CERN COURIER

NO. 5 VOL. 15 MAY 1975

CERN, the European Organization for Nuclear Research, was established in 1954 to '... provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, theoretical and experimental, in the field of sub-nuclear physics. This branch of science is concerned with the fundamental questions of the basic laws governing the structure of matter. The Organization has its seat at Meyrin near Geneva in Switzerland. There are two adjoining Laboratories known as CERN Laboratory I and CERN Laboratory II.

CERN Laboratory I has existed since 1954. Its experimental programme is based on the use of two proton accelerators — a 600 MeV synchro-cyclotron (SC) and a 28 GeV synchrotron (PS). Large intersecting storage rings (ISR), are fed with protons from the PS for experiments with colliding beams. Scientists from many European Universities as well as from CERN itself take part in the experiments and it is estimated that some 1500 physicists draw research material from CERN.

The CERN Laboratory I site covers about 80 hectares almost equally divided on either side of the frontier between France and Switzerland. The staff totals about 3200 people and, in addition, there are about 1000 Fellows and Scientific Associates. Twelve European countries contribute, in proportion to their net national income, to the CERN Laboratory I budget, which totals 410 million Swiss francs in 1975.

CERN Laboratory II came into being in 1971. It is supported by eleven countries. A 'super proton synchrotron' (SPS), capable of a peak energy of 400 GeV, is being constructed. CERN Laboratory II also spans the Franco-Swiss frontier with 412 hectares in France and 68 hectares in Switzerland. Its budget for 1975 is 237.9 million Swiss francs and the staff totals about 450.

CERN COURIER is published monthly in English and French editions. It is distributed free to CERN employees and others interested in sub-nuclear physics.

The text of any article may be reprinted if credit is given to CERN COURIER. Copies of most illustrations are available to editors without charge.

Advertisements are published on the sole responsibility of the advertisers.

Editor: Brian Southworth
Assistant Editors: Henri-L. Felder
Michel Darbin
Advertisements: Micheline Falciola
Photographs: PIO photographic section

Public Information Office
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 41 98 11 Telex 2 36 98

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

Contents

Superconducting magnets

CERN News

Around the Laboratories

Cover photograph : Gone fishin' — a most agreeable way to spend a working day in Spring. During the past year samples of air, water, etc.. . have been taken around the site of the CERN 400 GeV proton synchrotron to confirm that the coming into operation of the machine will not affect the environment from the point of view of radiation. (CERN 39.3.75)

Superconducting magnets A post-Frascati review

The Fifth International Conference on Magnet Technology was held from 21 -25 April. It is usually referred to as the Frascati Magnet Conference since its initially intended rendezvous was the Frascati Laboratory, until the attendance grew to around 300 and necessitated a move to a conference hall in Rome itself.

Our interests focus on the use of agnets in high energy physics research and it is still true that in many aspects of magnet technology, the extreme requirements of this research continue to push the technology further than elsewhere, as they have done in the past. Some other fields were, however, much more prominent than at previous magnet conferences.

This was particularly true of fusion research where recent advances in technique, coupled with the world energy crisis, have refired the desire to bring thermonuclear fusion reactions under control. An important route to such reactors requires large, complex, high precision magnet systems (Tokamak variety), which now 'esent the biggest challenges to magnet designers. This work was initiated in the Soviet Union under the late L.A. Artsimovich. A fine example of such a system is being developed at Frascati itself in a group headed by R. Toschi (reported at the Conference by L. Anzidei) ; a huge system — 250 million dollars worth — is to be built at Princeton USA (headed by FermiLab accelerator builder P.J. Reardon) and the European 'JET project' is on the horizon.

Magnets in medical applications also drew a good deal of attention. There are various 'medical beamlines' being developed at accelerators. The Los Alamos LAMPF team, urged on by M. Kligerman, are prominent here, having carried out the first patient irradiations, and there is work at Berkeley, SIN, FermiLab, Rutherford, etc... There are also devices such as the Medical Pion Generator under study at the Stanford High Energy Physics Laboratory (initiated by M. Bagshaw and H.S. Kaplan) using a magnet lens of large aperture with many superconducting coils to give high pion capture rates, and the use of superconducting magnets in surgery (reported by S.J. St. Lorant from the Stanford Linear Accelerator Center — see August 1973, page 221).

It is on superconducting magnets that we will now concentrate.

What does superconductivity offer? Materials which are superconducting pass electric current without resistance. The power requirements fall dramatically, high current densities can be achieved, high magnetic fields can be sustained, compact electrical systems can be built. What does it cost to achieve these advantages? Superconducting materials are comparatively expensive, sizable refrigeration systems are required to achieve the properties of the superconductor. Where does it make sense to select a superconducting solution? Wherever a conventional system cannot, without extreme measures, fulfil a particular requirement (such properties as magnetic field strengths, physical size, etc..) or wherever the costs of a superconducting system come out lower. Here costs include not only the initial capital cost, where superconductivity can rarely win, but also the running costs, where power bills could wipe out the difference in initial cost very quickly. Why are applications of superconductivity not already widespread in industry, public services, etc.? The development of superconducting systems using the new alloy conductors such as niobium-titanium, capable of operation in high magnetic fields, dates back to 1961 and fourteen years is a comparatively short time for radically new technological developments to become established in large scale systems. Here lies one of the important roles of high energy physics Laboratories — to demonstrate the efficacity, the economics and the reliability of superconducting systems. Many of these points were underlined by W. Heinz in his introduction to a review paper at the Conference.

Motors, Trains and Energy Stores

Applications are spreading. There were papers at the Conference on superconducting motors (from J.L Smith, A. Mailfert, A.D. Appleton, and J.P. Paillange) where work is underway in Leningrad USSR, Massachusetts Institute of Technology USA, International Research and Development Co. UK, etc. Small superconducting a.c. generators have been built and have worked well. It remains to demonstrate that they are competitive (commercially and in performance), with the conventional generators, which have years of development behind them, when moving to large systems. It is difficult to persuade power companies to take the plunge for a 1000 MW superconducting plant without more experience. There are some more limited uses such as ship propulsion where a great saving in engine size is feasible, liberating valuable cargo space.

The use of magnets to give high enough fields to levitate trains is under study at several centres (Tesla Engineering Ltd. UK, French National Railways, Mitsubishi Electric Corp. Japan, a consortium of AEG, BBC and Siemens Germany, Francis Bitter National Magnet Laboratory MIT USA) and several model trains have been operated. There were papers by D.R. Willis, considering comparatively slow speed trains using conventional magnets for travel within a city, and by H. Autruffe, considering fast (500 km/h) intercity travel using superconducting magnets. The advantages include low energy consumption and reduced effect on the environment. H.H. Kolm showed a film of the levitated train model at MIT and pleaded its cause very enthusiastically.

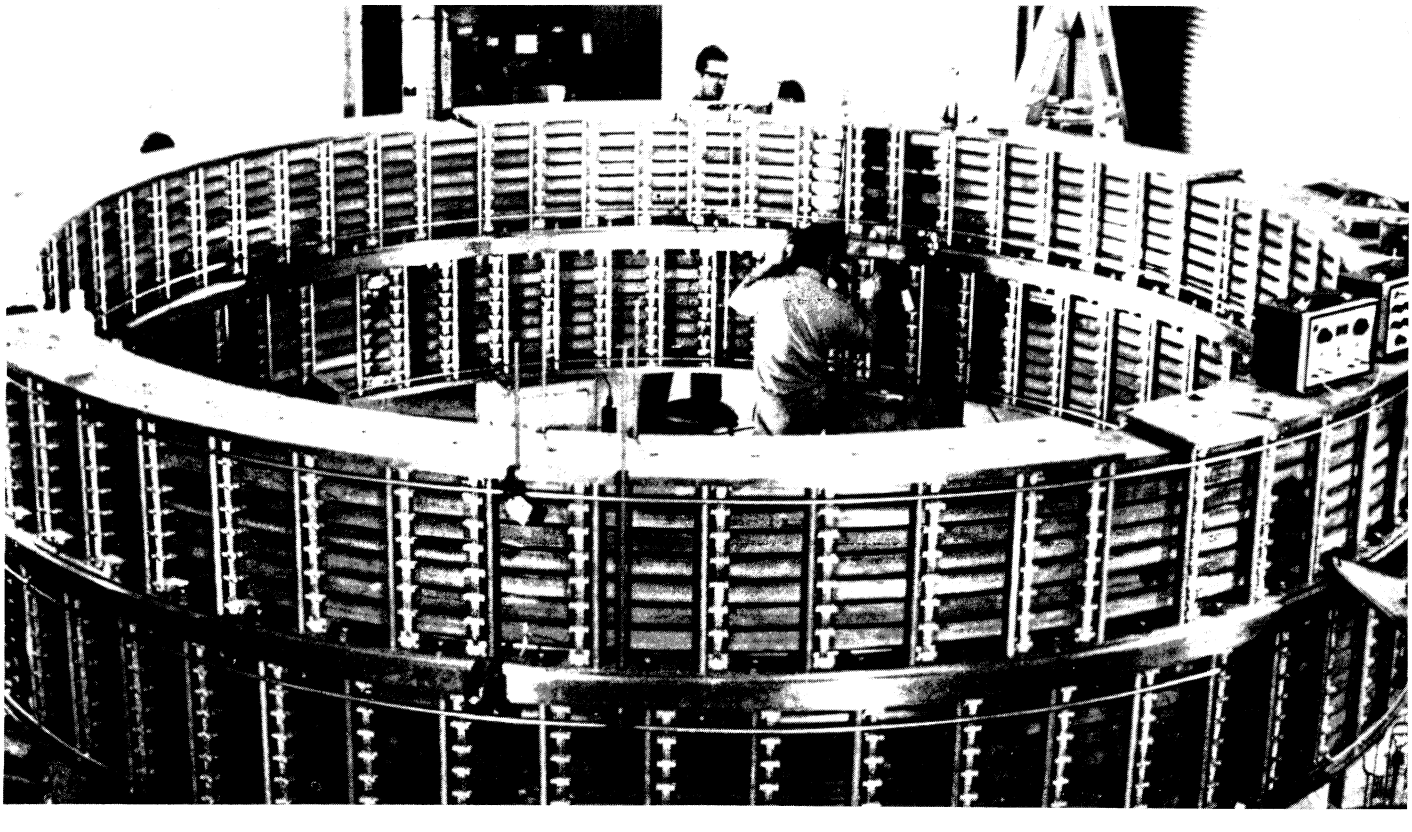
We have discussed the use of large superconducting coils as energy stores before (see September and October 1974). The FermiLab and Karlsruhe have taken a look at these possibilities. Work at Wisconsin was reported by R.W. Boom. It is aimed at huge coils to store energy in the 10 000 MWh range for load-levelling so that power generation need only meet average consumption and not peak consumption. Work at Los Alamos was reported by W. Hassenzahl. It is aimed at smaller systems for transient response to load fluctuations (lasting a second or less). These superconducting coils need not be much bigger than present bubble chamber magnets but must be capable of faster charge and discharge times. Hassenzahl pointed out that, in the world of the power companies, we are operating with a different scale of investment. Load fluctuations are met at present by large gas turbine installations or pumped hydroelectric storage systems — for example, an artificial lake 8 km square is being carved out to receive water pumped up from Lake Michigan.

Turning to superconducting magnets in high energy physics applications — the extent to which superconductivity has come home to roost in accelerator Laboratories was one of the striking features to emerge from the Conference. With the exception of pulsed magnets (which we will come to later) no-one runs away any longer from using a superconducting magnet where it is appropriate. To illustrate how widespread they now are, we will review the present uses of superconducting magnets in high energy physics research and then turn to the future possibilities which are under attack.

Magnets for bubble chambers

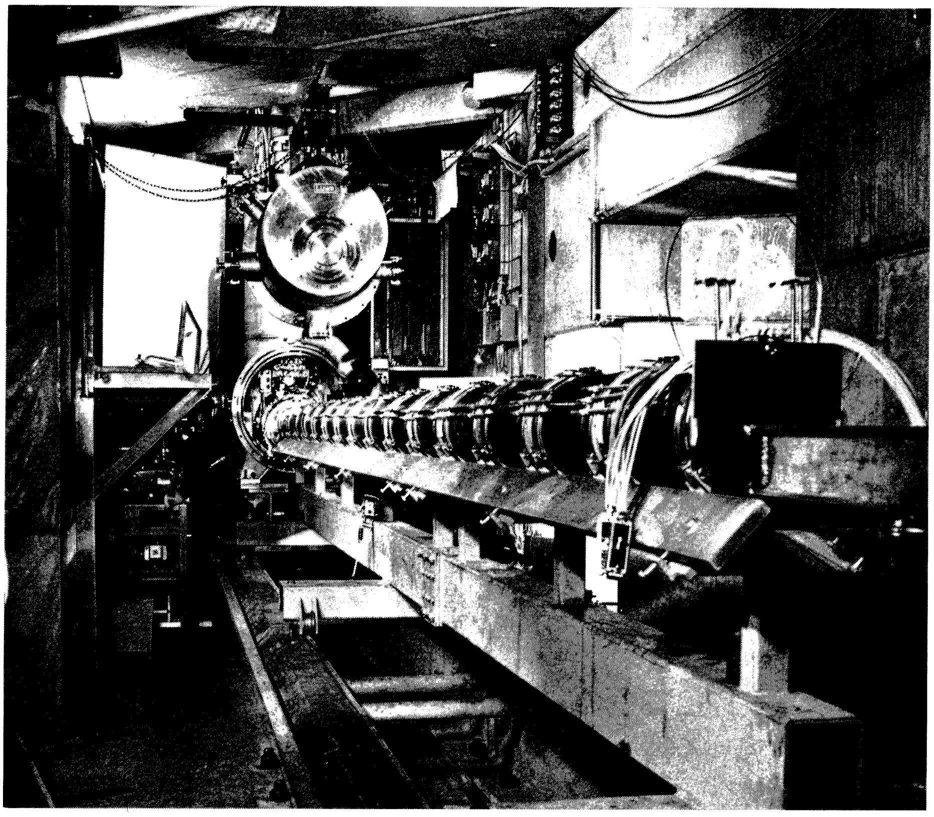
Particle detection systems often like to have high magnetic fields over large volumes. Conventional magnets to achieve this situation can involve high initial costs coupled with very high running costs. This is an obvious application for superconducting magnets. The pioneering work for bubble chamber magnets was done at the Argonne Laboratory which justifiably has a good reputation for instrumentation in general. They built a magnet to give a 2 T field in the 12 foot bubble chamber (see January 1969). It has operated for many years with negligible problems.

The Argonne magnet was succeeded by magnets for the Brookhaven 7 foot with 3 T (see February 1971), the FermiLab 15 foot with 3 T



A coil of the huge superconducting magnet built at Argonne for the 12 foot bubble chamber. This magnet was among the pioneering applications of superconductivity.

