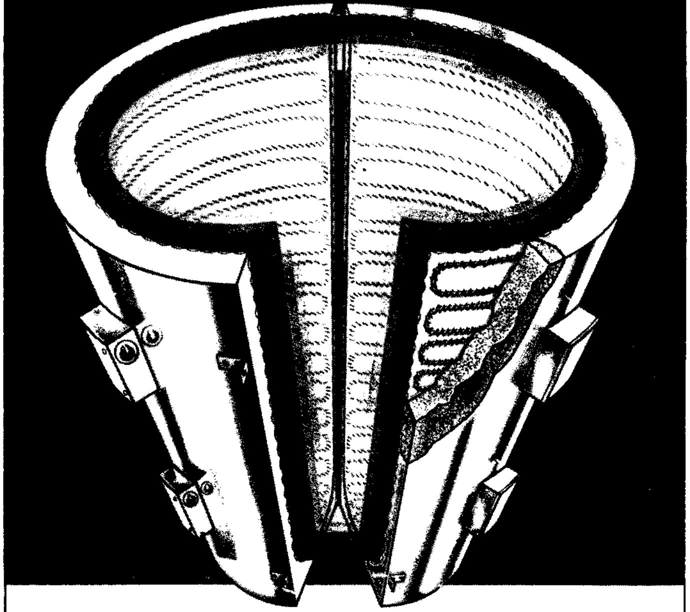
CALL OR WRITE FOR DATA SHEETS

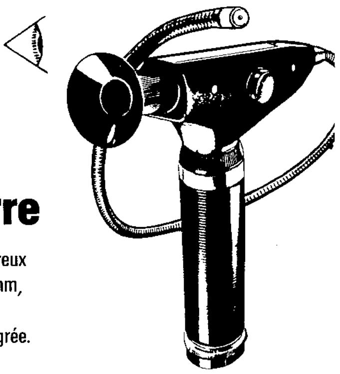
HAMAMATSU

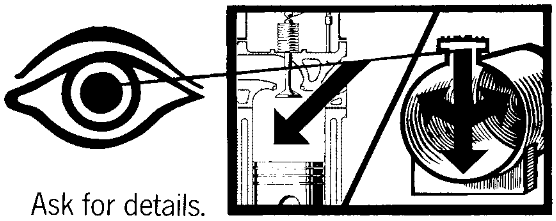
HAMAMATSU CORPORATION • 420 SOUTH AVENUE • MIDDLESEX, NEW JERSEY 08846 • PHONE:(201) 469-6640
International Offices in Major Countries of Europe and Asia.

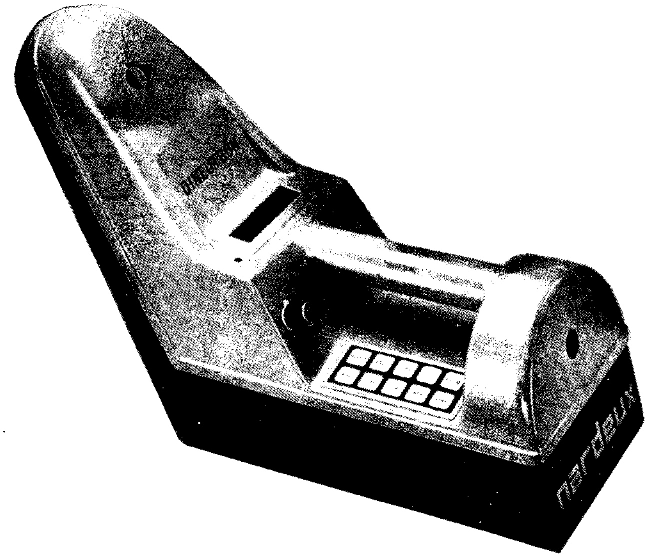
Hamamatsu Photonics K.K., 1126 Ichino-cho, Hamamatsu, Japan, 0534/34-3311 • Hamamatsu TV Europa GmbH, Postfach 1140, D-8031 Seefeld 1, W. Germany, 08152/7705

Netz
Beat Freq.
Lock
Frequenzstabilisierten He Ne-Laser

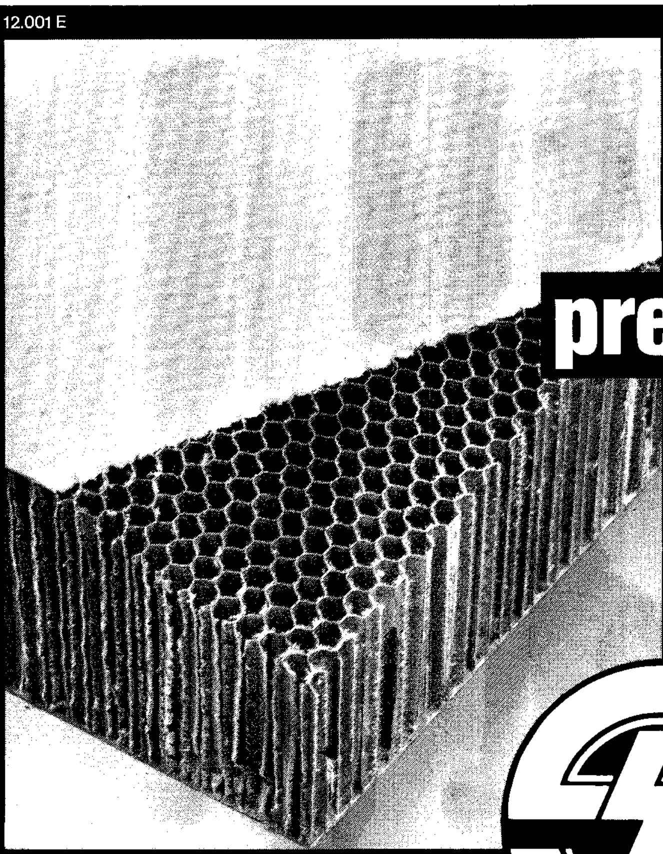








12.001 E



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

Sandwich prefab elements

of all types with various material combinations.

