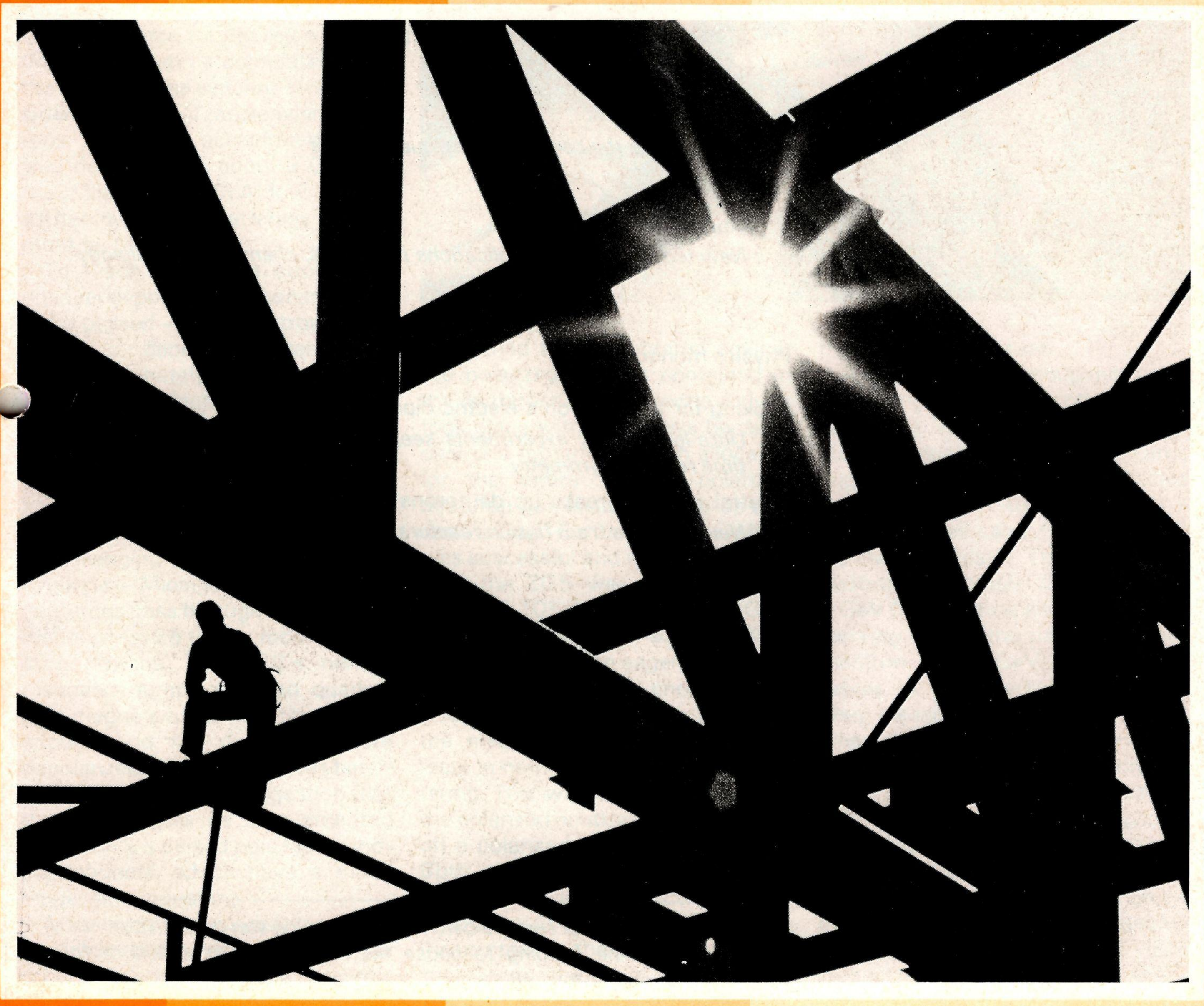
CERN COURIER

NO. 8 VOL. 19 NOVEMBER 1979



CERN COURIER
Journal of High Energy Physics
Editors: Brian Southworth
Henri-Luc Felder
Gordon Fraser
Advertisements: Micheline Falciola

Copies are available on request from:
Federal Republic of Germany
Frau G.V. Schlenther
DESY, Notkestr. 85, 2000 Hamburg 52
Italy —
INFN, Casella Postale 56,
00044 Frascati,
Roma
United Kingdom —
Elizabeth Marsh
Rutherford Laboratory, Chilton, Didcot
Oxfordshire OX11 0QX
USA/Canada —
Margaret Pearson
Fermilab, PO 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
Merrill Printing Company
765 North York, Hinsdale,
Illinois 60521, USA

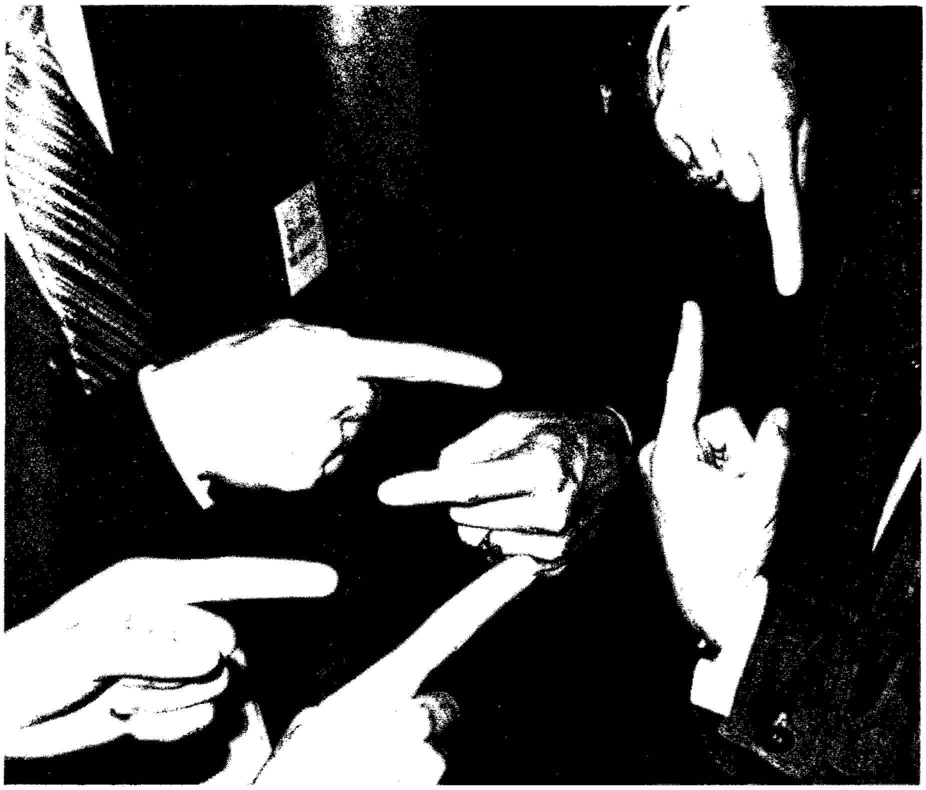
Published by:
European Organization for Nuclear Research
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 83 61 11, Telex 23698
(CERN COURIER only Tel. (022) 83 41 03)
USA: Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510
Tel. (312) 840 3000, Telex 910 230 3233

Contents

Cover photograph: The camera catches the morning sun through the framework for the building to house the Antiproton Accumulator for the CERN proton-antiproton collider project. (Photo CERN 252.8.79)

Around the Laboratories

Spin physics has always been a major interest at Argonne, as illustrated both by the latest result on neutron-proton spin forces and by this photograph, taken several years ago at an Argonne International Symposium on polarized beams and targets, which was used on the cover of our October 1976 issue.



ARGONNE
Neutron spin force opposite to proton

Towards the end of 1978, as the Argonne Zero Gradient Synchrotron began its final year of operation, it set another record and produced another physics surprise. For the first time polarized deuterons were accelerated to high energy (12 GeV). To achieve this, E.F. Parker and the ZGS staff had to modify the polarized ion source for deuteron operation and to retime completely both the linac and the synchrotron for the slower velocity of the heavier deuterons. They then accelerated polarized deuterons to about 2 GeV for the Minnesota/UCLA low energy deuteron-proton scattering experiment last fall.

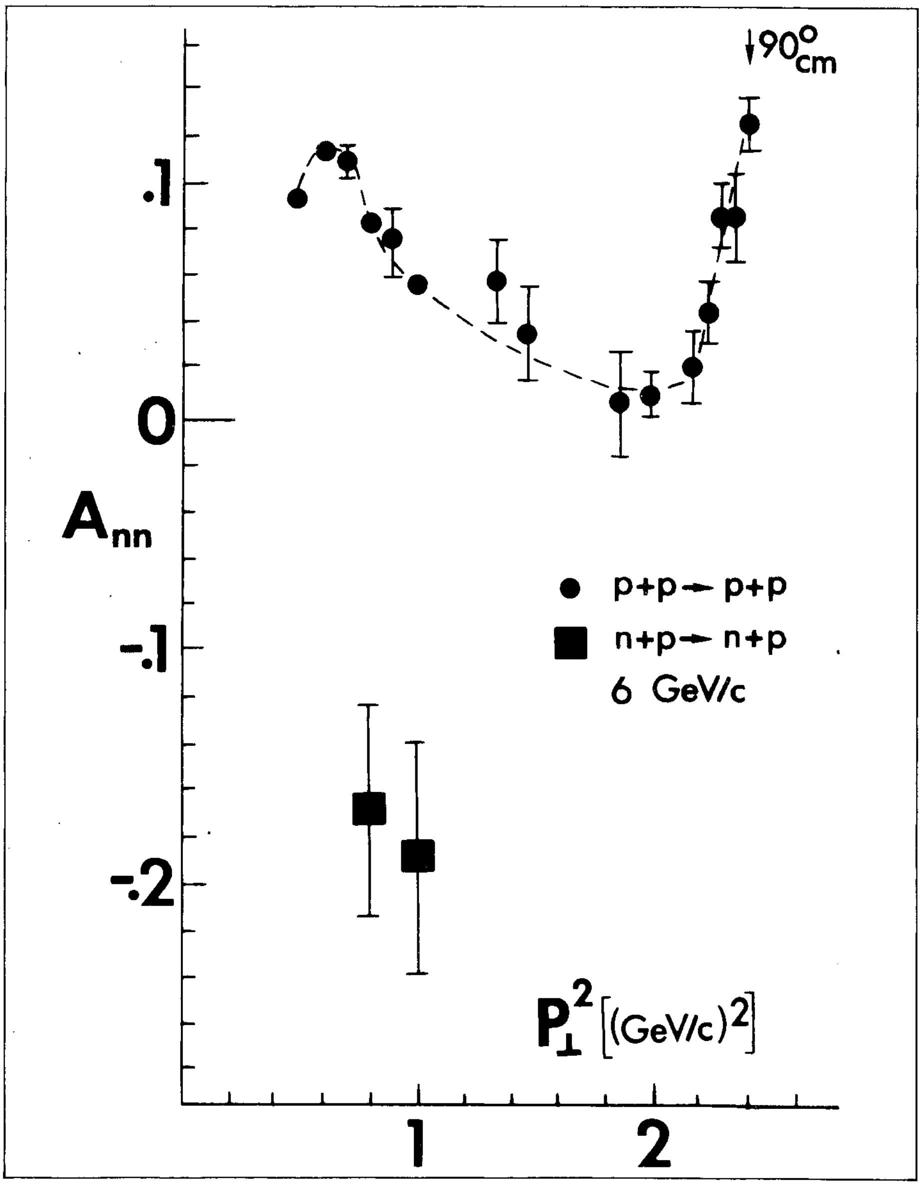
To reach 12 GeV a strong and unusual depolarizing resonance had to be passed — a superstrong 'zero harmonic' depolarizing resonance which fortunately never occurs for protons. The deuteron's very small g-factor (about twelve times smaller than the proton's) puts the resonance right into the deuteron's acceleration cycle at 10 GeV. Finding and jumping this resonance was a challenging new problem for the Argonne / Michigan team, because deuterons pass through depolarizing resonances 25 times more slowly than protons. The ZGS's normal resonance-jumping pulsed quadrupole magnets could not stay on long enough and the deuterons were depolarized. This problem was handled by L. G. Ratner's suggestion that the quadrupoles be supplemented by the ZGS's pulsed pole face winding magnets, which have a much longer time constant.

Measuring the polarization of the deuteron beam was also a new problem and the Michigan polarimeter had to be calibrated against the polarized protons contained in the deuterons. All this hectic activity took place within ten days because only one month had been allocated for the entire 12 GeV polarized deuteron run, including tune-up and data-taking. Fortunately the effort was successful and at the end of ten days the ZGS was accelerating a beam of 10^9 deuterons to 12 GeV with a polarization of 53 per cent.

Two teams were eagerly awaiting the world's first high energy polarized deuteron beam. Their goal was the measurement of spin-spin effects in neutron-proton elastic scattering. This was done by scattering the polarized neutron in the deuteron off a polarized proton in the target. Both the scattered neutron and recoil proton were detected so that events could be selected in which the proton in the deuteron was a spectator and did not participate in the scattering process.

A Rice University group measured small angle neutron-proton elastic scattering and is now in the final stage of analysing the data. Large angle spin-spin effects were studied by a Michigan / Argonne / AUA / Abadan / Bell Labs / Miami group led by A.D. Krisch. They measured neutron-proton elastic scattering at 6 GeV (the neutron and proton each carrying half of the deuteron's momentum of 12 GeV), at medium values of transverse momentum. They measured cross-sections both when the neutron and proton were spinning in the same direction and when their spins were opposite.

During the past few years Krisch's group has studied spin-spin forces in proton-proton elastic scattering and found a dramatic and rapidly growing spin-spin force at a transverse momentum squared of 5 GeV^2 (see August 1977 issue, page 237, *Results from the polarized beams at the Argonne Zero Gradient Synchrotron for elastic scattering of protons on protons and neutrons on protons. The spin-spin correlation parameter is plotted against the transverse momentum and shows surprising effects for both types of scattering.*



November 1977 issue, page 383 and October 1978 issue, page 347). This intriguing discovery can be summarized by noting that violent hard collisions at large transverse momentum rarely occur unless both protons spin in the same direction. In soft small angle collisions the spin effects are much smaller, however proton-proton scattering is always more likely when the protons spin in the same direction.

These huge proton-proton spin effects surprised and somewhat distressed many high energy theorists. Quark exchange models for large transverse momentum scattering can easily make spin-parallel scattering twice as likely as spin-opposite scattering. However, the experiments showed that it was already four times more likely at 5 GeV^2. It is very difficult to obtain so large a ratio from simple quark exchange models, and several theory teams have tried introducing more complex effects, such as instantons and triple quark scattering.

The neutron-proton spin-spin forces are found to be totally different. Even at the 1 GeV^2 of transverse momentum squared available in the first neutron-proton experiment, the spin-spin correlation parameter is twice as large as for similar proton-proton scattering though still smaller than the huge effect seen at very large transverse momentum. Even more surprising, the parameter for neutron-proton scattering is negative. Thus, neutrons strongly prefer to scatter from protons spinning in the opposite direction. This is the first time a negative spin-spin correlation parameter has ever been observed in high energy physics. There is no fundamental reason why strong interactions should always be dominated by particles spinning in the same direction. Nevertheless, this now vanished rule was one of the few regularities in spin physics where each new experiment seems to bring another surprise.

DESY
Physics with JADE

The JADE experiment at the PETRA electron-positron collider is being carried out by a collaboration of physicists from Germany (DESY, Hamburg and Heidelberg), from Japan (Tokyo) and from the United Kingdom (Lancaster, Manchester and the Rutherford Laboratory). The original design aimed to provide full solid angle coverage for both charged and neutral particles, dense sampling for charged tracks and fine granularity for electromagnetic showers, together with complete coverage for lepton identification.