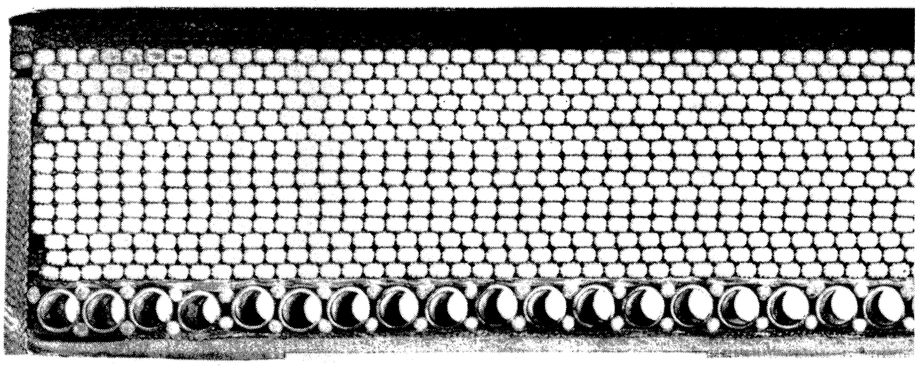
(Photo Argonne)



The superconducting solenoid used in the muon beam-line at the SIN cyclotron. It came into operation remarkably smoothly and is yielding the world's highest fluxes of muons.

(Photo SIN)

Below is a cross-section of the superconductor with the helium cooling channels at the bottom.



(see December 1971) and the 3.7 m European bubble chamber, BEBC, with 3.5 T (see March 1969). As an illustration of power savings, the BEBC magnet absorbs 360 kW while 70 MW would be needed to produce the same field with a conventional magnet.

An interesting smaller-scale magnet was constructed at Vanderbilt University for the HYBUC bubble chamber used in experiments at CERN (see March 1971). It was a hybrid type with a niobium-tin coil inside a niobium-titanium coil giving 11 T along the chamber axis.

Magnets for spectrometers

Similar high field, large volume needs are present in some spectrometers, usually of the multipurpose type. A leader here was the magnet for the Omega spectrometer at CERN with a 1.8 T field in a 1.5 m aperture achieved at the beginning of 1973 (see February 1969). A particular feature is the use of forced cooling with the helium flowing through hollow conductor.

Omega has been succeeded by the Pluto spectrometer (see February 1972) around an intersecting region of the DORIS storage ring at DESY giving 2.2 T in a 1.5 m aperture (and requiring 'compensation' with end coils so as not to perturb the stored beams) and a large aperture solenoid spectrometer, LASS, to give 2.5 T in a 2 m bore which is now under test at Stanford.

Special magnets in detection systems

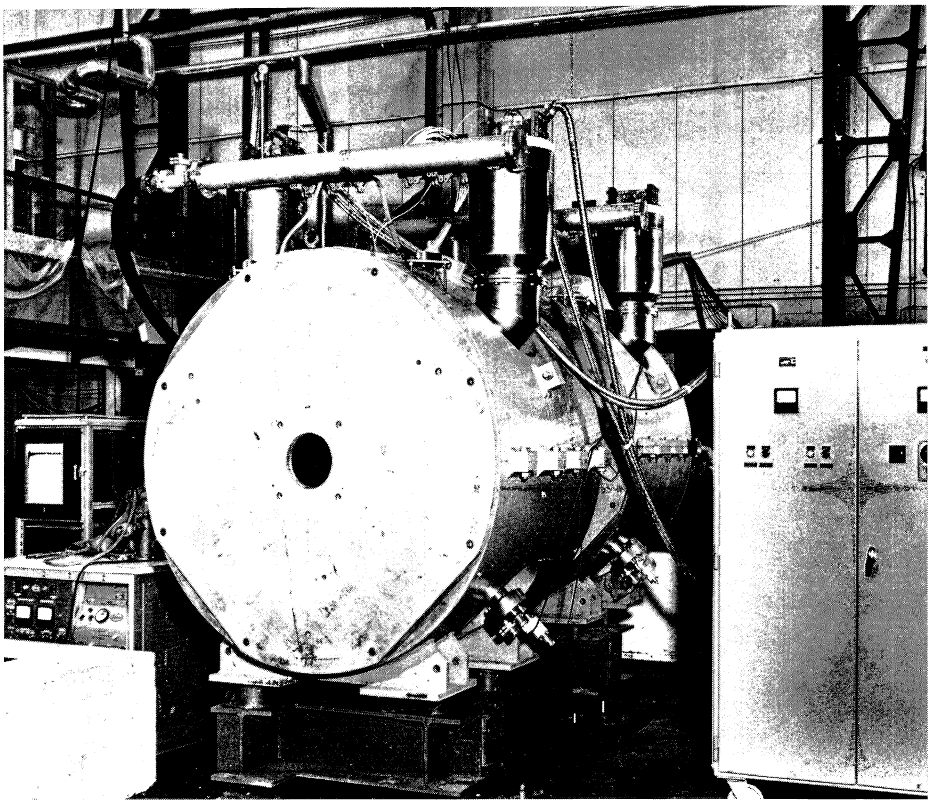
There have emerged some special applications of superconducting magnets in detection systems where features such as high field, small volume etc. have been exploited.

An example of this was the hyperon experiments at CERN (see May 1972). Hyperons are particles which live for around 10^{-10}s which is just long enough to manoeuvre them around after their production so as to observe their subsequent interactions in appropriate detectors. With only 10^{-10} s to play with, it is desirable that the region of the hyperon beam be very compact and this was achieved with two short superconducting quadrupoles. A second stage of this exercise has begun with the preparation of a hyperon detection system for use at the CERN 400 GeV proton synchrotron. Two short superconducting quadrupoles are being built for this at Karlsruhe.

A superconducting solenoid for use in an experiment at the Canadian TRIUMF cyclotron was built at Rutherford (see May 1974). It is a 6 Tesla metre magnet, called BASQUE, where the field is used to precess the spin axis of polarized protons in a scattering experiment.

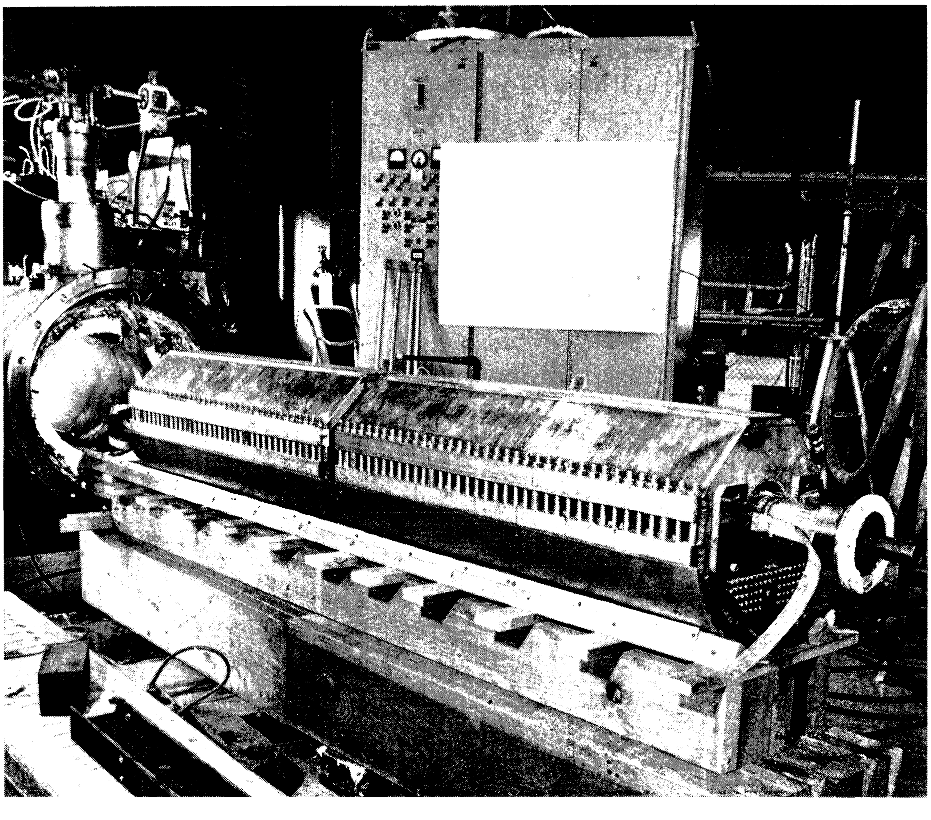
Another solenoid has been built at SIN for a muon channel (see February 1975). It is 8 m long giving a 5 T longitudinal field with the special feature of vacuum impregnated coils and forced helium cooling along one side. The solenoid concentrates muons from pion decay with near 100% efficiency yielding the highest intensity muon beams in the world. It came into operation with remarkable smoothness. As another reminder of operational cost savings — a conventional magnet to do this job would have absorbed 10 MW of power.

Another challenging application of superconducting magnets, which we will manoeuvre artificially under the heading of detection systems since it responds to particular experimental needs, is the possibility of using a set of high field gradient quadrupoles to squeeze the proton beams at an intersection in the CERN Intersecting Storage Rings. This would serve



The superconducting quadrupole doublet, OGA (Optique à Grande Acceptance), which is in action on a pion beam at the Saturne synchrotron at Saciay. It has operated well for over 2500 hours.

(Photo Saciay)



Two pulsed superconducting magnets, ISA I and ISA II, which are prototypes for the ISABELLE 200 GeV proton storage rings. They have pulsed happily for well beyond the number of pulses required in the foreseeable lifetime of the ISABELLE magnets.

(Photo Brookhaven)

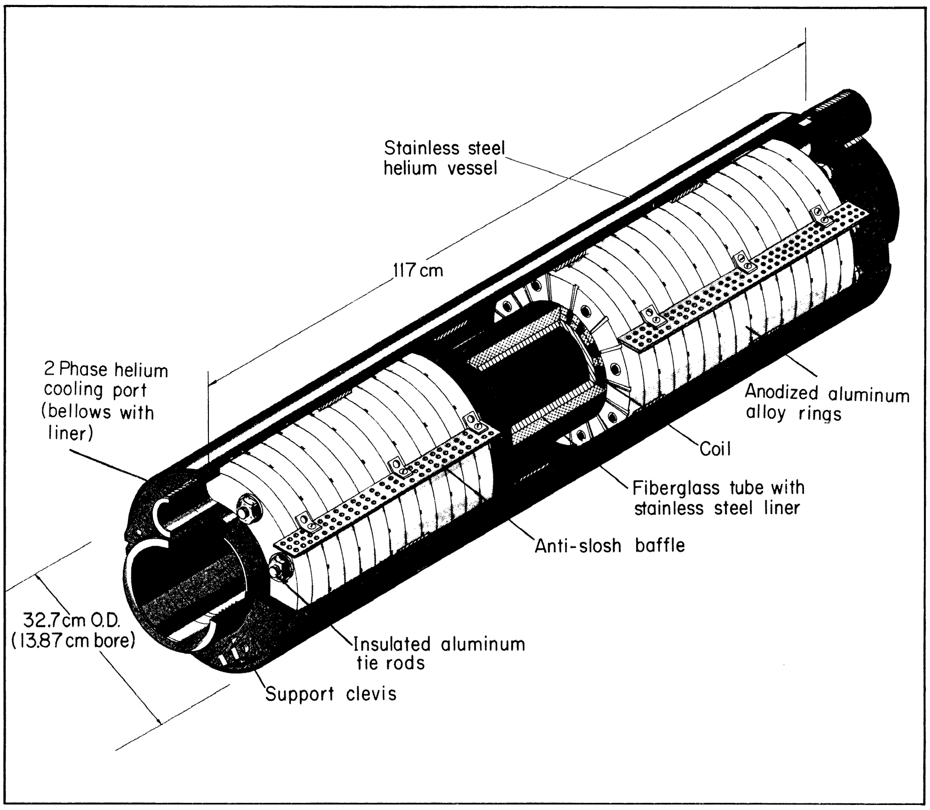
experiments which call for still higher luminosities. They would also test the abilities of superconducting magnets to live in the very stringent conditions prevailing in storage rings. R. Perin reported some quadrupole studies at the Conference. The design emphasis is on meeting the stresses where they occur rather than throughout the magnet structure.

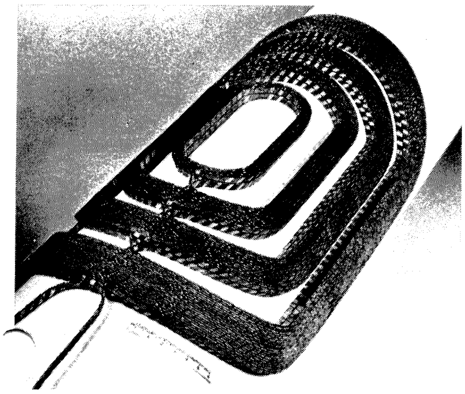
Magnets for beam-lines

As particle energies move higher, it becomes more difficult to bend them in required directions and higher fields become more useful. Alternatively, more bend can be achieved with higher fields acting on lower energy particles. In recent years more attention has therefore been given to the use of superconducting magnets. Their use in beam-lines is a good test-bed for perfecting their operation in accelerator environments and in addition they ease the heavy burden of powering an accelerator plus experimental areas.

In 1973, CERN had a 3.4 T magnet in the secondary beam-line to BEBC CERN (see May 1973), Saciay had r quadrupole doublet, OGA, on a pion beam from Saturne (see May 1972), Berkeley had a quadrupole doublet and 4 T bending magnet in a secondary beam-line at the Bevatron (see September 1973). The same year two 4 T magnets to give an 8° bend in the ejected proton beam-line were installed at the AGS at Brookhaven (see December 1973). These tests showed that such magnets could be used with very little extra attention as compared with conventional magnets and (demonstrated at Brookhaven) that they could tolerate high radiation doses without giving trouble.

Since then superconducting beam-line magnets have spread through many Laboratories. Worthy of particular mention for the near future are





The magnet design for ESCAR at Berkeley — the first superconducting synchrotron to be built. Note that iron is outside the cryostat which is shown. Below is a coil configuration evolved from a long series of dipole prototypes built at Berkeley.

(Photo Berkeley)

a high energy unseparated beam to be installed at Brookhaven, using four large superconducting dipoles, and a 33° bend, which Argonne is installing using magnets developed for the proposed SSR (Superconducting Stretcher Ring). A prototype octant of the SSR is to be installed at the ZGS to handle 12 GeV polarized protons.

Magnets for polarized proton targets

These targets require high fields in small volumes, to help line up the proton spins in a particular direction, and are another candidate for superinducting magnets. The complication is that particles should be able to emerge towards detectors over as wide a range of angles as possible. Designing a magnet to give a high field at the target with no obstruction to emerging particles is a difficult task.

The first to come into operation was at the late-lamented Cambridge Electron Accelerator in 1968. Since then there have been superconducting magnets for many polarized targets.

Saclay built a 2.5 T magnet in 1970 for experiments at CERN and then at Serpukhov and have a 5 T magnet now in operation. Argonne built a C-shaped 2.5 T magnet which first operated in 1973. Daresbury had a target in action for photoproduction measurements in 1974. Rutherford used a superconducting magnet for a 'frozen spin target' (where polarization is achieved in a very high field and the target is then moved to a holding field where there is wide access) in an experiment which was completed this year. They have also recently tested a magnet of novel design which was described in the March issue. SIN has a small magnet giving 1.2 T.