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

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

W&P

For multiple and extremely diversified applications: FRIALIT®

Electrical feedthroughs and insulating tubes

High vacuum proof and pressure resistant electrical feedthroughs and insulating tubes, produced in series or according to customers' specific requirements; for high voltage, high current and measuring techniques in industry and research.

The electrical feedthroughs can be delivered in non-magnetic version too.

We will be on show, at ACHEMA '85 Hall 9, stand BC 5-7

Distributed in Switzerland by:
Degussa (Schweiz) AG
Degussa (Suisse) SA
Letzigraben 89 · 8003 Zürich
Telefon 01-4913900 · Telex 822577

Friedrichsfeld

Friedrichsfeld
Division FRIALIT-DEGUSSIT
P.O. Box 7 · D 6800 Mannheim 71
Telephone (0621) 47040 · Telex 46310320

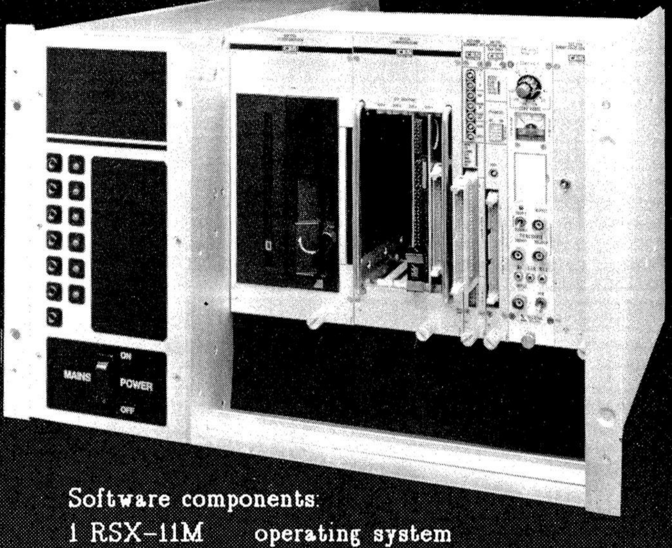
F 157/1 e


LeCroy
IBM

Creative Electronic Systems SA

CES

NOW, the 'STARBURST' MCA system.



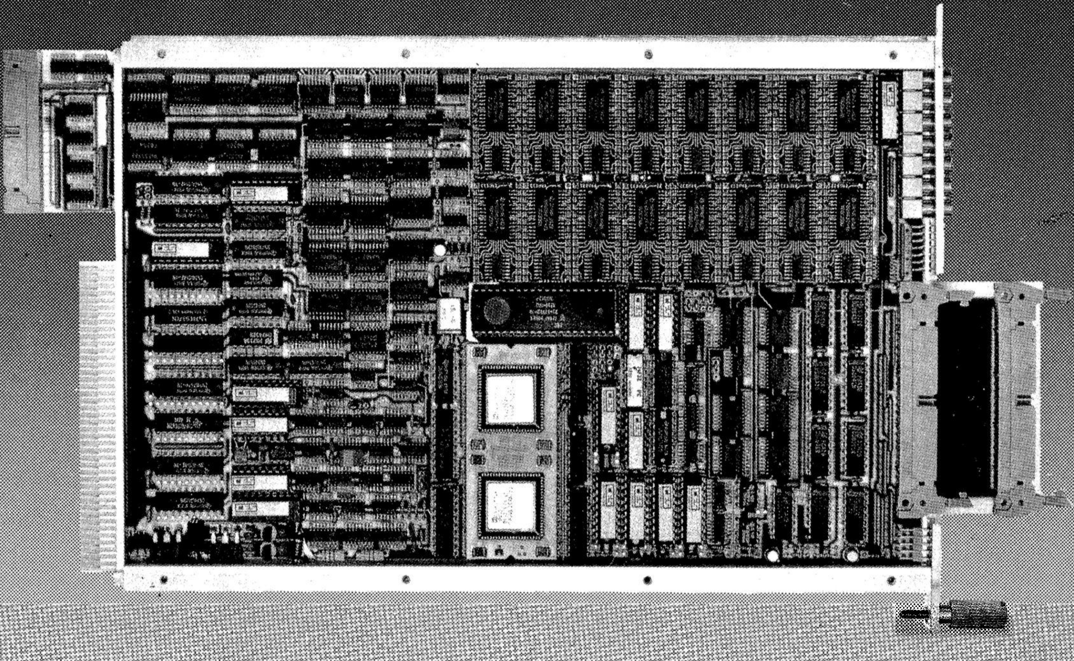
This complete Multichannel Analyser System offers a totally new concept, combining state of the art performance with ease of use and flexible extension. With the high processing speed of the ACC 2180, the complete quantitative Gamma analysis of a 4096-channel spectrum is realised in a few minutes.

Hardware components:

1	ADC 7423	ultra high speed spectroscopy ADC
2	HM 2161/S	64 Kword 1 Mhz HIST/LIST/MCS memory
3	MUX 1001	optional ADC multiplexer
4	MCR 2000	optional memory router
5	ACC 2180	single board computer; DEC J-11 CPU, console port, up to 512Kbyte cache dual-port memory, Q22-bus interface
6	BP 2134	mini-backplane; 4 dual-width Q22 slots
7	DSK 2135	disk subsystem with up to 40 Mb disks, and streaming-tape option
8	VT 24x	graphic terminal (monochrome or colour)
9	LVP 16	colour plotter
10	FX 100	printer
11	DEQNA	optional ETHERNET interface to VAX

Software components:

1	RSX-11M	operating system
2	FORTRAN77	with CAMAC acquisition library
3	CATY	high-speed CAMAC-BASIC
4	ACQUIRE	ADC data acquisition software
5	DISPL	display software
6	PLOT	PLOT 10 -based software
7	GAMMA	complete Gamma analysis
8	EXCHANGE	ETHERNET interface software