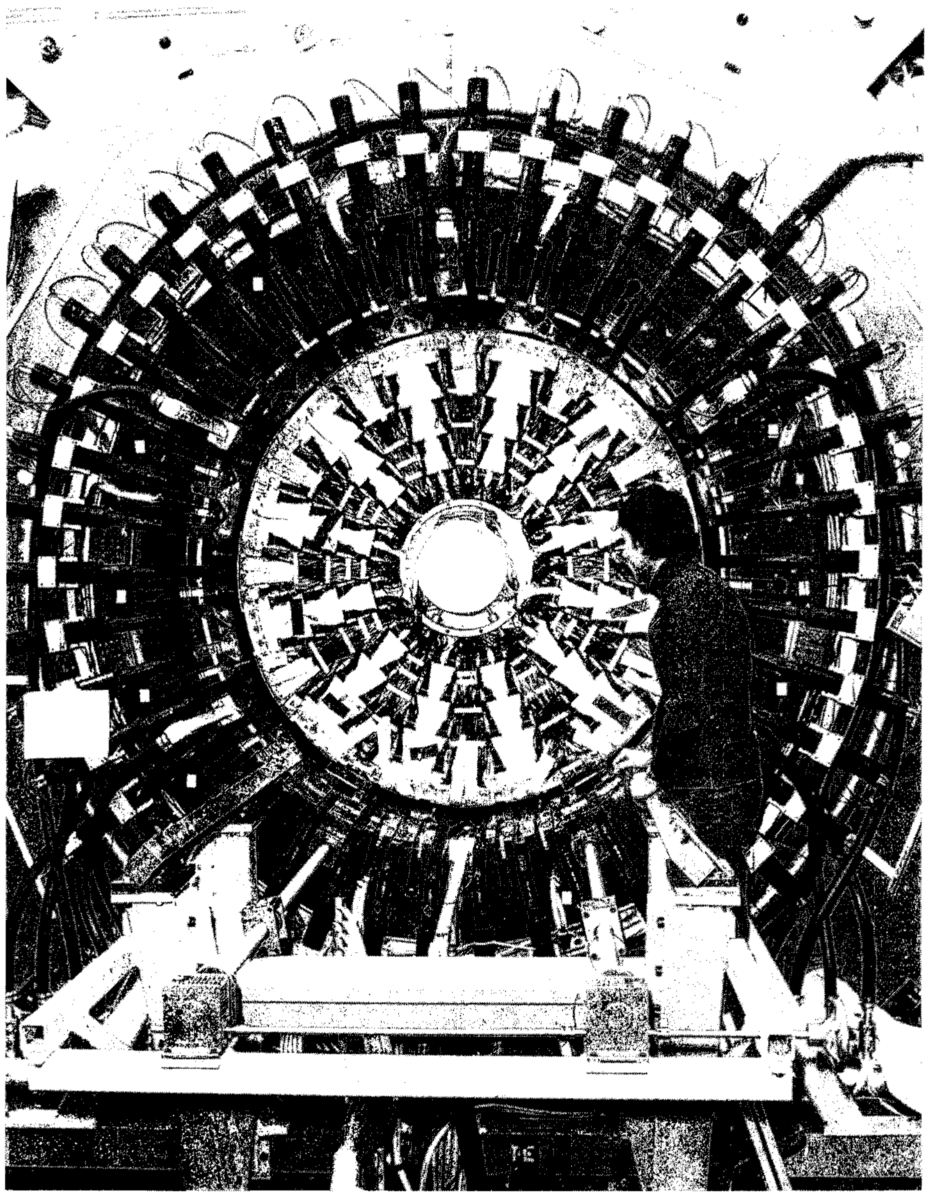
Construction and installation ended in the spring and data-taking started in June with the whole of the proposed detector in position at the highest energies available at PETRA.

The main features of the apparatus are the inner track chamber, the lead glass array and the muon filter. The cylindrical high-pressure drift chamber is 2.5 m long and 1.8 m in diameter and provides 48 separate measurements along the trajectory of a charged particle. The charge measurement from the sense wires also provides energy loss information which is being used for particle identification, and a preliminary resolution of ± 8 per cent has been obtained so far. The solid angle coverage for measuring at least eight points along the trajectories is 97 per cent.

The lead glass shower detector consists of a cylinder of inner diameter 2.1 m made up of 30 rings each containing 84 tapered glass blocks with an inner surface of 85 x 102 mm^2 and a depth of 300 mm (12.5 radiation lengths). These 2520 barrel shower counters, together with 192 end cap counters, cover 90 per cent of the solid angle and serve to identify photons and electrons and find their energy.

The magnet return yoke is utilized as one of the layers of the muon filter and is followed by three further layers of iron-loaded concrete making a total thickness of absorber of at least six interaction lengths. The absorber is interspersed with five layers of drift chambers which measure the continuation of the muon trajectories and the development of hadron showers with a solid angle coverage of 92 per cent.

There are two small angle tagging detectors close to the beam direction which detect electrons and positrons. These provide an on-line measurement of the luminosity and a trigger for two-photon exchange processes ($e^+e^- \rightarrow e^+e^-$ + hadrons).



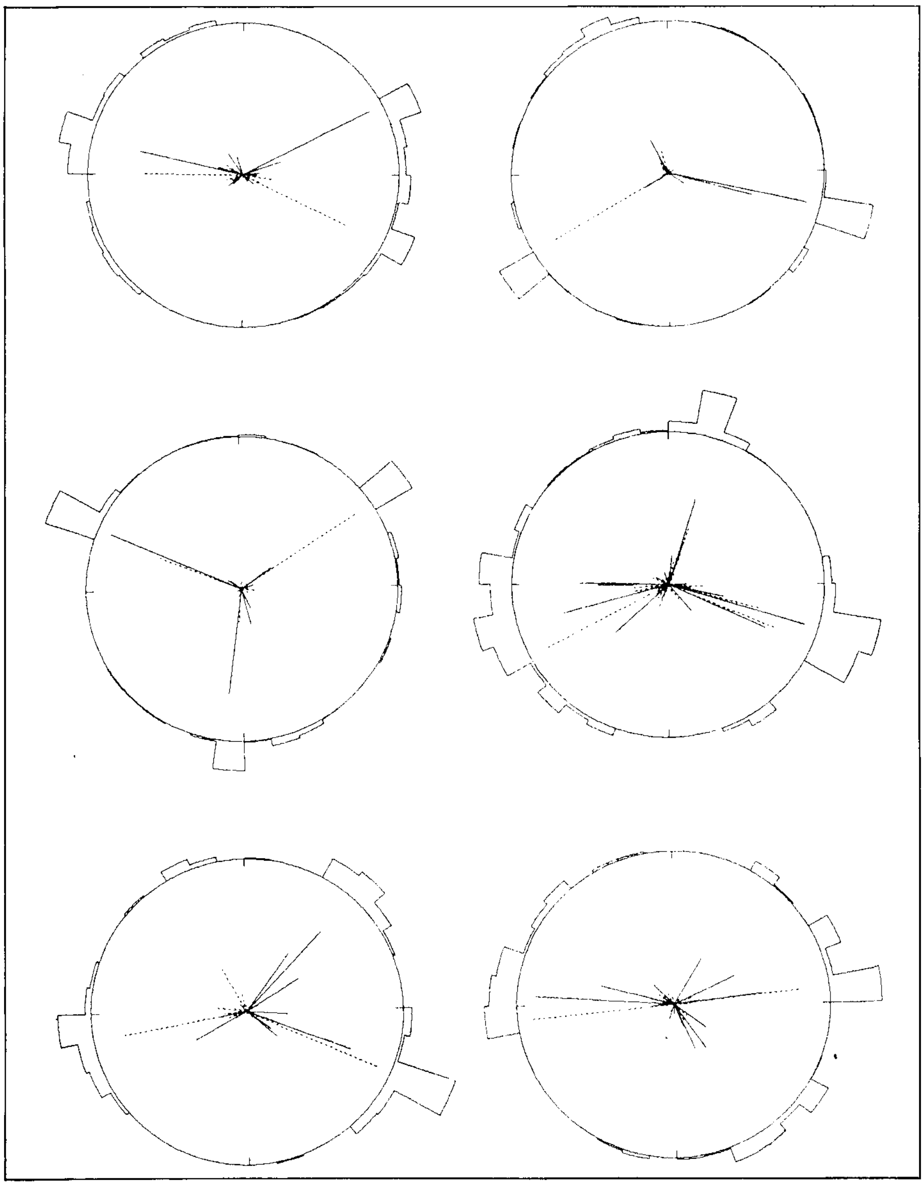
An end view of the JADE detector for the PETRA electron-positron collider at DESY during installation, showing the symmetrical drift chamber detector and array of time-of-flight counters.

(Photo DESY)

The first data from this experiment were presented at the Fermilab Lepton / Photon Symposium in August and covered both electromagnetic and hadronic processes. The validity of quantum electrodynamics has been verified by JADE down to distances of 2 x 10^{-16} cm, about a factor of five smaller than previous limits.

The total cross-section measurement, together with a notable absence of spherically-symmetric events with no hadron jets, indicates that there is no production of a new quark flavour in the present PETRA energy range.

Like other PETRA experiments, JADE observed a small but significant class of events which are neither jet-like nor spherical. They



A sample of six three-jet events in JADE, viewed looking down onto the event plane. The particles are shown as momentum vectors, and the energy flow is indicated by the circular histograms (see also page 358).

are characterized by being relatively planar, and in several cases the energy distribution within the event is separated into three distinct lobes. These events are more plentiful than would be expected merely from statistical fluctuations.

These events are attributed to electron-positron annihilation into a quark, an antiquark and a gluon. These three particles define a plane and fragment into three distinct jets. The JADE data add to the growing list of experiments which support the gluon hypothesis (see page 358).

The energy loss measurements have been used in a free quark search. No free quarks have been seen at a sensitivity of about one-fifth of the point-like cross-section.

Another interesting result from JADE indicates that there is beam polarization at PETRA energies. A substantial azimuthal angular dependence was observed both for collective jets and for inclusive hadrons within the jets. The beams appear to have almost maximal polarization.

JADE will now continue to collect data and the increase in statistics will allow the quantum electrodynamics limits to be pushed even lower and reach a sensitivity where interference effects between weak and electromagnetic interactions can be studied. The search for new quark flavours and new heavy leptons will continue, but JADE will always be on the lookout for the unexpected.

CERN
A new kind of radioactivity

Three kinds of radioactivity are known in the breakup of natural nuclei — alpha decay, beta decay and spontaneous fission. However for the ground states of exotic, highly unstable nuclei, additional kinds of radioactivity involving the release of one or two protons have been postulated, but not yet observed.

Another possibility is for particles to be emitted from excited states of unstable nuclei formed, for example, in beta decay. These emitted particles are said to be beta-delayed. Protons, alphas and neutrons have been seen to be emitted in this way. It was Luis Alvarez who first pointed out the important distinction between radioactivity and the emission of these beta-delayed particles.

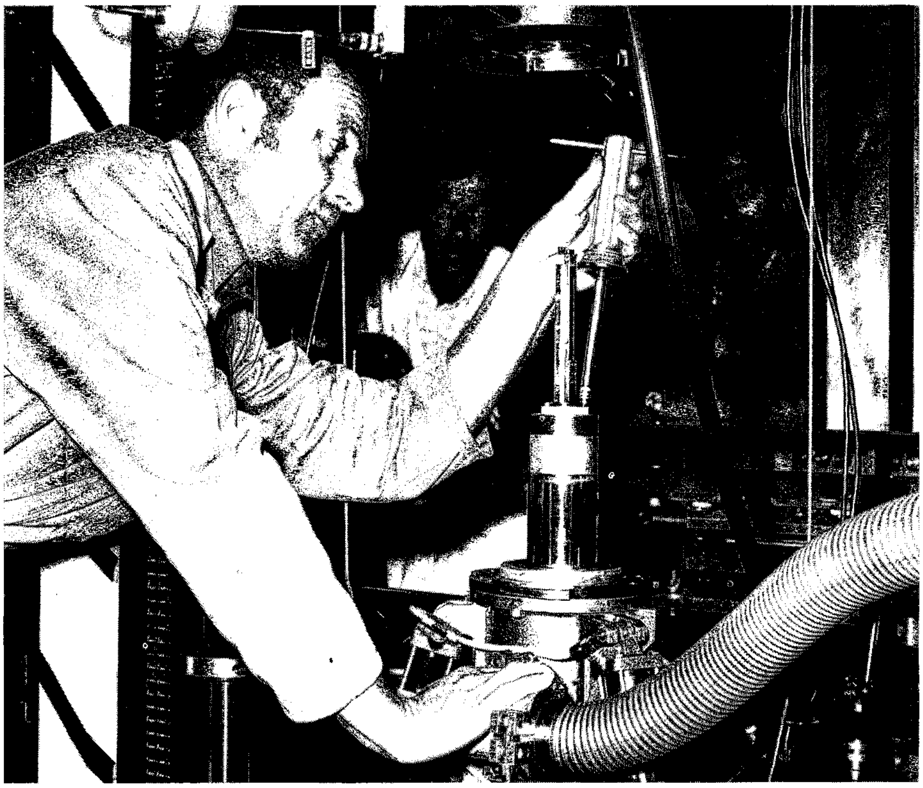
The search for new kinds of radioactivity is not new. The search for proton emission, for example, began as early as 1914, when even the idea of the proton itself was still in its infancy. It was Rutherford who first showed that the protons which came off when nuclei were bombarded with alpha particles were the result of nuclear reactions, and were not due to the decay of the target nuclei.

Now in an experiment at the CERN synchro-cyclotron (SC), beta-delayed emission of two neutrons has been seen in the decay of the isotope lithium-11 to beryllium-11.

In the experiment, the lithium isotope was formed by bombarding a uranium carbide target, heated to 2000°C, with 1.6 μA 600 MeV protons from the SC. The atoms were mass separated in the ISOLDE isotope separator, and a beam of some 15 atoms per second was obtained.

Mounting the chimney of the ion source which provides the particles for the new carbon ion beam at the CERN synchro-cyclotron. Left to right, M. Guillon, A. Auberson and M. Lubrano.

(Photo CERN 144.9.79)



Preliminary studies of single beta-delayed neutron emission revealed peaks corresponding to emission from well-known beryllium-11 levels, but in addition a broad distribution was seen. This was suspected to be due to two-neutron emission, but confirmation was needed.

In a second experiment, the lithium-11 beam was directed to the centre of a 60 cm paraffin block, equipped with eight helium-3 proportional counters. The neutrons stayed an appreciable time (about 100 microseconds) in the paraffin before they were detected by a helium-3 counter. This enabled the experimenters to connect their detectors together and look for time-correlated neutron events.

Correlated pairs of neutrons were seen, and the effectiveness of the method was checked by looking at multiple neutron emission in the spontaneous fission of uranium-238.

The two-neutron energy spectrum from lithium-11 is expected to show signs of final state interactions, so that further studies could reveal important information on the neutron-neutron interaction.

Accelerating carbon ions

The usefulness of the CERN synchro-cyclotron (SC) has been further extended by the availability of beams of carbon ions of over 1 GeV energy (85 MeV per nucleon).

Despite being the oldest accelerator on the CERN site (commissioned in 1957), the SC still benefits from improvements. The machine was substantially rebuilt in 1973/4 to increase its 600 MeV proton output, and last year saw its successful adaptation to accelerate helium-3 ions to 900 MeV (see June 1978 issue, page 206).

In addition, the on-line isotope separator ISOLDE caters for a large nuclear physics community studying rare isotopes, and the availability of beams of polarized muons, together with the increasing use of muon spin rotation techniques (see page 361), adds to the attractions of the SC as a research centre.

After the SC's success with helium-3 ions, attention turned to the possibility of using heavier ions with ratios of charge to atomic weight of one-third, such as carbon-12 atoms stripped of four electrons ($^{12}C^{4+}$).

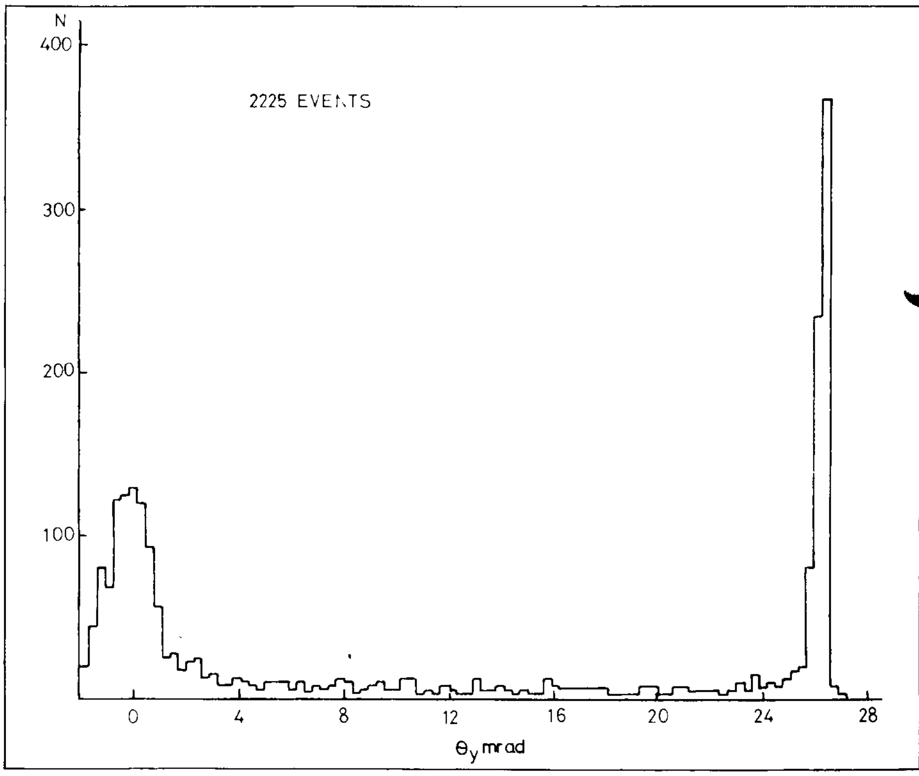
This required further modifications to the SC's r.f. system so as to provide the necessary 8.5 to 10.1 MHz range. This was accomplished by altering the compensating coils of the machine's rotating condenser (rotco), and changing the inner conductor of the r.f. transmission line between the rotco and the accelerating 'dee' electrode which had been built for helium-3 acceleration. With this scheme, even lower r.f. frequencies could be made available at the SC should the need for them ever arise.

To produce the ions required a more powerful ion source, giving a power in the arc twenty to forty times the output usually used in proton operation. This increased power means that the filament and the anticathode of the source erode quickly and have to be replaced every six hours or so, but this should not perturb the experimental programme too much.

The vacuum level in the SC was also improved to decrease the chances of collisions with residual gas molecules upsetting the electron configuration of the stripped carbon ions.

Trials of the new system began at the end of August, and after only

Bending of high energy charged particles by channelling in a bent crystal. This graph from an experiment at Dubna shows the angular distribution of outgoing particles from the crystal. The sharp peak corresponds to the crystal bend angle of 26 mrad, for which the bending radius is about 38 cm and the electric field in the crystal is 270 MV/cm (equivalent to a 72 T magnetic field).



three days a $^{12}C^{4+}$ beam was extracted. Initial intensity levels corresponded to some 4 x 10^{11} carbon ions per second, not far from the most optimistic figure quoted when the scheme was first proposed.