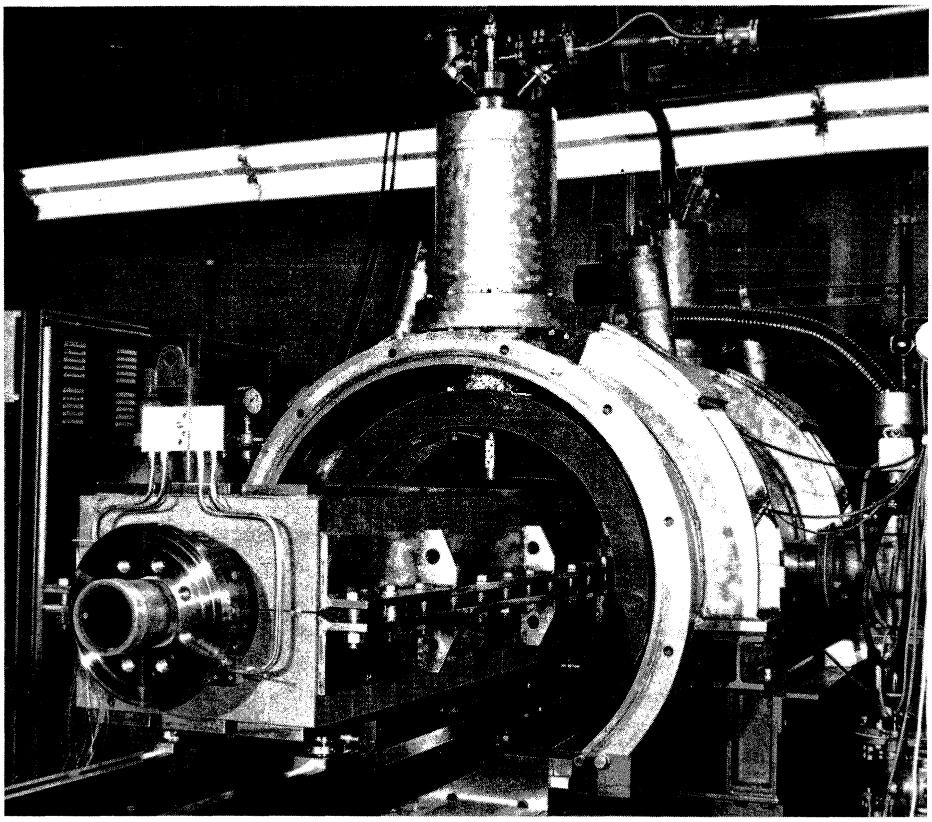
A challenging project for the future of superconducting magnets in polarized proton targets is part of a detection system to extend the studies of deep inelastic muon scattering to the higher energies which will be available at the CERN 400 GeV proton synchrotron. The experiment involves a multi-nation collaboration and the UK component, centred on Daresbury, in collaboration with CERN is considering a large polarized target with a 2.5 T field uniform to 2 parts in 10^4 over the target volume of 1 m by 50 cm.

Pulsed magnets

We turn now to the aspects of superconducting magnets which are not quite so tidy — those involved in the production of pulsed magnets. The interest here lies in the higher peak fields which, in particular, would allow the peak energies of synchrotrons to be taken higher without further increase in machine diameters. To put this into figures with an example — the Fermi Lab proton synchrotron hopes to reach 500 GeV with fields of 2.25 T from the conventional magnets around its 2 km diameter. If 4.5 T superconducting magnets could be used, the energy could reach 1 TeV without increase in the synchrotron diameter. Magnets for such an 'Energy Doubler' are under development at the FermiLab (see September 1974).

There are two other relevant projects in the USA (plus the Argonne SSR mentioned above). At Brookhaven, the future programme has 200 GeV proton-proton storage rings, ISABELLE, as its centrepiece (see August 1971). Pulsed superconducting magnets able to hold the protons as they are accelerated from injection around 30 GeV are a crucial part of the design. The team led by W. Sampson has built four 1 m long model magnets for ISABELLE, the successful tests of ISA IV being reported in the January issue of this year. It has reached 4.5 T and retained good field quality. They are building a full-scale prototype 4.25 m long.

At Berkeley a team headed by T. Elioff, with W.S. Gilbert leading the work on the magnets, is confronting head-on the problems of using pulsed superconducting magnets in a synchrotron by building a 4.2 GeV machine. It is known as ESCAR (Experimental Superconducting Accelerator Ring). This is the first superconducting synchrotron to be built and many of the design parameters



A prototype superconducting pulsed magnet D2a, built at Karlsruhe in the course of the development work to produce magnets suitable for use in a synchrotron. The magnet reached 4.7 T with good field homogeneity.

(Photo Karlsruhe)

are now fixed. (The project was described in February 1974.)

ESCAR will have 56 superconducting magnets, including 24 bending magnets 1 m long. They have to hold the protons from injection energy of 50 MeV up to 4.2 GeV involving a field rise from 0.3 T to 4.6 T. Cryogenically all the magnets are linked in series in a 'weir' system fed by a single 1.5 kW refrigerator. The superconductor for the bending magnets is in a rectangular cable 5><1 mm^2 with 17 strands containing filaments 6 [xm in diameter. The positioning of the conductor in the magnet coil is approximately a cosine distribution having two layers with compact ends. To push the project along, it has been decided to use 'warm iron' in the magnets (i.e. iron outside the cryostat rather than inside, tightly wrapped around the coils). This may not be the best solution for synchrotron magnets but design decisions were necessary before time was available to go carefully through the calculations taking account of saturation effects which would occur in cold iron close to the coils.

The important thing about the ESCAR exercise is that, at last, all the surrounding problems of superconducting synchrotrons — refrigeration, control, reliability, etc. — are being tackled in a way that is hardly touched when dealing with single model magnets. It is possible that many of the approaches in ESCAR will not be absorbed into the design of high energy superconducting synchrotrons but ESCAR's contribution will be to serve as an important test-bed. That is why the emphasis is on the word Experimental in its title.

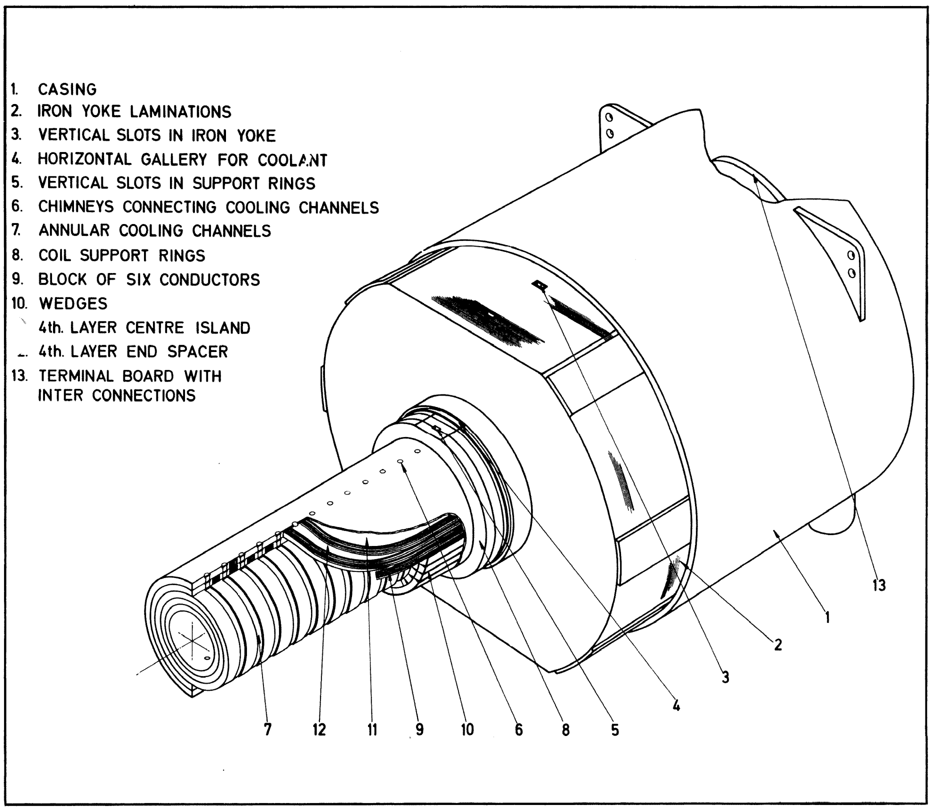
In Europe, pulsed magnets are under attack in the three Laboratories — Karlsruhe, Rutherford and Saclay — which are part of the GESSS collaboration. The collaboration was set up initially to examine the feasibility of incorporating superconducting magnets in the 400 GeV proton synchrotron which is under construction at CERN. Since this possibility faded, given the construction time of the project, and since no other large synchrotron projects are on the horizon, the title of the collaboration has been discretely changed from Group for European Superconducting Synchrotron Studies to Group for European Superconducting Systems Studies. This widening of the task of the collaboration is very important. When so much of the European high energy physics resources are being necessarily concentrated at CERN, to have a broad interesting development programme in superconductivity is an important component to sustain the vitality of these national Laboratories.

There is consultation and full flow of information between the three centres on their superconductivity projects. Many of the topics mentioned above as Karlsruhe, Rutherford or Saclay work were in fact under GESSS auspices. Other topics were described at the Conference in a review \ D.B. Thomas and the collaboration in total, gave sixteen papers.

Under the heading of pulsed magnets, the latest of a series of GESSS prototypes to emerge are the ALEC dipole at Saclay (which achieved a peak field of 5 T as described in the April issue) and AC5 at Rutherford reported at the Conference by J.H. Coupland.

AC5 aimed to eliminate training and to improve field homogeneity by comparison with its predecessors. It is 1 m long with a bore of 10 cm using 15 strand conductor compacted into rectangular cross-section, each strand containing 8900 7 **ptm** niobium-titanium filaments. When potting the coil in epoxy resin, wax strips were incorporated and later washed out to provide the helium cooling channels.

The latest of a series of pulsed superconducting magnets, AC5, at Rutherford, for which the first tests were reported at the Conference. Attention to mechanical rigidity in the design has resulted in a high performance magnet.



Stainless steel bands are shrunk around the coils and this structure is then fitted into a single-piece iron yoke. Training did occur (though it was difficult to spot because the magnet recovered very quickly) and it was interesting that it began at a field of 4 T, exactly the same as with AC4. The increased mechanical rigidity did not affect the onset of training but in other ways gave a much better magnet. The field climbed to 5.2 T and field homogeneity was excellent — no measured harmonic component was in excess of 8 x 10^{-4} over an aperture diameter of 8 cm.

Two other centres of pulsed superconducting magnet activity should be mentioned to complete the picture. The Radiotechnical Institute in Moscow has been doing development work using niobium-titanium superconductor for about eight years (see December 1970). A third prototype, SPD-3, was reported at the Conference by V.P. Alexeev. It is 67 cm long and of 8.5 cm bore with an eight layer coil construction, using 24 strand twisted braid with 10 μm filaments, potted in epoxy resin in one piece. Considerable training was experienced in climbing to a peak field so far of 3.4 T. A second version is being built to test reproducibility.

The KEK Laboratory in Japan is considering high energy proton-proton and electron-proton rings (proton energies up to 180 GeV) in a project known as TRISTAN. For the high energy proton rings they plan to use superconducting magnets rather like those foreseen for ISABELLE at Brookhaven. Development work on the magnets began in 1974.

As a closing comment on pulsed magnets — it is obvious that the phenomenon of training (the progressive move to higher fields over a series of quenches while the superconductor somehow settles down) has not yet been mastered. Even with the careful approach of Rutherford's AC5 to achieve mechanical rigidity, training was not eliminated. The cause may well not be the settling of the whole conductor in the coil (or not exclusively) and there are ideas concerning the relaxation of stresses within the conductor itself. F.R. Fickett, in a neat run-through of material properties, remarked that serrated yielding had been seen when pulling on a superconducting composite wire.

Even if measures to restrain conductor movement have not so far eliminated training, it seems clear that greater mechanical rigidity does result in a better magnet, capable of higher fields. As an illustration of this, a Saclay dipole, used as a polarized target testing facility, was reported by H. Desportes. It had the coil ends bent back and left free initially. The ends were then clamped with plates and, finally, the ends were potted. As each stage improved the mechanical rigidity, the field which could be achieved after training rose higher, finishing (with potted ends) at 6 T. There is a danger, however, in chasing mechanical rigidity too far — it could lead to a very complicated magnet structure. The ultimate aim is to produce hundreds of such magnets for a synchrotron or for storage rings. Complicated structures will make their manufacture in industry difficult and expensive.

Despite the unsatisfactory results with regard to training, it seems that magnets to reach 4.5 T can now be turned out on request. With the experience of ESCAR, in particular, coming in the next two years, the superconducting pulsed magnetsituation should soon be a lot clearer.

Superconducting materials

Superconducting materials were reviewed by M.N. Wilson in the finest paper given at the Conference. Practically all the magnets reported above use niobium-titanium superconductor. The technology of its production is well mastered and the most advanced form of composite conductor for pulsed magnets incorporates fine filaments surrounded by a resistive barrier within a copper matrix. Fine filaments are not necessary in all cases but help reduce losses in a.c. applications. The limitations of this conductor are that it does not retain its superconducting property much beyond current densities of 0.8 kA/mm^2 (which is reflected in the peak fields which can be reached) or at temperatures higher than about 5 K. In particular, this does not allow much leeway with the heat that is generated in a pulsed magnet if we are to avoid sending niobium-titanium 'normal' when cooling by helium at over 4 K.

Other superconducting materials offer higher field operation and higher temperature transitions. Niobium-tin, for example, can tolerate current densities of about 2 kA/mm^2, sustaining magnetic fields twice as high, and also retaining the superconducting property up to a temperature of 18 K. The problem is that niobium-tin is, at present, more difficult and expensive to make and metallurgically difficult to work, since it is very brittle.