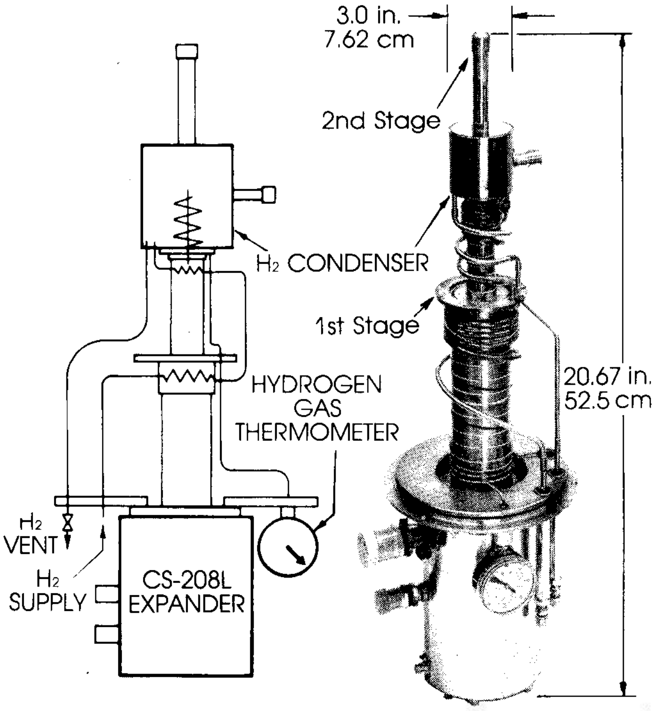
At CES, tomorrow's systems are available NOW

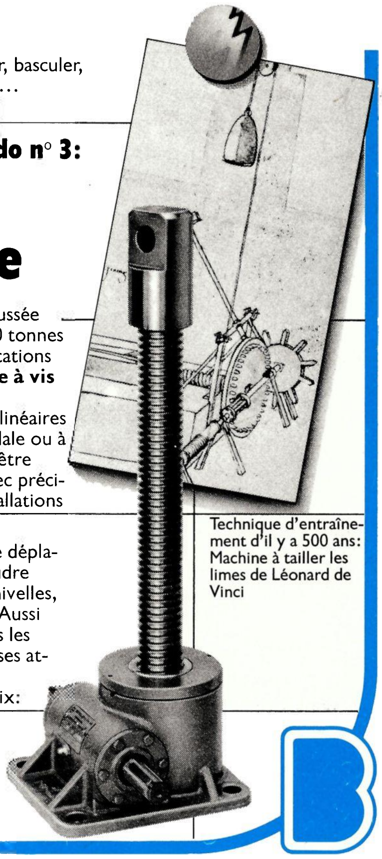
CES
CREATIVE ELECTRONIC SYSTEMS

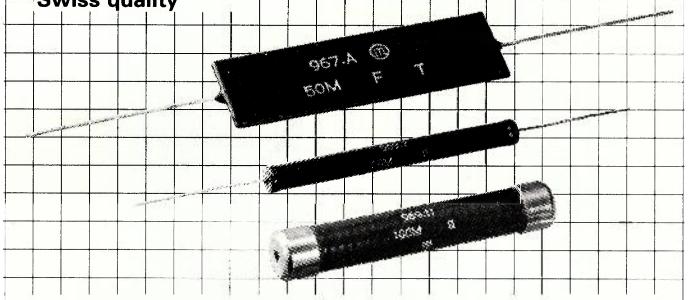
For more information contact us, or your local CES representative.
70, route du Pont-Butin Case Postale 122 1213 Petit-Lancy 1 Switzerland
Tel:(022) 92 57 45 Telex: 421320 CES-CH

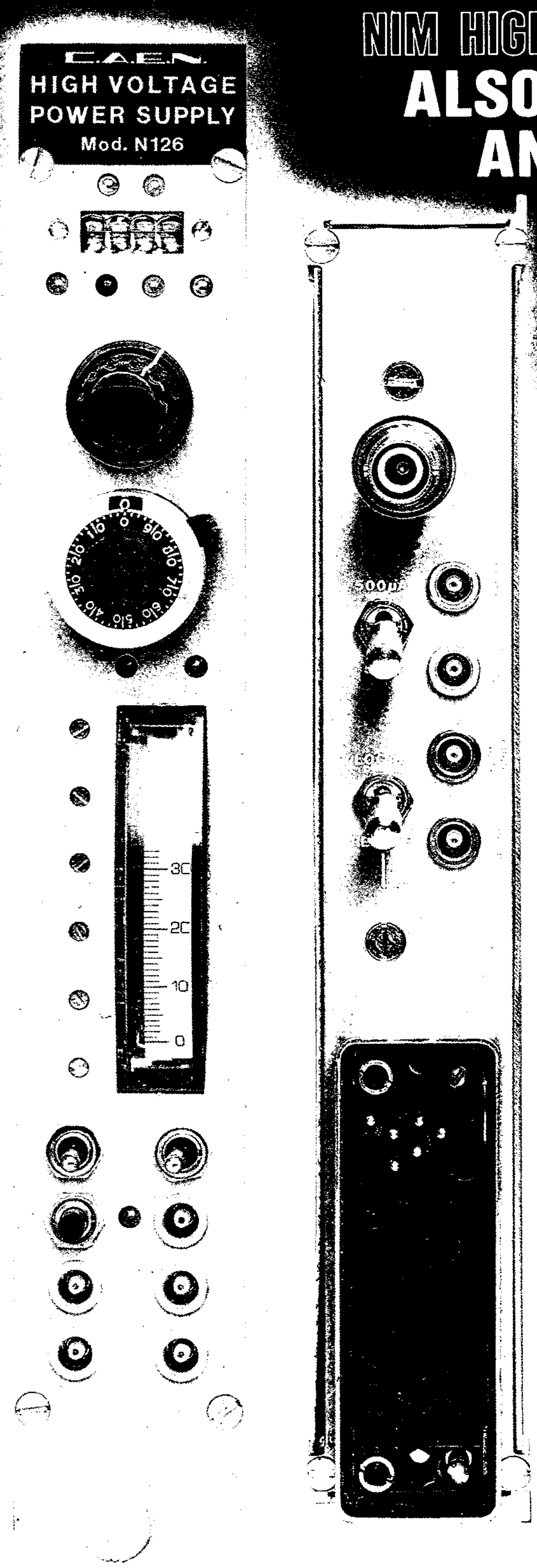
Germany:	SILENA	Tel:(06055)4021	North Germany:	PCP	Tel:(040)802046
North America:	BYTECH Eng. Vancouver	Tel:(604)9804131	Japan:	TOYO Corp.	Tel:(03)2790771
France:	INEL	Tel:(3)9563190	Italy:	SILENA	Tel:(02)7490565
England:	Nuclear Enterprises	Tel:(073)5212121	Netherlands:	Canberra Positronika	Tel:(040)416355

