CERN COURIER

No. 12 Vol. 9 December 1969

European Organization for Nuclear Research

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. CERN is one of the world's leading Laboratories in this field.

The experimental programme is based on the use of two proton accelerators — a 600 MeV synchro-cyclotron (SC) and a 28 GeV synchrotron (PS). At the latter machine, large intersecting storage rings (ISR), for experiments with colliding proton beams, are under construction. Scientists from many European Universities, as well as from CERN itself, take part in the experiments and it is estimated that some 1200 physicists draw their research material from CERN.

The Laboratory is situated at Meyrin near Geneva in Switzerland. The site covers approximately 80 hectares equally divided on either side of the frontier between France and Switzerland. The staff totals about 2650 people and, in addition, there are over 400 Fellows and Visiting Scientists.

Thirteen European countries participate in the work of CERN, contributing to the cost of the basic programme, 235.2 million Swiss francs in 1969, in proportion to their net national income. Supplementary programmes cover the construction of the ISR and studies for a proposed 300 GeV proton synchrotron.

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 Editor : Philippe d'Agraives
Advertisements : Micheline Falciola
Photographs : Gérard Bertin

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

Printed by: Ed. Cherix et Filanosa S.A.
1260 Nyon, Switzerland

42nd Session of CERN Council

The Council met at CERN on 18, 19 December under the Presidency of Dr. G. Funke.

300 GeV Project

Since it had been hoped to take the final decisions on the proposed 300 GeV Laboratory during this Session of the CERN Council we begin the report with this topic. There were many hours of discussion outside the Council particularly between representatives of the six countries who have so far indicated their willingness to participate in the project — Austria, Belgium, Federal Republic of Germany, France, Italy and Switzerland. The outcome of these discussions was summarized at the Council Session by the President as follows:

'The Council of CERN has made good progress towards establishing the 300 GeV Programme during the course of this year.

To date, seven of the twelve Member States of CERN *(United Kingdom, Denmark, Norway, Federal Republic of Germany, Austria, Switzerland and France)* have ratified the amendments to the present Convention which will enable a new Laboratory to be set up under a second Director General of the Organization and the ratifications of the remaining five States are expected shortly.

All the necessary documentation for the new Programme has been prepared and the design of the accelerator and the Laboratory has been greatly advanced in recent months.

In June of this year, a document was approved by the Council setting forth a definite programme for the 300 GeV Laboratory *(see CERN COURIER vol. 9, page 163)* including a description of its principal research tool, a large proton accelerator of an energy of about 300 GeV. This document also defines the cost of the construction and bringing into operation of the Laboratory and the time-scale for this work. Recently, the scale of contributions of the participants in the 300 GeV Programme has been prepared together with the budget for the first year of the Programme. Earlier this year, a Director of the 300 GeV Programme was appointed, and during the year he has worked with a group of European experts on the detailed design of the accelerator and the Laboratory. This work is continuing.

Contents

Cover photograph: On 24 November, there was a light-hearted celebration for the tenth anniversary of first operation of the CERN proton synchrotron. After speeches by P. H. Standley (on the development of the machine over ten years) and J. B. Adams (paying tribute to the role of Odd Dahl in the initiatives which led to the building of the PS), the PS Division Dramatic Society was let loose to present their version of experimentation at the accelerator. Drinks followed in the coffee lounge and to eat was a 1 m diameter edible replica of the PS and its experimental halls. Assisting in the traditional blowing out of candles are (left to right) P. Germain, Mrs. H. Blewett and P. H. Standley. (CERN/PI 512.11.69)

Thus the point has been reached at which the location of the new Laboratory can be determined. I am informed that in order to facilitate a decision on the site a meeting at Ministerial level will be held in the very near future by the Member States intending to participate in the 300 GeV Programme.

This Item of the Agenda will therefore be taken up at the next Council Session. So we can expect that the Programme will be started early in the New Year.'

The sites which will be discussed by Ministers, or their representatives, are — Doberdo (Italy), Drensteinfurt (Federal Republic of Germany), Focant (Belgium), Gopfritz (Austria) and Le Luc (France). It is hoped that the meeting can take place before the end of January.

The next Session of the Council is scheduled for 19, 20 March 1970 but the President remarked that the dates for forthcoming Sessions could be changed to meet developments in the situation.

Progress Report from CERN-Meyrin

The Director General, Professor B. Gregory, situated his progress report for 1969 in the context of the development of CERN-Meyrin. On the one hand CERN has now completed about ten years of physics and, on the other hand, CERN is now at the peak of a second phase of construction which will extend into 1972 opening up a new range of facilities for physics research in the future.

The two graphs on the following page illustrate two interesting aspects of the development of CERN. Through to the first operation of the proton synchrotron in 1959, construction — equipment and buildings — absorbed the bulk of the budget. Research and operation then took a large and growing share. In 1966, with the authorization for the Intersecting Storage Rings and the improvement programme on the 28 GeV proton synchrotron, construction again absorbed a high proportion of the total budget while the research budget was held almost steady. When the construction is nearing completion in the early 1970's, research will again climb fast while the total budget of CERN-Meyrin will have reached a 'plateau'.

During the past ten years the total, and the breakdown, of the number of research scientists at CERN has changed dramatically. Starting in 1960 with a total at CERN at any one time of around 100 research scientists of whom about 30 % were CERN staff, the total has grown to around 550 — of this total CERN staff represent about 8 % while visitors based in European Universities account for 60 %. The number of Universities who have been involved in the experimental programme has reached the remarkable total of 187.

Tribute to Professor Scherrer

Before the formal opening of the Council Session, the President, Dr. Funke, payed tribute to three great friends of CERN who have died during the past six months — Professors C.F. Powell, A. de Shalit and P. Scherrer. Tributes to Professor Powell (page 235) and Professor de Shalit (page 305) have already appeared in CERN COURIER. The following is Dr. Funke's tribute to Professor Scherrer.

'Professor Paul Scherrer had a great enthusiasm for physics. He belonged to the generation of Schroedinger, Debye and Weyl. Together with Debye, he developed a method for the study of the crystalline structure of matter by means of X-rays which became one of the fundamental tools in solid-state physics.

In 1927, he was appointed Director of the Institute of Physics at the Federal Institute of Technology in Zurich, and Zurich became, under his leadership, one of the most important nuclear physics centres in Europe.

Paul Scherrer's deep interest in nuclear physics led him naturally to play a prominent role in the foundation of CERN. He was among those who signed the Agreement constituting a Council of Representatives of European States for Planning an International Laboratory and Organizing other Forms of Co-operation in Nuclear Physics, in February 1952, and in May of the same year he was elected first President of the Interim Organization.

He became one of the original members of the Scientific Policy Committee in 1954, and for over ten years, he took a most active interest in the work of the Committee. We were very sorry to lose the benefit of his clear insight and of his advice when he retired in 1965.

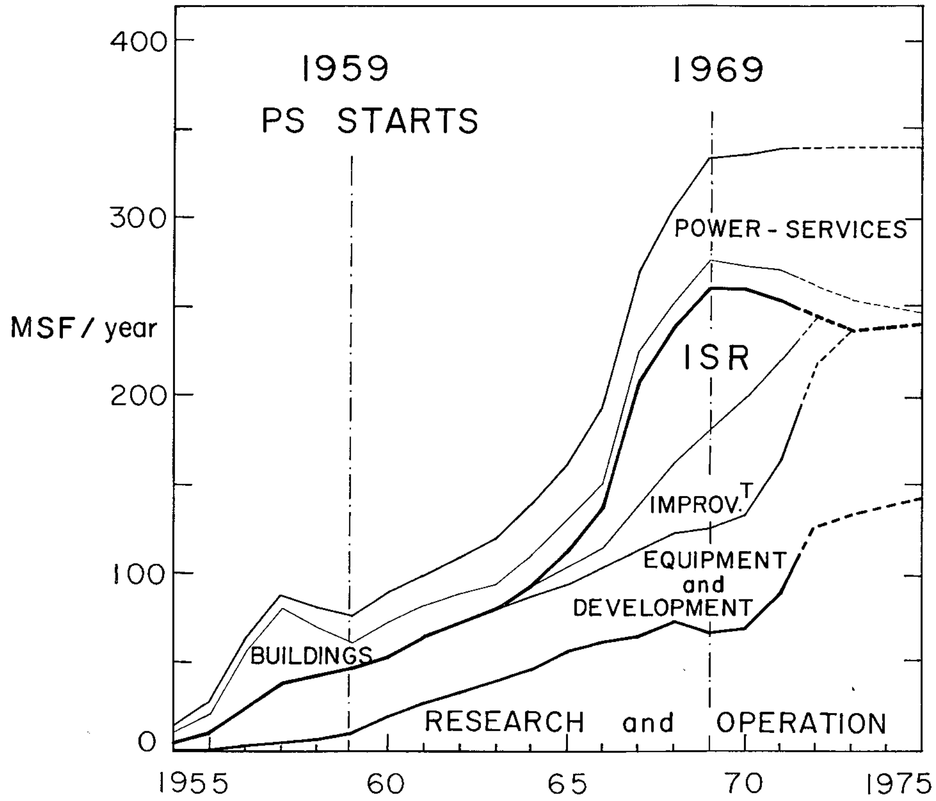
All his life, Paul Scherrer was deeply interested in the young. He was a marvellous master who understood his students well and was able to establish a very close contact with them. Perhaps this close association with the younger generations reflected on him, since — both physically and in spirit — he was a young man till the very end. This is why his death last September, at the age of 79, was an unexpected shock to all who knew him and admired his passion for science and his enthusiasm.'

Professor Scherrer, on the right, in conversation with Professor Peyrou during a visit to CERN in 1963.

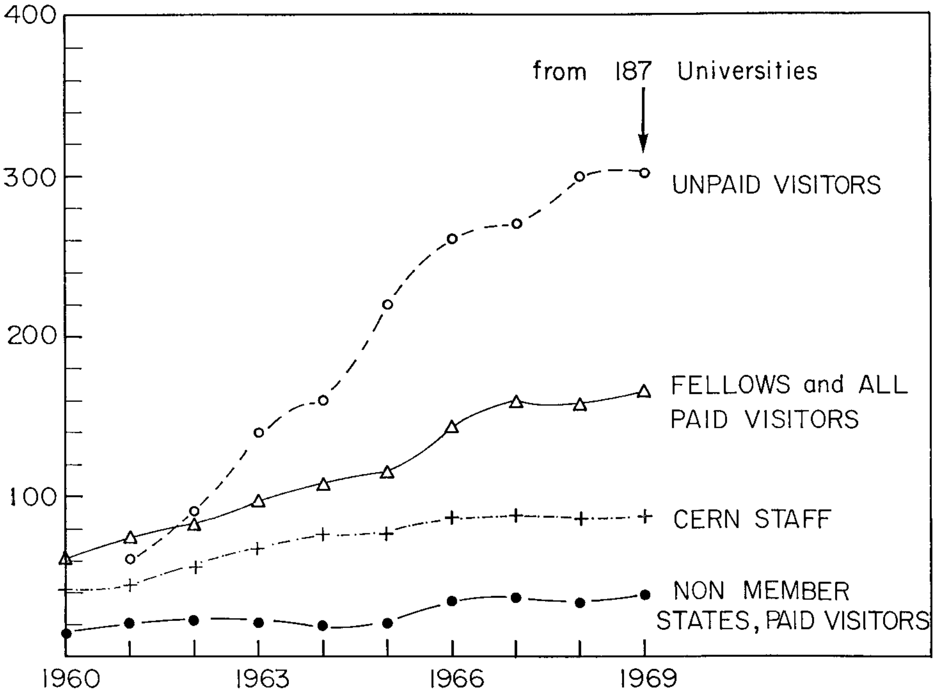
CERN/PI 102.10.63

1. A breakdown of the budget of CERN-Meyrin over twenty years. The steep rise in recent years is due to the present major construction programmes — the Intersecting Storage Rings and the improvements to the proton synchrotron. These wil be completed in 1972. By 1975 it is aimed to reach a 'plateau' in the budget.