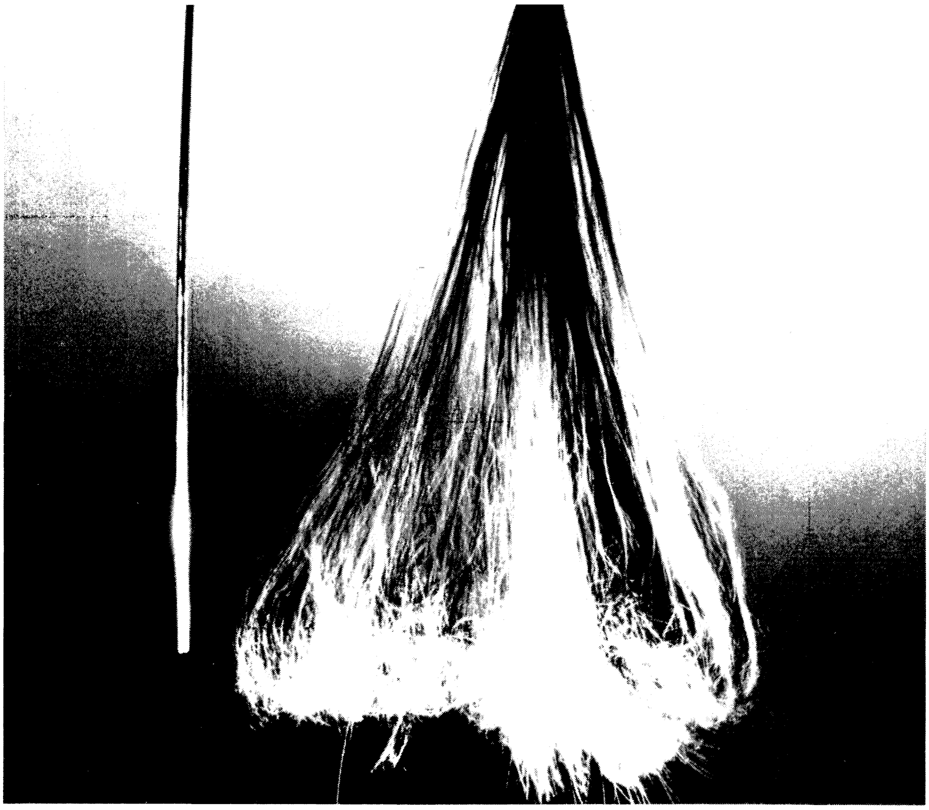
During the past year the possibility of realizing the potential of niobium-tin has come much nearer. Harwell/Rutherford workers have made solenoids using filamentary niobium-tin superconductor with a composite wire of niobium rods in copper-bronze. When the coil is formed, it is cooked and tin diffuses from the bronze to produce the niobium-tin alloy on the surface of the niobium. Pure copper regions, protected by an inert barrier, are retained in the conductor to help remove heat and act as a low resistance shunt in a quench.

Another approach is used by Brookhaven workers. They believe that to retain mechanical tolerances while swinging a coil from a cooking temperature of about 700 °C down to superconducting temperature is very difficult. Therefore, instead of the above 'wind and react' technique, they prepare braid in a similar way but react the braid before winding the coil.

Other work on niobium-tin is under way at Frascati, at Wright-Patterson in the USA (for use in motors), at IMI in the UK (where the latest conductor is made using niobium tubes so that tin from the bronze can reach it at both inner and outer surfaces) and Furukawa Electric Co. in Japan.

Another possible superconducting alloy is vanadium-gallium which retains its properties up to 14.5 K. This is under attack at Brookhaven and in Japan. Frascati has looked at niobium-aluminium and some work has been done on producing niobium-germanium by sputtering.

It seems clear that even after niobium-tin is mastered there will still be challenges confronting superconducting material specialists. This implies that there will still be challenges confronting superconducting magnet specialists also.



Niobium-tin multifilamentary conductor which holds out the promise of much higher fields and better temperature stability in superconducting magnets than the niobium-titanium conductor almost universally used at present. The wire on the left contains filaments which are revealed (on the right) when the bronze matrix is etched away.

(Photo AERE Harwell)

CERN News

Titanium chambers for the ISR

For several years, work has been in progress at CERN attacking the problems of manufacturing titanium vacuum chambers for use in the Intersecting Storage Rings. Such chambers hold out two advantages compared with the initially installed stainless steel chambers.

With titanium around the beam intersections, the experimental physicists would be able to achieve greater precision in their measurements because particles coming from the proton-proton interactions would emerge towards the detectors through a curtain of more transparent material. Titanium has a lower density (4.5 g/cm^3 as against 7.9 g/cm^3 for stainless steel) and its alloys have greater mechanical strength. The use of titanium thus presents a considerable advantage.

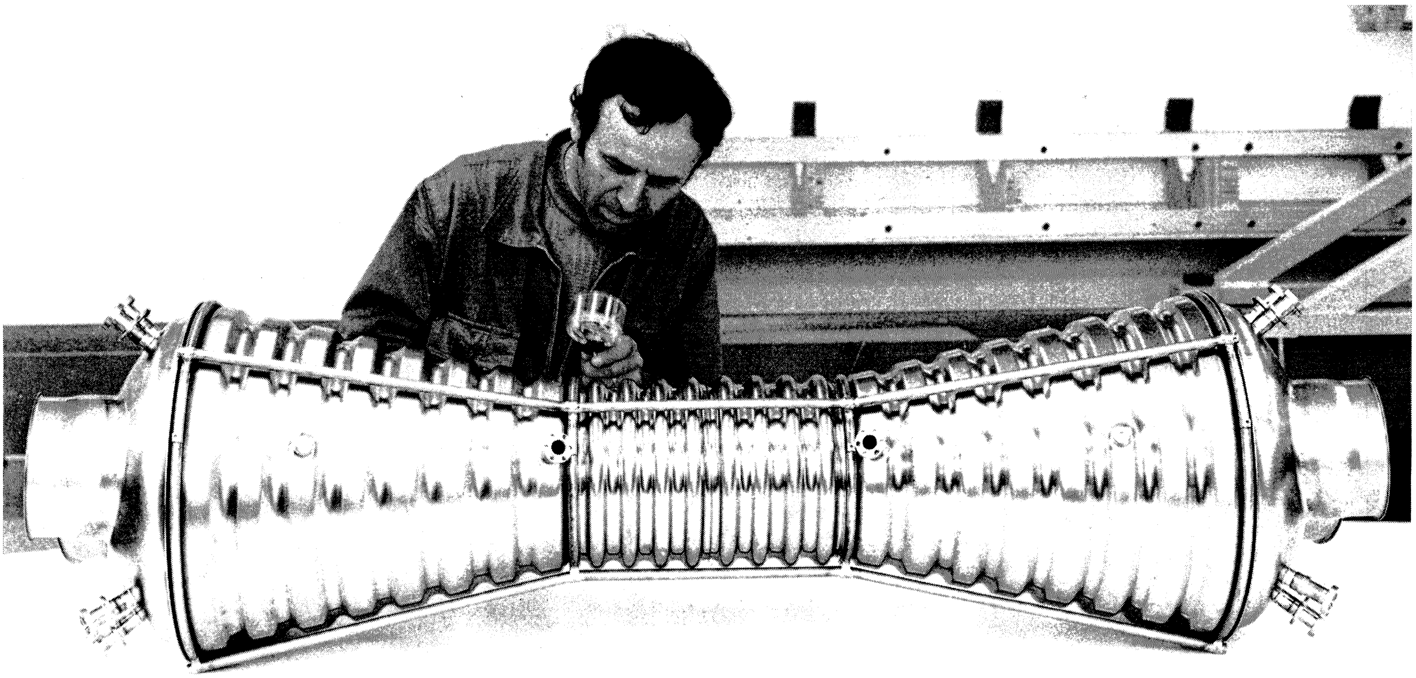
In addition titanium has favourable properties as a material for high vacuum use. The static desorption rate is almost an order of magnitude lower than that of stainless steel and it has been found that a chamber wall of titanium, in the presence of the proton beam, can act as an ion pump. The technical design studies have now reached an important stage with the installation of a titanium chamber for tests in the ISR.

There are however many difficulties in the working of titanium and some of its alloys. Their mechanical properties make forming of the alloys more difficult and two techniques — cold and hot forming — are under development in parallel. Industry is also working on forming techniques which might be adapted to the ISR requirements.

Welding of titanium is a delicate operation: it must be carried out in an inert atmosphere to avoid the titanium becoming brittle due to absorbing gases of the normal atmosphere. A glove box has therefore been procured, filled with argon and fitted with gloves via which the operator can carry out the welding without contaminating the inert atmosphere. For pieces which are too long to be treated in this glove box, a welding technique has been developed using a healthy argon blast.

To install the chambers in the ISR, the problem of the connections between the stainless steel sections and the titanium had to be solved. A number of techniques now exist for this in industry, such as vacuum brazing, explosive cladding and gasket flanges of aluminium foil.

A titanium chamber was installed in a straight section of the ISR during the annual shutdown at the beginning of the year. It is 7 m long and has



This bi-cone is a prototype vacuum chamber made of titanium for an ISR intersection region. Its thickness varies from 0.2 to 1 mm and it is about twice as 'transparent' to particles as the normal bi-cones made of stainless steel. There are ten outlets (four at each end and two near the centre) where joints of titanium-stainless steel are made.

CERN 247.5J4

a thickness of 1.5 mm. It consists of three sections of pure titanium with five titanium/stainless steel connections. The first tests have shown that the titanium walls, with orbiting proton currents of up to 25 A, act as a low speed vacuum pump, in contrast to the outgassing hitherto observed in most cases.

A prototype of a chamber which could be installed at an intersection region has been constructed in a joint effort by CERN and industry. It comprises a bicone with its central portion of titanium-based alloy and the remainder of pure titanium. The thickness varies between 0.2 and 1 mm. Four arms, in the form of an undulating tube 0.2 mm thick, are mounted on the bicone and there are fourteen titanium/stainless steel connections using various techniques. The unit is at present undergoing vacuum tests. After a first bake-out at 300°C, a vacuum in the 10^{-12} torr range was achieved.

Another titanium project is at the design stage — a vacuum chamber to be installed in the aperture of the Split Field Magnet at intersection I-4 Two sections, 50 cm long and elliptical in form (inside dimensions 500x 200 mm, thickness 0.7 mm) have been constructed at CERN using a titanium-based alloy. They are at present undergoing stress, stability and creep tests. An order is being placed with industry for the manufacture of two elliptical chamber arms with inside dimensions of 250x50 mm and a thickness of 0.4 to 0.5 mm.

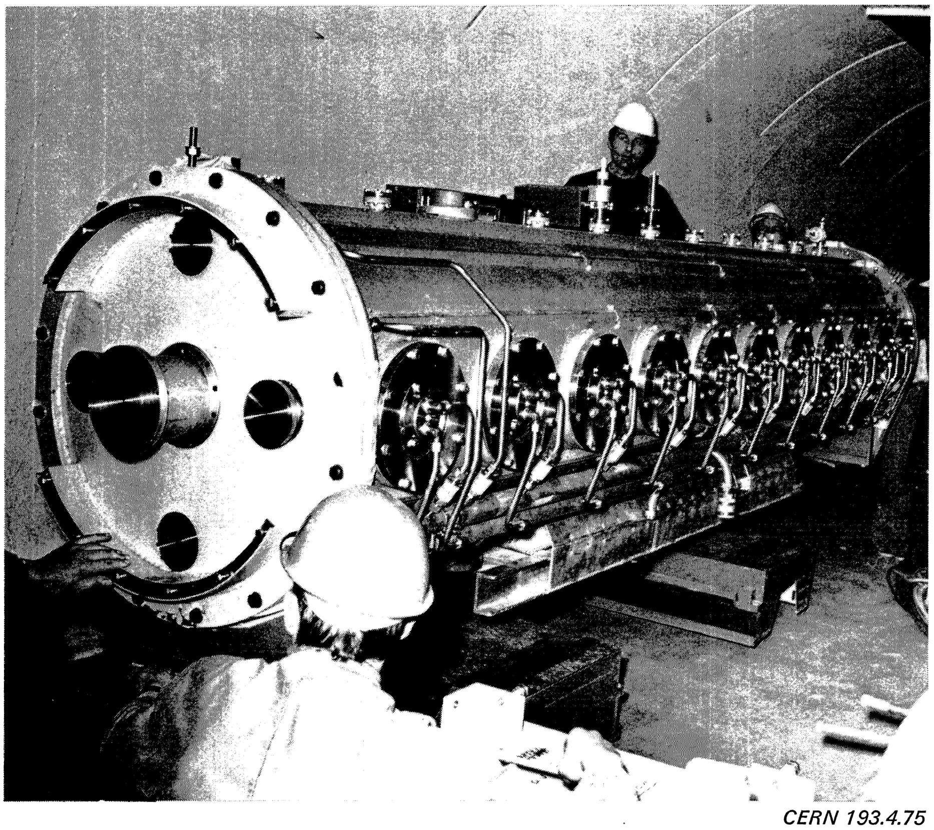
400 GeV machine vacuum and r.f. progress

Things are obviously hotting up in the construction of the 400 GeV proton synchrotron, the SPS. With comple-

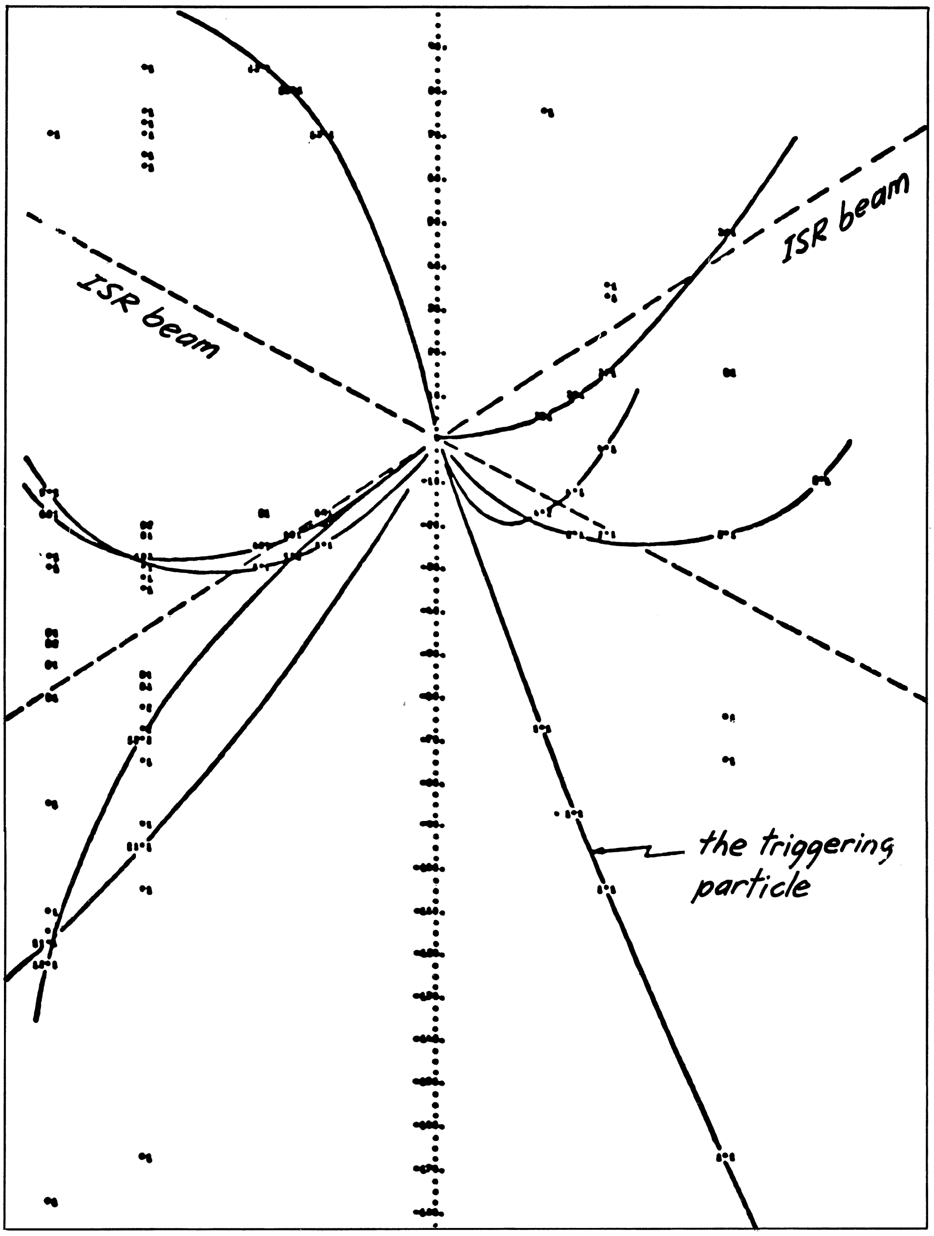
The vacuum chamber straddling a straight section of the 400 GeV synchrotron. A length of 970 m of the vacuum system has now been pumped down and is at 1×10^{-8} torr. An ion pump can be seen hanging below the chamber at the centre of the straight section. These pumps have a capacity of 25 lis. They are very compact end are distributed around the circumference of the machine.