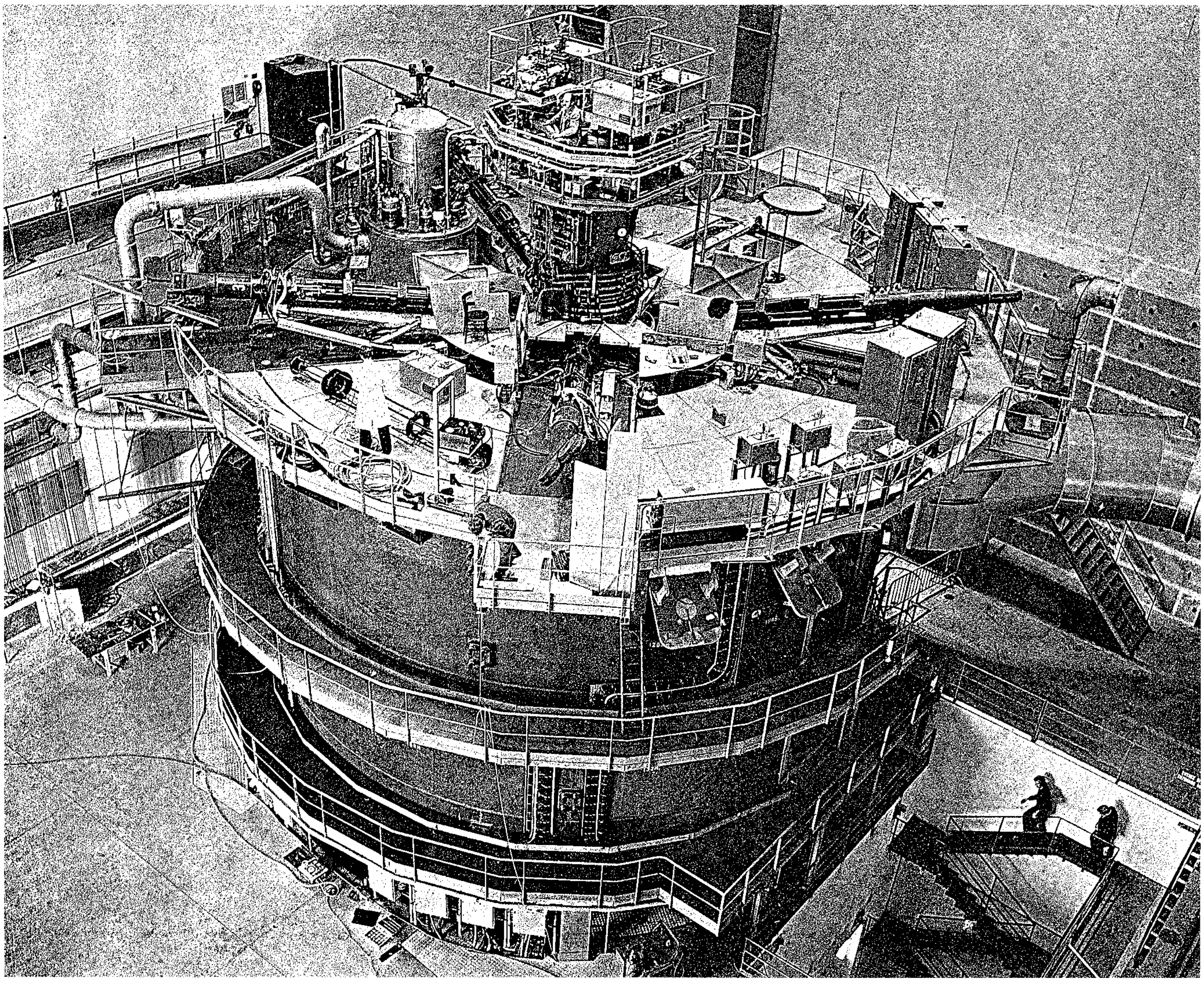
*PDP, Q22-bus are trademarks of Digital Equipment Corporation


3.0 in.
7.62 cm
2nd Stage
H_2 CONDENSER
1st Stage
HYDROGEN
GAS
THERMOMETER
20.67 in.
52.5 cm
H_2
VENT
H_2
SUPPLY
CS-208L
EXPANDER




967-A
50M
F
T


C.A.E.N.
HIGH VOLTAGE
POWER SUPPLY
Mod. N126

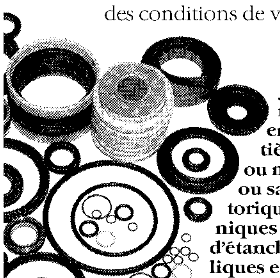


CERN Genève: BEBC. Grande chambre à bulles européenne. Dimensions du corps de la chambre: 3 m de hauteur, 3,7 m de diamètre intérieur, 39 000 litres de capacité.

Le plus petit de nos joints tient au moins 50 ans... et le plus grand résiste à un dosage d'irradiation 166 666 fois supérieur à ce qu'un être humain peut supporter.

Au CERN, à Genève, on accélère des particules à charge électrique jusqu'à la vitesse de la lumière. On ne peut le faire que dans des conditions de vide poussé. Les joints d'étanchéité de 7 m de circonférence dont sont dotées les chambres doivent donc présenter une précision et une qualité de surface élevées. Afin qu'ils puissent résister à un dosage d'irradiation à haute charge énergétique représentant 166 666 fois ce qu'un être humain peut supporter, nous avons conçu, chez Maag Technic, un mélange de caoutchouc tout à fait particulier.