2. A breakdown of the number of research scientists at CERN during the years that research has been under way at the proton synchrotron. (This does not give the total number of physicists using the two CERN accelerators for research — which is over 1000 — but the number at CERN at any one time.) Particularly noticeably is the rise in the number of 'unpaid' visitors (i.e. visitors not paid by CERN). These are scientists doing research at CERN while still based in the Universities of the Member States. The number of Universities involved, 187, is a measure of the impact of CERN on physics in Europe.



1.



2.

The change is reflected particularly in the figures for the number of scientists involved in counter experiments. In 1964, there were 16 experiments of this type at the PS with 9 participating groups from the Member States, and 9 at the SC with 5 Member State groups. In 1969 these figures have become 22 at the PS with 24 Member State groups and 13 at the SC with 16 Member State groups. The change is not so dramatic in the bubble chamber experiments where participation of outside groups was well developed from the beginning. In 1964, 30 Member State groups shared in the analysis of a bubble chamber output of 2 600 000 pictures. In 1969, 37 Member State groups shared in the analysis of 6 908 000 pictures (1 953 000 from the 81 cm hydrogen chamber, 3 485 000 from the 2 m hydrogen chamber which is now taking two pictures per pulse, and 1 470 000 from the heavy liquid chamber).

Running parallel with this growth of the experimental programme, and an essential part of its success, is the growth of computer operations at CERN. In 1964, when the IBM 7090 was CERN's main computer, there were about 160 computer users requiring the processing of about 200 'job' per week, while the measuring units for the film from the bubble chambers and spark chambers called for the analysis of some 200 000 events. By 1969, when the main computer complex was built around a CDC 6600 aided and abetted by a CDC 6400 (now being converted to a 6500), there are some 500 users feeding in 6500 jobs per week, while the measuring equipment calls for analysis of 350 000 events.

Operation of the synchro-cyclotron has been remarkably efficient during 1969. The machine operated 80 % of the available hours during the year with only 3 % time lost through breakdowns. At the same time, the research potential of the SC was about doubled by more efficient sharing of the ejected proton beam and internally produced beams, together with an increase in the intensity of the beam in the machine and of the ejected beam (to a record level of 5.6×10^{11} protons/second). The improvement programme on the SC, which is designed to increase the accelerated beam by a factor of about ten, is going well.

Among the experiments, the work on mesic X-rays has been particularly successful and reflects the growing interest in nuclear structure research at the SC. Negatively charged mesons can sit in orbits around the nucleus, just like electrons, but the orbits are much closer to the nucleus (even passing through the nucleus) and are influenced by the distribution of particles in the nucleus which can no longer be regarded as a point charge. As the mesons fall from one orbit to a lower one, they emit X-rays which can be detected. The experiments have been done with muons and with pions which also feel the strong nuclear force. Thus pionic X-rays from say oxygen 16 compared with oxygen 18 give a measure of the effect of adding two further nucleons. These experiments will be extended using negative kaons at the PS.

The PS has celebrated its tenth anniversary by reaching much higher beam intensities. Slow ejection is much more thoroughly understood and it has at last been possible to achieve in practice the slow ejected beam intensities predicted by theory. This is of great importance in view of the coming much higher accelerated beam intensities which need to be handled much more efficiently.

The experimental programme has been influenced by a major development in particle theory — the so-called Veneziano model has been successfully submitted to a series of experimental checks. The model relates two ways of tackling particle phenomena. At comparatively low energies it had been customary to consider particle collisions in terms of resonance formation. Thus the scattering of two pions was interpreted as proceeding via the production of, for example, a rho meson which then decayed giving again two pions. At higher energies the scattering was interpreted by an 'exchange mechanism' — one pion passing a rho to the other. The Veneziano model has related these two methods of interpretation showing that, properly treated, they are equivalent.

Spectacular results came from the first experiment by a joint CERN-Soviet team at the 76 GeV proton synchrotron at Serpukhov. The experiment gave values for the total cross-sections of high energy negative particles interacting with the proton very different from those predicted by theory and from those anticipated by the measurements at lower energies at Brookhaven and CERN. We are obviously still not in a position where theory can predict what will happen at higher energies which underlines the need for a higher energy machine.

The construction of the ISR and the PS improvement programme are going very well. Construction of the ISR tunnel is virtually complete, half the magnets are installed, preliminary vacuum measurements have reached almost 10^{-9} torr even before 'bake-out'. Preparation for the ISR experimental programme is in full swing and some thirteen groups have had experiments approved.

The civil engineering work on the 800 MeV synchrotron injector is well advanced and many contracts have been placed. The model work for the large European hydrogen bubble chamber (BEBC) has gone well and most components are ordered. There has been a delay on the delivery of the chamber body for the new heavy liquid chamber, Gargamelle, but it should arrive in a few months time and the chamber should be operational before the end of the year. The Omega project will use a new type of superconducting coil and a special polarized target is being developed.

The completion dates for these major projects are: Gargamelle 1970; ISR, BEBC 1971; Synchrotron Injector, Omega 1972.

Budgets

The budget adopted for the basic programme at CERN-Meyrin for 1970 is 244.1 MSF (this is at 1970 prices following the application of a 'cost variation index' of 3.48 % to take account of price movements during the past year).

The budget adopted for the construction of the Intersecting Storage Rings is 81.9 MSF. Of the total expenditure at CERN next year, 318.1 MSF (not counting any budget for further 300 GeV studies) will be met by contributions from the Member States. The percentage contributions to the basic programme divide among the Member States as follows:

Austria	1.96
Belgium	3.77
Denmark	2.26
Federal Republic of Germany	23.27
France	19.90
Greece	0.60
Italy	12.89
Netherlands	4.43
Norway	1.52
Sweden	4.59
Switzerland	3.20
United Kingdom	21.61

In accordance with what is known at CERN as the 'Bannier Procedure', budgets for three further years (at 1970 prices) are also put before Council. Firm estimates for 1971 were accepted as 255.9 MSF for the basic programme and 82.6 MSF for the ISR. Provisional determinations for both 1972 and 1973 were 269 MSF for the basic programme and 82.8 MSF for the ISR.

These last figures represent the approach to a 'plateau' in the overall budgets and numbers of staff for CERN-Meyrin. During the past year, in the light particularly of the anticipated expenditure on the 300 GeV project, there have been extensive discussions on the programme and budgets for CERN-Meyrin through to 1975. It has been generally accepted that a plateau of about 340 MSF (at 1969 prices) should be the aim.

New appointments

This Session marked the end of the three year tenure of office of Dr. Gösta Funke as President of the CERN Council. Since the beginning of 1967, Dr. Funke has competently steered Council through a most difficult and complex period. With the preparations for the 300 GeV project underway, while at the same time the improvement programme and the ISR project gathered momentum at CERN, the volume of Council work has grown considerably. The rising costs also made the governments of the Member States look more closely at CERN's affairs. It has been Dr. Funke's role as President during these developments to sustain in Council the excellent spirit of collaboration which has always distinguished CERN. He was warmly thanked by the Vice-President, M. J. Martin, and the Director General. Happily, he will remain involved in CERN affairs as a Council delegate from Sweden, a position he has held since 1954.

His elected successor is Professor Eloardo Amaldi from Italy. Professor Amaldi is no stranger to CERN COURIER readers. He was a founding father of CERN becoming Secretary-General of the 'Conseil Européen pour la Recherche Nucléaire' from 1952-54 and was then Deputy Director General in 1954-55. Since 1958, he has been a member of the Scientific Policy Committee (being Chairman from 1958-60) and since 1959 he has represented Italy in the Council. He is perhaps best known as Chairman of the European Committee for Future Accelerators (ECFA) and the ECFA report in 1963 where the 300 GeV project was first recommended is often referred to as the 'Amaldi Report'. There are few people with a better knowledge of the European high energy physics community and of CERN in particular. His wide experience in science and in international affairs and his enthusiasm for the cause of CERN will be great assets in the three years to come.

Other elections were those of Mr. H. Haunschild (Federal Republic of Germany) and Mr. A. Chavanne (Switzerland) as Vice-Presidents of the Council, Prof. W. Gentner (Federal Republic of Germany) as Chairman of the Scientific Policy Committee and Prof. W. Kummer (Austria) as Chairman of the Finance Committee.

Dr. Pierre Germain is resigning as Director of the Proton Synchrotron Department because of ill-health (though he will remain at CERN). Dr. Germain came to CERN in 1955, working in the r.f. group of the PS Division. In 1961, when the PS was in operation, he became Leader of the Division. Following the internal reorganization in 1966 he became Director of the Proton Synchrotron Department.

Dr. Cornelius Zilverschoon, at present Deputy to the Director of the Intersecting Storage Rings Department, was appointed to succeed Dr. Germain. Dr. Zilverschoon came to CERN in 1954 to head the mechanical engineering group in the PS Division. In 1963 he became alternate Division Leader of the Accelerator Research Division and there participated in the design study for the 300 GeV machine. He has remained in close contact with the preparatory work for the project.

1. Dr. G. Funke, retiring President of the Council.

2. Professor E. Amaldi, newly elected President of the Council.

Saclay and Orsay

Accelerator Laboratories in France

A report of the activities at the major centres of particle physics research in France — the Centre d'Etudes Nucléaires, Saclay (where there is a 3 GeV proton synchrotron 'Saturne') and the Laboratoire de l'Accélérateur Linéaire, Orsay (where there is a 2.3 GeV electron linear accelerator and a 550 MeV electron-positron storage ring, 'ACO').

Before beginning a description of some of the present activities and future plans of the two research centres, it is useful to situate them in the context of the total particle physics effort involving France. In the midst of the work towards the 300 GeV project it is as well to remember that, as costs are high and money is scarce, the project can go ahead because it has been given priority over others and that someone somewhere will feel the pinch as a result. This situation is already influencing decisions affecting the Rutherford and Daresbury Laboratories in the UK, which has not supported the 300 GeV Laboratory, and it will strongly affect the Saclay and Orsay Laboratories.

Discussions on the detail of the VIth National Plan in France, which will run from 1971 to 1975 inclusive, are not yet complete but it seems probable that the money available for particle physics and nuclear physics will be pegged to a total budget, which will be allowed to grow less quickly than the total expenditure on research (probably implying a growth rate of about 5 % per annum). This includes the money for the 300 GeV and means that it is unlikely that any major new project or major development of an existing facility will take place within the context of the national programme in France through to 1975.

Much more clearly than in the past, it is evident that money spent at CERN (at least for the next few years) is money not spent at the National Laboratories. This is fully appreciated in these Laboratories and does not detract in the least from their courageous support of the 300 GeV project which they have always given first priority. It is recognized that CERN is not an international organization drawing financial support to the detriment of physics in a particular country but, on the contrary, is an integral part of the research programme of every participating country, making available research facilities which would otherwise be inaccessible. Nevertheless local facilities have proved important in covering areas of research which are not possible at CERN or which would be an uneconomic use of CERN. This is an addition to developing a strong national particle physics community capable of making the most efficient use of CERN.