CERN 150.3.75

On 17 April two of the five sections of an r.f. accelerating cavity descended, via access shaft PA 3, to the tunnel of the 400 GeV proton synchrotron. They are installed in the long straight section No.3. These sections are being used to check couplers, the vacuum system and the co-axial line which links the cavity in the tunnel to its power supply in the equipment building on the surface. Their three confreres will join them by the end of June.



CERN 193.4.75



A 'reconstruction', via a computer, of a proton-proton interaction at the CERN Intersecting Storage Rings which produced nine emerging particles. The event was recorded by the Split Field Magnet detection system at intersection 1-4 which has a large array of multiwire proportional chambers installed in the magnet aperture. Recording of the event, from among the many thousands taking place every second, was triggered by surrounding detectors which observed that a high momentum particle came off at a wide angle. The reconstruction illustrates the remarkable abilities of the MWPC detectors.

tion of the ring not much more than a year away, there is new information every month concerning the progress of installation. This time the vacuum system and the radio-frequency acceleration system have passed two important milestones.

Assembly and testing on the vacuum chamber and the pumping stations in the SPS tunnel began last November and the work has continued at about the rate at which the magnets have been installed — 32 m per day, equivalent to one half-period. By now a tenth of the full system, including beam transfer lines, has been evacuated and held under vacuum for a month.

At the beginning of February, a 550 m length of the vacuum chamber in sextant 3 was pumped down. The pressure was taken to the region of 10^{-5} torr by three roughing pump stations fitted with vane and turbomolecular pumps. At this stage, the control computer in auxiliary building No. 3 brought in forty-one ion pumps with a capacity of 25 l/s, distributed along the length of the vacuum pipe. The time involved in reducing the pressure from atmospheric to the nominal operating pressure of the SPS — 3×10^{-7} torr — in this first pump down, was sixteen hours. A pressure of 1×10^{-7} torr was reached in forty-five hours.

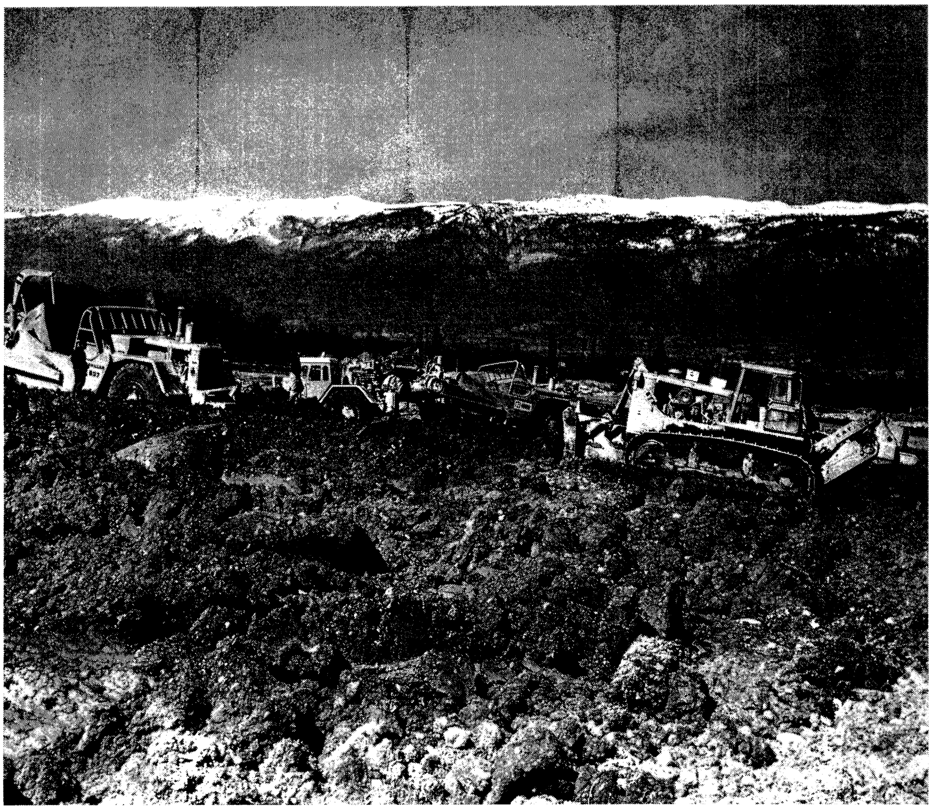
It was then necessary to open up the chamber. The second pump down gave the nominal pressure after only five hours. In March, a further 420 m section was pumped with the same success. After a month under vacuum, this 970 m length is at 1×10^{-8} torr.

Two sections of one of the r.f. accelerating cavities have now been installed in the SPS tunnel and have successfully undergone vacuum tests. Each cavity is some 20 m long with five tank sections and the machine will have two cavities located in straight section No. 3. The five sections for the first cavity are now at CERN. Some work has to be carried out on them before they are taken down to the tunnel — the trickiest job being the fitting of the drift tubes. There are eleven in each section and they have to be aligned with great precision. Allowance must be made for any irregularity in the shape of the tank and the length of the drift tube bars has to be adjusted before they are welded and brazed to the mounting blocks which make contact with the tank walls.

The coaxial lines and couplers which feed the power to the cavities in the tunnel are already in place. The lines, some 80 m long, go up to the power amplifiers in auxiliary building No. 3. Cooling pipes are also installed as are the terminating loads which absorb the r.f. power once it has passed through the cavities.

All that remains to be done in the

Excavation work for the North Experimental Area of the SPS began in April. In the photograph a bulldozer and two scrapers are in action, against the background of the Jura mountains, removing the top soil from an area of 8 hectares.



CERN 168.4.75

Part of the construction for the West Area Neutrino Facility. The BEBC bubble chamber building is on the left and the new building will house giant electronic detectors positioned on a rising ramp to line up with the neutrino beam coming from SPS tunnel level. The Gargamelle bubble chamber will be located further downstream.

CERN 266.4.75

tunnel is to install and connect up the tank sections. They must be aligned very accurately so that the intermediate seals remain completely vacuum-tight and allow the cavity's 500 kW of r.f. power at 200 MHz to be properly conducted all the way around the tank. The sections rest on special supports which are designed to absorb any distortion caused by temperature rise in the cavities during operation.

The last three sections of the first cavity will be taken down to the tunnel at the rate of one every three weeks and the cavity will be completed towards the middle of June. The second cavity will be installed in Autumn.

North Area and Neutrino Facility

Since mid-April, the earth-moving operations for the North Experimental Area of the 400 GeV synchrotron have been in full swing. This is on the Jura side of the three administrative block and the large Assembly Hall of Laboratory II. In the first phase of the work, a layer of about 60 cm of topsoil is being removed from an area of some 8 hectares and stocked on one side. Bulldozers and giant scrapers are used for this. On the area thus cleared is dumped the moraine from the subsequent excavations of tunnels, etc. The top soil will be used later to cover the transfer tunnels and target hall.

The civil engineering work for the North area is a major operation as this list of constructions indicates:

- tunnel TDC2 linking the North ejection tunnel from the 400 GeV accelerator, TT20 and the target hall TCC2; TDC2 is some 300 m in length and its cross-section will vary from 4.50 x 3 m^2 to 10 x 8.55 m^2 (the larger cross-section takes the ventilation equipment for the tunnel and the target hall)

- target hall TCC2, 132 m in length with a cross-section of 16 by 7 m^2
- transfer tunnels TT81 and TT82 linking the target hall with the first experimental hall, EHN1, with a cross-section 4 x 3 m^2 and length 270 m
- experimental hall, EHN1, 300 m long by 50 m by 19 m
- transfer tunnel TT83, length 410 m and cross-section 4 x 3 m^2, linking the target hall with chamber TDC8
- chamber TDC8, bifurcation of tunnels TT84 and TT85
- tunnel TT84, 520 m long and 4 by 3 m^2 in cross-section, connecting chamber TDC8 with experimental hall EHN2; part of this tunnel will be constructed under the 'Lion' stream, which will have to be reinforced, probably by means of a bed of concrete
- tunnel TT85, leading from chamber TDC8 with a cross-section of 4 x 3 m^2 extending initially for 130 m
- experimental hall EHN2, 100 m long by 18 m by 15.5 m
- auxiliary buildings BA80 and BA81 to house the power supplies and installations for the target hall and EHN1 (BA80 is 110 m long by 21 m by 7 m, BA81 is 140 m long by 21 by 7 m)
- four service tunnels, mainly for the electricity and fluids supply networks for the experimental areas
- two smaller auxiliary buildings for the power supplies and installations serving experimental hall EHN2 and, in part, transfer tunnel TT84.

To all this must be added the construction of a road network for the North area with a total length of about 3 km and even then the list is not complete.

Neutrinos go West

In the direction of the other ejected beam from the 400 GeV synchrotron, work began on buildings for the West Area Neutrino Facility (often abbreviated to WANF) in November 1974. The location is to the west of the 3.7 m European bubble chamber, BEBC and two buildings are rising above ground. The first will house vast and massive electronic type detectors and the second the heavy liquid bubble chamber, Gargamelle.

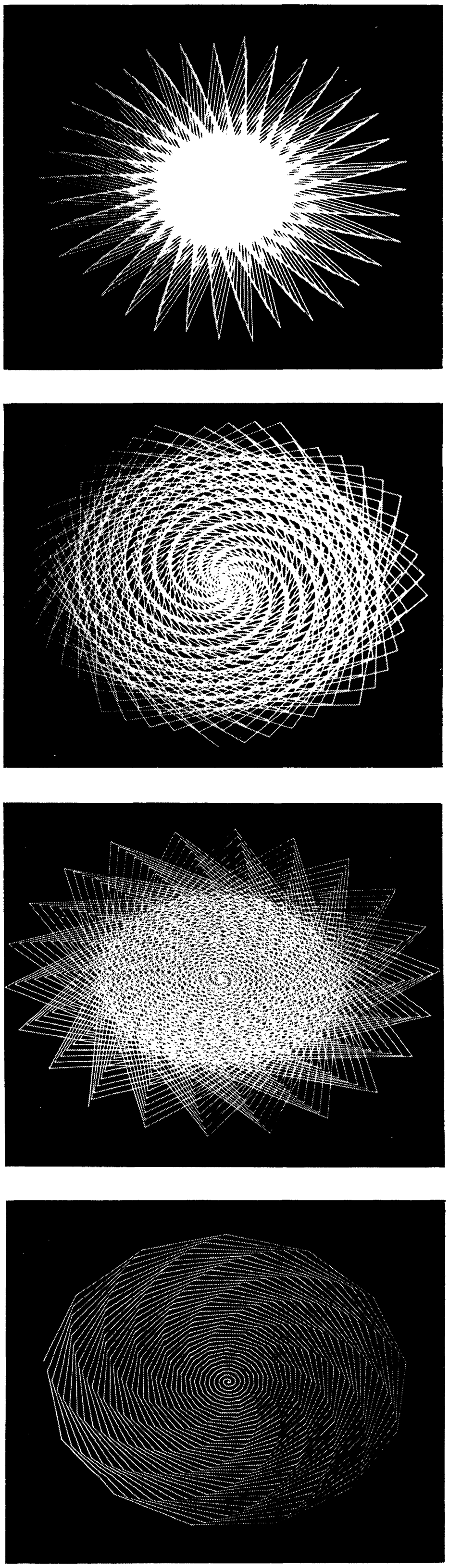
The detectors must be located along the line of the neutrino beam produced by the SPS protons. For the first building, a ramp is being constructed 44 m from the centre of BEBC some 50 m long, 15 m wide and with an incline of 2.5°. It is supported on 49 pillars which are bedded about 18 m down in the moraine to support, in addition to the building, 1500 tons or so of magnet steel. A metal framework will complete the 18 m high experimental hall. The neutrino beam will enter the hall over 6 m above ground level and leave it 2 m higher.

About 40 m further to the west, the foundations for the new Gargamelle building are starting. The dynamic effects of the chamber and its expansion system, which will be about 10 m above ground level, present one of the most difficult civil engineering problems to be solved. The base, on which the chamber will sit along the line of the neutrinos, will weigh nearly 1000 tons and construction of the foundations has started 5 m below ground level. The hall, 23 m high, should be ready to receive Gargamelle next Spring.

All this work is at present on schedule and the end of this year should see the structure of the buildings completed.

Radiation Protection and Radiotherapy

The main activity of the CERN Health Physics Group is that of radiation protection — checking the doses received by the personnel and monitoring the radiation levels around the



Abstract art generated from mathematical formula fed into the interactive computing system, SIGMA. The figures were produced on a television screen linked to the CDC 6400 computer located in the CERN computer centre.

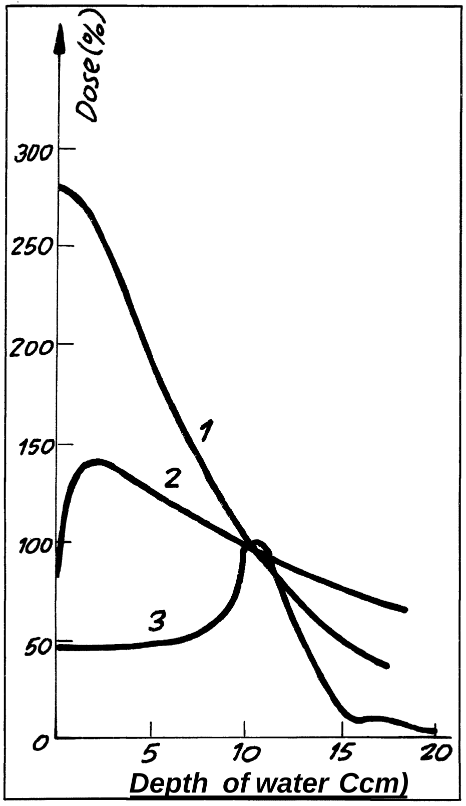
accelerators and experimental halls. The Group also devotes part of its time, in view of the development of accelerators towards ever higher energies, to the study of the radiobiological effect of small doses of high energy radiation. It appears unlikely that what happens at lower energies can be extrapolated to higher energies and there has been very little experience so far with this type of radiation.

By studying the biological effects of radiation, we can find how it acts and thus learn how to control and use it. This results not only in protective measures but also in medical applications. Radiation physics has made considerable progress in the past forty years. We now know how to produce and control X and gamma radiations over a broad spectrum of energies and knowledge of their action in ionizing atoms and molecules can be used in radiography and radiotherapy.