Bien sûr, nous n'avons pas à résoudre des problèmes aussi ardus tous les jours. Parfois, il s'agit «simplement» de minuscules joints d'étanchéité destinés à des arroseurs anti-incendie. Quoi qu'il en soit, chaque joint doit répondre à des impératifs plus ou moins grands. Vous en trouverez chez nous un vaste assortiment. En plus, vous pouvez compter, sans aucune contrainte matérielle, sur nos conseils fondés sur des années d'expérience portant sur tout le spectre de la technique.



Joints d'étanchéité normalisés ou sur mesure, en caoutchouc, en matière plastique, textiles ou métalliques, à l'amiante ou sans amiante, etc. Joints toriques. Garnitures mécaniques FLEXIBOX. Bagues d'étanchéité. Joints hydrauliques et pneumatiques. Garnitures de presse-étoupe.

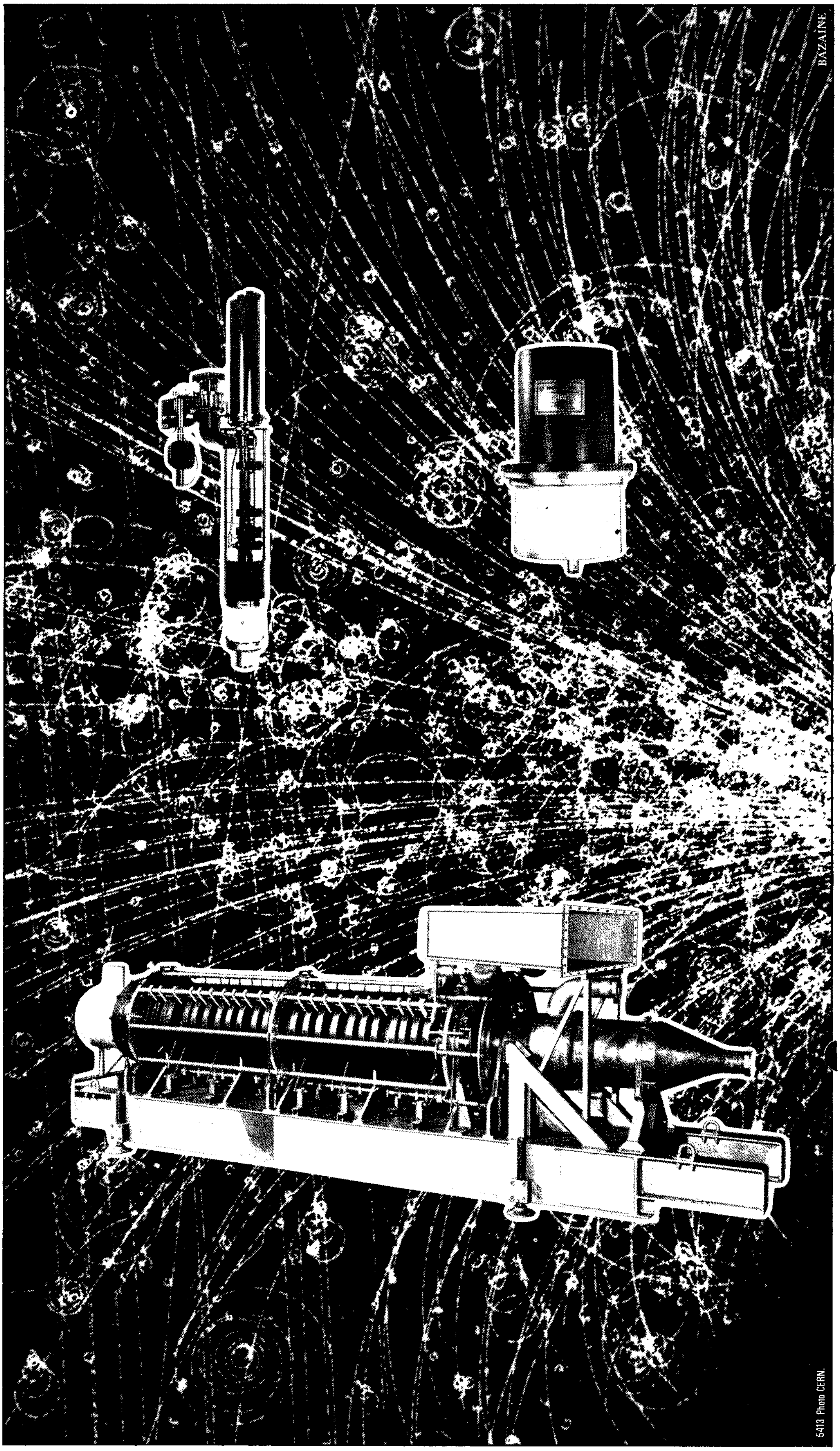
Maag Technic se fait fort de résoudre vos problèmes de joints d'étanchéité.