It is probable that these problems will be carefully examined under the auspices of ECFA (the European Committee for Future Accelerators) which provides a forum for discussion including all the components of the particle physics community in Europe. CERN, the National Laboratories and the Universities all have their voice in ECFA and it is an obvious place to discuss the coordination and the optimum balance of the total resources in Europe. There is also a lot of thought being given to the question of how the expertise in National Laboratories, which has been heavily involved in the preparatory work for the 300 GeV project, could continue to play a part during the construction of the accelerator.

It is against this background that the report on Saclay and Orsay is written.

SACLAY

The Saclay Nuclear Research Centre is the largest of the Laboratories of the CEA (Commissariat à l'Energie Atomique) where the research covers the many aspects of the generation and application of nuclear power in addition to various fields of physics. Particle physics comes under the *'Direction de la Physique'* headed by Professor A. Abragam who is well-known as a specialist in magnetic resonance and for his pioneering work on polarized targets. Three of the 'Departments' under him are:

Elementary Particle Physics — headed by A. Berthelot, which has sections covering electronics experiments, bubble chamber experiments and a technical section at present occupied with the construction and operation of 'Mirabelle' the 4.5 m hydrogen bubble chamber destined for Serpukhov.

Nuclear physics — headed by A. Messiah, which is now mainly concerned with the long duty-cycle 600 MeV electron linear accelerator (ALS), which was inaugurated last February, and a variable energy cyclotron with a polarized beam. (The ALS was described in CERN COURIER vol. 9, page 74 and will not be covered again here).

Saturne — headed by R. Levy-Mandel which sees to the operation and development of the 3 GeV proton synchrotron with sections for beam optics (covering fundamental accelerator physics) for machine operation and for experimental areas. (This last section includes the team building the heavy liquid bubble chamber 'Gargamelle' for use at CERN, and superconductivity studies.)

Saturne

Saturne accelerated its first protons in August 1958. It is a weak focusing synchrotron of 22 m diameter. The magnet is in four quadrants weighing a total of 1200 tons and producing a peak field of 14.9 kG. One of the four straights is taken up by the r.f. accelerating station which gives 1.2 kV per turn to the protons, rising in frequency from 1.7 to 8.45 MHz. Injection is from a 20 MeV linac which has recently replaced a 3.6 MeV Van de Graaff. The new injector, which is widely admired for the elegance of its design, came into operation on Saturne in September of this year. It is expected that it will serve to increase the intensity of the full energy beam to 10^{12} protons per pulse (3×10^{11} ppp was possible with the Van de Graaff). The pulse repetition rate varies from one pulse every 2 seconds to one pulse every 4.6 seconds depending upon the mode of operation — particularly on the length of the flat-top (up to 500 ms with 350 ms usable). The possibility of connecting direct to the mains for the flat-top is being investigated in the hope of improving the repetition rate and a dynamic ripple filter will be installed in the main magnet power supply early in 1970 to reduce the flat-top ripple. There is one ejection system (of the Piccioni type) on the machine using three magnets, two of which are mechanically plunged into the vacuum vessel. Extraction efficiencies of 45 % are recorded on the external target.

Restarting after a shutdown of seven months during which the experimental halls were modified, Saturne is just at present in use solely to provide a beam to Mirabelle. As reported in CERN COURIER vol. 9, page 308, the huge chamber is now in operation having its proving tests before being shipped to the 76 GeV accelerator at Serpukhov (the move being scheduled in the Spring of

The 3 GeV proton synchrotron Saturne at Saclay. This photograph was taken with much of the concrete shielding, which normally surrounds the accelerator, removed. The future experimental programme at Saturne is being largely re-oriented towards special topics not covered elsewhere.

(Photo Saclay)

1970). The first particle beam was fed to the chamber on 13 November.

The agreement with the USSR is that the chamber will operate at Serpukhov for four to five years. It is anticipated that, in fact, this period will be considerably extended. A team of about fifty French scientists and technicians will go to Serpukhov (about ten are already installed in Protvino near the Laboratory) to reassemble, operate and use the chamber, experiments being carried out in collaboration with Soviet scientists.

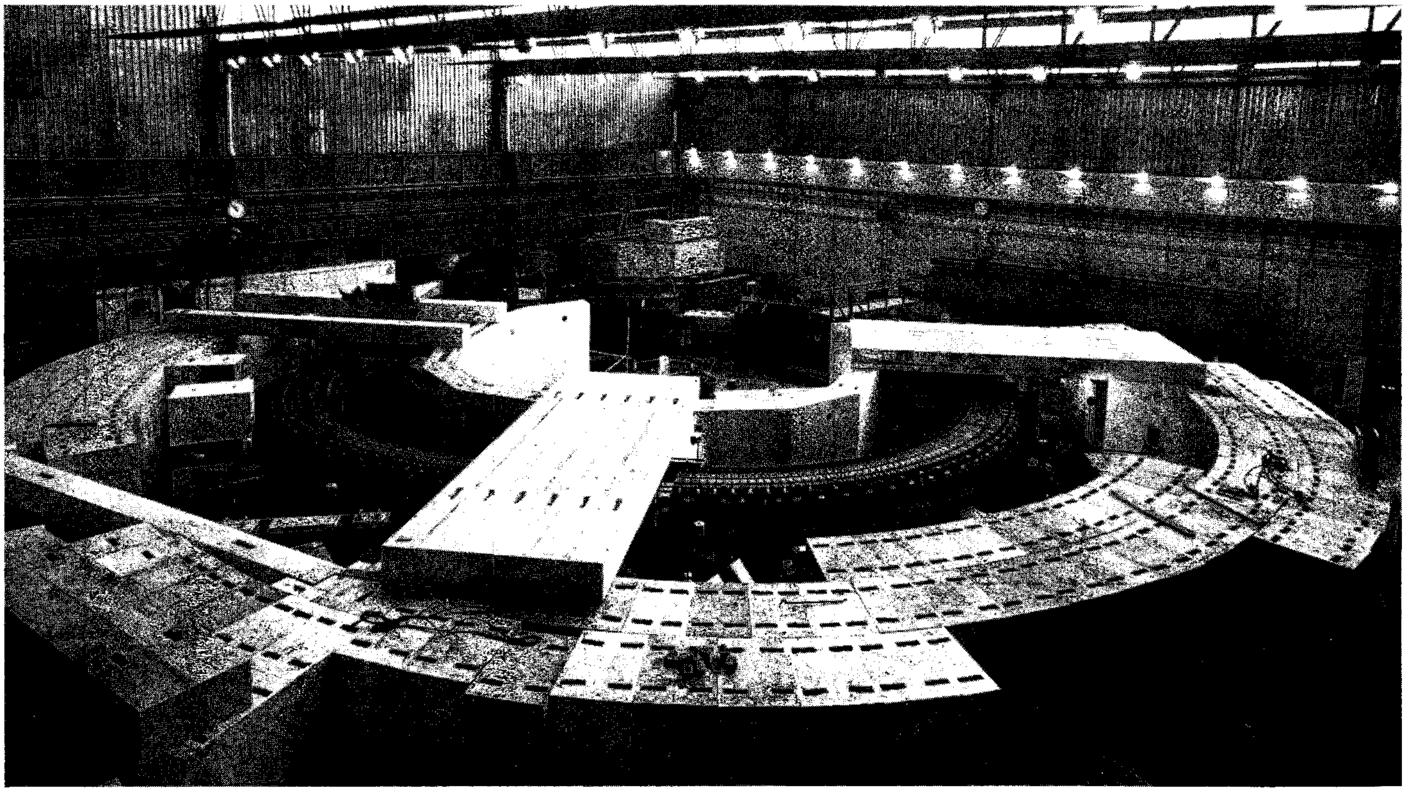
Data analysis facilities are being built up considerably to cater particularly for the increased volume of bubble chamber film needing to be analysed which will come from Mirabelle. An HPD I has been in operation for some time and an HPD II (CERN COURIER, vol. 8, page 79) on-line to a PDP-10 has been going through various commissioning stages since it arrived at Saclay early in 1969. In addition there will be a Spiral Reader (CERN COURIER vol. 8, page 247) of the type built by CERN in collaboration with the Collège de France.

Nuclear structure research

By the end of 1970, Saturne will be occupied with a full programme; eleven experiments are scheduled to be installed around the accelerator. A noticeable trend, which is being encouraged, is towards the use of the machine for nuclear structure physics (absorbing about 25 % of the programme) rather than particle physics. The energy of a few GeV makes Saturne an appropriate instrument for new studies in nuclear structure.

The use of particle beams at energies around 1 GeV for these studies began at the 3 GeV Cosmotron at Brookhaven and was proving so fruitful that a strong, but unsuccessful, attempt was made to keep the Cosmotron alive beyond its scheduled closing-down date at the end of 1966. The possibility of continuing this work has been a major aim in the LAMPF project for a high energy proton linear accelerator (now under construction at Los Alamos) and is promoted at Princeton (on the 3 GeV rapid-cycling proton synchrotron) and at Saclay.

The problem is that in order to achieve the sort of precision that is needed for measurements in nuclear structure, the energies of the particles involved have to be known with great accuracy. Experiments are scheduled on Saturne for 1970 which will reach accuracies of 1 in 10^{-3} (the energy spread from the accelerator). But Saclay hopes to make major contributions to nuclear structure research from the end of 1971 when a large spectrometer (usually referred to simply as 'the spectro') will be in operation in a new extension of the experimental area. The spectro will be used by a Saclay team headed by J. Thirion in collaboration with the University of Caen, Collège de France and Orsay. It will consist of two large spectrometer magnets (90 tons and 60 tons) with ten quadrupoles, three sextupoles and target arranged in an achromatic system, and with multi-wire proportional chambers as detectors. It is designed to improve the measurement to 1 in 10^{-4} and is likely to absorb about a quarter of the machine programme when it comes into operation. A special ejection



system for beams up to an energy of 1.4 GeV is being prepared for use with the spectro and is scheduled to produce its first ejected beams by mid-1970.

Acceleration of special particle beams

Again on the theme of making available facilities which are not available elsewhere in Europe, it is intended to accelerate beams of deuterons (proton-neutron) and of alpha particles (2 protons-2 neutrons) from the middle of 1970 and latter of polarized protons and polarized deuterons (leading to the production of a high energy beam of polarized neutrons).

Saturne has already accelerated beams of deuterons using the Van de Graaff as injector. The high energy deuterons were used for experiments, carried out from January 1968 to February 1969 by the University of Caen and Saclay, concerning elastic scattering of deuterons on protons; inelastic scattering into deuteron plus 'missing mass' or helium-3 plus 'missing mass'; inelastic scattering of deuterons on deuterons into helium-4 plus missing mass. (When helium is produced the missing mass can be a resonance with zero isotopic spin). A study was also made of the production of intense beams of monoenergetic neutrons at high energy when the deuterons are split on a target into their component protons and neutrons.

The deuterons were accelerated to a maximum energy of 2.3 GeV and average beam intensities were from 1.5 to 2×10^{11} deuterons per pulse. The main problems that had to be overcome were due to higher radiation levels and to the need for some gymnastics with the r.f. system (switching from the third harmonic to the second harmonic in the course of the acceleration cycle). It is intended to accelerate deuterons again with the new injector which will give 10 MeV deuterons. Injecting at this higher energy will avoid the frequency jump in the r.f. system, which was necessary with the Van de Graaff as injector, and should result in substantially higher deuteron beam intensities.