The aim of radiotherapy, in the case of a cancerous tumour, is to destroy it with as little damage as possible to the healthy tissue around it, which inevitably has also to be irradiated. At the present time, no radiation is known which can act specifically on tumour cells and no fundamental process is known which is capable of arresting the growth of a tumour. X and gamma rays are widely employed but heavy particles, whose effects can now be studied at high energy accelerators, may add a broad new range of radiations for use by radiotherapists. In radiography, protons are already being used and they seem to offer many advantages (see September 1974, p. 303).

At CERN, using the 600 MeV synchro-cyclotron, experiments are in progress on neutrons and stopped negative pions. The behaviour of the latter is highly unusual: a negative pion, penetrating tissue at very low velocity may replace a peripheral electron of an atom and, by virtue of its heavy mass compared with that of the electron, will revolve very close to the nucleus, finally falling into it. The strong interaction between the pion and the nucleus causes spallation and a large quantity of energy is released, divided among ionizing nuclear fragments emitted in all directions. These fragments cause major damage in the area around the nucleus.

The problem is to find out exactly what is the biological effect. Is the damage caused by the products emitted in star formation repairable? If so, how? These are difficult questions to answer, especially as direct experiments on the human body are not possible. Studies are being carried out at CERN with plant roots (vicia faba) and mouse testicles. Observations are made of changes in the growth of the roots of vicia faba and



Three graphs of radiation dose brought to a standard depth of 10 cm in water: 1) 250 keV X rays, 2) 1250 keV X rays, 3) 60 MeV negative pions. This diagram clearly shows that the doses absorbed in front of and behind the irradiated area (at a depth of 10 cm) are much less with negative pions than with X rays.

Another 'gone-fishin' photograph this month, taken in the 'Lion' stream which crosses the Laboratory II site. For work in connection with the beam-line to the North Experimental Area the stream has to be temporarily rerouted. The Franco-Swiss fishing Union was alerted and cleared 700 m of the stream of its population — a haul of 366 trout. The trout were stunned by an electrical fishing rod (a 350 V, 4 A device) and transported to safety further downstream.

CERN 185.4.75

Around the Laboratories

of the survival potential of the mouse spermatogonia after irradiation by stopped negative pions.

These processes are also under investigation, for example, in Canada at the TRIUMF cyclotron, in the United States with the LAMPF linear accelerator and in Switzerland with the SIN cyclotron. One of the aims is to determine the relative biological effect (RBE) of the negative pions. The RBE is the ratio between the absorbed dose of gamma rays and the dose of the radiation under study which produce the same effect. If this ratio were known for negative pions it would be possible, within certain limits, to predict their effect on living tissue. Unfortunately, this is a complex problem — it is not even certain that the RBE is the most important parameter — since the action of stopped negative pions is different from that of gamma rays.

Nevertheless, many hopes are placed in this form of radiation, which shows a number of advantages over X and gamma rays:

1) the doses absorbed around the irradiated area are weak;

2) the action can be effected at any depth in the body by changing the velocity of the negative pions;

3) the 'flat top' can be varied by altering the energy spread of the beam, making possible the homogeneous irradiation of small as well as large tumours;

4) a further hope with stopped negative pions is that, unlike X and gamma rays, they may have greater effect on tumours than on healthy tissue.

These are the hopes but there are plenty of question marks. Though it now seems highly probable that high energy radiations will lead to new abilities in radiotherapy, much remains to be done before they are fully mastered.

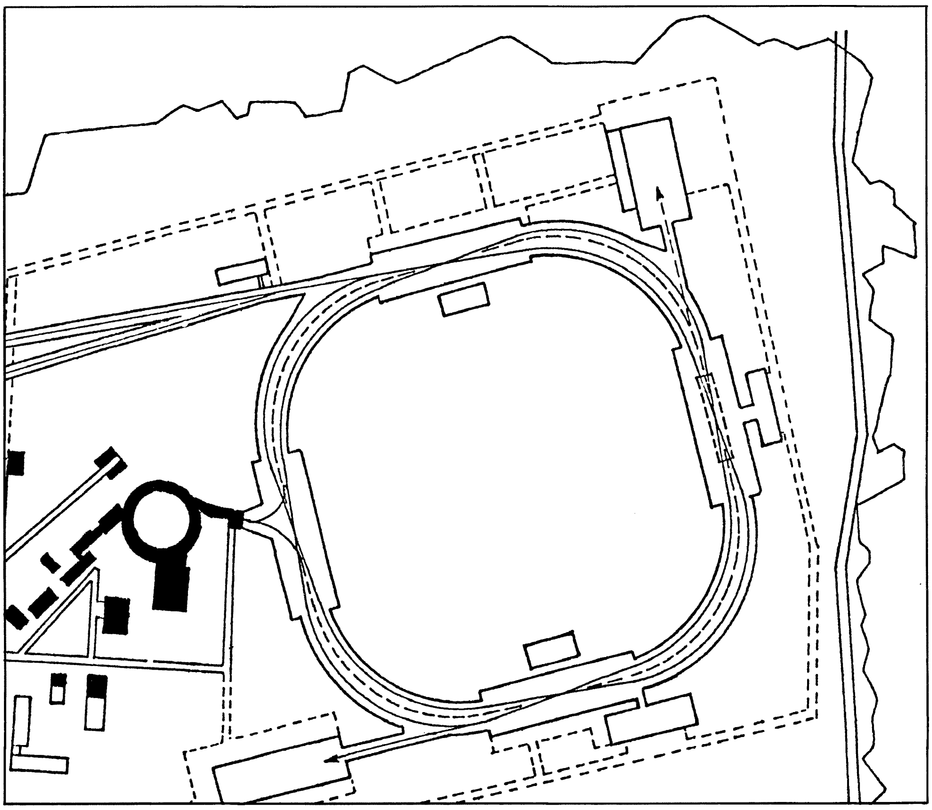
Japan: Future prospects

The KEK proton synchrotron is nearing completion at the Laboratory near Tokyo; it is hoped to have first beams from the 12 GeV machine at the end of the year. Construction of the accelerator has brought familiarity with modern accelerator techniques — as an example of how competently they have been learned, the 500 MeV booster synchrotron recently gave full energy protons within a few hours of the start of commissioning.

With this experience, it is natural that the Japanese high energy physics community is considering projects for the future, since it is aware that 12 GeV is not the energy range of much front-line physics at the present time. A collaboration of the KEK Accelerator Department, university scientists and cryogenic specialists are drawing up a design study of an accelerator/storage ring complex known as TRISTAN (for Tri-Ring Intersecting STorage Accelerators in Nippon).

TRISTAN has two intersecting storage rings of superconducting magnets, giving 4.5 T, similar in basic design to the ISABELLE project at Brookhaven (see August 1971). A conventional accelerator ring would raise the 12 GeV protons from the existing machine to about 50 GeV before transferring them to one of the superconducting rings for acceleration to 150-180 GeV. The conventional and the two superconducting rings are all in the same tunnel and the rings have a circumference of just over 2 km, including four 150 m straight sections for colliding beam physics.

The conventional ring would take six pulses at 12 GeV distributed around its circumference so as to build up a circulating beam intensity of 6×10^{13}. These protons would then be accelerated to 50 GeV for injection into a



Possible layout of the TRISTAN storage ring project on the KEK site in Japan. The existing synchrotron buildings are in solid black on the left. The 12 GeV machine would feed a 50 GeV conventional machine (dashed ring) which could also be used for electron acceleration and storage. 50 GeV protons would then be taken to 180 GeV in the two intersecting rings.

storage ring and the process repeated about ten times to stack up to 15 A per storage ring. Maximum luminosity is calculated as up to 10^{34} per cm^2 per s with collinear crossing (about 10^{32} with 70 mrad crossing).

To achieve electron-proton interactions, the conventional ring could also be used as an electron synchrotron to yield a 17 GeV beam of 30 mA intensity. The ep luminosity would then be a few times 10^{31} per cm^2 per s. A scheme using r.f. cavities both to accelerate the electrons up to injection energy of 1 GeV and then to function as the ring accelerating system is being studied.

Construction of the conventional ring is the probable course for phase I of the TRISTAN project. It would be used as a storage accelerator for colliding beam experiments with 12 GeV protons and 13 GeV electrons. The superconducting rings would follow later and work on pulsed superconducting magnets has started in collaboration with industry. The total TRISTAN project is seen as spanning the next decade if the necessary authorizations enable work to begin soon.

A smaller scale project is also under design at KEK — a dedicated synchrotron radiation facility known as the Photon Factory. It involves a 2.5 GeV electron storage ring to store a current of 1 A. Ten beam ports will allow radiation out to experiments with wavelengths down to 1 angstrom. Superconducting wigglers could be used to extend the wavelength range down to 0.1 angstrom.

User groups are working on the detailed design of the experimental facilities to be used for research in pure and applied chemistry, solid-state physics, biology, medicine, atomic physics, etc... If authorization for construction is obtained next year, it is hoped to have the storage ring in action by 1980.

UK Laboratories Reorganization of activities

The Science Research Council announced on 6 May that it has decided to regroup the activities which have been carried on at the Rutherford, Daresbury and Atlas Computing Laboratories.

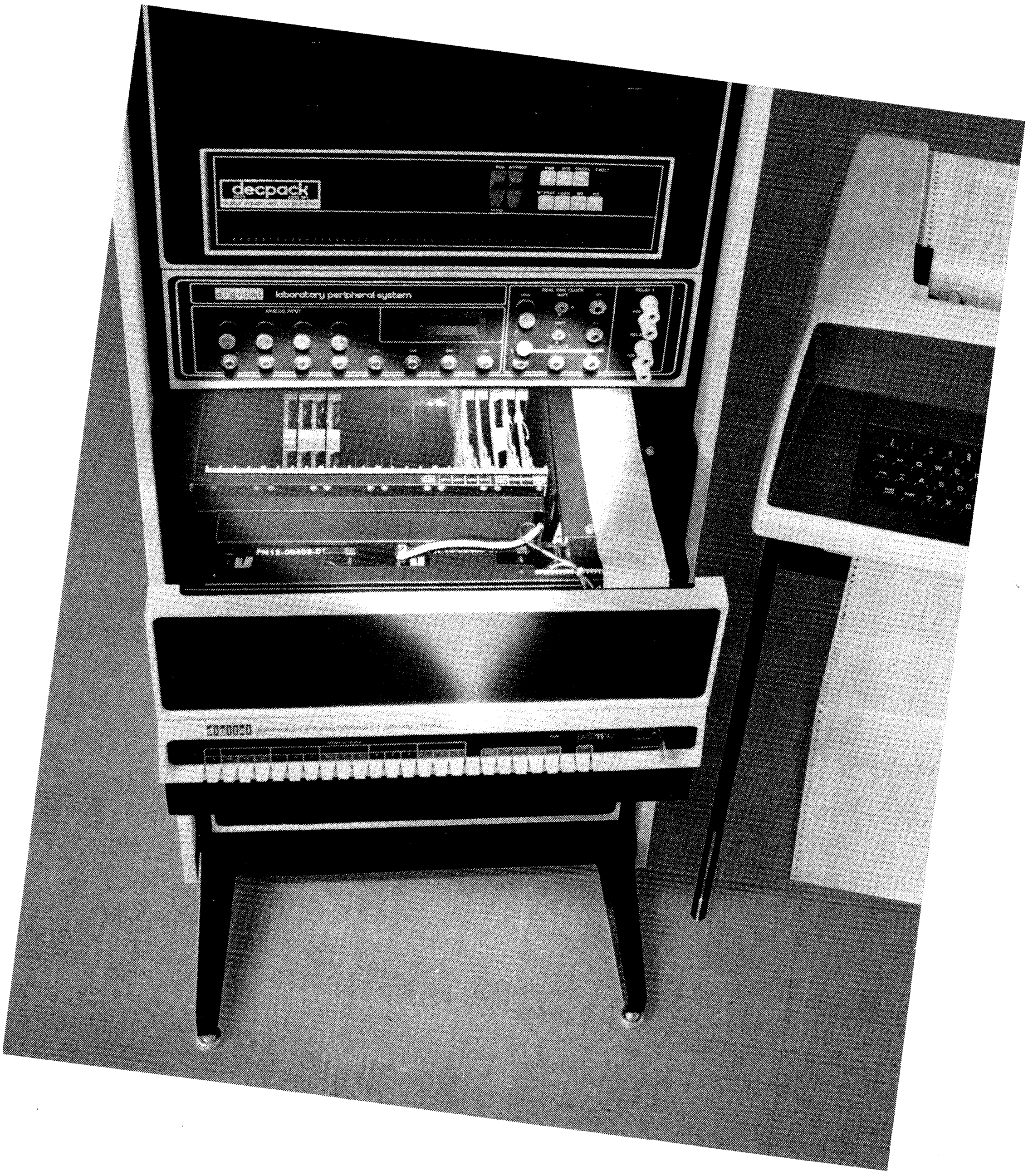
High energy physics research will be concentrated at Rutherford both for the national programme and for the collaborations using the CERN machines. The work which is already under way at Daresbury in connection with experiments at CERN, including those for the 400 GeV programme, will however continue at Daresbury.

Next year, Daresbury will begin to take over much of the computing service which has been the province of the Atlas Laboratory. This covers computing for a wide range of sciences outside high energy physics. The Atlas Laboratory (alongside the Rutherford Laboratory) will become the centre of a national interactive computing facility. This may be part of a 'national computing campus' which is now being discussed by the SRC and the U.K. Department of Industry.

Another Gordon Conference

In April we announced a Gordon Conference on 'High Energy Hadronic Interactions'. A second one has come to our attention on 'Nuclear Chemistry' which will be chaired by P.G. Hansen of CERN. The conference will be held at Colby, New Hampshire, USA from 23 to 27 June.

Five new low-cost lab computer systems with a big heart.



Powerful low-cost systems. That's Digital's DECLAB-11/10 system family. Five generous hardware/software packages designated A through E. Priced from only S.Fr. 43.700 to S.Fr. 112.000. Capable of handling the research jobs you're likely to encounter without having to develop additional programs. And fully compatible so they'll expand as your needs grow.

Powerful low-cost heart. That's Digital's performance-proved 16-bit PDP-11/10 CPU. The heart of the systems. Now at a new low price. With 8K words of memory, line frequency clock, power fail and auto restart serial line unit and paper tape software, just S.Fr. 22.800. With 16K words, just S.Fr. 28.500.

Wide hardware range. The DECLAB-11/10 family gives you a wide range of hardware options. So you can choose the right system to meet your price/performance needs. All systems include the PDP-11/10 processor with 16K words of memory. With a choice of paper tape, magnetic cassette or cartridge magnetic disk drive storage. And a hardcopy teleprinter or DECwriter.

Plus Digital's new AR-11 one-module real-time analog subsystem. The AR-11 features a 16-channel multiplexer, 10-bit analog-to-digital converter, programmable real-time clock and display controller. Or, if you want a more comprehensive analog subsystem, you can choose our LPS laboratory peripheral system.

Lab-oriented software. User programs for the DECLAB-11/10 systems are developed using Digital's unique Applications-11 library. A package of laboratory applications modules subdivided into five categories: data processing, data display, data analysis, data acquisition and interactive dialogue. The library can be used in conjunction with Digital's RT-11 and CAPS-11 cassette programming systems. In addition, BASIC and FORTRAN compilers are available.