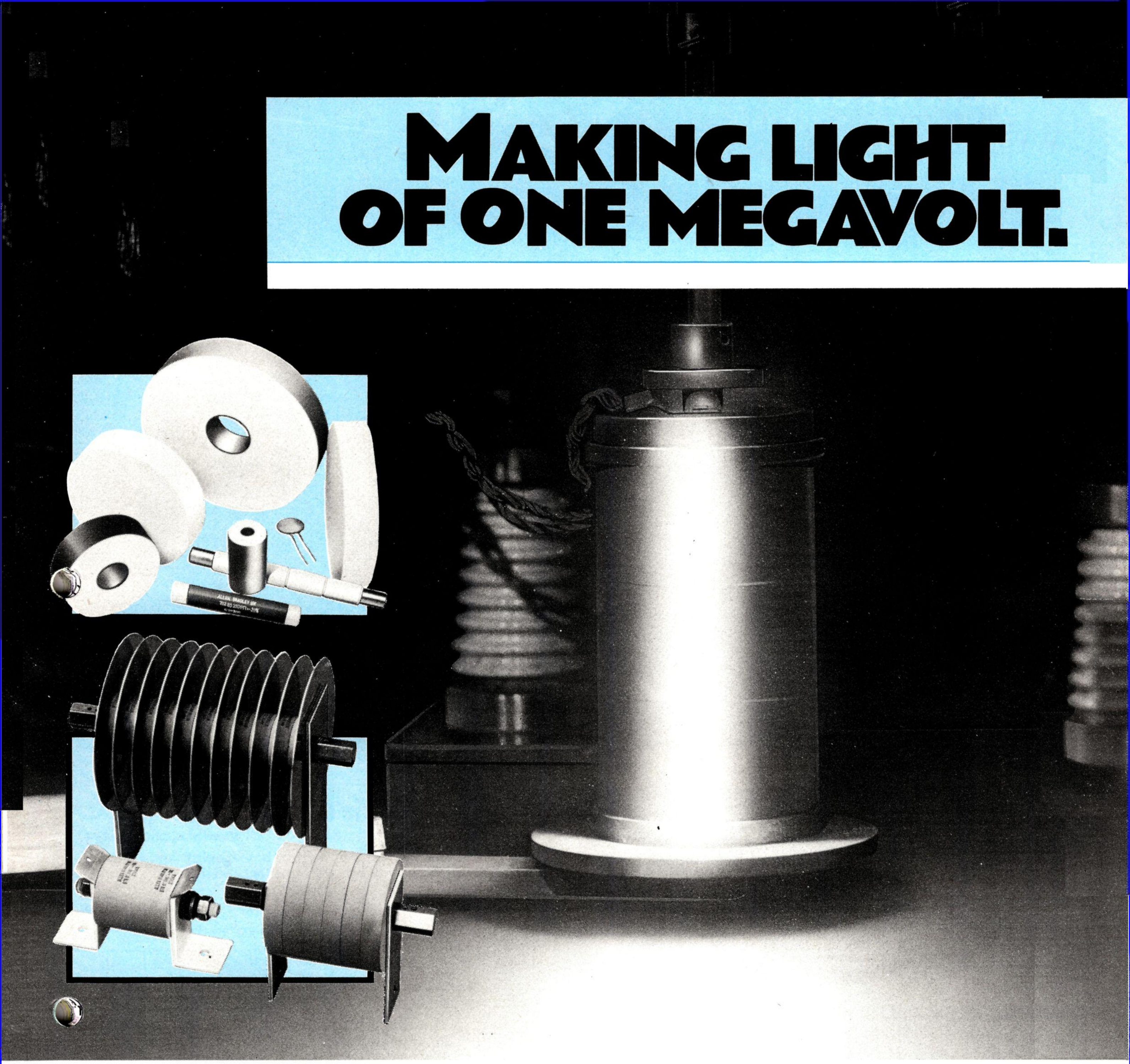
maagtechnic
CaoutchoucMaag

Caoutchouc et matières plastiques
Eléments d'étanchéité Technique de transmission Oléohydraulique
Pneumatique Graissage central
Protection de travail

AGENCE KLÖTI

Maag Technic SA, CH-1024 Ecublens, (021) 35 74 64 – Dubendorf – Berne-Wabern – Bâle – St-Gall-Neudorf


BAZAINE
5413 Photo CERN.



MAKING LIGHT OF ONE MEGAVOLT.

- **High Voltage** ● **High Energy**
- **Non-inductive** ● **Robust**
- **Easily Assembled Stacks**
- **Air, Oil or SF6 Environments.**

A comprehensive range of high transient powered Linear Ceramic Resistors, that make light of high voltage situations time after time in a diverse range of applications, such as switching resistors in air, oil and SF6 EHV Circuit Breakers, Dump and Dummy Loads, Impulse Generator Wave Shaping and Laser applications to name but a few.

TECHNICAL CHARACTERISTICS

Resistivity Range:	5 ohm cm to 25000 ohm cms
Bulk Density:	2.25 grams per cc
Specific Heat:	2 joules/cc/°C rise
Temperature Coefficient:	−0.05% to −0.15% per °C temperature rise, depending on resistivity value.
Voltage Coefficient:	Between −0.5 to −7.5%/kV/cm depending on resistivity.
Maximum Energy:	300 joules per cc (600 joules/cc infrequent)
Maximum Temperature:	150°C continuous (300°C infrequent)
Maximum Working KVrms/cm (Free Air):	$0.87 \times (\rho/t)^{0.3}$ ρ = Resistivity of 25 to 2500 ohm cms t = Time of 10 to 50 milliseconds
Maximum Working Impulse Voltage kVpk/cm 1/50 microseconds (Free Air):	$4.3 \times \sqrt[1.2]{\mathrm{Log}_{10}\,\rho/2.54}$ ρ = Resistivity 25 to 2500 ohm cms
Size - standard discs; (Standard Thickness: 25.4mm)	Diameter (mm) 32 51 76 94 111 127 152 Volume (cc) 17 41 85 153 224 297 430

ALLEN-BRADLEY ELECTRONICS

Edenbridge, Kent, TN8 5LY England. Tel: Edenbridge (0732) 866566. Telex: 957293

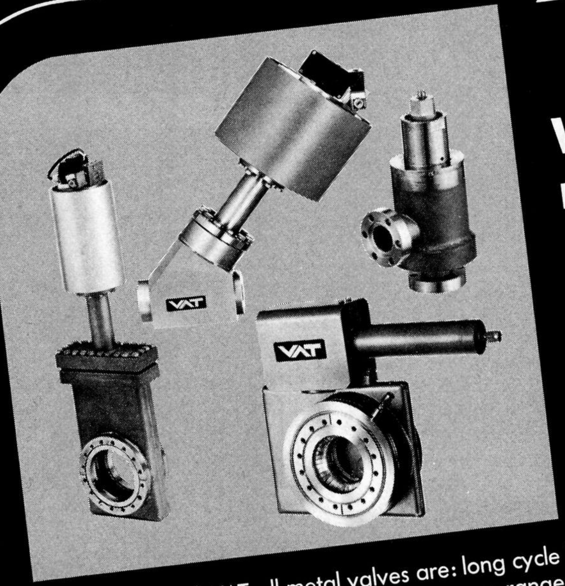
FRANCE: Allen-Bradley Electronics
23 avenue du Général Leclerc
92340 Bourg la Reine Paris
Tel: (1) 547.60.06 Tlx: 205465F