The carbon beam was transferred to the target of the ISOLDE isotope separator and experimentalists had a first but brief look at isotope production. In addition, a neutron production and shielding experiment carried out by Jan Tuyn verified the data used in the design of shielding for the experiments under construction.

By changing the carbon monoxide gas bottle used for the production of carbon ions for a bottle of nitrogen-15, a beam of $^{15}N^{5+}$ ions was extracted. A small change in the settings of the rotating condenser would have given a beam of $^{14}N^{5+}$ ions carrying 97 MeV per nucleon, but due to lack of time this had to be postponed till the next ion run.

To give a first impression of the potential of the new ion source, internal beams of $^{16}O^{5+}$, $^{19}F^{6+}$, $^{20}Ne^{6+}$ and $^{22}Ne^{7+}$ ions were produced. A minor change in the r.f. transmission line would enable these beams to be extracted.

This new SC development opens up a potentially very interesting energy range for physics. An energy of 85 MeV per nucleon falls between the low energy region where nuclei tend to interact collectively, and the relativistic region where they behave as collections of independent nucleons. New transition behaviour could therefore be seen.

A number of teams are preparing to exploit the new beams and these experiments are scheduled to start in December.

DUBNA
Steering particles by bent crystal

When channelling of charged particles occurs in a single crystal, the particle oscillates between two planes of the crystal lattice. It was proposed a few years ago that bent crystals could be used to steer the trajectories of high energy particles in a way similar to bending magnets. The electric field intensity of a crystallographic plane exceeds 10^{10} V/cm, so one may hope to bend particles a factor of several thousand times more effectively than by a conventional magnetic field.

Such a possibility was demonstrated in August at the Joint Institute for Nuclear Research, Dubna. The international group, headed by Edward Tsyganov, consisted of people from Dubna, Kharkov, Tomsk, Leningrad (USSR), Swierk (Poland), Batavia and Albany (USA). The experiment was performed using the 8 GeV external proton beam of the JINR High Energy Laboratory accelerator.

The trajectories of the particles incident upon the target crystal were read out by twenty drift chamber planes. The front part of the 2 cm-long silicon crystal was prepared as an intrinsic totally depleted semiconductor detector to identify channelled particles by their anomalously low ionization loss.

A simple technique was employed to control the bending of the back part of the crystal. Channelled particles were selected by requiring an ionization loss less than about one half of the most probable energy loss and measurements were performed for a variety of crystal bending angles.

For all bending angles it was found that the channelled fraction of the beam followed the geometry of the bent crystallographic plane and the number of dechannelled particles did not change significantly by increasing the crystal bending angle. This demonstrates the feasibility of steering charged particle trajectories by a bent single crystal.

The phenomenon may find some applications in high energy physics. For example, bending and splitting of high energy beams at TeV energies by single crystals could become practical because the dechannelling length scales as the beam energy and approaches several metres at these high energies.

The influence of crystalline structure on the penetration of high energy particles is also being actively studied at other Laboratories, including Brookhaven, Fermilab, Los Alamos and CERN.

TRIUMF Radioisotope production

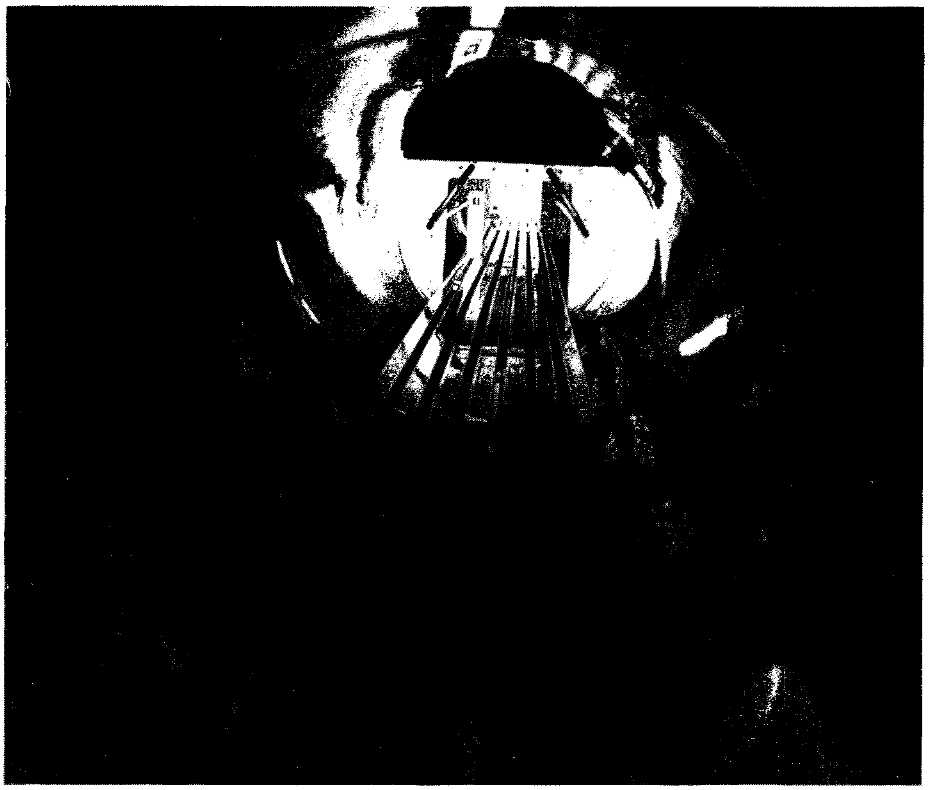
The applications programme at the TRIUMF cyclotron includes radioisotope production, cancer therapy using negative pions, neutron activation analysis, conversion of fertile to fissile nuclear fuel and proton radiography, and we review here the progress in isotope production.

The importance of the 'meson factories' as sources of radioisotopes, particularly for medical applications, has been recognized for some time. It follows first of all from the decay characteristics of accelerator–produced radionuclides. Many decay almost entirely by electron capture followed by gamma emission and the absence of emitted beta rays leads to a substantially reduced radiation dose for the patient during conventional gamma camera imaging. Others decay by positron emission and the strong angular correlation between the photons which come from the positron annihilation may be exploited in three-dimensional measurement of the radioisotope distribution in vivo using positron emission tomography.

A second consideration is the high beam power at the meson factories which implies high isotope production rates; not only is there a high beam intensity available, but substantial target thickness may profitably be employed. (The production at the SIN Laboratory was described in the April issue, page 72.)

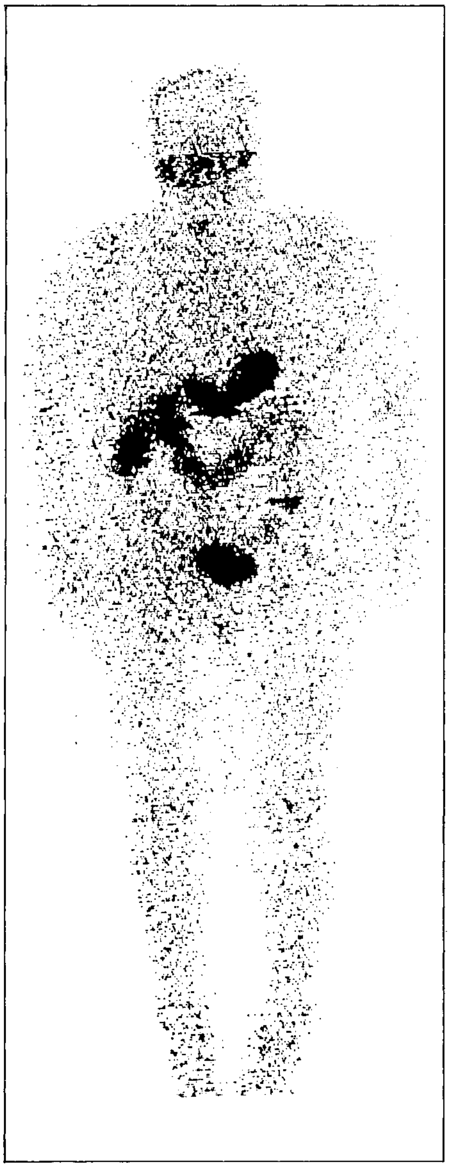
The 500 MeV proton-induced spallation reaction on caesium has been exploited for some years at TRIUMF by a TRIUMF/University of British Columbia/Vancouver General Hospital team to produce iodine-123 for radiopharmaceutical research. They use a heat-pipe target (designed in collaboration with J. Blue of NASA, Cleveland) to produce quantities ranging recently up to 1 curie per batch. Practical yields are 12 mCi per microampere-hour for a 20 g/cm^2 target. With funding from Health and Welfare, Canada, this material has been shipped to collaborating hospitals in Vancouver, Edmonton, Winnipeg and Toronto for evaluation, primarily in measurements of thyroid function.

The figure (next page) shows a whole body image obtained with a rectilinear scanner taken with iodine-123 on a patient with thyroid cancer. The thyroid activity has been ablated, so that radioiodine uptake



This 10 metre-long irradiation facility has been constructed at TRIUMF to enable multiple isotope production targets to be inserted into the high intensity beamline.

(Photo TRIUMF)



Whole body image of a patient with thyroid cancer taken using iodine-123 produced at the TRIUMF cyclotron.

by this gland is not observed; activity in the salivary glands, the gastrointestinal tract and the bladder is, however, present and diffuse uptake is visible in the lung. In addition, a small region of intense iodine uptake is seen in the vicinity of the left hip; this proved to be a metastatised thyroid tumour, exhibiting thyroid function in its new location.

The spallation reaction is also being exploited by this team for the research production of xenon-127, iron-52 and other materials, and by a second TRIUMF/University of British Columbia team for the production of short-lived positron emitters, carbon-11, nitrogen-13, oxygen-15 and fluorine-18. These are destined for application in positron emission tomography studies after incorporation into appropriate radiopharmaceuticals by chemical synthetic techniques.

The iodine-123 produced at 500 MeV contains an irreducible 0.5 per cent of iodine-125 as an impurity. This contributes excessively to the patient radiation dose beyond 28 hours after production. As noted in the April issue of the COURIER, the ideal energy for producing pure iodine-123 is near 70 MeV, and TRIUMF has implemented a third extracted beam covering the 60 to 100 MeV range, with the production of iodine-123 (and other potential radiopharmaceuticals) as its main use. A 5 μA extracted beam of good quality was obtained and a molten sodium iodide target is under development for early installation in this beam for iodine-123 production. Higher intensities are planned for a later stage, which will require several shielded target stations.

In addition to the above research programme, TRIUMF radiopharmaceuticals will be distributed commercially via an agreement negotiated with the Commercial Products Division of Atomic Energy of Canada Ltd. Financing from the British Columbia Development Corporation, through the University of British Columbia, is paying for the construction of high-level radioisotope laboratory facilities at TRIUMF for processing irradiated targets into radiopharmaceuticals. Also a commercial variable energy 42 MeV negative hydrogen ion cyclotron will be installed to provide additional production facilities for radioisotopes produced with proton energies between 11 and 42 MeV. Grants from the British Columbia Provincial Government have allowed the second cyclotron to be upgraded to become a potential neutron source for cancer therapy and the equipping of the radioisotope laboratories for the research programme.

Looking for gluons

In his concluding talk at the Geneva high energy physics conference earlier this year, Abdus Salam predicted that the gluon is likely to be discovered sooner than the long-awaited intermediate particles of weak interactions. In the light of the new high energy results, from PETRA (see September issue, page 307), this prediction now looks a pretty safe bet.

The existence of gluon is far from being physics history, but evidence is steadily mounting. Even if high energy proton-antiproton collider projects live up to their promise and quickly reveal the intermediate weak particles, the gluon seems to be winning the race at the moment.

Spin one gluons are postulated to be the carriers of the 'colour' force acting between quarks, and are thus ultimately responsible for all strong interaction phenomena. Theorists are gradually piecing together a quantitative theory of quantum chromodynamics (QCD) to describe these forces at work deep inside hadrons.

Delicate effects (so-called 'scaling violations') seen in neutrino experiments had previously given useful encouragement to the QCD theorists. But the contributions from QCD mechanisms can be masked by other effects and so be difficult to measure.

However high energy annihilation of electrons and positrons at DESY, first at the souped-up DORIS ring and then at the new PETRA ring, have provided a new and effective way of testing QCD.

There are a number of big problems which beset QCD. Firstly, it is limited, like all relativistic field theories, to a perturbation-style approach where progressively smaller contributions are added together to converge (hopefully) on a final result. This convergence should improve at higher energies.

In addition, no recipe has been found to explain the apparent confinement of quarks and gluons within hadrons — at least at the energies we know, quarks and gluons do not appear as free particles.

The perturbative QCD formalism therefore has to be embedded in an empirical 'hadronization' formula which describes how quarks and gluons produce jets of hadronic matter in high energy collisions.

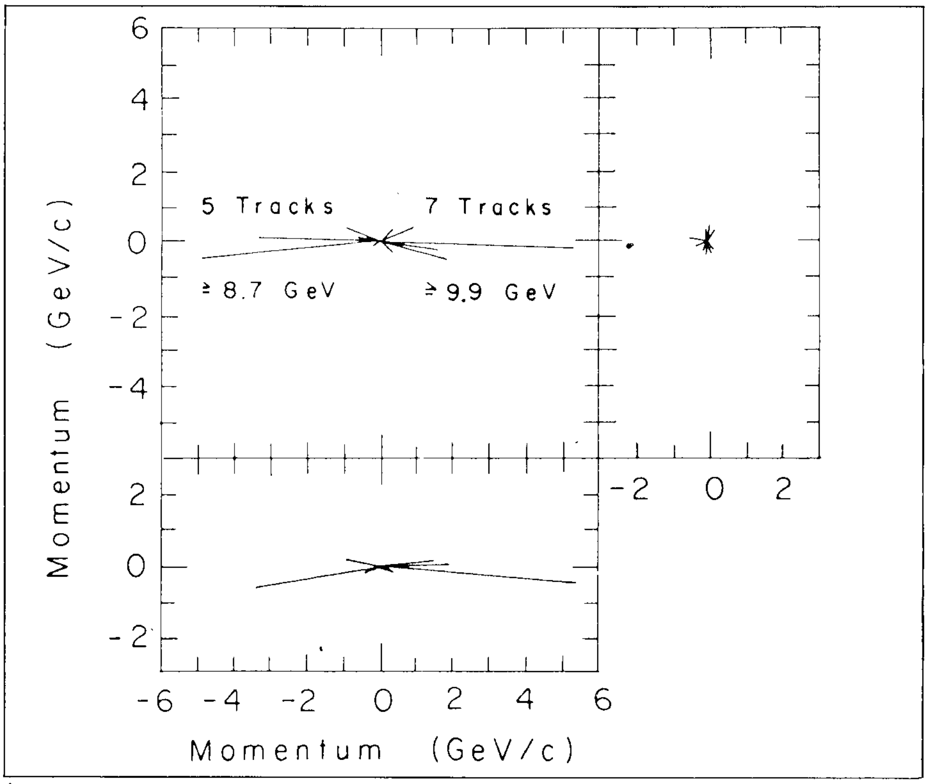
This limits the predictive power of the theory to situations where quark/gluon behaviour is not completely masked by hadronization. This is what makes the DESY electron-positron data on the formation and subsequent decay of heavy quark-antiquark bound states and on the emission of 'hard' (energetic) gluons so interesting.

The first evidence came from DORIS data on the decay of the upsilon resonance. As a vector (spin one, negative parity) particle, this should decay into an odd number of vector gluons, analogous to the well-known decay of positronium (an electromagnetic bound state of an electron and a positron) into three photons.

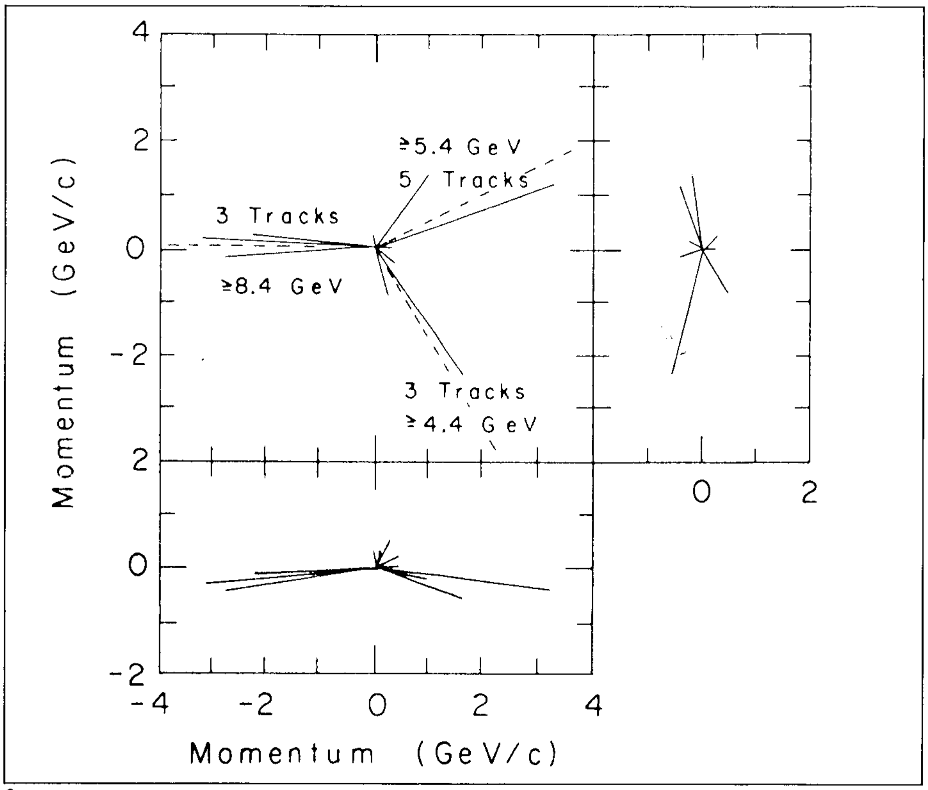
Hopefully these gluons would produce three clearly-defined jets of hadrons, but in the upsilon mass range, this behaviour might not show up as clearly as might be hoped. It is difficult at these energies to differentiate between true jets and the amorphous behaviour given by a statistical decay model.