There had been ambitious plans for the acceleration of heavy ions such as nitrogen, oxygen and carbon, the experimental interest being particularly in the field of cosmology as ions of these elements are accelerated in space. However, this would require a major re-equipping to the Van de Graaff for heavy ion injection and also a complete new vacuum system to enable pressures of 10^{-10} torr (rather than the present 10^{-6} torr) to be achieved. It is unlikely that this project will be financed in the foreseeable future.

Computer control plans

A preliminary survey of the use of a control computer in the operation of Saturne has been carried out using a CII 90-40. It has been employed mainly in studies of the performance of the main ring magnet system concentrating on two types of measurement.

The first was a survey of the magnetic field values in the median plane during the magnet cycle. The second concerned the reproductibility of the magnetic field cycle over many cycles. A program has also been developed to monitor faults in the accelerator but this has not yet been applied since the computer was rarely available.

The results so far have been encouraging and the decision has been taken to acquire a small computer specifically for use in Saturne control. It will be used for:

Studying beam emittance from the pre-injector and the new linear accelerator, and the energy spread in the beam;

Data-collection, monitoring and recording of some important machine parameters with alarm signals for the operators when attention to machine settings is needed;

Provision of rapid emergency procedures to the operators if there is serious deterioration in beam quality and provision of programs which will change the characteristics of the accelerated beam to meet the needs of the experimentalists. This should result in more efficient operation and reduce the lost time.

It is hoped that the computer system will be installed within the next two years.

Superconductivity

A group in the Saturne Department has done important work on superconductivity for both d.c. and pulsed applications. For example, a large coil of 1 m diameter (known as BIM is in operation (see CERN COURIER vol. 9, page 76). They have also built a 1/20 scale model of the large European bubble chamber (BEBC) magnet in order to check the shielding requirements to contain the stray magnetic field. A major unit, which is nearing completion, is OGA (Optique de Grande Acceptance) — a superconducting quadrupole doublet designed to increase the flux of pions in a beam at Saturne by a factor of four or five. It has an internal diameter of 20 cm and a field gradient of 3.5 kG/cm for the first quadrupole and 30 cm and 2.6 kG/cm for the second. It should be ready for testing mid-1970 and for installation in the experimental area a few months later.

Research into the problems of pulsed superconductors is following the, by now, standard pattern of using very fine filaments of superconductor, twisted with a specified pitch and embedded in a conducting matrix (see CERN COURIER, vol. 8, page 186). Nineteen small coils have been built using niobium-titanium as superconductor in filaments down to 28 microns diameter. This filament size will soon be further reduced to 10 microns in January 1970 and to 4 microns a few months later (Thomson-Houston, suppliers of the superconductor, now have filaments of 1.5 micron diameter on laboratory test).

In 1970 it is intended to begin construction of a magnet dipole such as would be used in any conversion of Saturne to a superconducting magnet ring. The dipole will have an internal aperture of 10 cm and will be 50 cm long. It is designed to give a field of 50 kG at its centre. The dipole is scheduled for completion by the middle of 1971.

A superconducting conversion could take Saturne to 15 GeV. Obviously at present such a project is talked of only in the context of developing the appropriate technology. However, such a conversion, which is of smaller scale than the previously proposed 45 GeV proton synchrotron project for a new accelerator in France, could be initiated at the start of the VIIth National Plan (1976). In the meantime, by implementing the small improvements to Saturne described above it should be possible to keep a healthy research programme going for some time. The role of Saturne will then be particularly the preparation of teams to use the international machines, the provision of special beams for experiments and the provision of facilities for nuclear structure research.

ORSAY

The particle physics research laboratories at Orsay are part of the Faculté des Sciences of the University of Paris. Research there is even more integrated into a University environment than at most accelerator centres. In this report we will choose two topics where Orsay has made outstanding contributions — research with electron-positron storage rings in the Laboratoire de l'Accélérateur linéaire (Director - Professor A. Lagarrigue), and research on isotope separation which has relevance in nuclear structure physics and astrophysics in the Centre de Spectrométrie Nucléaire et de Spectrométrie de Masse (Director - Professor R. Bernas).

ACO and Coppelia

For the past two years ACO (Anneau de Collision d'Orsay) has been extensively used for experiments. Prominent among the reported results have been studies of the three vector mesons — rho, omega, and phi — and checks on quantum electrodynamics. The width of the rho was accurately measured as well as the partial widths of the decay of the three vector mesons into electron-positron pairs. This made it possible to estimate the important omega-phi 'mixing-angle' (see CERN COURIER vol. 8, page 245).

At the beginning of 1969 a series of improvements were made on the ring to give much easier operation and a new beam interaction section was installed with very thin windows so that the decay of the phi meson into positive and negative kaon pairs could be studied. 1300 events of this type were recorded and made it possible to calculate the width of the phi with great accuracy (4.3 ± 0.3 MeV) as well as its branching ratio into $e^+ e^-$.

The ring is now shut down for the installation of a new experiment which will be capable of detecting neutral particles (neutral pions, eta mesons and photons) over a very large solid angle.

The physics results from ACO are the finest yet to emerge from the use of storage rings and have been made possible by a growing expertise at Orsay in colliding beam techniques. The taming of ACO to its present performance levels where beam conditions can be established with high stability and reproducibility (of the order of 0.02 % in energy) has taken several years. Luminosities reach $1.3 \times 10^{32}\,\text{cm}^{-2}\text{h}^{-1}$ with one bunch in each beam at an energy of 535 MeV. The circulating currents are then 20 mA per beam. (The filling time from the electron linear accelerator is less than half an hour, positrons being injected typically at a rate of 300 mA/h.)

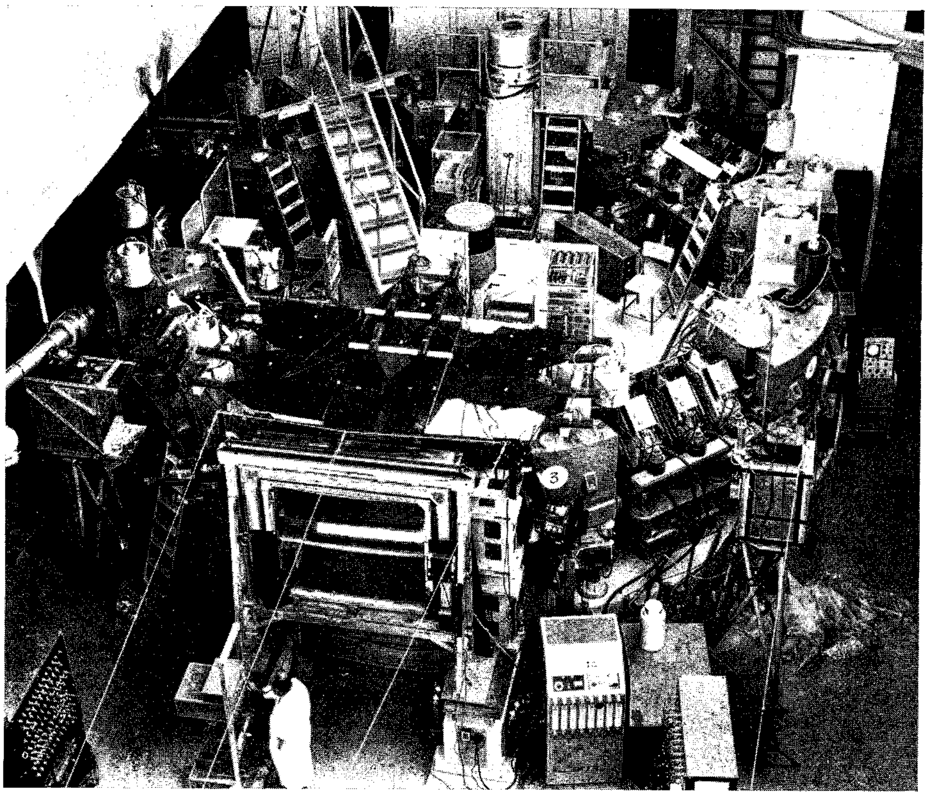
Based on this accumulated expertise, the ACO group led by P. Marin (for machine aspects) and J. Perez-y-Jorba (for physics aspects) have recently produced a design for a ring with energies 2 to 3 GeV per beam. The project is known as Coppelia. (Since Coppelia goes around a ring, one can begin with the letter 'A' and tortuously extract the name as follows 'Anneaux de Collisions à Paquets de Positrons et Electrons à Luminosité Intense'.) The project is built around the idea of 'four-beam space charge compensation' developed at Orsay from thinking about how to achieve high luminosities (and thus high interaction rates for the experiments) while retaining reasonable simplicity in the operation of the rings. Some of the ideas involved will be described here.

The main hindrance to reaching high luminosities over a range of energies in the GeV region is the beam-beam interaction, the effects of one beam on the other, leading in particular to the 'blow-up' of the less intense beam. These are space charge effects and to achieve space charge compensation it is necessary to bring together identical oppositely charged beams — identical in intensity, identical in particle distribution within the beams, and colliding together along the same axis (head-on collisions). If these conditions can be produced, all space charge forces cancel when the oppositely charged beams pass through one another in the interaction region. It is possible to reach high luminosities with 'conventional' beams — beams with reasonable cross-sections of the order of a millimetre — which can be stacked with more current up to the limit set by the available r.f. power (which has to replace the energy lost by synchrotron radiation). This is a different approach to other storage ring projects where the beams are specially treated in the interaction region (in storage ring jargon 'given a low β value') to pack the particles into a very small cross-section while achieving low beam-beam macroscopic interaction. Very precise beam control is then necessary to achieve high luminosities.

The design consists of two magnet rings one on top of the other with four common straight sections where beams collide head-on. In each ring there are two orbiting bunches of particles — one of electrons and one of positrons. (It is considered possible to equalize the number of particles per bunch to within 1 % at injection.) Identical particle distribution in the bunches can be achieved using matching quadrupoles positioned outside the common interaction regions. All four bunches pass simultaneously through an interaction region and if the 'working-point' of the rings (the settings of the focusing fields) is appropriately chosen, the beams will be self-adjusting, tending to pull closer together in the interaction region so that they travel along the same axis. This implies a great simplification in the requirements for adjustment.

Some of the advantages of having one bunch of each type of particle in each ring are — for a given luminosity and r.f. power, the value of the β function at the interaction region is conventional; feedback control can be easily applied since the number of bunches in each ring is small; sweeping out the ions produced by the beams in collision with residual gas is simple; with one or two bunches in each beam electrostatic separation of electrons and positrons is not needed making it possible to achieve luminosities higher than $10^{32}\,\text{cm}^{-2}\,\text{s}^{-1}$ over a large energy range.

Some parameters of Coppelia: the radius of the rings is 49 m — the bending radius of the magnets is 10.3 m in quadrants separated by long straight sections of which 6 m is free for the installation of experiments. The magnetic field strength rises to 9.7 kG in the bending magnets and 0.7 kG/cm in the quadrupoles for 3 GeV beams. The weight of the magnets is just over 1000 tons. The in-



The storage ring ACO at Orsay as it was when the first experiment on vector meson production was carried out. The detectors, surrounding the interaction region where electron and positron beams collide, are at the bottom of the ring as seen in the photograph. Diametrically opposite, at the top, is the r.f. station. The ring is filled with electrons and positrons from the Orsay electron linear accelerator which is off left.