GERMANY: Allen-Bradley GmbH
Unternehmensbereich Bauelemente
Karl Hromadnik-Strasse 3 D-8000 München 60
Tel: (089) 8348056 Tlx: 0521 3066

ACHEMA 85
Frankfurt (Main), 9.–15.6.1985
Halle 8, Stand L 12

VAT

20 Years of VAT-Technics – for Research and Industry



VAT all metal valves – reliable and long cycle life

Our objective was to obtain greatest possible operating life on all metal valves. The most important criterion for this is a form-mating configuration of the seal partners whose shape does not change in use.
This has been realized. Many thousand VAT all metal valves in sizes 10–400 mm are successfully used all over the world – specifically in nuclear research that is in particle accelerators and fusion test installations (Tokamaks).

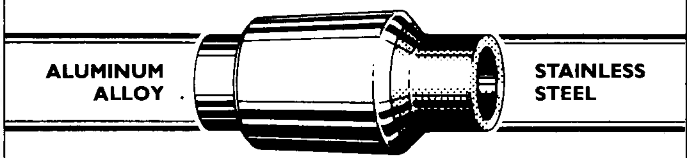
In the near future, valves with larger port diameters will be available.

Main features of VAT all metal valves are: long cycle life (more than 10,000 closures), bake-out to 450°C, excellent leak tightness (<$5 \cdot 10^{-10}$ mbar 1 sec^{-1}) and pressure range from UHV to 1 or 10 bar.

VAT – the leading specialist for high and ultra high vacuum valves. Our catalog 82 gives ample information – call for it!

VAT AKTIENGESELLSCHAFT für Vakuum-Apparate-Technik
CH-9469 Haag (Switzerland)
Phone: (085) 7 01 61 – Telex 855162 vat ch

THEVENET CLERJOUNIE
TRANSITION JUNCTIONS CEA* SYSTEM
FOR CRYOGENIC, VACUUM, NUCLEAR AND SPACE APPLICATIONS



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 Ø 600 MM (24")
10^{-9} atm. cm^3. 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 380544 F

Advertisements in CERN COURIER

Format A4 **Monthly publication**

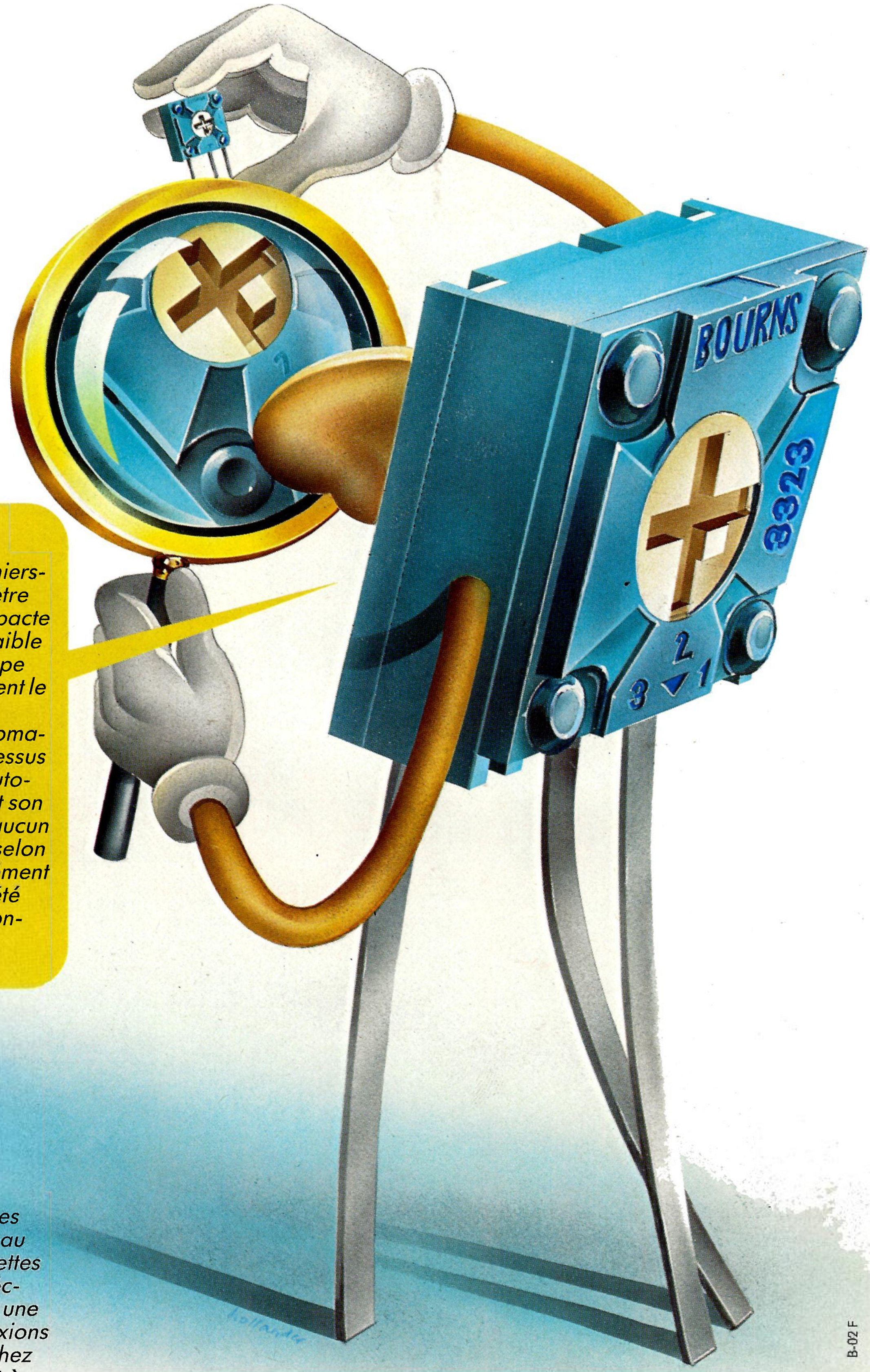
All advertisements are published in both English and French editions. Second language versions accepted without extra charge.