To distinguish clearly between three-jet events and the two jets coming from quark-antiquark pairs, the experimentalists need some means to measure the 'jettiness' of their data. This jet analysis should also be amenable to QCD calculations.

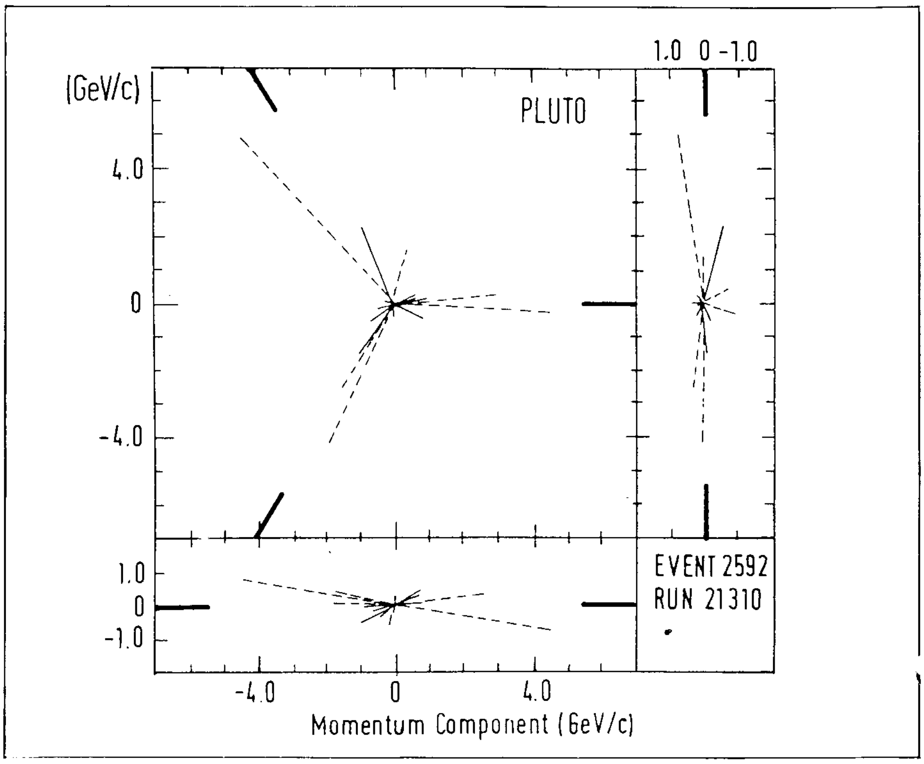
Momentum distributions in three projections for 1.– a two-jet event and 2.– a three-jet event, as measured by the TASSO detector in high energy electron-positron collisions at PETRA.



1.



2.



Momenta of the particles produced at 31.6 GeV total energy in the PLUTO detector at PETRA. Solid and dotted lines correspond to charged and neutral particles, respectively, and the thick bars show the directions of the jet axes.

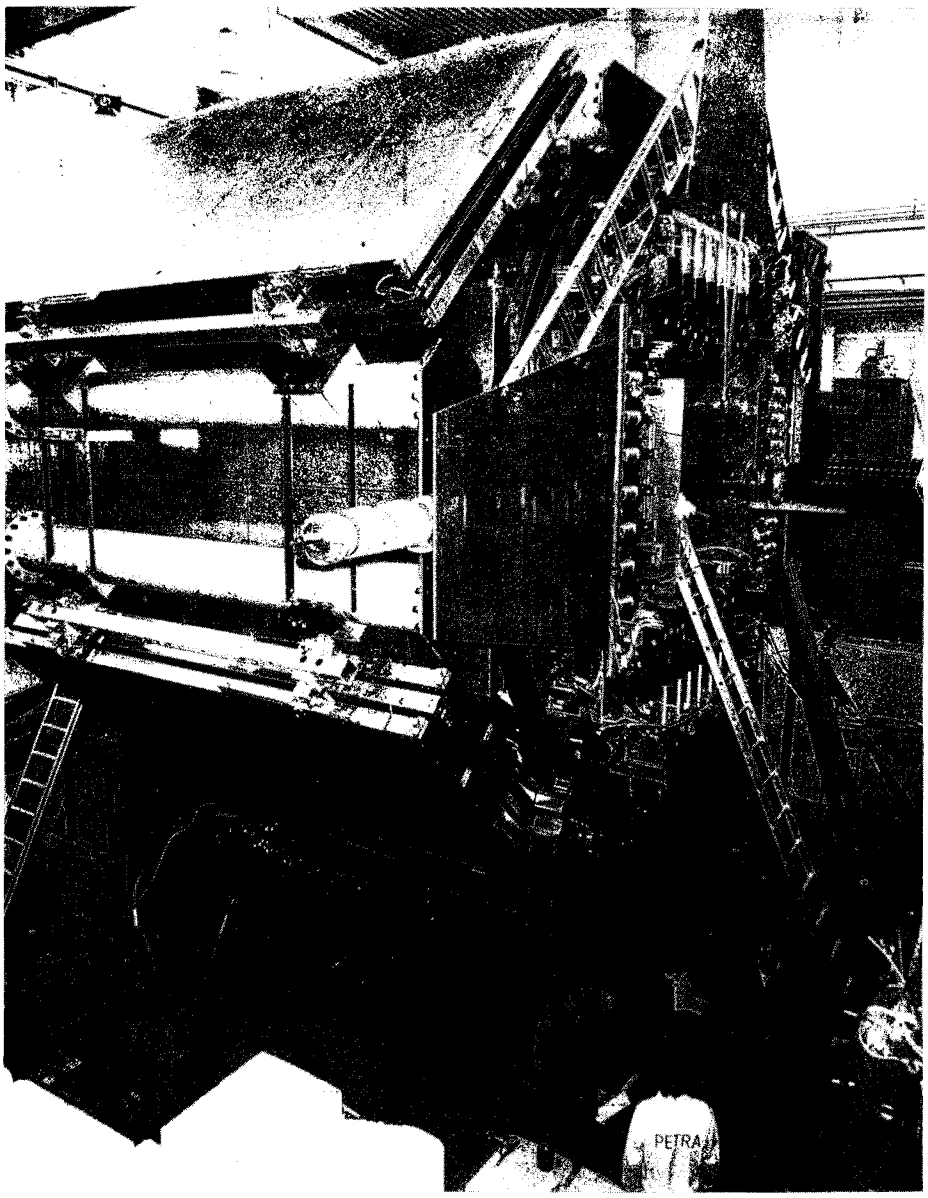
One such parameter which has emerged takes the name of 'thrust'. A decay producing two back-to-back particles would have a thrust value of exactly one, and the deviation from this value indicates the likelihood of additional energetic particles.

Analysis of upsilon decays revealed more events with low thrust than would be expected from the production of quark-antiquark pairs, and found decay products grouped in a plane. This gave the first hint that a new kind of behaviour was being seen, and the hunt for the gluon began in earnest.

The next step came with the availability of higher electron-positron annihilation energies in PETRA to search for signs of three distinct jets produced by a quark, an antiquark and a hard gluon. The annihilation energies at DORIS are too low for the perturbative QCD mechanisms to pierce through the accompanying hadronization and produce observable effects.

Following preliminary evidence from the TASSO collaboration, all the PETRA groups now have some evidence which suggests that hard gluon emission (called 'Gluestrahlung' by some) is being seen. While the data up to collision energies of 17 GeV can be explained by quark-antiquark production, energies round the 30 GeV mark show clear signs of three-body behaviour.

The next step is to measure the spin of the additional particle which is emitted along with the quark and the antiquark. Indications from upsi-



The Mark-J detector at PETRA. As well as finding evidence for three-jet events, the Aachen / DESY / MIT / NIKHEF (Amsterdam) / Peking collaboration has also made important studies of the production of electron, muon and tau particle-antiparticle pairs.

(Photo DESY)

lon decays and from lepton scattering experiments suggest spin one, but a final conclusion cannot yet be made. Confirmation should come from analysis of the jet angular distributions.

While it is important to confirm the existence of the gluon and to pin down its quantum numbers, another vital test is to search for evidence of a single gluon decaying into a gluon pair. This three-gluon coupling has no analogue in more familiar field theories, such as quantum electrodynamics, but is a necessary consequence of QCD.

This three-gluon coupling, which would be seen as a softening and broadening of gluon jets at high energy compared to the showers coming from quarks, provides a vital test of QCD.

All this will be helped by the availability of full energy (2 × 19 GeV) in PETRA next year, and the hunt for the gluon will soon be given another boost when experiments begin at the new PEP electron-positron ring at Stanford.

Exploiting muon spin rotation

Last year, some twenty per cent of the available beam time at the CERN 600 MeV synchro-cyclotron (SC) was taken up by studies using the technique of muon spin rotation (μSR).

The idea of muon spin rotation dates back some twenty years to the pioneer experiments on parity violation in weak decays, but it has only come into its own as an experimental technique in the 1970s.

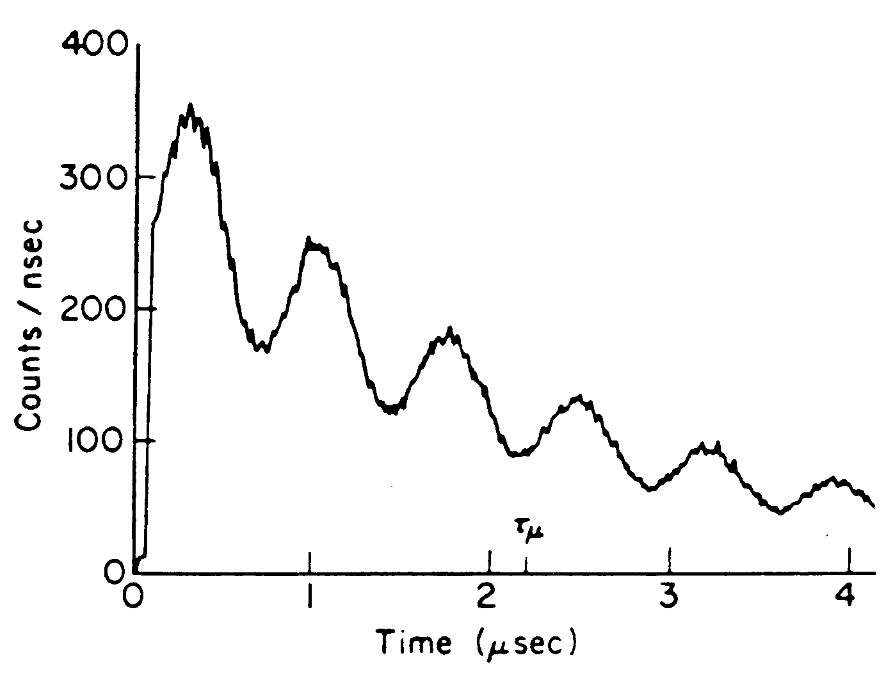
Polarized positive muons are brought to a stop in a target and precess in the local magnetic fields. (Negative muons are quickly captured by nuclei and are much less useful.) Because of parity violation, positrons from the decay of these positive muons are preferentially emitted in the direction of the muon spin.

This behaviour can be monitored by positron detectors which record the rate of muon decay and show the characteristic precession of the muons. In this way the stopped muons can be used to probe the inner structure of a wide range of materials.

Early experiments had shown that at sufficiently low temperatures, muons come to rest in metals and that the muon precession rates in ferromagnets can be used to measure internal magnetic fields at the muon sites. Early μSR applications at CERN were aimed at ferromagnetic materials.

However it was soon discovered that, first, much more had to be learnt about the way muons interact in metals, and in particular, what types of sites in the crystals the muon energies prefer.

The importance of the electric field which the charged muons exert on the surrounding nuclei was first realized at CERN. Once this was understood, stopping sites could be confi-



Typical muon spin rotation signal showing the characteristic pattern due to the precession of the stopped muons in a sample. This technique is finding increasing application in physics, chemistry and biology.

dently determined from muon depolarization measurements in single crystals.

It was also found that while muons could be brought to rest in some metals with relatively little cooling, muons seemed to be mobile in others right down to a few degrees Kelvin. In many metals irregularities in the depolarization rate also showed up at certain temperatures.

The understanding of all these phenomena has been a major objective at CERN. In 1977, the first systematic studies of the effect of impurity content were carried out and its strong influence on muon mobility was clearly shown.

A model for 'trapping' and release of muons at impurities in metals was formulated. This can be related to corresponding behaviour in the metallurgically very important technique of hydrogen diffusion in metals. Muons have a great advantage over hydrogen in this respect as they can be studied at extremely low concentrations.

As a very light particle, the muon is prone to tunnel quantum mechanically through barriers in its path, in contrast with heavier particles which have to find their way over these obstacles.

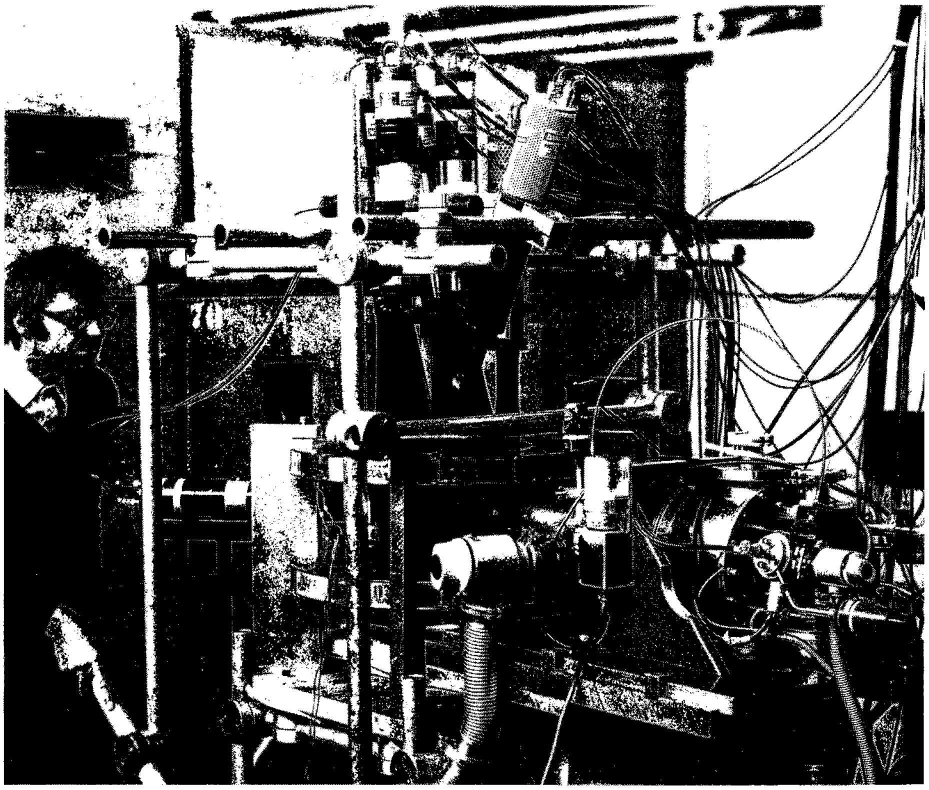
This has opened up a new field of diffusion studies which is of interest to theoreticians as well as experimentalists, and provides new insights into the propagation mechanisms in disordered systems in general, such as electron propagation near the transition region between metals and insulators. Experiments at CERN have penetrated the temperature range from 2 down to 0.03 K and discovered many new and interesting phenomena.

These studies are still being pursued, but experimenters are now confident that they know enough about the influence of purity on the localization of muons to be able to re-embark on their original programme of ferromagnetic studies.

Another speciality involves subjecting the metallic samples to pressures of up to 7000 atmospheres to increase the electron densities in experiments on ferromagnetic substances. These studies complement those which measure the influence of temperature and impurity level on the localization of muons.

Erik Karlsson with the experimental arrangement used at CERN for measuring muon spin rotation at temperatures down to 0.03K. These low temperatures are needed to reveal the quantum mechanical nature of muon diffusion in certain metals and semiconductors.