Digital. Gets to the heart of your needs.

Please send me complete information about Digital's five new DECLAB-11/10 laboratory systems.

Name ______________________

Position ______________________

Company ______________________

Address ______________________

____

Telephone ______________________

Digital Equipment Corporation
International (Europe),
81 route de l'Aire,
CH-1211 Geneva 26,
Tel. (022) 42 79 50.

Cern

Offices in Reading, London, Birmingham, Bristol, Manchester, Edinburgh, Munich, Berlin, Cologne, Frankfurt, Hambourg, Hannover, Stuttgart, Vienna, Stockholm, Oslo, Copenhagen, Helsinki, Paris, Grenoble, Utrecht, Brussels, Geneva, Zurich, Milan, Turin.

digital

CAMAC

TWO NEW TEST UNITS

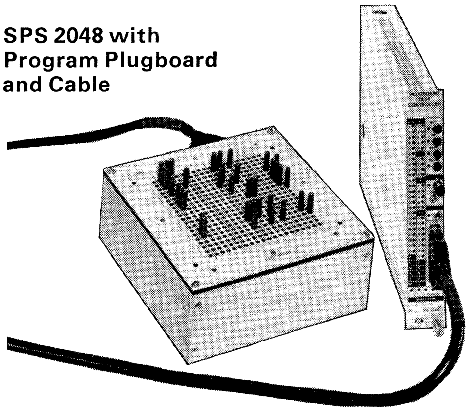
SINGLE CRATE TEST CONTROLLER SPS 2048

SINGLE CRATE TEST CONTROLLER SPS 2048

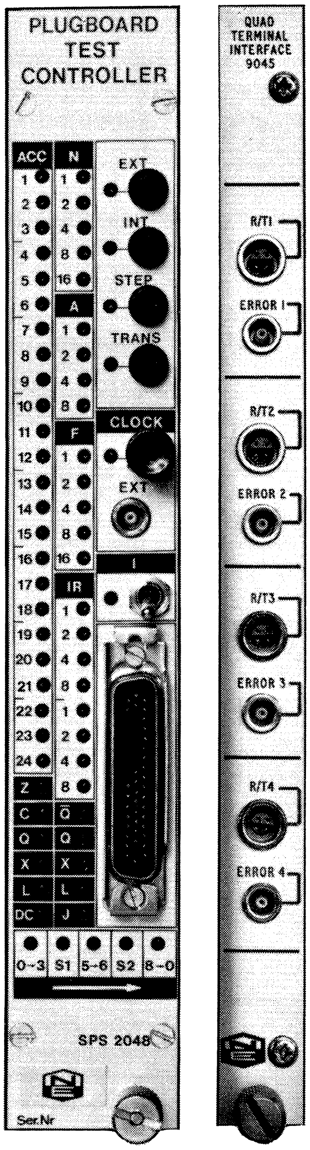
The double width SPS 2048 permits CAMAC modules and interfaced peripheral equipment to be tested without the aid of a computer. Batch testing of modules is simplified with pre-plugged program plugboards.

The SPS 2048 Test Controller occupies the control station and adjacent user station of the crate and accepts commands from a free-standing plugboard connected by a 52-way cable. Up to 20 instructions can be accommodated on one plugboard, and up to 5 plugboards can be linked.

AM 'NAF' commands can be generated
Tests can be performed on Q, Q, X, L
Conditional or unconditional jumps may be executed
High speed testing at low cost



SPS 2048 with Program Plugboard and Cable



DATAWAY DISPLAY 9554

The 9554 module can be used to diagnose basic dataway faults, to indicate errors presented on the dataway by faulty modules, and to display immediately the state of the dataway when a control program halts.

The 9554 Dataway Display has three modes of display as listed below. The trigger mode can be used to latch the display by patching to the appropriate module addressed by the program.

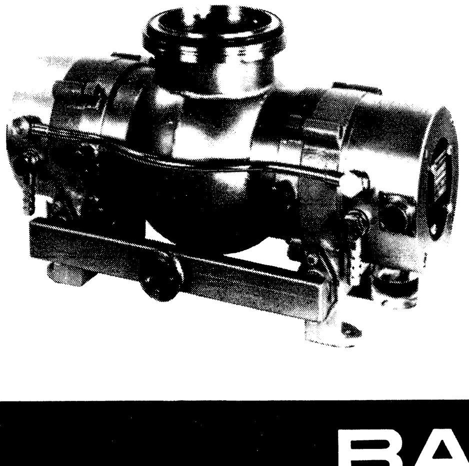
Trigger Mode-register update occurs from an external trigger
Follow Mode-the dataway is monitored continuously
On line Mode-the state of the dataway is memorised at time S1

Write for details and for 125-page CAMAC Catalogue No. 66 containing full specifications of the most extensive range of units available from a single manufacturer.

NUCLEAR
ENTERPRISES
LIMITED

BATH ROAD, BEENHAM, READING RG75PR, ENGLAND
Tel: 07-35212121. Cables: Devisotope, Woolhampton.
Telex: 848475

Associate Companies
Nuclear Enterprises GmbH, Schwanthalerstrasse 74,8 Munchen 2,
Tel: 53-62-23 Telex : 529938
Nuclear Enterprises Inc., 935 Terminal Way, San Carlos, California 94070.
Tel: 415 5931455. Telex: 348371.



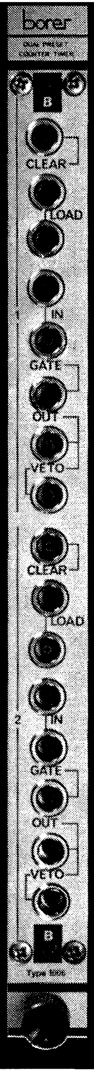
LEMO - universally recognized to be the finest connectors in the world, guaranteeing the strongest connections!

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.

Electrotechnique
Tel. (021) 711341 Telex 24683 1110 Morges (Switzerland)

This is the "Do (almost) Everything" Camac Counter



The Dual Preset Counter/Timer, 1006 can be used for:

- preset count/preset time jobs in nuclear counting
- sequential time programming
- maximum value supervision
- parallel-to-serial conversion (pulse train generator)
- «gate» signal generation
- frequency division

Just a few of the features of the 1006 are:

- 2 x 16 bits of buffered content
- intermediate readout possibility
- simple daisy-chaining
- one-step re-loading by an external pulse or by a Camac command
- inputs and outputs optionally at NIM or TTL-level
- output can be vetoed

borer

4500 SOLOTHURN 2, SWITZERLAND
tel: 065/311131 telex: 34228

FIVES-CAIL BABCOCK

- Composants lourds nucléaires
- Echangeurs de chaleur nucléaires
- Boucles expérimentales
- Masses polaires en acier moulé
- Tuyauteries en aciers alliés et inox
- Portes, dalles et bouchons
- Compresseurs d'air et de gaz
- Turbines, groupes turbo-alternateurs
- Traitement des minerais d'uranium (broyeurs, centrifuges de filtration, etc)
- Appareils de levage et manutention, ponts roulants
- Pièces sur plans

- Heavy nuclear components
- Nuclear heat exchangers
- Experimental loops
- Cast steel magnets
- Alloy and stainless steel tubing
- Air tight doors, plugs
- Air and gas compressors
- Turbines, turbo-generators
- Uranium ore processing (grinding mills, centrifuges, etc)
- Hoisting and handling equipment, overhead travelling cranes
- Job-engineered parts

fcb

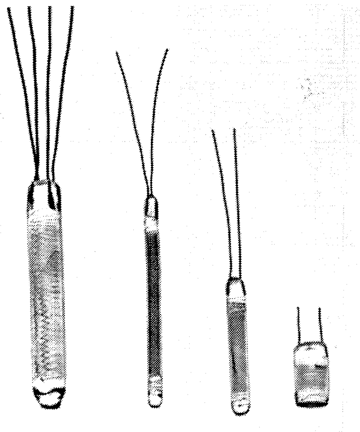
7, rue Montalivet - PARIS 8ᵉ
☎ 265.22.01 et 742.21.19 - Télex : FIVCAIL 65328 - Télégr. : FIVCAIL-PARIS
Code postal : 75383 PARIS CEDEX 08

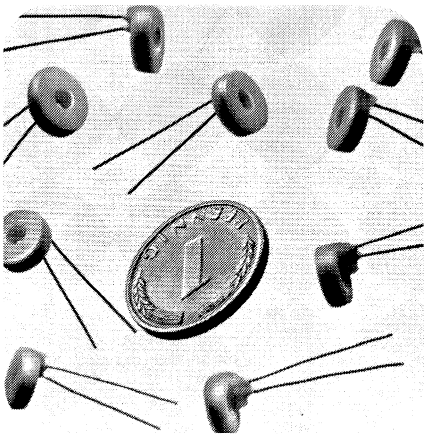
SAGAL Publicité - 558

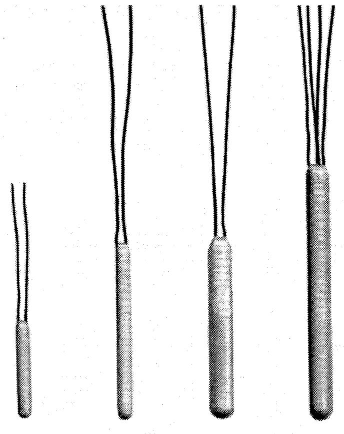
DEGUSSA

Messwiderstände...

égal welchen Typ und welche Ausführung Sie benötigen, wir liefern sie Ihnen preisgünstig ab Lager







Nach DIN 43760 • Für Temperaturen -268°...+850°C • Toleranzen 1, 1/2, 1/3 DIN • Durchmesser 1,9...5 mm, Länge 8...60 mm • In Hartglas vergossen oder in Degussit® eingesintert

Mit Einfach-, Doppel-, Dreifach-Messwicklung • Für 2-, 3-, 4-Leiterschaltung • Flach-Ausführungen mit plan geschliffener Messfläche
Fordern Sie ausführliche Unterlagen und Preislisten an

Degussa (Schweiz) AG

Postfach2050 • 8040 Zürich • Telefon 01-543900 • Telex 57946

New Generation Measurements

Precision d.c. Resistance Bridge BR 100 Mk 2.

- ✱ Rapid Precision Measurement and Grading of Resistors.
- •Jf Absolute or Deviation Measurement.
- •3f Seven Measurement Ranges - 0-11,111,110 ohms.
- •5f Percentage Deviation - ± 0.0002% to ± 10%.
- ✱ Calibration Accuracy 10ppm.
- •Mr Preset off-limits - 3 bands each side of zero with Lamp Indication and External Outputs.
- •$f Six Decade Balance with optional BCD output.
- •Jf Lead compensation from one micro-ohm.
- ✱ Temperature Coefficient of Internal Standards<1 ppm/°C.

Just one of our range.

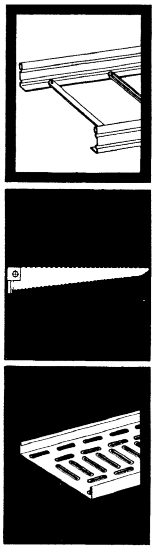
J.J. Lloyd Instruments Ltd

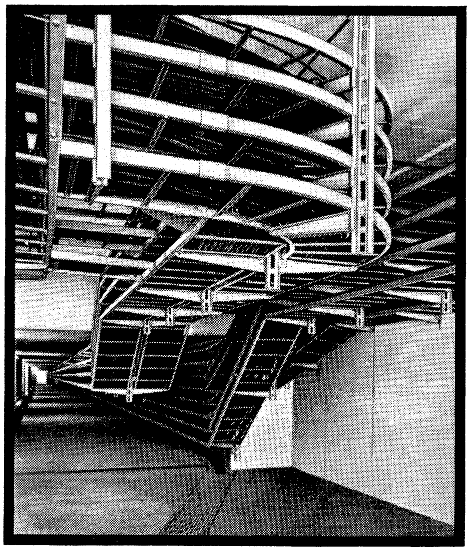
Brook Avenue, Warsash,
Southampton S03 6HP.Tel: Locks Heath 4221
Telex 477042 JAY JAY - SOTON

RICO-Gouttières à câbles Chemins de câbles

Eléments fabriqués en série, disponibles de stock, prêts à être assemblés selon le principe de la boîte de construction, permettent des gains de temps importants dans l'établissement des plans, dans les bureaux d'études, sur le chantier et à l'atelier.

1/4



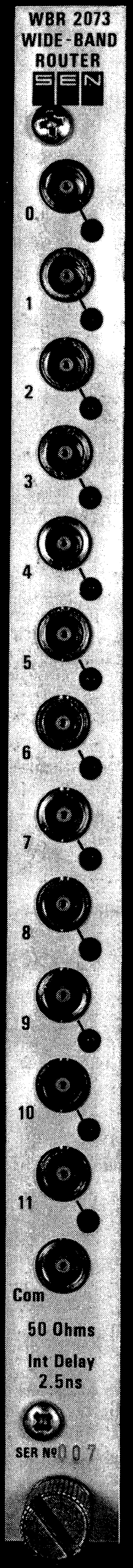


RIETH & Co.
Fabrik für Eisenkonstruktionen
D-7312 Kirchheim-Teck
Tel. (07021) 45051
Telex 07267881

Max Bänninger AG
8050 Zürich
Nansenstr. 1
Tel. 1/46 36 42

camac

TIME
your fast logic system
AUTOMATICALLY



SEN's new range of CAMAC FAST LOGIC modules includes this high-speed router which provides multichannel switching or automatic survey of fast analog signals (e.g. PM outoutputs) under Dataway control and without distortion.

Other modules in this series include fast logic units, shapers and discriminators, and a programmable delay unit. All these modules are part of the SEN DELAYPL.OT system - a completely automatic way to plot delay curves.

WIDE-BAND ROUTER

WBR 2073

This fully-shielded single width CAMAC module has a choice of operating modes which provides the user with two seperate fields of application. In a survey application, 12 PM type signals can be switched through the common output to other instruments for examination and/or processing (e.g.display, recording, attenuation etc.). The termination of non-selected inputs is in 50 Ohms.

In a multiplexing application, the router makes the connection of 1 input signal to any 1 of the 12 output channels. If the characteristic impedance does not have to be maintained, the input signal can be connected to more than one output.

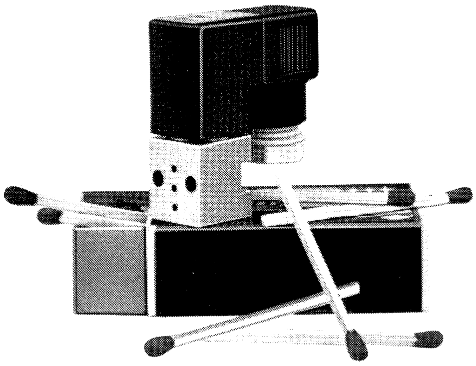
In addition, several router modules can be cascaded where extra channels are required.

SEN
ELECTRONIQUE

Contact any of the SEN offices below for more details about this and other CAMAC equipment.