(Photo Orsay)

stalled r.f. power foreseen for the first stage of operation, when beams would be restricted to a peak energy of 2 GeV, is 200 kW per ring (about 75 kW available for each beam). The rings are filled with electrons and positrons in less than half an hour with the linear accelerator. The current in each of the beams is just over 1 A at 1.5 GeV falling to about 90 mA at 3 GeV. Luminosities vary from 3.4×10^{32} $cm^{-2}s^{-1}$ at 1.5 GeV with a round beam to 6.8×10^{30} at 3 GeV with a 'flat' beam (the beam shape is changed to achieve maximum luminosity). If more r.f. power (up to 500 kW per beam) is added at a later stage the number of particles per beam can be increased to give luminosities of 1.75×10^{33} at 1.5 GeV to 2.2×10^{32} at 3 GeV.

The estimated cost is 90 million French francs. Construction would take three years and about another year would be necessary to bring Coppelia into operation for physics.

Mass spectrometry

Another well known team centred at Orsay is that led by Professor R. Bernas which has specialized in isotope separation using mass spectrometers 'on-line'. Their work has concentrated on two topics — the production and study of new isotopes of elements to increase the understanding of the structure of the nucleus; the study of isotopes of elements which are important for the understanding of phenomena in astrophysics.

The first topic will be fairly familiar to CERN COURIER readers since it concerns the same type of investigation as is carried out on ISOLDE (the Isotope Separator On-Line described in vol. 7, page 23) at the CERN 600 MeV synchro-cyclotron. Briefly : new nuclides of particular elements are produced which contain more (or less) neutrons than the nuclides readily found in Nature. These new nuclides may be 'stable' on the scale of nuclear phenomena — lasting for some seconds or fractions of a second before 'decaying' into a more stable variant. Generally speaking, the further one gets from the familiar nuclides, for example by adding more and more neutrons, the faster is the decay.

By producing such nuclides one can observe how the nucleus behaves under extreme conditions, and can thus learn more about the properties of the nucleus. (Just as much can be learned about human nature by its behaviour under extreme conditions !) Unfortunately, as the lifetimes of the nuclides become very short, it is increasingly difficult to get at them fast enough to carry out observations before they decay. In ISOLDE and in the Orsay system, the different stages of production, separation and observation are 'on-line' and this has made it possible to observe nuclides never seen before.

The Orsay team have also made their system transportable so that they can move, as necessary, from machine to machine and back to the laboratory at Orsay. They have, in the course of experiments covering energies from the MeV to the GeV range, moved from the 550 MeV cyclotron at Orsay, to the 3 GeV Saturne, to the 28 GeV PS at CERN and to a nuclear reactor.

Their latest results were reported in Physical Review Letters (page 652) on 22 September 1969, following experiments using high energy proton beams from the CERN PS which have revealed five new isotopes of sodium and have measured the lifetime of an isotope of lithium. They used special targets, 6 mm in diameter, consisting of a sandwich of foils of graphite and uranium (in the case of sodium) or iridium (in the case of lithium) heated to 2000° C. The isotopes of alkali metals (lithium, sodium, potassium, etc.) produced by the proton bombardment of the heavy nuclei, diffuse out through the graphite in about a tenth of a second. They emerge as positive ions and can then be separated into the different masses in a mass spectrometer. They are detected using an electron multiplier capable of counting single ions and the electronics give cumulative counts of the different ions over many pulses from the PS.

Using this technique, the lifetime of lithium 11 (which was first observed, but without a measurement of the lifetime, at Berkeley) was measured as 8.5 ms. Isotopes from sodium 27 to sodium 31 were observed for the first time and their lifetimes measured as varying from about 288 ms (^{27}Na) to 16 ms (^{31}Na). It is hoped to push the technique further so that sodium isotopes up to sodium 35 can be observed.

These experiments provide additional information to those carried out at ISOLDE (which will be reported in the next issue of CERN COURIER). They could not be done at ISOLDE energies where the cross-section for the production of the newly observed nuclides is too low.

The work in connection with astrophysics has involved some of the most refined mass spectrometry ever undertaken. It has been necessary, for example, to produce water (providing oxygen nuclei as a target) free from contamination by lithium, beryllium and boron down to the level of 10^{-13} grams, and to observe concentrations of an element down to as low as 10^{-14} grams.

One aim is to explain the observed abundances of elements in stars and cosmic rays. In a paper in 1956, W. A. Fowler, G. R. Burbridge and E. M. Burbridge, suggested that particles could be accelerated by magnetic fields to sufficient energies to produce nuclear reactions at the surface of a star. In particular, they suggested that the observed abundances of lithium, beryllium and

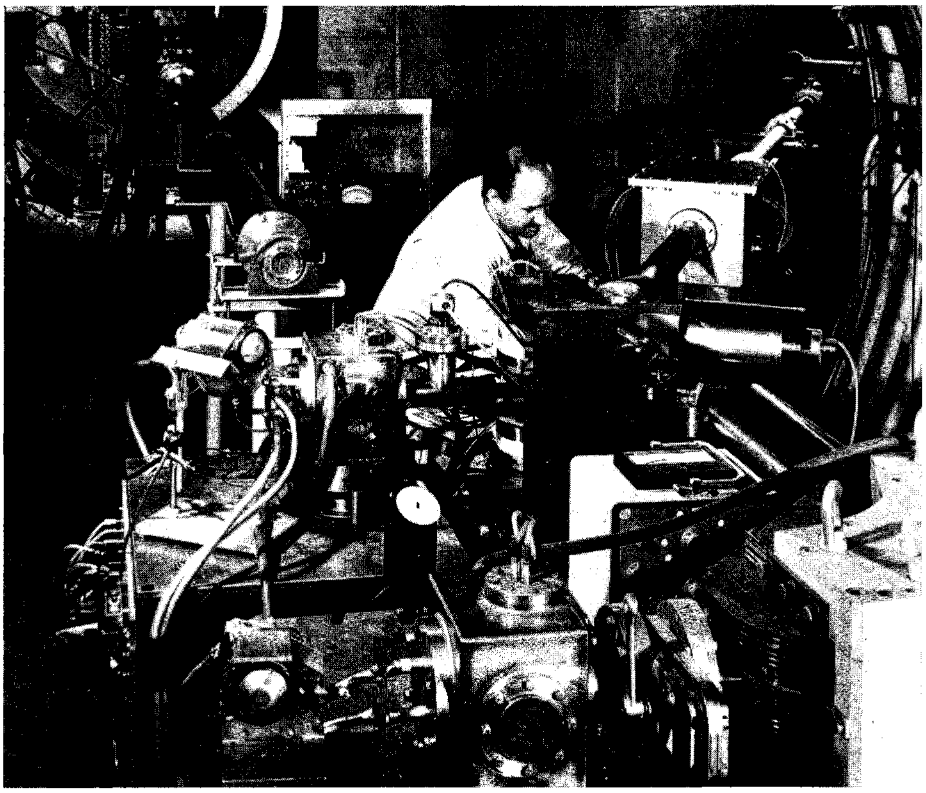
CERN News

boron could be the result of the spallation (when a number of light fragments break off a nucleus leaving a lighter nucleus) of carbon, oxygen and nitrogen in the stellar atmosphere. The same reactions in interstellar gas could explain the very high abundances of lithium, beryllium and boron in cosmic rays.

Thus it become important to know the cross-sections for the production of the long-lived isotopes of lithium, beryllium and boron from carbon, oxygen and nitrogen. One intriguing possibility is to have an estimate of the distance travelled by cosmic rays before they reach the earth. If the production theory is correct and if the cross-sections are known at cosmic rays energies, then the observed abundances at the earth give a figure for the amount of interstellar gas traversed by the cosmic rays. This is a particularly interesting figure now that the source of cosmic rays is becoming widely accepted as the pulsars.

Taking oxygen as a representative nucleus, very pure samples of water were irradiated at energies from 155 MeV at Orsay, to 600 MeV and 19 GeV at CERN. (The cross-sections do not vary very much with energy.) These samples were then examined in a special mass spectrometer designed and installed at Orsay. In this spectrometer a beam of singly charged cesium ions impinges at 45° on the sample and liberates singly charged ions of lithium, beryllium and boron from atoms produced during the previous irradiations of the oxygen. Minute quantities of these ions can be observed. The technique gives the ratios of these ions and absolute values are then found by reference to the radiochemically determined ^{7}Be cross-section. In this way values for the production cross-section of ^{6}Li, ^{7}Li, ^{7}Be, ^{9}Be, ^{10}Be, ^{10}B and ^{11}B have been determined.

The results have been influencial in many theories in cosmic ray physics and astrophysics. For example, the calculation of the quantity of matter traversed by galactic cosmic rays of energies greater than 1.5 GeV/nucleon gives a figure of 5.4 g/cm^2 which is higher than the previously accepted value of 3 g/cm^2.



The on-line isotope separator from Orsay installed in the neutrino tunnel at the CERN PS. The proton beam, which produces the nuclides of interest by bombarding a target of heavy nuclei such as uranium, enters from top left. The on-line mass spectrometer goes off towards top right. Five new isotopes of sodium were studied in the course of this experiment.

CERN/PI 120.3.69

3 MeV first beams

The 3 MeV experimental linac accelerated its first proton beams on 18 November. It will now be launched on a series of investigations of beam behaviour at low energies in a linac structure.

As mentioned in the article in the last issue of CERN COURIER on the ten years operation of the linac of the 28 GeV proton synchrotron, effort is going into trying to acquire a thorough understanding of how linacs actually work as opposed to how they are supposed to work. The 'simple' theory of linacs has been successful in producing beams to meet most requirements until recent years. But now, with the imminent demand for higher quality beams, it is important to have much more detailed knowledge of how accelerator components behave in order to push their performance to near the optimum.

On the PS linac, for example, despite the achievement of 50 MeV beams well in excess of 100 mA, there are many phenomena which are not well understood. The beam appears to be reaching space charge limits, brilliance limits ('brilliance' being a measure of beam quality concerning the number of protons which can be packed into the beam with the right parameters to take them through the linac) and appears to suffer some sort of transfer between its transverse and longitudinal properties. With the PS obviously in use as much as possible for high energy physics experiments, it is difficult to find time for a thorough analysis of these phenomena. Also the PS linac is, in its design, not well adapted to the type of detailed measurements such as would make the analysis easier.

Most of the trouble seems to arise at the low energy end of the linac and since there already existed at CERN an ion source and pre-accelerator test station and a linac r.f. development station, it was decided to add a low-energy experimental linac (taking beams from 0.5 to 3 MeV) to study beam behaviour under high current density conditions. The drift tube geometry of the 10 MeV first tank of the PS linac was used but the experimental linac was built of copper-clad steel rather than using a copper tank inside a steel vacuum envelope. It was constructed to give easy access, and better and stable alignment of the drift tubes. The vacuum system, using turbomolecular and ion pumps and metal seals, restores operating conditions very quickly after the linac has been opened up. The linac is surrounded by a battery of conventional diagnostic equipment.

Experiments with the 3 MeV linac will measure beam parameters such as accelerated beam current, beam emittance, energy and energy spread, phase and phase spread, and will study their variations in a variety of operating conditions. The more detailed knowledge that this will bring should benefit both present and future accelerator projects.

Use of a 'miniscanner'

When the accelerated protons are being ejected from the PS using slow ejection, the beam is made to travel outwards radially in a spiral. For the particles to be ejected, the pitch of the spiral increases exponentially and, when it is of the order of 20 mm, they can 'jump' the width of the septum of the ejection magnet, which will then steer them out of the machine. This 'jump' takes the protons from one side of the septum to the other on successive turns and has to be at least equivalent to the thickness of the septum in order to reduce to the minimum the number of particles lost by striking the septum.