(Photo CERN 260.9.79)



Muonium effects

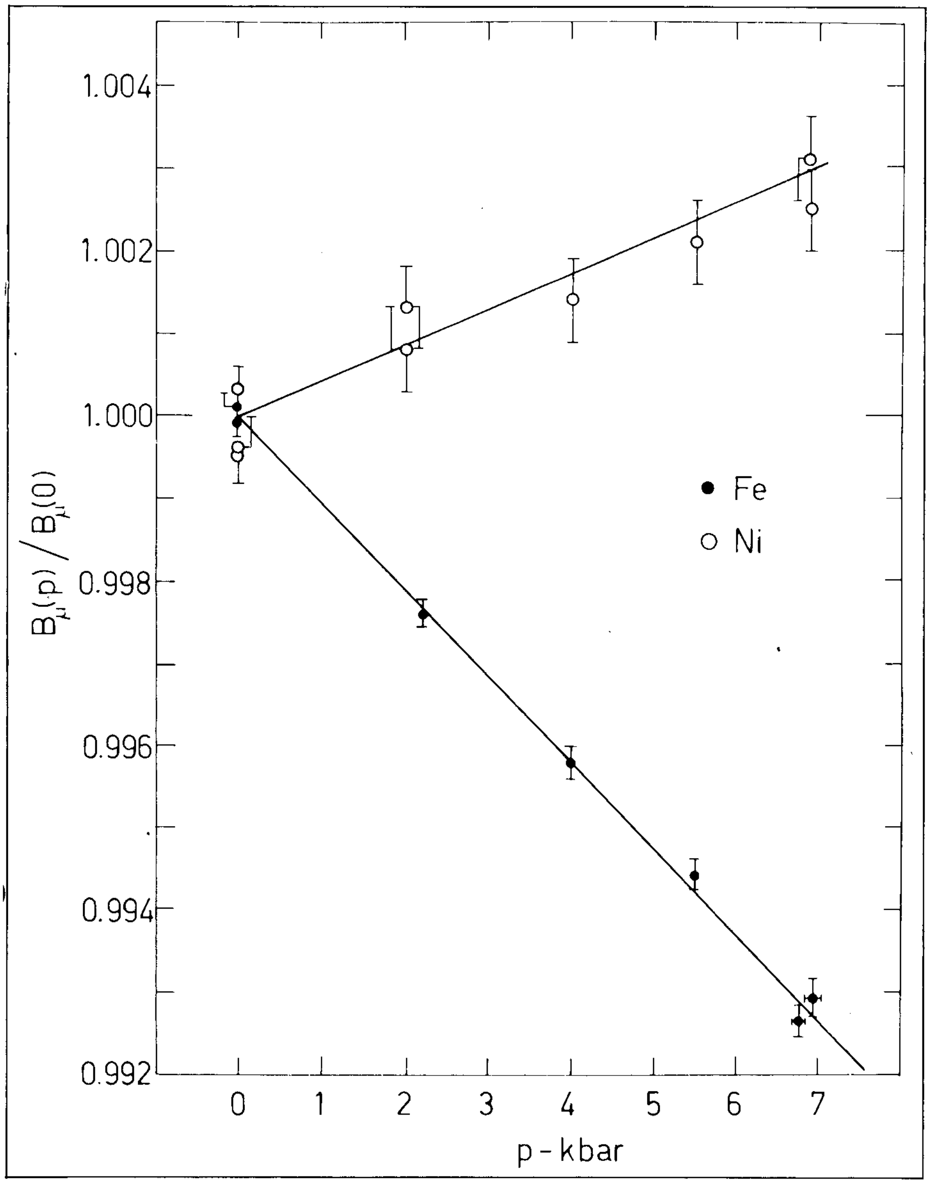
In metals, it is principally free positive muons which are stopped, as the conduction electrons which could pair with the muons are smeared out through the sample. Any hyperfine interactions between muons and conduction electrons are cancelled out by quantum mechanical exchange forces.

In insulators, this is not the case and the muons pair up with electrons to form muonium — a hydrogen-like atom with a positive muon, rather than a proton, as nucleus. Thus the inner structure of insulators can be studied through the hyperfine spectroscopy of muonium, as revealed by the muon spin rotation technique.

Of course, the boundary between free muons in metals and muonium in insulators is not clear-cut, and there is a transition through semimetals, such as arsenic, antimony and bismuth, which has been extensively studied at CERN.

The main aim in muonium studies in non-conductors is to hope that the muonium atoms with their single electrons could behave in certain respects like hydrogen atoms, and the technique could complement the results obtained directly from hydrogen.

Relative change of the local magnetic fields in nickel and iron with applied pressure, as measured in muon spin rotation experiments at CERN. The behaviour reflects the changes in the polarization of electron spins around the muons.



While in some cases this comparison with hydrogen is valid, the lightness of the muon also means that quantum mechanical tunnelling takes on an important role, so that other effects occur up to a hundred times faster with muonium than with hydrogen.

If an itinerant hydrogen atom meets a molecule, it may react or not. If it does not react, the atom moves on and must travel a distance comparable to its mean free path before encountering another likely molecular target.

However muonium tends to react with the first molecule it meets, so that reaction mechanisms are considerably faster. But the muon spin rotation technique enables much faster reaction rates to be studied (down to 5 ns) than with other methods.

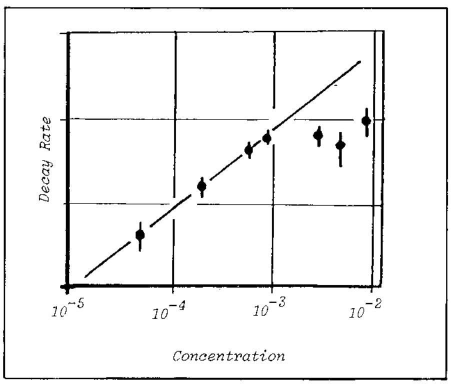
Again optimistic initial studies to explore the behaviour of biomolecules encountered the same sort of general problems as were found with metals, and experimenters first had to go backwards and investigate how muonium was formed in these materials before making important progress.

In complex biological molecules, such as DNA, the transient radicals are expected to exist on a timescale which can be probed by μSR, and recent results at CERN have shown evidence for such radicals containing muonium.

The reaction rates of muonium have been studied not only with complex biomolecules but also with model molecules such as benzene. This work has shown how the resulting radicals can be detected and their electronic configurations probed.

From a radiobiological viewpoint, the most interesting outcome of the DNA studies using muonium is that all of DNA's four molecular bases react strongly with the hydrogen-like atom. The focus is now on understanding the evolution of these

Results (below) from experiments on the formation of muonium atoms in water and their subsequent reaction with DNA bases. The decay rate of the muonium signal is found to rise in proportion with the solute concentration up to a certain point, when a plateau is reached. Work done at CERN on both biological and model molecules in this region has shown that muonium radicals are formed as the first reaction products.



muonium-base radicals. These studies, and others on complex polymers, could give important insights in molecular chemistry and biology.

At CERN, the study of the hyperfine interactions in muonic radicals in liquids proceeds along with studies on insulating or semiconducting crystals. In particular, the properties of muonium in semiconductors at low temperatures are being investigated.

An important development in the μSR camp at CERN revolves around the use of wire chambers as detectors. In principle, this will be able to monitor the precessions of muons at many different sites and could speed up the analysis considerably.

With widespread applications, muon spin rotation is now a powerful new technique in physics, chemistry and biology which is only just beginning to show its worth.

Looking for the neutron's electric dipole moment

An experiment now being prepared by a Grenoble / Harvard / Munich / Oak Ridge / Rutherford / Sussex collaboration to run at the research reactor at the Institut Laue-Langevin, Grenoble, will use new techniques to search for an electric dipole moment of the neutron.

The magnetic dipole moment of the neutron was first measured in 1940 at the Berkeley cyclotron by Luis Alvarez and Felix Bloch, but any electric counterpart has yet to be seen.

The existence of an electric dipole moment in this neutral particle would provide the first evidence for the violation of time reversal symmetry outside the world of the neutral kaon.

While the total electric charge inside the neutron is of course zero, the constituent positive and negative charges (the quarks in the neutron are charged) might be distributed so that the positive and negative regions are permanently displaced. This could produce an electric dipole moment.

Any such dipole moment would have to point along the direction of the neutron's spin axis. Because the neutron has spin, any separation of electric charge away from the spin axis would be averaged out by the rotational motion, and only a separation of positive and negative charge along the spin axis would be detectable.

Applying a time reversal operation to a neutron flips the spin direction — a film of any object spinning right-handedly, when run backwards, shows the object to be spinning left-handedly.

However a time reversal operation has no effect on electric charge. Thus, if initially the electric dipole moment and the spin axis point in the same direction, after a time reversal operation they will point in opposite directions. This is a violation of time reversal symmetry — a film of a neutron, when run backwards, would no longer look like a neutron.

(Unlike an electric dipole moment, a magnetic dipole moment does switch direction under a time reversal operation, so for the magnetic moment, time reversal symmetry is good.)

Neutron experiments have already established that if an electric dipole moment exists, it must be less than 3×10^{-24} e cm (e being the electronic charge). To go beyond this limit requires neutrons which can be kept under observation for a long time, and this requires special techniques.

Very slow neutrons were first used in this type of experiment by a group working at the Institute for Nuclear Physics in Leningrad, but the experiment now being prepared at Grenoble plans to 'bottle' these unhurried neutrons to further increase the observation time.

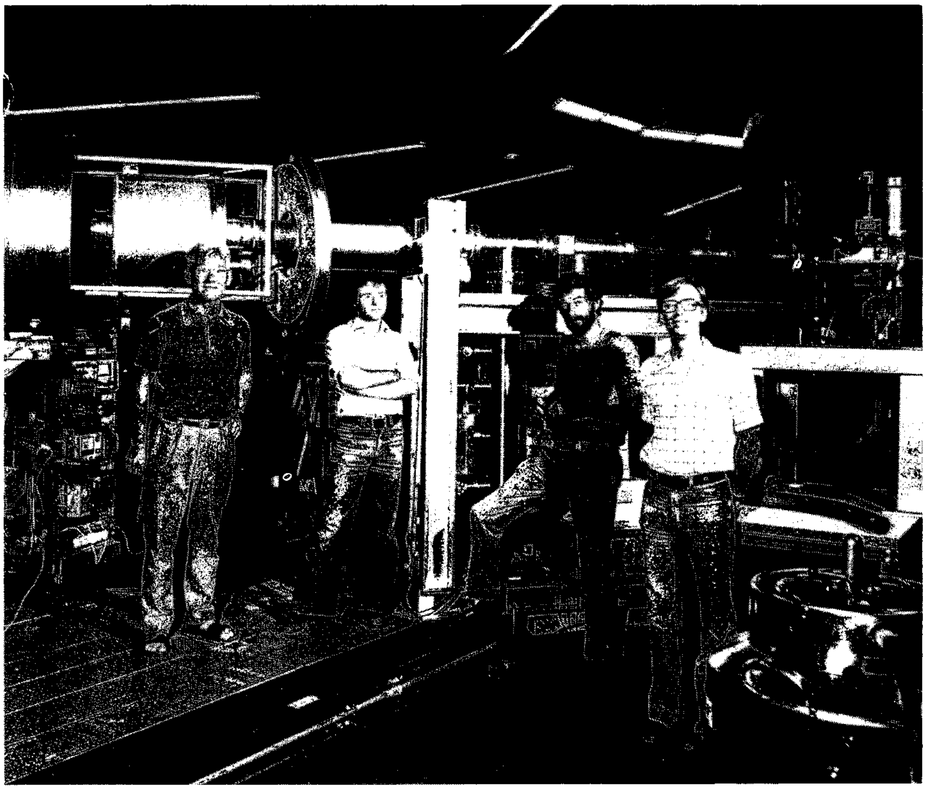
As the energy of a neutron wavepacket falls, so its wavelength increases according to the Planck law. For more energetic neutrons, a solid appears as a lattice of nuclei through which the particles can filter. As the energy falls and the wavelength increases, the solid eventually becomes a continuous barrier which the particles cannot easily penetrate. This phenomenon is analogous to the total internal reflection of light in a glass prism, and was predicted by Enrico Fermi in 1945.

Thus when neutrons are slowed down past this critical energy (when they are said to be 'ultra-cold'), they can be trapped and stored in a container. For copper, this critical energy is about 2 x 10^{-7} eV, which means that the neutrons are moving at about six metres per second — running pace!

A magnetic storage ring, designed at the University of Bonn and now in operation at the Grenoble reactor, exploits the properties of these neutrons (see November 1977 issue, page 365). The group which designed this ring is now preparing a new spherical magnetic neutron bottle to be filled with liquid helium and exposed to a neutron beam cooled by superfluid helium.

As well as being used to search for a neutron electric dipole moment, these new techniques should enable the neutron lifetime to be measured more accurately. At present this lifetime (about 15 minutes) is only known to within 1.5 per cent, while much rarer particles, such as the muon, have their lifetimes known to within a few parts per thousand.

In this way, new results from ultra low energy experiments could well provide additional insights into the physics usually associated with high energies.



An experiment is being prepared at the research reactor of the Institut Laue-Langevin (ILL), Grenoble, to search for the electric dipole moment of the neutron. If found, this would provide new evidence for violation of time reversal symmetry. Seen here in front of their apparatus are four members of the experimental team — left to right, K. Smith (Sussex), P.R. Meek (Sussex), W. Mampe (ILL) and J.M. Pendlebury (Sussex).

(Photo ILL)

Neutral current breaks up deuterons

The wealth of neutral current data in line with the Weinberg-Salam angle has been augmented by a new result from the Irvine group working at the 2000 MW fission reactor at Savannah River.

This is not the first time that important neutral current results have been obtained without the use of accelerators. The relatively modest atomic physics experiments at Novosibirsk and elsewhere provided vital early evidence for parity violation in neutral current interactions (see June 1978 issue, page 200).

It is also not the first time that the Savannah River reactor has contributed to neutrino physics, for it was here in 1953 that Reines and Cowan made their historic observation of the free antineutrino, some twenty years after the particle had been predicted by Pauli.

In the latest experiment, the Irvine Group (including Reines) uses a 2.5 x 10^{13} cm^{-2} s^{-1} flux of electron antineutrinos from the beta decay of fission products to look for the disintegration of deuterons by neutral currents in 256 kg of very pure heavy water.

The experiment uses the heavy shielding built for earlier studies on another neutral current reaction, antineutrino-electron elastic scattering. Cosmic ray and reactor backgrounds are minimized by a lead/cadmium shield and 2200 litres of liquid scintillator as anticoincidence detector, all wrapped in lead, concrete and water. Immersed in the heavy water target are gas-filled proportional counters which identify the neutrons liberated in the breakup of deuterium.

The theoretical prediction for the neutral current disintegration of the deuteron corresponds to about 50 events per day, in good agreement with the observed rate of 38 ± 9 per day.

This new evidence for the Weinberg-Salam model is particularly compelling because the low energy of the reactor antineutrinos means that only a single coupling constant is involved. (In high energy neutrino interactions at accelerators, there are in general four coupling constants, corresponding to left- and right-handed couplings to both up and down quarks.) Because this coupling constant does not depend on the weak mixing angle, the experiment confirms the Weinberg-Salam prediction but does not determine the mixing angle.

The experiment is being continued to improve the statistics.

People and things

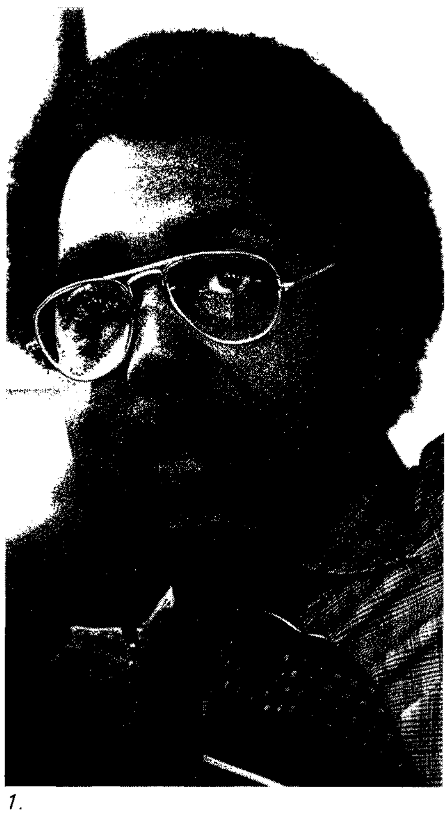
✱ *In our December issue we shall cover the award of this year's Nobel Prize for Physics to Sheldon Glashow, Steven Weinberg and Abdus Salam.*

On people

Andy Sessler has announced his intention to resign as Director of the Lawrence Berkeley Laboratory as from the beginning of next year. He has guided the Laboratory through a period of great change when diversification and the swing to many energy and environmental areas of research have been implemented with success.

In his letters to President David Saxon of the University of California and to Berkeley staff, Andy Sessler raised several reasons for handing over leadership. He wishes to return to research and, in particular, to contribute creatively to the vital area of fusion energy. He believes that it is good to change Director after a seven-year period — allowing adequate time for objectives to be attained and yet providing for change when change is most likely to be needed. He also regretted that the focus of interaction with the Department of Energy during his years of office had been on "procedural matters and on a severe constraint on the utilization of the Laboratory rather than on a mutually supportive exploration of the ways this excellent institution can be more fully utilized to work on the nation's critical energy problems."

Also at the Lawrence Berkeley Laboratory, Hermann Grunder has succeeded Ed Lofgren as Head of the Accelerator and Fusion Research Division. In recent years, Hermann Grunder has led the Bevalac work accelerating heavy ions in the accelerator combination of the Bevatron and SuperHILAC. For many years, Ed Lofgren has been one of the leading physicists in the accelerator field.



1.

2.

1. Walter Massey, new Director of the Argonne National Laboratory.
2. Andy Sessler, resigning Director of the Lawrence Berkeley Laboratory.

Bjorn Wiik, new Chairman of the CERN SPS Experiments Committee.

Bill Walkinshaw, applied theoretical physicist from the Rutherford Laboratory, retired on 16 August. He had played an important part in the history of the Laboratory, having been involved in the design of the Proton Linear Accelerator and of the Nimrod synchrotron. In more recent years he moved to computing and built up at Rutherford one of the largest scientific computing centres in Europe.