31, Av. Ernest Pictet 1211 GENEVE 13 SUISSE Case postale 33 Tel,(022)44 29 40 Telex 23353CH
SEN ELEKTRONIK AG ZURICH Tel. (OD 86 51 CD3 Telex 58257CH
SEN ELEKTRONIK GmbH HAMBURG, Germany Tel. 04103 6282 Telex 2183 548D

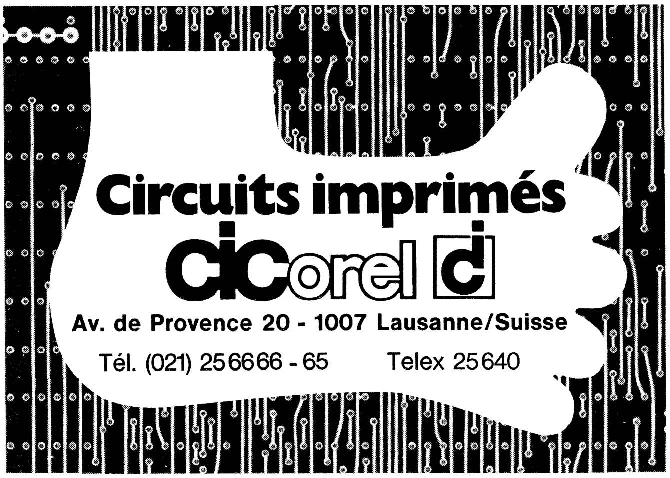
MICROSOL, la plus petite électrovalve sur le marché mondial



2/2- et 3/2-voies
6 et 10 bar
pour air, gaz neutres, liquides
tous les voltages habituels
2,5 watt
peut être actionnée directement
par circuits transitorisés
largeur 15 mm!

TECALTO SA
Hydraulique et pneumatique
Rautistrasse 58
8048 ZURICH
✆ 01 52 25 50

tecalto

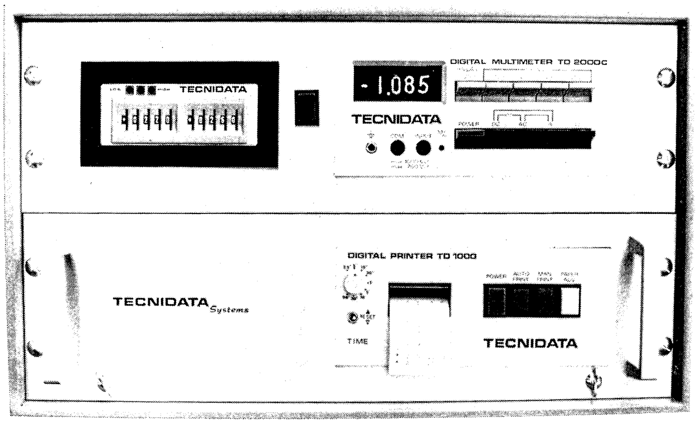


Circuits imprimés
cicorel
Av. de Provence 20 - 1007 Lausanne/Suisse
Tél. (021) 256666 - 65 Telex 25640

TECNIDATA®

Digital Measuring Systems

Measuring/Printing System
with control of limit values



comprising:

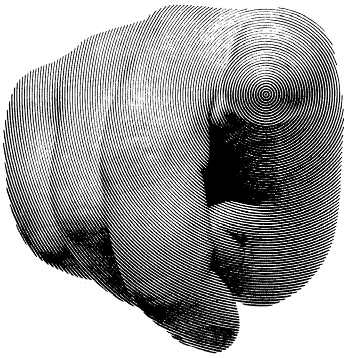
- **Digital Multimeter TD 2000 C**
  3Vz digits, 2500 measuring points, precision 0.1%, 5 functions, 25 measuring ranges, overload protection 1000 V DC or 750 V AC.
- **Digital Printer TD 1000 M**
  TTL-BCD Input, 6 columns, 2 lines/second, paper advance 20 lines/second, automatic and manual print, power 220 V AC or 12 V DC.
- **Digital Comparator TD 30**
  selection of 2 independent limits, selectors capacity ±0000 to ±9999, BCD-TTL input, logic TTL output level, optical status display, relay output 10 A/220 V per channel.
- **BCD-Transmission Wire**

APPLICATION is found in all industries: machinery and instruments manufacturing, chemical industry, electric industry etc. Wherever values have to be measured, surveyed and processed, i.e. in laboratories, machine control, manufacturing, final control and repair, the TECNIDATA Measuring System contributes to rationalization and increased quality.

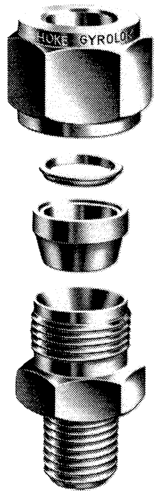
The values measured by the Digital Multimeter TD 2000 C (e.g. Voltage DC, Ohm) are compared by the Digital Comparator TD 30 with the limits selected. All values over or under these limits are printed out by the Digital Printer TD 1000. The result of the comparison is displayed on the TD 30 and is also available in Output TTL-Levels and relays with change-over contacts for further processing. Other digital measuring systems are possible with the wide range of TECNIDATA instruments in modular technology.

TME

Technique Moderne Electronique SA
CH-1844 Villneuve Tel. 021/6022 41 Telex 24771



**You too should make use of our
Know-How in the field of
Light Structures Technology!**



Time is money.
DECsystem-10 saves both.
The big way.

New DECsystem-10, the big timesharing computer. Performing and saving for you in a big way right from the outset. That's because unlike most large systems, the DECsystem-10 was designed from the start to handle a large number of computing jobs at the same time - local and remote batch, interactive EDP and timesharing.

This capacity for multi-task activity has built for the DECsystem-10 the reputation of being the best timesharing system for the money. That's why the DECsystem-10 is the number one choice of successful independent timesharing bureaus worldwide. And for these companies computers are their lifeblood.

Price is one thing, what you get is another. You will find it hard to match DECsystem-10 features or performance anywhere else for the price. A price with a range as wide as the choice of operations DECsystem-10 offers. From 1.05 to 7.0 million Swiss Francs.

For 1.05 million Swiss Francs you can have a system which offers a choice of high level languages, powerful utility programs and a whole library of user application software. Simultaneous service can be provided for sixteen lines whilst still maintaining a batch processing service. A time proven operating system, re-entrant software and highly efficient file management ensure maximum job throughput.

And you can grow! The single operating system with user-software compatibility throughout the whole range of DECsystem-10 make expansion using the modular hardware simple. The smallest system can easily be extended to run over 100 simultaneous jobs, 14 batch streams, local or remote whilst also ensuring response to time dependent real time tasks.

For today's problems, tomorrow's solutions. If your present and future computing needs are pure batch, which would be unusual today, stay with a batch computer. But, as we suspect, if you have a mix of requirements, the DECsystem-10 is definitely for you. On program development alone, the DECsystem-10 is many times more productive than batch systems. You can take our word for it, but you don't have to. You can talk to our customers - over 400 penny-wise businesses, manufacturers, schools and research institutions who are saving time and making money with the DECsystem-10. We'll be happy to put you in touch with them.

Timesharing computers: a Digital tradition. Digital is the world's leader in timesharing with a thousand large and small systems around the world. Which amount to a lot of time and money saved.

For the new DECsystem-10 information kit, contact Digital Equipment Corporation International (Europe), 81, route de l'Aire, CH-1211 Geneva 26, Tel. (022) 42 79 50.

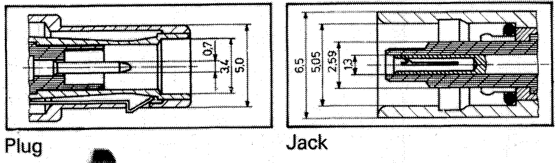
Offices in Reading, London, Birmingham, Bristol, Leeds, Manchester, Edinburgh, Munich, Berlin, Cologne, Frankfurt, Hamburg, Hannover, Stuttgart, Vienna, Stockholm, Gothenburg, Oslo, Copenhagen, Helsinki, Paris, Grenoble, Utrecht, Brussels, Geneva, Zurich, Milan, Turin.

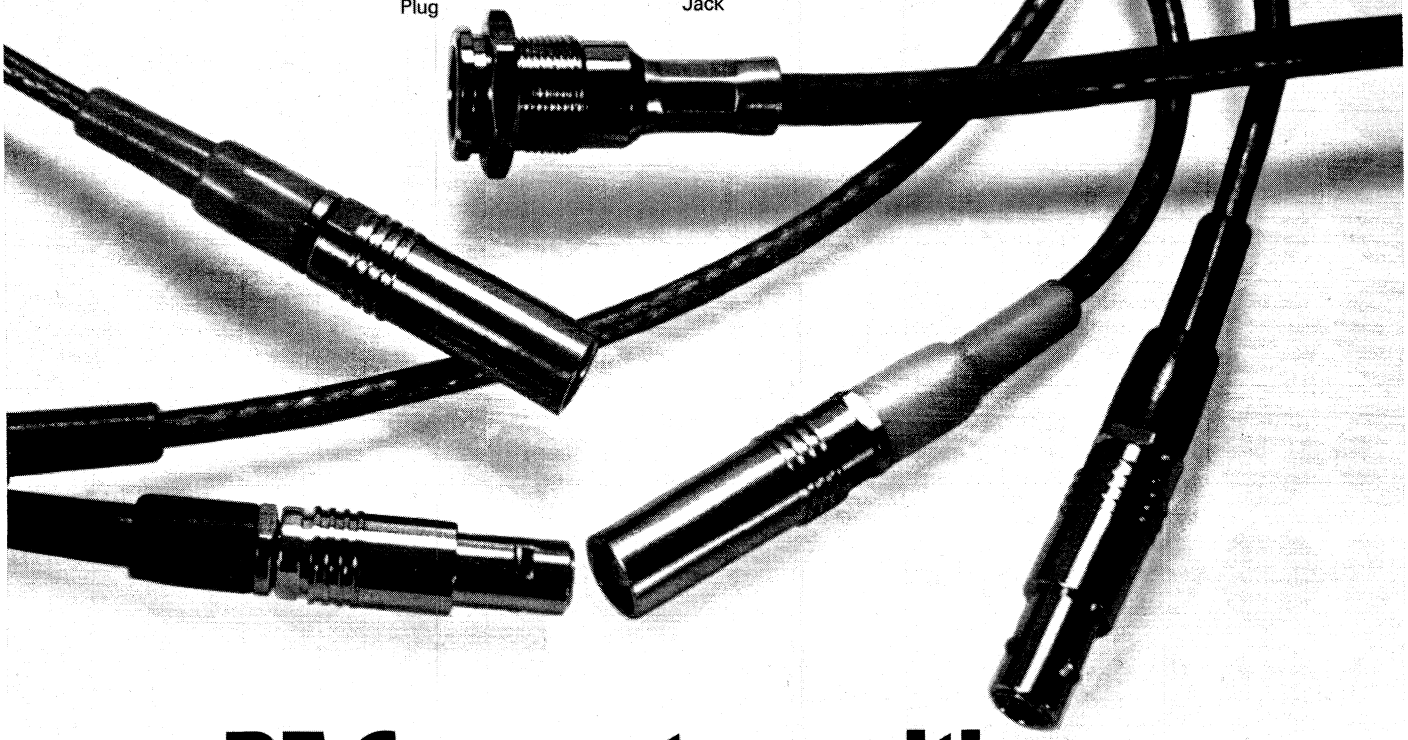
Time is money. Save both.

digital

Atelier Epper

NEW: SUHNER QLA





RF Connectors with quick latch mechanism* according to NIM-CAMAC Series QLA.00**

* Patents applied for
** Matches with Lemo-00250

3 latch springs of tempered Be-copper. (HV approx. 380). This material guarantees long life.

Connector body without slots, no radiation of RF energy.

Moisture-proof without increased outer dimensions.

HUBER+SUHNER LTD.
CH-9100 Herisau/Switzerland
Phone 071 531515/Telex 77426

Dependable contact characteristics by heat-treated, gold-plated Be-copper six-finger circular contact. Contact resistance ≤ 0.2 mΩ.

2 cable entries:
SUHNER crimp technique
SUHNER pressure sleeve.

Please ask for detailed literature.

Etanchéité... Quand 2 clients sur 3 ont des problèmes particuliers, le mieux est de posséder une méthode universelle

Une méthode qui permet de résoudre au niveau du joint n'importe quel problème d'étanchéité. Il nous afalludes'années pour omettre au pointa partir d'études réalisées pour le secteur nucléaire, le plus exigeant dans ce domaine. Désormais l'efficacité d'un joint peut se calculer d'avance, ainsi que les paramètres à respecter pour chaque type d'application. Les résultats sont garantis : il vous suffit de nous indiquer avec précision les conditions d'utilisation.

Nous avons aussi un stock permanent de près de 5 000 joints différents : celui qu'il vous faut s'y trouve peut-être.

Dans tous les cas, le service technique Joints Fargère est à votre disposition pour vous conseiller : l'étanchéité c'est son problème.

CEFILAC
JOINTS FARGERE

90, rue de la Roche-du-Geai
42029 Saint-Etienne CedexlFrance
Tél. : (77) 33.09.26
Télex : 33 697 F

91, rue Carnot
92300 Levallois France
Tél. : (1) 7,57j43)52
Télex :63817 F

édipress - grenoble 160 R

E. LOTTI S.A.

Réactifs MERCK
Produits chimiques
Produits pharmaceutiques

Traitement des eaux
Produits pour piscines

PLUS DE
5000 PRODUITS
EN STOCK

8, RUE BAYLOIM, 1227 CAROUGE
TÉLÉPHONE 42 57 66 / 42 57 65
TÉLEX: 289 382 LOTI. CH.

Touches lumineuses
série 11 avec diodes Ga As
Boutons poussoirs série 21

— signalisation soit par diodes Ga As ou lampes Bi-Pin longue durée T1
— microrupteur en argent plaqué or 10μ, 250 V~, 5 A, cos. φ 1
— 1–3 pôles action momentanée ou maintenue
— durée de vie garantie 2 mio. de manoeuvres

309 F

Electro-Appareils Olten SA, Tannwaldstrasse 88,
CH-4600 Olten, téléphone 062/21 19 61

RPA 'VITESS' power conversion equipment

Experience counts: RP Automation set the pace in the application of solid state devices in power control.
RPA 'VITESS' power conversion equipment and systems are in commission throughout the world; from Canada to the Far East — from Southern Africa to Siberia VITESS equipments are giving efficient and reliable service.
Perhaps RP Automation can meet your power conversion requirements.

VITESS equipment

- VITESS equipment
- Thyristor Motor Controllers
- Thyristor/Diode Rectifiers
- MAR Replacements
- Excitation Control Systems and AVR's
- No Break Supplies
- Thyristor Control Modules

For Complete System Engineering: development design, manufacture, installation, commissioning.

Telex: 537040 'Automate' GHEAD

Kingsway, Team Valley Trading Estate, Gateshead
Tyne & Wear, England. NE11OQJ, Telephone 0632 870811

Reyrolle Parsons Automation Limited

Reyrolle Parsons Group

Representative in Switzerland :

Airtechnik AG, 6, Sântisstrasse, 8153 Riimlang/ZH. Tel: (010411) 8177/471. Telex: 55204