Until recently, a squared screen arranged perpendicularly to the beam was used to observe the position of the beam on successive turns. The luminous spot produced on the screen by the beam was viewed by a closed circuit television camera. However, the information obtained in this way did not always show with sufficient precision the radial distribution of the particles in the beams, and this knowledge is essential for fine adjustment of the slow ejection system.

A detector referred to as the 'miniscanner' was therefore developed. It consists of a probe, in the shape of a small flag, which can be moved radially to stop at regular intervals, and which scans the cross-section of the beams in front of the ejection magnet. The probe is connected to a system for measuring the charge induced in it by the beam particles; the charge is proportional to the beam density.

The movements of the probe, which can be tracked to an accuracy of ± 0.075 mm, are controlled by the IBM 1800 control computer in the PS control room, which also receives the information from the miniscanner and is thus able to plot the radial distribution curve directly. One series of measurements, generally corresponding to twenty-five positions of the probe, takes about twenty minutes. The fluorescent screen system, fitted on the same mechanism, is still used for quick overall checks.

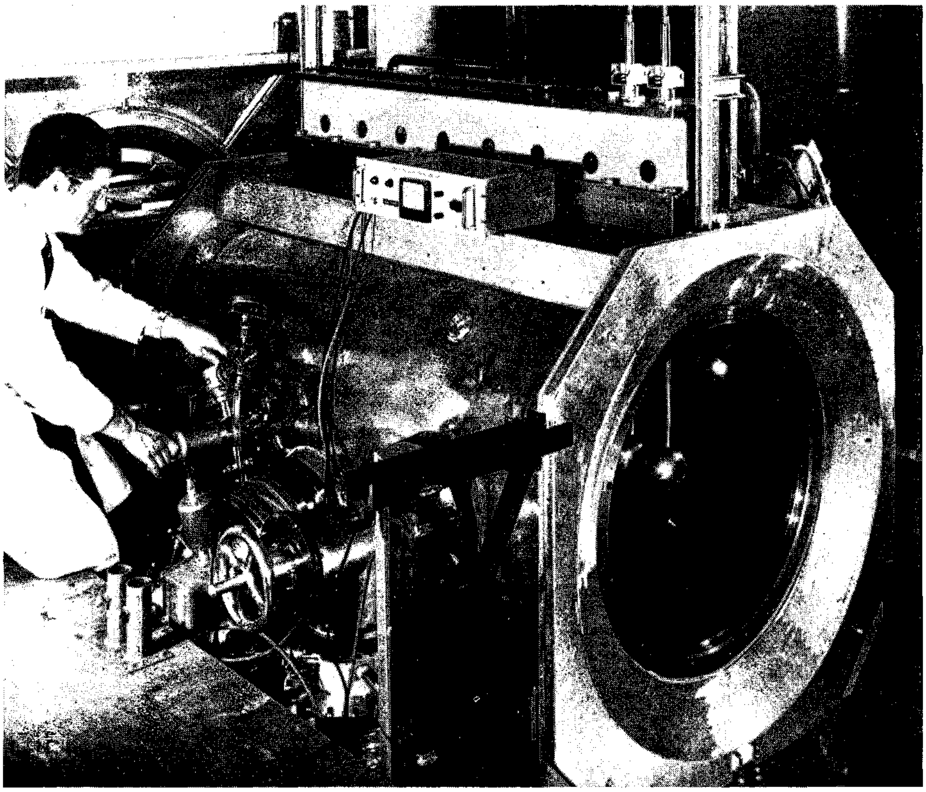
The first tests with the miniscanner showed that measurements could be falsified due to the ionization of the residual gas in the vacuum chamber by the proton beams and by the presence of variable electric and magnetic fields. This has been overcome entirely satisfactorily by surrounding the flag with a copper sleeve maintained in position by alumina 'pips' and held at a positive potential of 50 V. This electric field eliminates the effects of the surrounding variable electric and magnetic fields, and also protects the probe from the positive ions.

Three miniscanners are currently in use on the PS — one for ejection 58, one for ejection 62 and one in straight section 63, upstream of ejection 62. It is intended to use other devices of the same type for ejection 16 which will send beams to the ISR and, later, for the measurement of spatial densities (both vertical and horizontal) of one of the slow-ejected beams.

New CERN Restaurant

At its one hundredth meeting, held on 12 November, the Finance Committee approved the award of the contract for the civil engineering work of the new CERN restaurant to the firm Reaktorbauforschung und Baugesellschaft (RFD), Austria, for a sum of 1 654 000 Swiss francs.

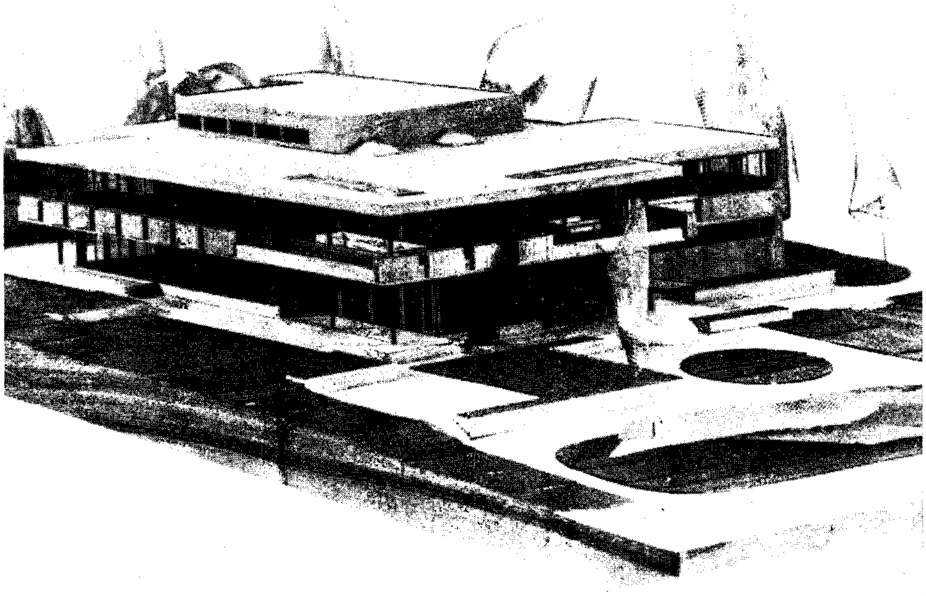
Construction is scheduled to begin on 1 March 1970 and to finish at the end of the same year. The restaurant should be in use by about October 1971, at a time when several new buildings will be occupied on the site of the Intersecting



The 3 MeV accelerating cavity photographed with its output end cover removed. This experimental linac produced its first beams in November.

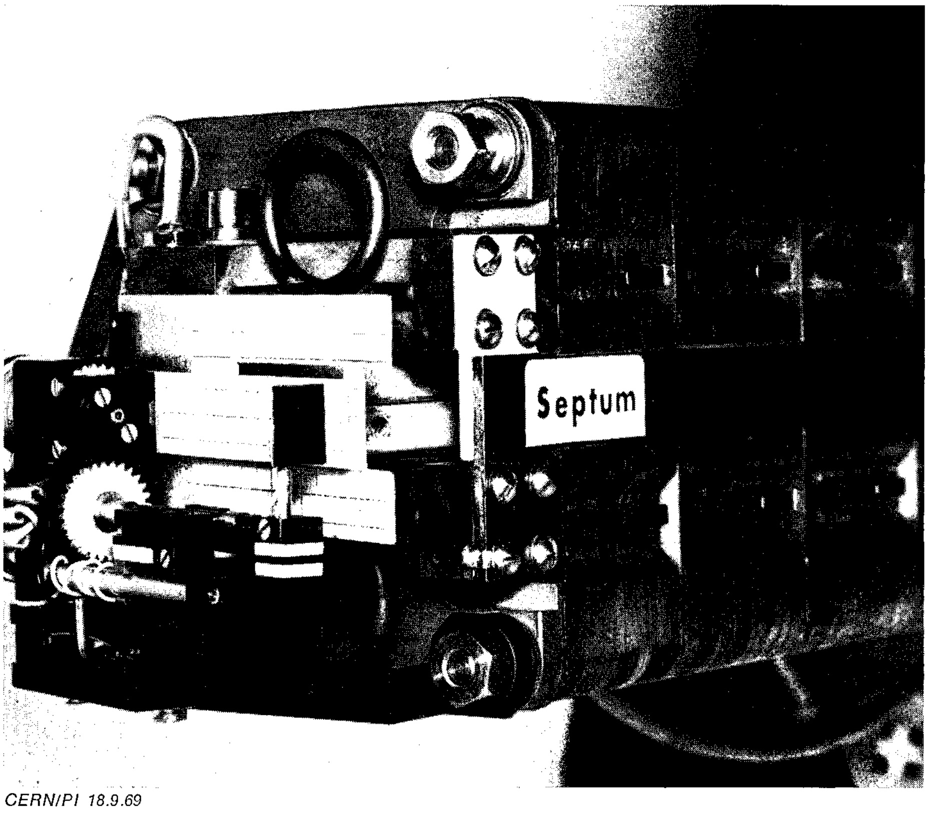
CERN/PI 241.2.69

A model of the new CERN restaurant to be built behind Mont Citron, near the Franco-Swiss border running across the site. It is scheduled to come into service before the end of 1971. Its seating capacity will be the same as that of the present restaurant in the Main Building, and it will also house a library, a discothèque and a games room.



CERN/PI 200.9.69

The 'miniscanner' in position in front of the ejection 58 septum magnet. The mechanism provides for the movement of a probe, in the shape of a flag, across the proton beam to allow the spatial density of the beam to be accurately measured. The squared screen rapidly provides more general information about the radial position of the beam.



CERN/PI 18.9.69

Storage Rings. The restaurant will thus meet a growing need.

The main purpose is to provide a restaurant equipped to serve 1000 midday meals, but the whole complex is designed to be a centre where people can relax. There will be a cafeteria adjoining the restaurant, a library, a discothèque, a games room, a newspaper kiosk, a bank, telephone booths and even a 'Bancomat' (distributing bank notes to people who possess a special magnetic card). A post office may also be installed.

In order to simplify the problem of customs concessions for products consumed in the restaurant, it will be built on a plot of land in Switzerland (surface area around 6500 m^2) recently acquired by CERN. It borders on French territory adjoining the Mont Citron car park.

The terraces and bays of the building will open to the South-East and the South-West and will overlook the peaceful landscape of the Satigny and Bourdigny vineyards. The calm atmosphere will be reinforced by excluding cars from around the building.

Plans for the building were drawn up by the Geneva architect Ernest Martin et ses Associés in close collaboration with the SB division. It will be on two levels with a smaller area, the entresol, between. The restaurant on the first level will seat 400 (about the same number as the present restaurant in the Main Building). There will be two counters with a serving system similar to the one in the Tortella restaurant. The service should be faster because payment will be made on leaving the restaurant and not at the end of the queue for meals.