Space (page)	Actual size (mm) width by height	Cost per insertion (Swiss Francs)			
		1 insertion	3 insertions	5 insertions	10 insertions
1/1	185 × 265	1730	1680	1630	1530
1/2	185 × 130 90 × 265	960	930	910	860
1/4	90 × 130	550	520	500	480

Supplement for:	
— each additional colour	1500 SwF
— Covers:	
Cover 3 (one colour)	2000 SwF
Cover 4 (one colour)	2750 SwF
Publication date	1st of month of cover date:
Closing date for positive films and copy	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 1985.

All enquiries to:
Micheline FALCIOLA / CERN COURIER – CERN
CH-1211 Geneva 23 Switzerland
Tel. (022) 83 41 03 Telex 2 36 98



Ce petit est l'un des derniers-nés de Bourns, un potentiomètre Trimmer de la catégorie compacte Cermet, 6 mm × 6 mm: très faible encombrement. C'est à la loupe que ses avantages apparaissent le plus clairement.

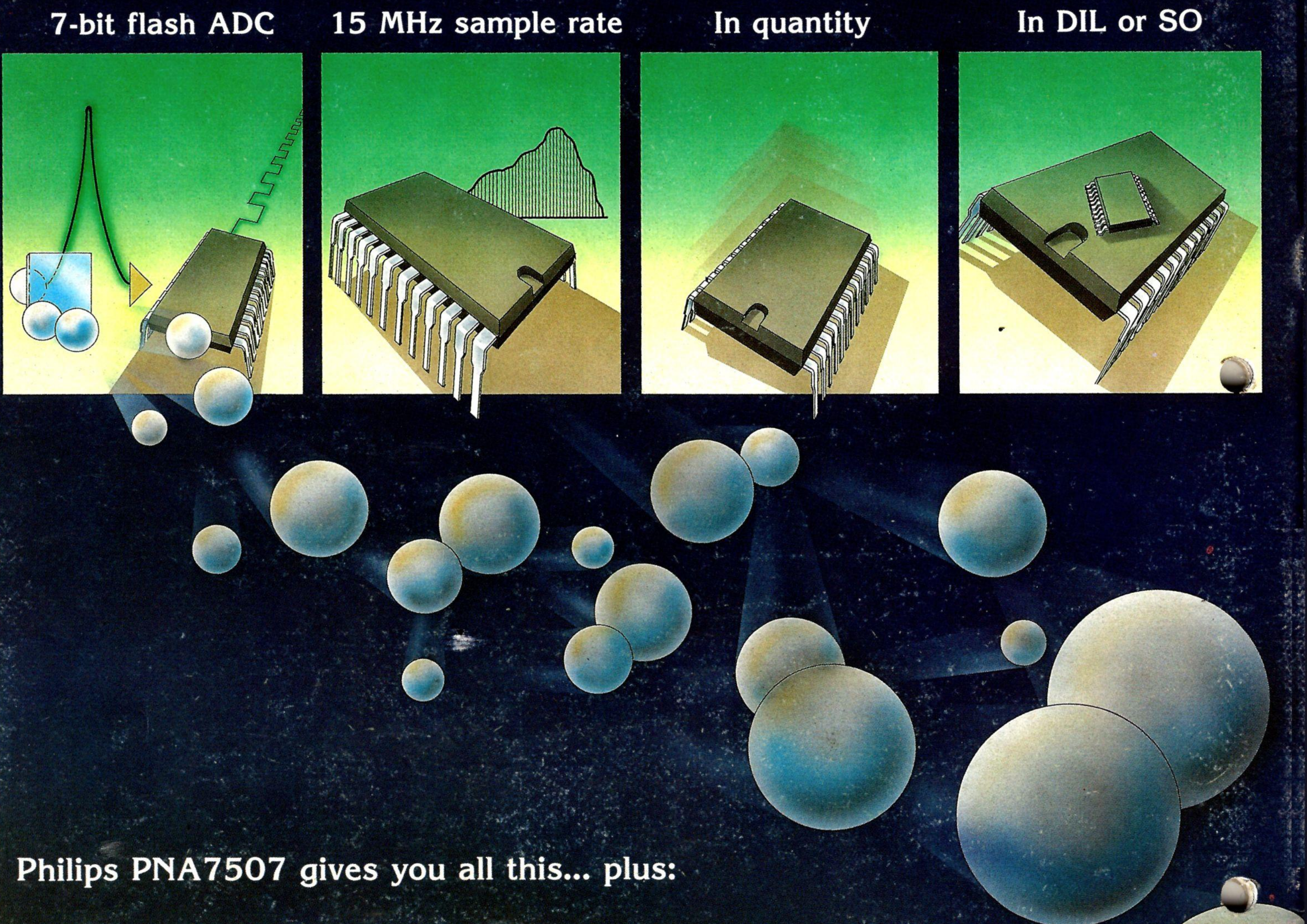
Vous pouvez l'inserrer automatiquement et le régler par le dessus ou le côté, au choix, même automatiquement. Il est étanche et son nettoyage ne pose vraiment aucun problème, de plus, il est testé selon un NQA de 0,1 %, sans supplément de prix pour vous. Là où il a été soudé, il reste longtemps – conséquence de sa fiabilité.

Comme tous les potentiomètres Trimmers de Bourns, le nouveau modèle 3323, est livré en barettes plastiques de 50 pièces. Impéccable, d'accès aisé, il permet une protection parfaite des connexions sorties. Invitez donc le 3323 chez vous. Son curriculum vitae est à votre disposition.

BOURNS®

Bourns (Schweiz) AG, Zugerstrasse 74
CH-6340 Baar, ✆ 042 333333

cpw B-02 F


7-bit flash ADC
15 MHz sample rate
In quantity
In DIL or SO