It is sad to record the death on 27 September of Otto Frisch. He is best known in physics for his participation in the discovery of nuclear fission, and it was he who gave the phenomenon its name. A highly cultured man — artist, musician, witty and articulate conversationalist — he was of a school no longer around in large numbers.

Giuseppe Cocconi's 65th birthday was celebrated by his friends at CERN on 3 October. Friends he has in large numbers because of his involvement in particle physics and astrophysics and because of his warm personality.

Committee changes: at CERN, Bjorn Wiik has succeeded Ian Butterworth as Chairman of the SPS Committee. At Fermilab, John Rutherfoord has succeeded Frank Sciulli as Chairman of the Users Executive Committee.

On 12 September, Giuseppe Occhialini received the 1979 Wolf Prize for Physics in a ceremony held at the Knesset, Jerusalem, in the presence of the President of Israel. The prize was awarded for two major discoveries — electron – positron pair production (at Cambridge in 1933 in collaboration with P.M.S. Blackett) and detection of the pion (at Bristol in 1948, together with C.F. Powell). These two discoveries were fundamental steps in the development of elementary particle physics and have led to the award of two Nobel Prizes. Since 1930, Occhialini has played an important role in the development of physics in Italy. In 1950 he was among the founders of INFN — the National Institute for Nuclear Physics — promoting in particular the creation of the Groups for Elementary Particle Physics of the INFN Sections at Genoa and Milan. In addition, he was in the 1960s the Director of the INFN Section at Milan. The Wolf Prize, which is considered one of the most prestigious in the world after the Nobel award, acknowledges the important contributions which Giuseppe Occhialini has made to the advancement of knowledge of the fundamental structure of matter.

A number of distinguished British-based theoreticians, including Roy Chisholm, Richard Dalitz, Herbert Fröhlich, John C. Gunn, Peter Higgs, Abdus Salam and Euan Squires, attended a ceremony at the University of Edinburgh in October to mark the retirement of Nicholas Kemmer as Tait Professor of Mathematical Physics.

Following Yukawa's first ideas on nuclear exchange forces, Kemmer's work in the 1930s substantially developed our ideas of the pion. He predicted that the pion would be a pseudoscalar (spin zero, negative parity) particle, and that it would exist in electrically neutral, as well as charged, forms. While it was Heisenberg who first proposed the idea of isotopic spin, Kemmer had the idea of using invariance principles in an abstract isotopic space and so paved the way for later developments of internal symmetries for particle interactions. In 1975 he received the Oppenheimer Memorial Prize.

In addition to his research, he is a distinguished teacher who has been highly influential in shaping the present generation of theoreticians working in British universities.

Peter Carruthers, head of the Theoretical Division at Los Alamos, has been elected chairman of the board of trustees of the Aspen Center for Physics, Colorado, USA, succeeding Murray Gell-Mann.

HEPAP subpanel

The USA Department of Energy has appointed a subpanel of HEPAP to review the overall quality and scope of the high energy accelerator research and development effort in the U.S. High Energy Physics Program. The review is to include:

Celebrating completion of the last bending magnet for the PEP electron-positron ring at Stanford. Flanking members of the design and fabrication team are Gerry Fischer on the left and Bob Bell on the right. Al Mixon (with the cast on his hand) reported for work to complete the magnets, despite his injury.

(Photo SLAC)

1. The examination of the existing accelerator R. and D. effort
2. A comparison of U.S. efforts with those in other countries
3. Specific recommendations with particular emphasis on
a) Breadth and depth of the R. and D. effort
b) Balance among short-term, mid-term and long-term R. and D.
c) Priorities
d) Appropriate funding levels.

The subpanel hopes to complete its work by June 1980. Its members are R. Diebold (Argonne), K. Johnsen (CERN/BNL), D. Keefe (LBL), A. McInturff (BNL), F. Mills (Fermilab), W.K.H. Panofsky (SLAC), C. Pellegrini (BNL), J. Sandweiss (Yale), R. Schwitters (Harvard), L. Teng (Fermilab), M. Tigner, Chairman (Cornell), A. Tollestrup (Fermilab), W. Willis (BNL/CERN).

Those with opinions on the subject matter of the review are invited to write to the Secretary of the subpanel, D. Sutter, Division of High Energy Physics, Office of Energy Research, U.S. Department of Energy, Washington, DC 20545.

New life for old computers

After many years of sterling service at CERN, two venerable Control Data Corp. (CDC) 3100 and 3200 computers are being shipped to Yugoslavia where they will be used at the Novi Sad Institute of Physics.

These computers were the heart of the FOCUS (Facility for On-line Computing and Updating System), developed at CERN during the years 1967 to 1971, and eventually phased out in 1978 with the commissioning of the CERNET communications network (see May 1978 issue, page 162).

PEP progress

The PEP electron-positron storage ring, being built by a Berkeley/SLAC collaboration at Stanford, is now nearing completion. All bending magnets are assembled and were scheduled to be installed, together with all the quadrupoles and sextupoles, in the ring by mid-October. The restart of the linac in October after its summer shutdown would then enable electrons to be injected and steered through interaction region 8, r.f. cavities and part of magnet arc 7. Injection studies will then continue during week-ends in November, allowing construction to be completed in the ring during the remainder of the week. In this way it is hoped that colliding beams can be achieved before Christmas.

1. One of the star attractions at CERN's Journée du Personnel held on 29 September was the rescue chute built and manned by the CERN Fire Brigade. Over 1000 intrepid souls made the 20 metre descent.

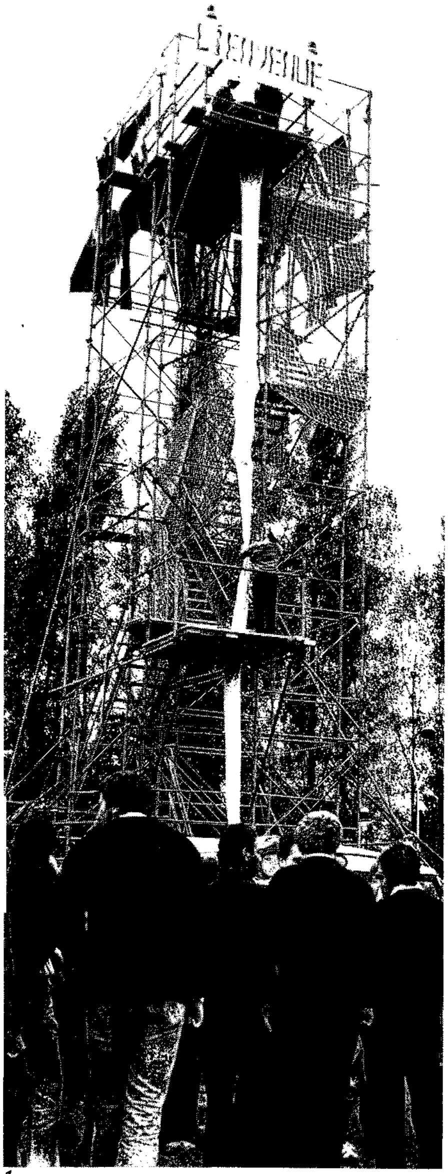
(Photo CERN 271.9.79)

2. An inside view of the CERN Fire Brigade's rescue chute.

(Photo CERN 359.9.79)

3. Over 130 people entered for the various races which had been organized. Everybody got a medal.

(Photo CERN 338.9.79)



1.

2.

3.

Journée du Personnel

On 29 September, the actual 25th birthday of CERN, over 3000 CERN staff, friends and relatives turned up to enjoy the 'Journée du Personnel' (Staff Day). Among the attractions were games, sports, sideshows, competitions, films, music and entertainment, and dancing that went on into the small hours. One highlight was the playing of 'Happy Birthday, CERN — From Fermilab', recorded at Fermilab. The song was composed by Arthur Roberts, and directed by Janice Roberts, with R. Lubway as soloist. Among those in the chorus were Leon Lederman, Dick Carrigan, John Peoples and Drasko Jovanovic:

I.

Near the lake of Geneva, near the ski slopes Jurassic,
Lies a physics Yeshiva, in a home neoclassic.
They've a budget elastic, their machines are the best —
Their ideas are fantastic, and precisely expressed.

They're smart, they're rich,
they've heart — they've which?
They're the elite — who can compete? Ah...

Some of the 52 staff with 25 years' service at CERN who took part in a special ceremony on 29 September.

(Photo CERN 425.9.79)

Refrain:
CERN is great!
Twenty-five and still expanding,
CERN's first-rate,
Sneers and envy notwithstanding,
CERN's well-run,
Trying to gain a lead commanding,
Everything a physicist desires is at CERN!

II.

The cafeteria's stupendous, serves ambrosia and nectar,
All the leaders tremendous, from concierge to director,
Electronics transcendent, wire chambers are tops,
Superstars most resplendent, also excellent shops.

They've guile, they're sleek,
they've style, they've chic!
Their pace is fleet and hard to beat! — Ah...

CERN is great!
Physics there's a thing of wonder!
CERN's first-rate!
Selection panels never blunder.
CERN's well run!
Just a little blood and thunder.
Everything a physicist desires is at CERN!

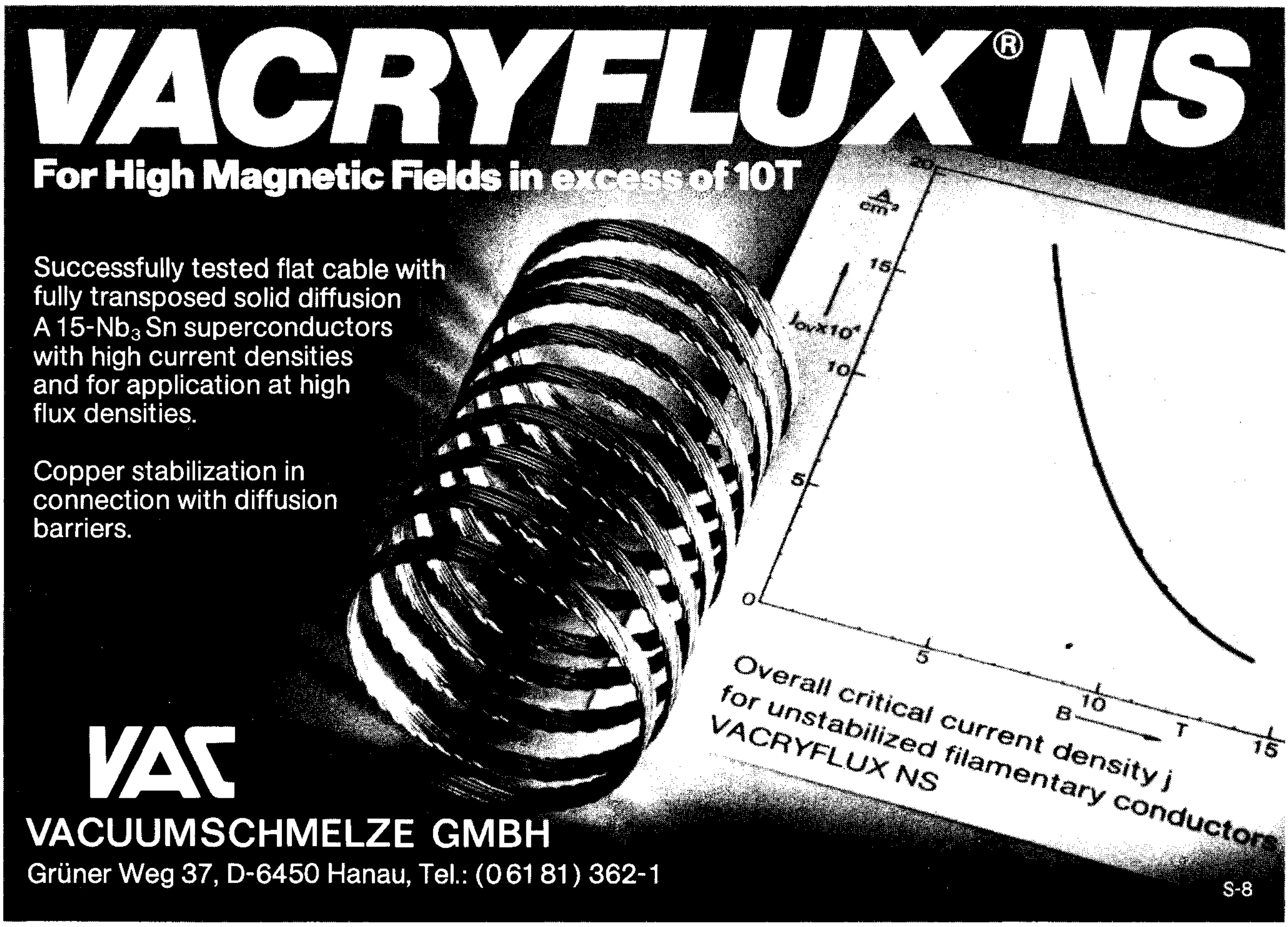
III.

Here's the toast we're proposing:
may your future be greater,
And the budget imposing for your next accelerator;
May your staff be effective and your beams full of pep,
May you gain your objective of constructing the LEP!

They're tough — that's true.
They're rough — That too.
They're kind — they're not!
They're sweet — they're WHAT?
Ah...

CERN is great! All good men find recognition,
CERN's first-rate! Bright ideas all reach fruition,
CERN's well run! Decisions all above suspicion,
Everything a physicist desires is at CERN.

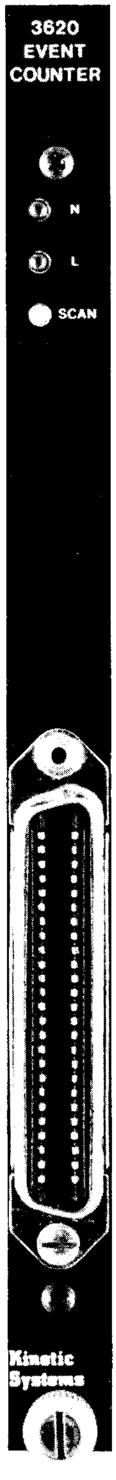
CERN is great! Everybody loves each other!
CERN's first-rate! Trust each other like a brother!
CERN's well run! Except one guy I'd like to smother!
Everything a physicist desires is there!


VACRYFLUX® NS
For High Magnetic Fields in excess of 10T
Successfully tested flat cable with fully transposed solid diffusion A 15-Nb3 Sn superconductors with high current densities and for application at high flux densities.
Copper stabilization in connection with diffusion barriers.
Overall critical current density j for unstabilized filamentary conductors VACRYFLUX NS
VAC
VACUUMSCHMELZE GMBH
Grüner Weg 37, D-6450 Hanau, Tel.: (0 61 81) 362-1
S-8


SELF-EXTINGUISHING AND CHLORINE-FREE CABLES
NOflamm
CABLES AUTOEXTINGUIBLES ET SANS CHLORE
COSSONAY
SOCIETE ANONYME DES
CABLERIES & TREFILERIES
DE COSSONAY
Vente par CABLEX S.A., B.P. 274, 1110 MORGES, Tél. 021/71 09 81, Télex 257 84

Kinetic Systems Adds

Event Counter to CAMAC Line



3620

WITH THE ADVENT of the new 3620 Multichannel Counter, our line of CAMAC timing and counting modules beomes even more flexible. Complementing existing KineticSystems high-speed counters, this module is designed specifically to handle your low-speed applications (up to 200 hertz) where the counting source is a relay contact or has a slow rise time.

FEATURES OF THE 3620

- 24 independent counters
- maximum count, each counter, 24 bits
- on-board microprocessor
- contact bounce filter on each input
- count rate, DC to 200 hertz
- LAM on overflow
- many input options

The 3620 contains twenty-four independent 24-bit counters and associated input circuits. The 24-bit word of data stored for each input channel provides for an accumulated count from 0 to 16,777,215. An on-board microprocessor scans the input channels and increments the count in RAM memory when an input has changed from its Zero to One state. The LAM is set when an overflow is detected in any counter. All I/O connections are made via the 50-contact ribbon connector on the front panel.

A VARIETY OF INPUT OPTIONS

The 3620 is available with numerous input options, both isolated and non-isolated.

Isolated. Each circuit is a floating pair that is isolated from ground with voltage breakdown of greater than 500 volts. LED/phototransistor optical isolators are used. Users can choose from three different voltage options: 12, 24, and 48 volts DC. The switching threshold is approximately one half of the nominal voltage.

Nonisolated. Each circuit is single-ended with a ground return. The signal level option operates at TTL level.

READING DATA COUNT

The count for any channel is read by setting the channel address to that input channel and then reading the register. Data is available several microseconds after the address is changed. A Q=0 response will be given if data is not yet fetched. For most program transfer sequences, the data will be available before the read command is executed. To read a block of channels, the address of the first channel is written, followed by read commands. The address increments after each valid command.

CONTACT BOUNCE FILTERING

Each input incorporates a CMOS Contact Bounce Eliminator which is basically a digital integrator. This bounce eliminator is composed of a 4 1/2-bit register (the integrator) and logic to compare the input with the output of the shift register. Internal clock frequency controls the filter time constant. This filtering is necessary to prevent multiple counts due to contact bounce. The 24 counter inputs are divided into four groups of six with each group under the control of one Hex Bounce Eliminator IC. Each IC has an internal clock source. Strap options have been provided to allow a single clock to drive any or all of the other groups.