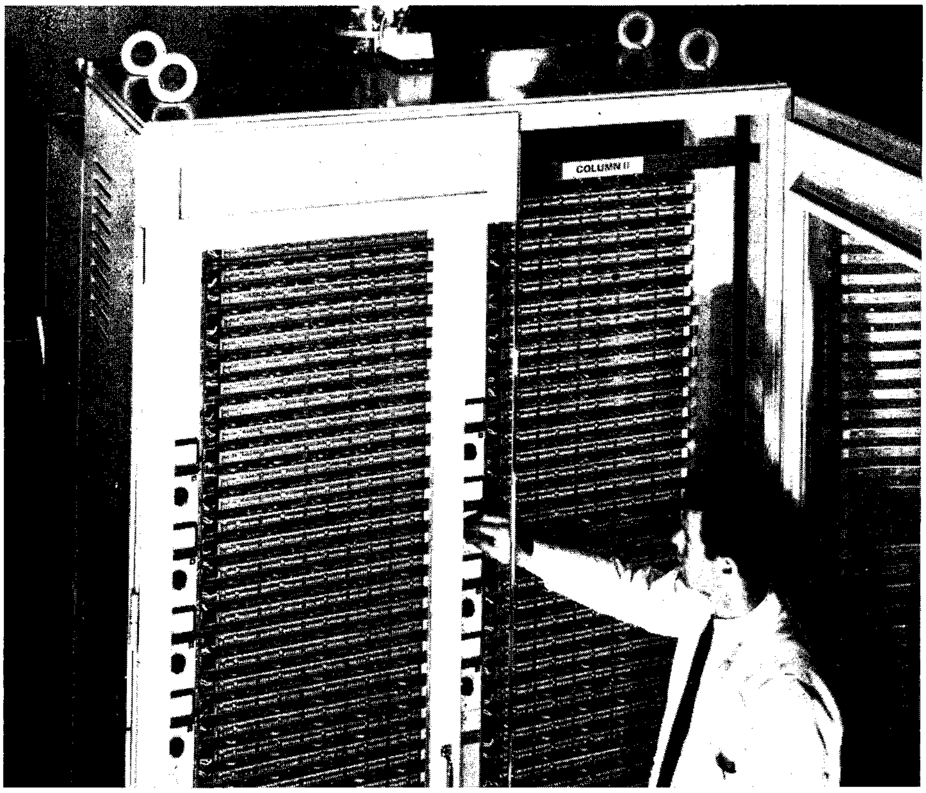
There will be terraces on two sides of the restaurant with seats for 200, where people can eat their lunch when the weather in fine.

The cafeteria on the ground floor includes a bar and will have about the same capacity as the one in the Main Building (including its recent extension). The entresol will house the games room placed at the disposal of the Staff Association and will remain open even when the restaurant is closed.

The restaurant could be extended at a later date to increase its seating capacity by 30 % to 40 %.

A large transistor bank, shown in the photograph, to give a nominal current of 13 000 A has been designed at CERN and built by J. Alge (Apparatebau, Austria). It is to be used as the control element of a pulsed power supply (100 V, 13 000 A) for the flat-top current in septum ejection magnets. One of its main advantages is that it enables the current to be held stable within the order of 10^{-4} of the nominal value (an improvement of a factor of about ten on the previous power supply).

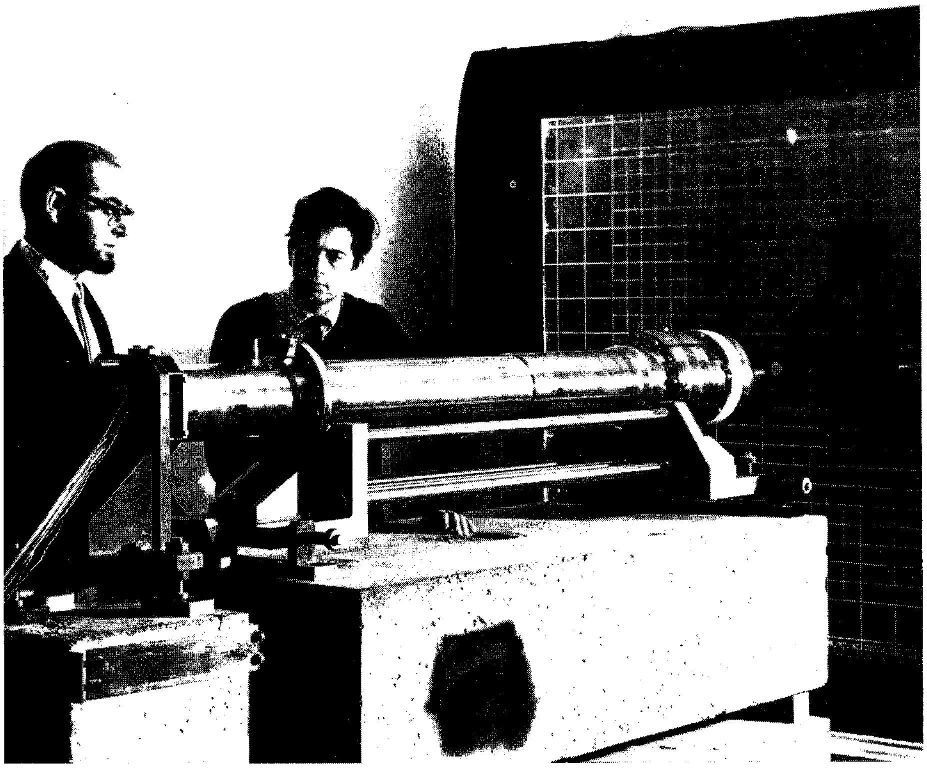
The transistor bank consists of 7580 transistors in a three stage Darlington circuit. The transistors are mounted on water-cooled modules which are stacked in a self-contained cubicle with all electrical and water connections at the rear and with simple arrangements for checking of individual components. Development of the transistor bank, including an extensive test programme to ensure long-term reliability was carried out in the PS Division by F.F. Depping. The new power supply is scheduled to come into operation on the proton synchrotron at the beginning of 1970.



CERN/PI 353.10.69

With a bubble chamber such as Gargamelle, which has a volume of several cubic meters, major errors are liable to occur because of optical distortion in the lenses. In the worst conditions these errors may be as great as 3 cm. It is therefore essential to know the extent of distortion exactly in order to be able to correct for it when processing the data. The eight lenses of Gargamelle are being calibrated at CERN — work began in August 1969 and should finish by February 1970. The lenses were made by Sopelem (France) and cost nearly 80 000 Swiss francs each.

The measurement procedure is to fix a squared panel perpendicular to the axis of the lens, and to photograph this on a film which is then scanned. The position of the lines on the panel (to a precision of 0.01 mm) and the measurement precision of the film (± 3 microns) are known. Measurements are taken at 1000 points for two different positions of the plate. The results are punched on to cards and processed by the CDC 6600.



CERN/PI 261.11.69

1. Saturday 25 October was 'Open Day' at CERN when CERN staff, their families and friends could tour the site to see the big machines and specially prepared exhibits illustrating the work of the different sections. By the end of the day 2472 visitors had been clocked through the gates.

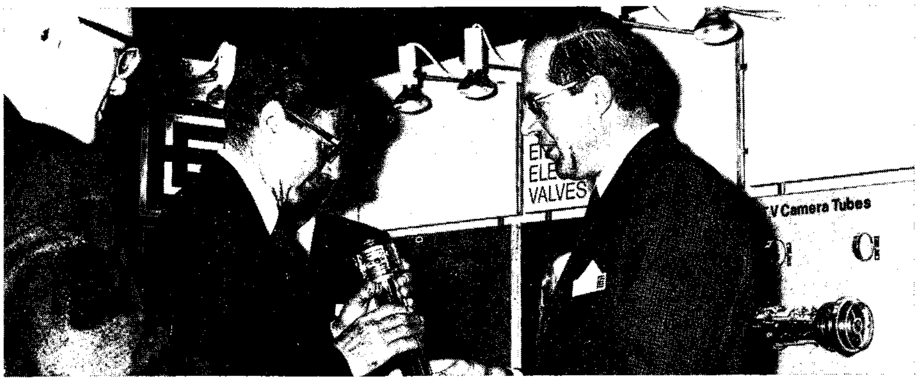
For the first time on an Open Day, there was much to see at the Intersecting Storage Rings and the photograph shows visitors flowing through the huge tunnel where many magnet units are now installed.

CERN/PI 562.10.69

1.

2. From 3-7 November a group of British companies organized an exhibition of electronic, electrical and engineering equipment at CERN under the auspices of the trade association BEAMA. The companies represented were Airflow Developments, Alma Components, Arco Electric, Drallim Industries, Edwards Vacuum Components, Electrosil, EMI Valve Division, English Electric Valve Company, J. and P. Engineering, North Bridge Engineering Co., Nuclear Enterprises, G.D. Peters and Co., Vera Electronics, and Westinghouse Brake and Signal Co.

On 5 November the British Ambassador, Mr. H. Hohler visited the exhibition and is seen, second from the left in the photograph, at the English Electric stand holding a fibre optic tube used for low light television.



2.

3. A celebration was held in Experimental Hall I4 of the Intersecting Storage Rings on 7 November to mark the 'closing' of the ring tunnel to house the ISR. Work on the site began almost exactly three years ago, involving the excavation of over a million cubic metres of soil, and in October 1967 construction of the tunnel itself started. Now the full circumference of almost one kilometre has been completed.

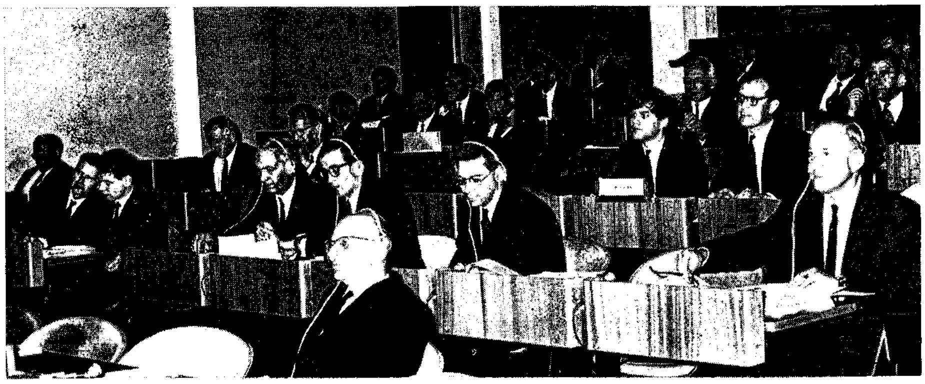
The main contractor for this construction has been the firm Sogene of Italy with the firm Albanese, also of Italy, as subcontractor for the excavation. The photograph shows a group of contractors' staff celebrating the end of the major part of their work.

CERN/PI 111.11.69

3.

4. The Finance Committee in session on the 12 November, its one hundredth meeting since the beginning of CERN.

The Finance Committee is an advisory committee to the CERN Council regarding CERN's financial policy. It has the exacting job of supervising CERN's finances being concerned with such things as examining budget proposals, salary structures and cost variation formulae and with approving the award of major contracts placed with industry. It exists to keep CERN on its toes in matters of finance. But CERN owes a lot to the constructive way in which the Finance Committee has always carried out its role and to the devotion to the aims of CERN which has guided its decisions.



CERN/PI 179.11.69

4.

Electron/Photon Symposium

A report on the International Symposium on Electron and Photon Interactions at High Energies which took place at the University of Liverpool, UK, from 14 to 20 September.

The conference, the fourth in a biennial series on high energy electromagnetic interactions, was sponsored by the International Union of Pure and Applied Physics (IUPAP), the Science Research Council (SRC), the Daresbury Nuclear Physics Laboratory and the University of Liverpool, and was organized by the Daresbury Laboratory.