Please contact us for additional information

Kinetic Systems International S.A.

the CAMAC people

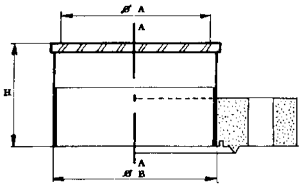
Dept. CC119 * 6 Chemin de Tavernay * 1218 Geneva, Switzerland * Tel. (022) 98 44 45 * Telex 28 9622
KineticSystems Corporation * 11 Maryknoll Drive * Lockport, Illinois 60441 * Tel. 815 838 0005 * TWX 910 638 2831

vérélec
91, av. de Villeneuve-Saint-Georges - 94600 Choisy-le-Roi - tél. 890 89.90 et 890 92.17
FRANCE

HUBLOTS D'OBSERVATION (amagnétiques)

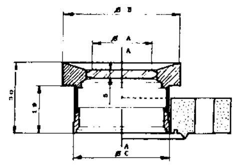
vérélec

• fenêtres cristal 801-51 Pyrex

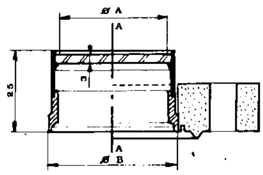


REF.	Ø A optique	Ø B inox	H
HCA 01	20	25	30
HCA 02	25	31,8	35
HCA 03	30	38	36
HCA 04	45	51	40
HCA 05	55	63	42
HCA 06	66	76	48

• fenêtre quartz

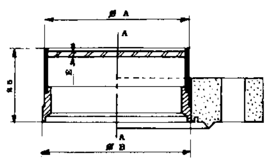


REF.		Ø A optique	Ø B	Ø C
HAQ 1.01	cotes en mm	22	45	40
HAQ 1.02		32	60	50
HAQ 1.03		42	75	70
HAQ 1.04		52	90	80



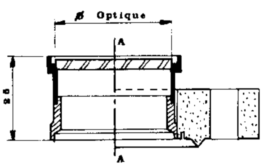
REF.		Ø A optique	Ø B	Ø C
HAQ 2.01	cotes en pouces	0,60	0,75	0,08
HAQ 2.02		0,84	1	0,08
HAQ 2.03		1,34	1,5	0,10

• fenêtre saphir

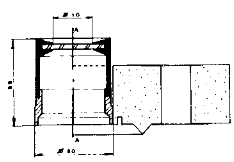


REF.		Ø A optique	Ø B	Ø E
HAS 01	cotes en mm	16	20	2
HAS 02		26	30	2
HAS 03		36	40	2
HAS 04		46	50	2,5
HAS 05		56	60	3
HAS 06	cotes en pouces	0,84	1	0,08
HAS 07		1,34	1,5	0,08
HAS 08		1,84	2	0,10
HAS 09		2,34	2,5	0,12

• fenêtre geranium



• fenêtres Fluorure de lithium Fluorure de magnésium



En outre, notre activité ne se limite pas au matériel présenté ici, une équipe de techniciens se tient à votre entière disposition pour étudier toute réalisation sur plan ou toute modification du matériel standard.

The latest techniches are used. Also we guarantee a perfect nightness. All our production is tested with helium. In addition our activity is not limited to the material presented here, a team of technicians is at your entire disposal for studying any work from drawing or any modification of standard equipment.

vérélec
FRANCE
Distributeur officiel POUR LA SUISSE
VACOTEC, 3, rue des Flamands, 2525 LE LANDERON/NE
91, av. de Villeneuve-Saint-Georges - 94600 Choisy-le-Roi - tél. 890 89.90 et 890 92.17

New high-level modular real-time system

The Macamac microcomputer design features:

New concept:
- self contained system
- resident development aids
- High level interpreter links Assembler modules
- Hardware Arithmetics, DMA + Communication
- Resident file handler links standard mass storage

High level software:
- Algorithmic
- Interfacial
- Interrupt and file handler
- Extensive user's library

Modular:
- Software
- Hardware

Interactive:
- Fast development cycle
- user-oriented dialogue
- handy service routines

Standard:
- International standard bus (CAMAC/IEEE 583)
- normalized mechanics
- language compatible with BASIC

On line:
- program development
- testing
- debugging
- operation

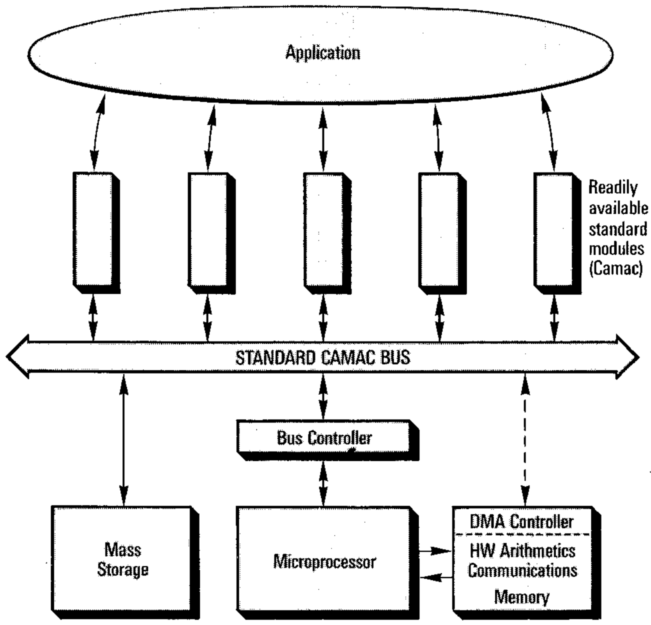
Real time:
- prompt interrupt handling
- built-in clock and time reference
- automatic powerfail restart

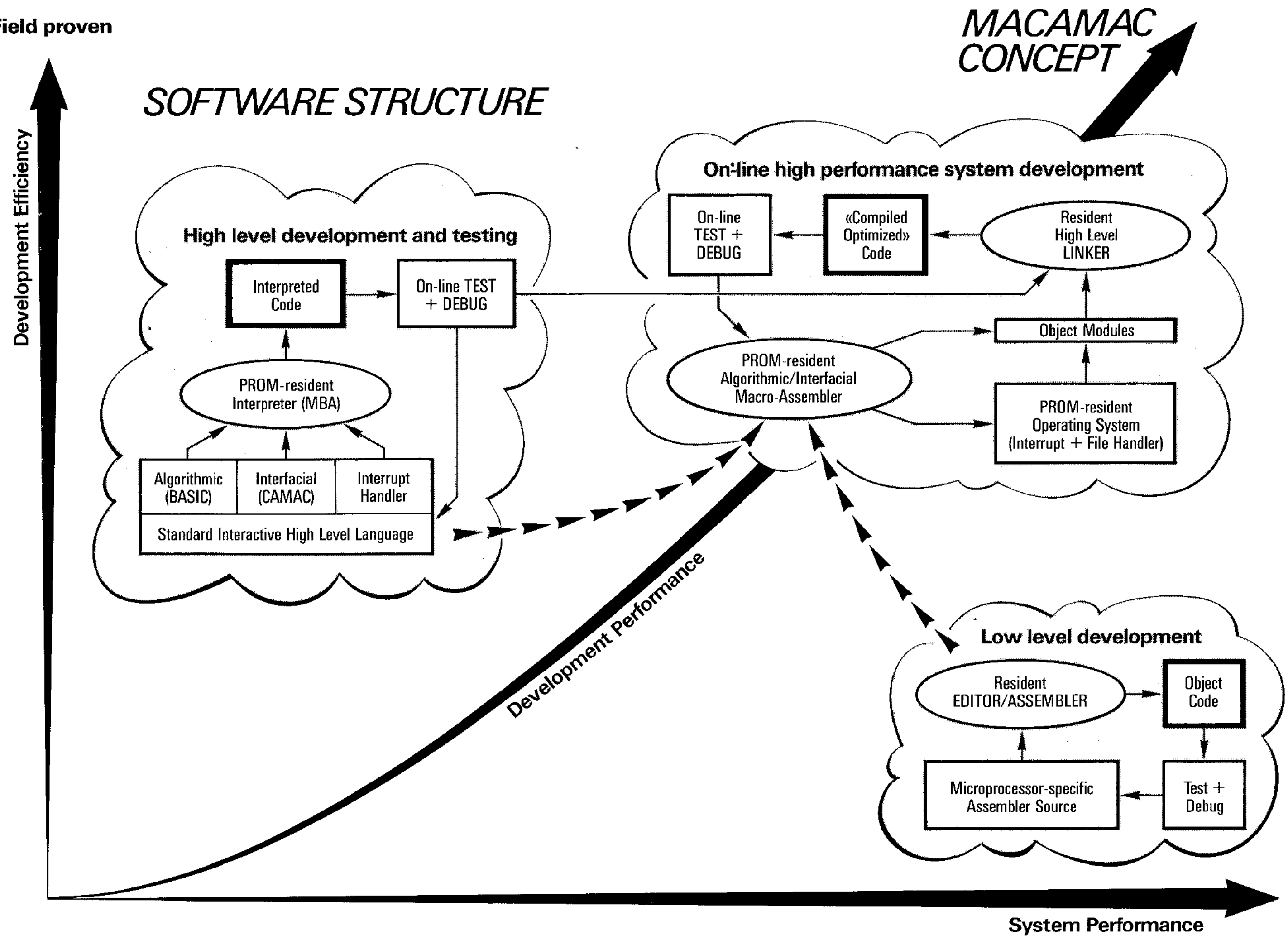
Fast operation:
- hardware options e.g. DMA
- assembler modules

Resident:
- development and library

Field proven

HARDWARE CONFIGURATION





BORER ELECTRONICS AG, 4501 Solothurn, Switzerland. Tel.: 065/311131
BORER ELECTRONICS GmbH, Rellinghauserstr. 304, 4300 Essen 1, W. Germany. Tel.: 0201/25928
BORER ELECTRONICS, Box 17–126, West Hartford, CT 06117, USA. Tel.: 203 677 8022

borer

CAMAC

The most powerful intelligent CAMAC controller system.

– from SEN ELECTRONIQUE

description

During the past few months we have introduced the various elements of the new SEN Controller system: in this issue we wish to describe the software and typical applications.

The heart of the system is a powerful ***16-bit microprocessor*** (TMS 9900) associated with 16K-RAM, 2K-EPROM and TTY interface, located on a single CAMAC PC-board which is found in each of the intelligent units of the system (ACC 2099, ACC 2103 and STACC 2107).

Front-end processing in a typical problem of large CAMAC process – control and data collection systems. The ACC provides the best solution to this problem due to its processing power and easy implementation in the system – ***both hardware and software.***

On the hardware level, the ACC 2099 or ACC 2103 is compatible with all commonly used controllers – the A2 parallel controller, the L2 serial controller and the NORD 10 dedicated controller. Due to its very high density, a minimum of CAMAC space is lost to achieve front-end processing as fast as the main computer.

Software implementation is achieved by simply adding-on the front-end programs to your existing software. The front-end programs can be either assembly programs or high level programs loaded down-line through the crate controller into the ACC RAM memory, or resident in the ACC EPROM memory. Assembly programs are normally written on the host computer using cross assemblers: high-level programs in NODAL – a BASIC with floating point arithmetics – are written, either on the NORD 10 main computer using a cross-compiler*, or locally at the ACC level using an EPROM resident NODAL interpreter. Debugging facilities are available at the ACC level.

Test and stand-alone systems have the common problem of simulating the exact environment of the under-test device. Our new CAMAC controller system is able to test the device through the same controller used in the experiment and under the same software. The front-end system can be converted into a stand alone system simply by placing the CAMAC branch off-line. Test programs are loaded from a floppy disc connected directly to the ACC (ACC 2103 only). For permanent stand-alone systems, the STACC 2107 (Stand-Alone CAMAC Computer) combines the functions of a microprocessor and a controller. A floppy disc resident software is also available.

* available from CERN, div. SPS

for more details, please contact SEN ELECTRONIQUE

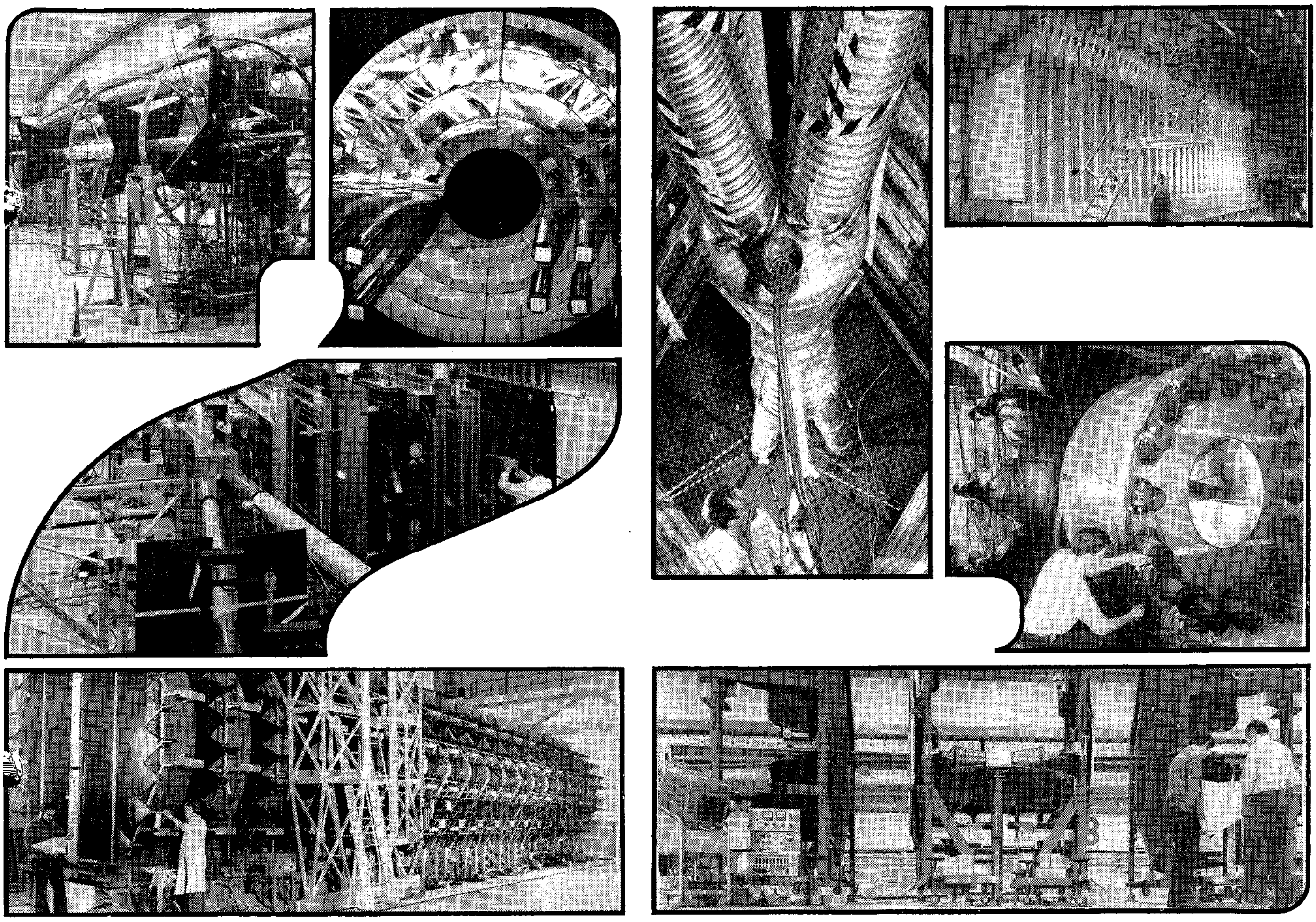
France: **ORTEC Sarl**; 7, rue des Solets; Tel. (1) 687 2571 - Tlx 202553F, F-94 RUNGIS – **Germany: SEN ELEKTRONIK GmbH**; Brandstücken 11; Tel. 041 80 2046 - Tlx 2163705d, D-2000 HAMBURG 53 – **DIDAS Digital System**; Radspielstrasse 8; Tel. 089 916710 - Tlx 529167d - D-8000 MÜNCHEN 81 – **Switzerland: SEN ELECTRONIQUE SA**; CP 39; Tel. (022) 442940 - Tlx 23359ch - CH-1211 GENÈVE 13 – **SEN ELEKTRONIK AG**; Austrasse 4; Tel. (01) 9455103; Tlx 58257ch - CH-8604 VOLKETSWIL – **United Kingdom: SEN ELECTRONICS LTD**; London Street; Chertsey; Tel. 9328.66744 - GB - KT168AP SURREY – **OFFICES THROUGHOUT THE WORLD.**

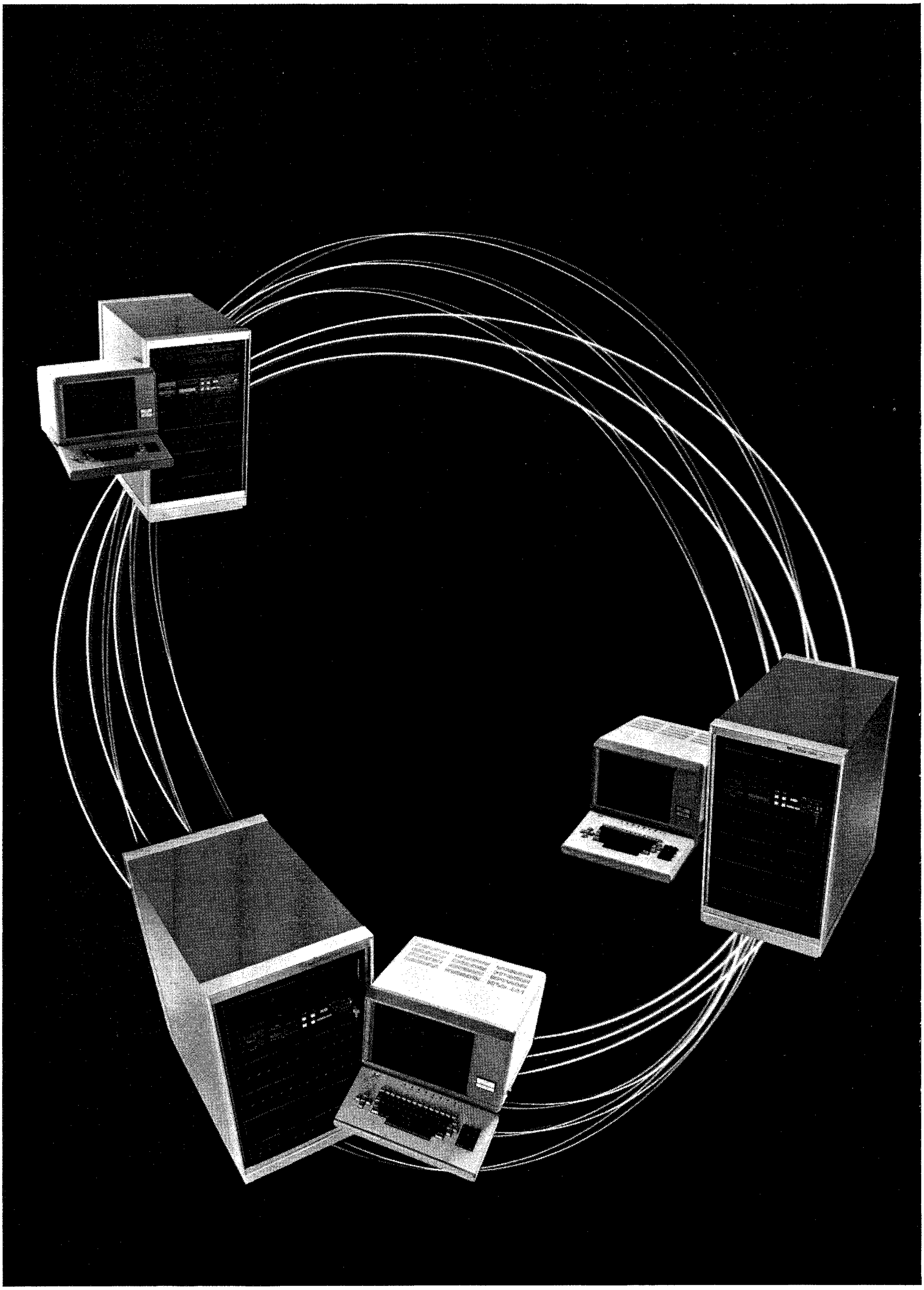
Headquarters:

SEN ELECTRONICS S.A.; Avenue Ernest-Pictet 31; Tel. (022) 442940 - Tlx 23359ch - CH-1211 GENÈVE 13.

SEN

ELECTRONIQUE





NORD-100 - la nouvelle gamme d'ordinateurs Norsk Data allant du "mini" au "supermini"

NORD-100 bénéficie du logiciel complet éprouvé depuis des années sur le matériel Norsk Data dans des domaines aussi variés que la gestion, la recherche et l'éducation, les réseaux d'ordinateurs, la communication, le contrôle de processus, le traitement de texte et beaucoup d'autres. La gamme des NORD-100 offre des modèles de 90 000 francs à 1 400 000 francs totalement compatibles avec des possibilitiés d'extension du plus petit au plus performant. De plus, une grande variété de systèmes multiprocesseurs est disponible. La gamme NORD-100 est entièrement compatible, tant au niveau logiciel qu'au niveau matériel, avec le NORD-10, mais elle est conçue à partir de la technologie la plus récente. La performance du processeur est considérablement améliorée, la mémoire centrale peut être augmentée jusqu'à 32 moctets et la capacité des disques jusqu'à 2300 moctets.

La gamme NORD-100 supporte le logiciel de Norsk Data:

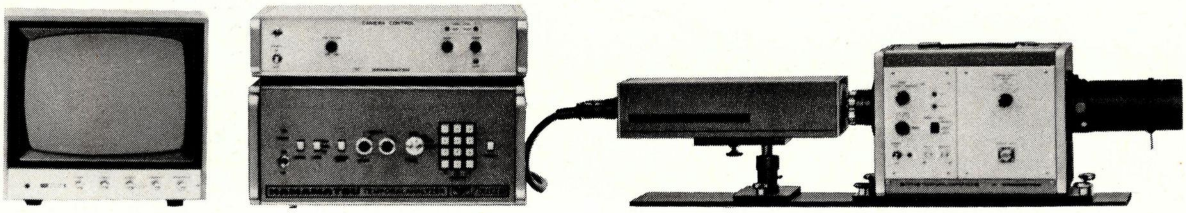
- le système d'exploitation SINTRAN III/VS créé en 1973 permettant les traitements temps réel, temps partagé, par lot en local ou à distance simultanément.
- COBOL, FORTRAN, BASIC, RPG II, PASCAL et SIMULA.
- le système de gestion de base de données: SIBAS, le premier SGBD aux normes CODASYL sur un mini-ordinateur en 1973.
- le système de gestion de transactions TPS sur un ou plusieurs ordinateurs.
- NSHS gestionnaire d'écrans, DATA ENTRY, système d'acquisition de données.
- NORDNET, logiciel de communication pour ordinateur NORD, compatibilité x 25, émulateur de communication vers des centres IBM, HB, CII, CDC, Univac.

Norsk Data

Ferney-Voltaire:
Norsk Data France
"Le Brevent"
Avenue du Jura
01210 Ferney-Voltaire
Tel.: (050) 40 85 76
Tlx.: 385653 nordata fernv

Paris:
120 Bureaux de la Colline
92213 Saint Cloud Cedex
Tel.: (01) 60 23 366
Tlx.: 201108 nd paris

Which Streak Camera System is best for you?



10 PICOSECOND TIME RESOLUTION

TEMPORALDISPERSER MODEL C-979

- Exclusive streak tube with built-in MCP*
- Dynamic range better than 1:100
- Trigger jitter less than ±50 ps
- Streak speeds full scale 1, 2, 5, 10 ns fast plug-in, or 10, 20, 50, 100 ns slow plug in
- Easy to set up and get operating first day
- Outstanding record of dependable operation worldwide

DELIVERY 30-90 DAYS

X-RAY

TEMPORALDISPERSER MODEL C-1102X

NEW

- Complete with 5° bias custom flange to fit your vacuum chamber port.
- Time resolution better than 30 ps
- Trigger jitter less than ±50 ps
- Exclusive streak tube with built-in MCP*
- Variable sweep speeds controllable at the front panel
- Optional SIT camera/temporalanalyzer readout system available

DELIVERY 6-9 MONTHS

2 PICOSECOND TIME RESOLUTION

TEMPORALDISPERSER MODEL C-1370

NEW

- Time resolution better than 2 ps
- Exclusive streak tube with built-in MCP*
- Trigger jitter less than ±50 ps
- Broad spectral range 200~850 nm (with use of optional UV optics)
- Easy to operate
- Real time analysis

DELIVERY 9-12 MONTHS

1 NANOSECOND TIME RESOLUTION

TEMPORALDISPERSER MODEL C-1155X

NEW

- Ideal for applications too slow for picosecond cameras
- Time resolution better than 1 ns
- Wide range of streak time from 100 ns to 50 μs full screen in a single unit
- Exclusive streak tube with built-in MCP*
- Dynamic range better than 1:100
- Small size, light weight

DELIVERY 6 MONTHS

*Each of the four models features an exclusive Hamamatsu streak tube with built-in microchannel plate (MCP). Provides weak signal amplification greater than 3×10^3, needs no external image intensifier.

CALL OR WRITE FOR DESCRIPTIVE LITERATURE

HAMAMATSU

HAMAMATSU CORPORATION • 420 SOUTH AVENUE • MIDDLESEX, NEW JERSEY 08846 • PHONE: (201) 469-6640

International Offices in Major Countries of Europe and Asia.

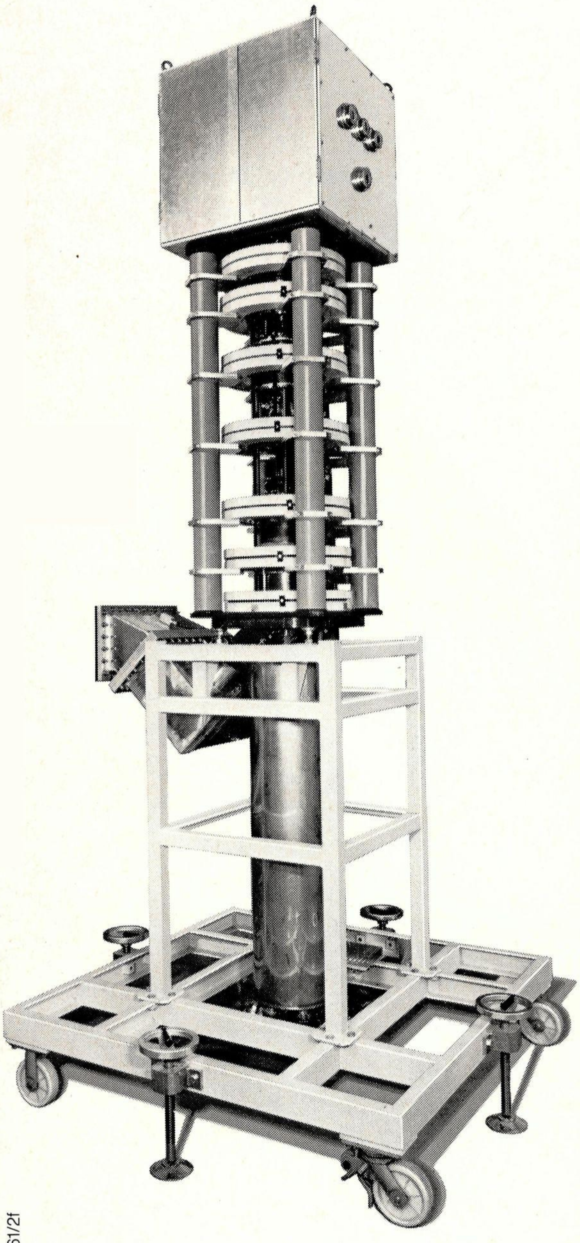

LEMO - universally recognized
to be the finest connectors in the world,
guaranteeing the strongest connections!
Ever since 1957 when the first LEMO self-locking connectors roused the enthusiasm of experts all over the world, LEMO has never ceased setting ever higher standards of quality, culminating in near-perfection from the points of view of appearance, simplicity and efficiency. LEMO connects all types of cable: coaxial, multiple, high voltage and combined. And if your problem calls for a new solution, LEMO will find it for you!
LEMO S.A.
LEMO - Electrotechnique
Tel. (021) 711341 Telex 24 683 1110 Morges (Switzerland)

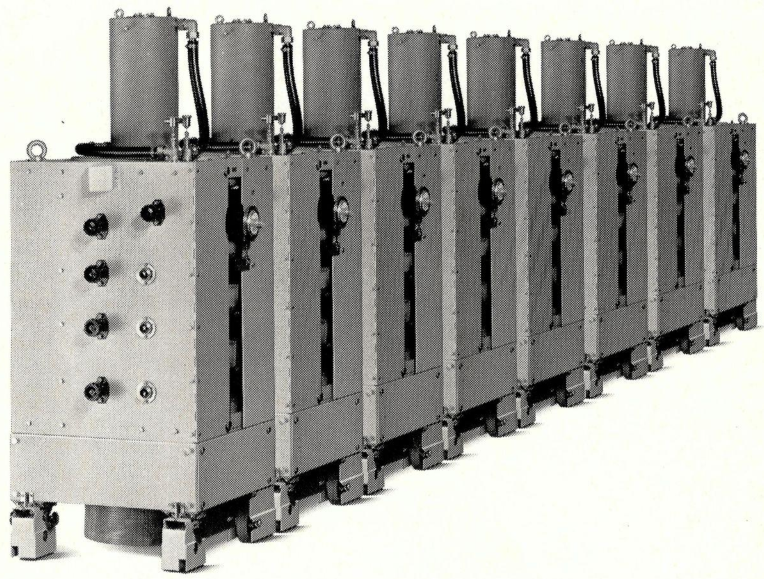
Big Klystrons for Big Science.

Only klystrons deliver the rf power at frequencies between 300 und 1000 MHz needed for research in pure and applied physics.

Highest cw power per unit
realised at DESY/PETRA 600 kW cw at 500 MHz
Efficiencies
in operation 60 %; demonstrated 70 %
Combined operation
of 8 modified UHF TV klystrons at CERN/SPS
450 kW cw at 800 MHz

Progress in development shall lead to still higher efficiencies and powers – $\eta = 75\,\% / P_O = 1000$ kW at $f = 350$ MHz.
For CERN/SPS Valvo has delivered the complete rf power amplifier; BBC, Mannheim and SPINNER, München have been subcontractors.





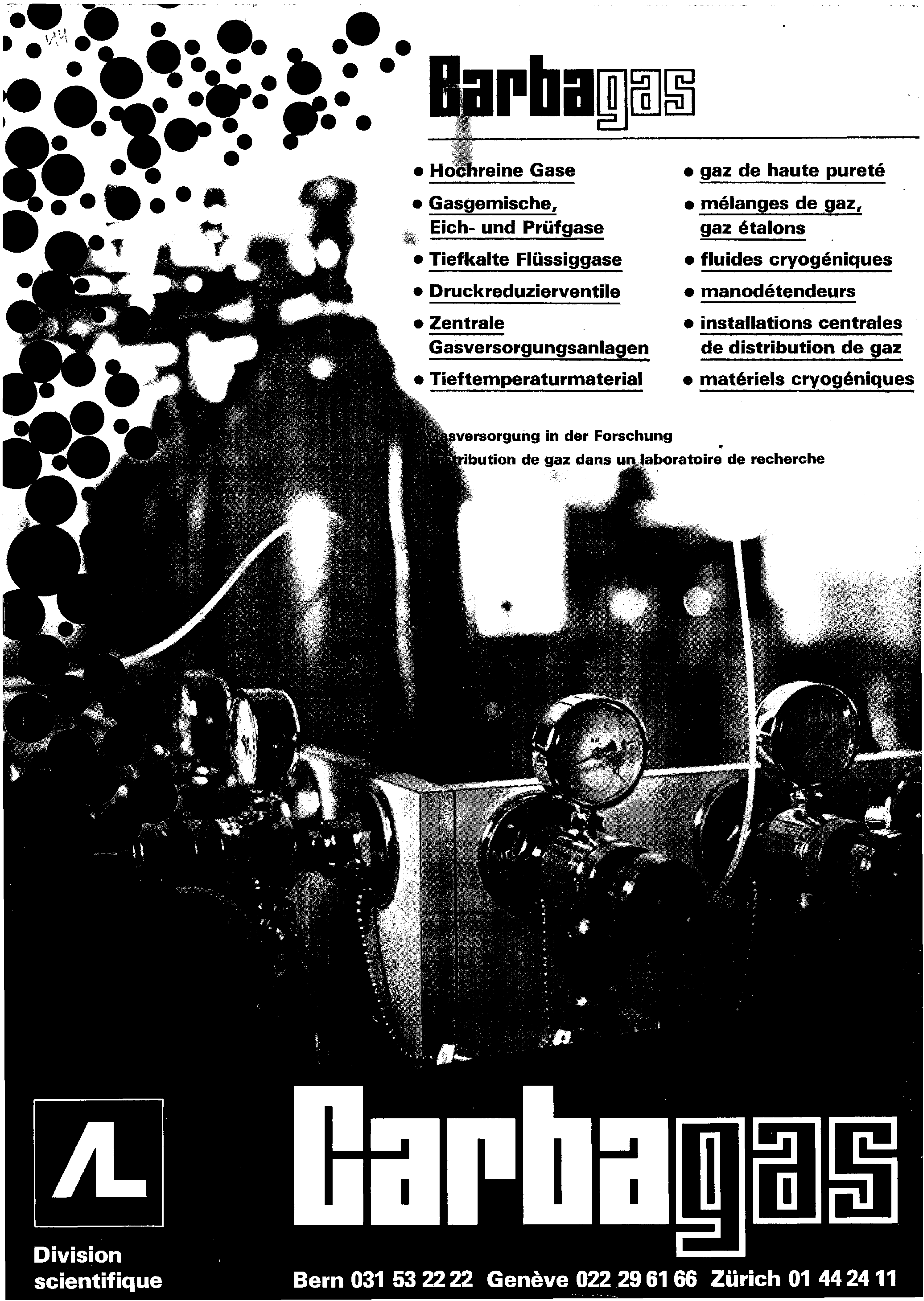
▲ **800 MHz / 450 kW cw**
8 klystrons YK 1198
mounted in their
magnet frames

◀ **500 MHz / 600 kW cw**
Klystron YK 1300
mounted in its
magnet frame

1179/1461/2f

Burchardstraße 19
D-2000 Hamburg 1

Bauelemente
für die gesamte
Elektronik
VALVO


Carbagas
• Hochreine Gase
• Gasgemische, Eich- und Prüfgase
• Tiefkalte Flüssiggase
• Druckreduzierventile
• Zentrale Gasversorgungsanlagen
• Tieftemperaturmaterial
• gaz de haute pureté
• mélanges de gaz, gaz étalons
• fluides cryogéniques
• manodétendeurs
• installations centrales de distribution de gaz
• matériels cryogéniques
asversorgung in der Forschung
tribution de gaz dans un laboratoire de recherche
AL
Division scientifique
Carbagas
Bern 031 53 22 22 Genève 022 29 61 66 Zürich 01 44 24 11