There were two departures from what has become normal conference procedure. Firstly, there were no parallel sessions of contributed papers, the whole conference being given over to review talks by invited speakers, thus giving more time both to the speakers and to the subsequent discussions, which contributed greatly to the relaxed atmosphere of the meeting. Secondly, as a result of the generous co-operation of the speakers and the unprecedented efforts of scientific secretaries, and technical and secretarial staff, copies of most of the talks were available to the delegates within twenty-four hours of their presentation. This latter service was one much appreciated by all delegates, and is certainly to be recommended to future conference organizers.

In the high energy tests of quantum electrodynamics, nearly all the predictions for the Born amplitudes are now confirmed in detail by some twenty or so experiments in the ranges of energy and momentum transfer accessible to present accelerators. In terms of cut-off masses in the appropriate propagator, lower limits can now be set at 2.4 $(\mathrm{GeV}/c)^2$ for electron-electron scattering, 2.6 $(\mathrm{GeV}/c)^2$ for electron-positron scattering, 1.4 $(\mathrm{GeV}/c)^2$ for wide angle pair production on carbon and 0.7 $(\mathrm{GeV}/c)^2$ for wide angle pair production on hydrogen. These, and other high energy tests are applicable only to the Born term since the higher order corrections, which are at the 3 % level, are lost in normalization and statistical errors which are typically of the order of 5 %. Tests of the higher order corrections are all low energy tests, in atomic structure and in the anomalous magnetic moments of the electron and muon.

After a recent re-evaluation of the fine structure constant, all such tests, with the possible exception of the Lamb shift, are in agreement with theoretical calculation up to sixth order. This includes the (g-2) experiment which differs from theory by less than one standard deviation, once all sixth order contributions have been taken into account. This experiment sets an upper limit of 8 μb on the total hadronic annihilation cross-section above 1 GeV, and it is interesting to speculate that the proposal for a new, still more accurate (g-2) experiment at CERN may provide the most precise measurement of this total hadronic cross-section. As far as the Lamb shift is concerned, there are discrepancies among experiments which have yet to be resolved, and the new discovery of a systematic error (in the velocity distribution of atoms used in calculating the Stark corrections) makes one take the disagreement with theory less seriously.

Despite a continued influx of data on photopion production in the resonance region, the general situation is unaltered. The process is clearly proceeding predominantly via the P 33 (1238), D 13 (1512), F 15 (1690), and F 37 (1940) with a dash of S 11 (1550) superimposed on a real (or nearly real) background. The S 11 (1550) is also seen clearly in eta photoproduction, where there is also some evidence for the P 11 (1780). The P 11 (1470) remains an enigma, it being variously 'seen' or 'not seen' depending on the model used by the multipole analyst. It is clear that more data are required, and the massive program of measurements involving polarized photons, recoil nucleon polarization and polarized targets which has been proposed for the next year or two should go a long way to giving a definitive answer to the interesting question of the electromagnetic coupling of the N*'s. Another encouraging sign is the appearance of a considerable amount of data on $\gamma n \rightarrow \pi^- p$ from deuterium, and on the reverse reaction $\pi^- p \rightarrow \gamma n$, which hopefully will at last allow a separation of the isoscalar and isovector amplitudes.

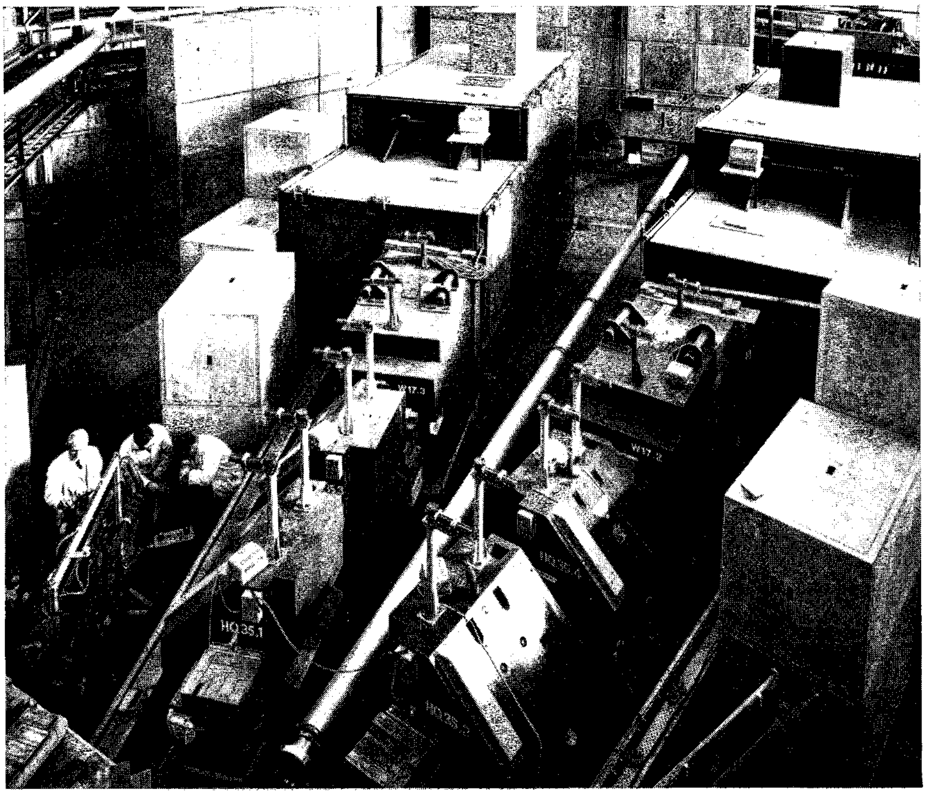
At high energies, much new data has become available on pseudoscalar meson photoproduction, and the insight into exchange mechanisms which can be gained by the use of polarized photons has now been powerfully demonstrated. The general feeling is that the correct explanation of all processes is in terms of a few

The Symposium Proceedings are being published by the Daresbury Laboratory and will be available in January 1970 at a price of £ 6. Copies can be obtained from :

The Conference Office
1969 Electron/Photon Symposium
Daresbury Nuclear Physics Laboratory
DARESBURY
Warrington, Lancashire, England.

simple Regge exchanges plus cuts, although such a description is neither unique nor essential. One of the most exciting results in this field is very strong evidence for the observation of exotic exchange. Unlike previous experiments of this kind, which have investigated processes with 'exotic-only' exchanges allowed, the current ones have looked at the interference between a possible 'exotic' exchange and a normal exchange. If in $K^+\Sigma^\circ$ production, the reaction proceeds purely by a normal $I = 1/2$, t — channel exchange, then the ratio dσ/dt ($\gamma n \rightarrow K^+\Sigma^-$) over dσ/dt ($\gamma p \rightarrow K^+\Sigma^\circ$) should be 2, or the D_2/H_2 ratio equals 3. For 11 GeV photons, the data give a ratio of 2.37 ± 0.11 for $0.025 < t < 0.46$ $(GeV/c)^2$. Since the photon energy is too high to invoke residual s-channel effects, and since it is found that $K^+\Lambda$ production is the same from D_2 as H_2, indicating that absorption uncertainties in the deuteron nucleus are not significant, this result implies that at least 10 % of the amplitude is $I = 3/2$ exchange. A similar conclusion can be drawn from a study of $\pi^+\Delta^\circ$ photoproduction. If this proceeds dominantly by $I = 1$ exchange, then the D_2/H_2 ratio dσ/dt ($\gamma p \rightarrow \pi^+\Delta^\circ$) + dσ/dt ($\gamma n \rightarrow \pi^+\Delta^-$) over dσ/dt ($\gamma p \rightarrow \pi^+\Delta^\circ$) should be 4. Experimentally it is found to decrease from about 3.3 ± 0.3 for $\sqrt{-t} \sim 0.15$ GeV/c to about 2.3 ± 0.45 for $\sqrt{-t} \sim 1.2$ GeV/c.

Vector meson photoproduction also contained some surprises. Firstly, by a study of rho photoproduction with polarized photons, by a comparison of rho photoproduction off protons with rho photoproduction off neutrons and by measurements of total photoproduction cross-sections on protons, which show a small but steady decrease up to 15 GeV, the conclusion can be drawn that the production amplitude is not purely diffractive. Secondly, new data on photon absorption in nuclei and rho photoproduction on nuclei can be made compatible, via the vector dominance model, with currently accepted values of $\gamma^2\varrho/4\pi$ only if an appreciable real part of the forward scattering amplitude is assumed i.e. that it is not purely diffractive. Thirdly, extensive searches in eight different experiments to look for high mass vector mesons in the 1 — 2 GeV region have found nothing. If there is a 1^- meson in this new mass range, its coupling to the photon is at least one order, and probably two orders, of magnitude smaller than that of the rho meson.



It is clear that electroproduction is still a wide-open field for investigation, both theoretically and experimentally. At low and intermediate energies, there exist a number of models which the scant data at present available show to be too naive but in no way indicate how we should progress beyond naivety. At high energies, and high momentum transfer, the deep inelastic region continues to remain deep and inelastic. New, wider-angle data, shows precisely the same features of a 'universal function' as observed before, and some attempt has been made to separate the transverse and longitudinal cross-sections. This new data also shows that the vector dominance predictions for the inelastic region are no more successful than those for pure elastic scattering.

Detailed investigation of the constituents of the inelastic production is obviously an immediate requirement, but will presumably have to await the advent of a high energy, high duty-cycle electron accelerator, such as the proposed 20 GeV extension to NINA at Daresbury, or the production of much more intense muon beams than are at present possible.

Electron storage rings continue to provide interesting and stimulating results. Apart from quantum electrodynamics experiments already mentioned, there are new results for the branching ratio of the phi into K^+K^-, K_S° K_L° and 3π, a slight preference for current-mixing over mass-mixing and preliminary evidence for rho-omega interference in $e^+e^- \rightarrow \pi^+\pi^-$, yielding a partial width $T^{1/2}$ ($\omega \rightarrow \pi^+\pi^-$) of 0.63 ± 0.23 $(MeV)^{1/2}$. The effect of rho-omega interference on the electron pair mass distribution was well illustrated by two photoproduction experiments with good mass resolution. Previous measurements on leptonic decays of rho and omega mesons produced by hadronic interactions should therefore be treated with caution.

Around the Laboratories

MUNICH
Electron rings achieved

Electron rings have been formed and compressed in experiments on Electron Ring Accelerator (ERA) techniques at the Institute of Plasma Physics in Garching near Munich.

The aims of the Munich work were described in CERN COURIER, vol. 9, page 200. Construction of their compressor began about one year ago and the research involves a group of 12 physicists and engineers. Their first success was well timed, coming just prior to a meeting on collective ion accelerators called by the working group set up by the 300 GeV Steering Committee held at Karlsruhe on 30, 31 October.

A distinctive feature of the Munich experiments as compared with those at Berkeley, Dubna and Karlsruhe is that ring compression is achieved at very high velocity. By using three single-turn coils to set up the magnetic fields to compress the electron ring in three stages, it is possible to reduce the compression time to 9 μs as opposed to about 250 μs elsewhere. In this way the integer resonances (the magnetic field conditions which can destroy the ring) are passed through very quickly and also the necessary vacuum conditions are less stringent.

The experiments began powering just one coil. Electrons were injected from a field emission gun (Febetron) with a current of 25 A through the snout. The half-width of the current pulse was from 8 to 10 ns which corresponded to two-turn injection into the compressor at an energy of 1.9 MeV. When the coil was powered, a blow-up of the electron ring was observed at the end of compression probably due to the $n = 1/9$ or $Q_r = 1$ resonances. The latter could have occurred due to ion-loading of the rings since the background pressure was high enough to allow several percent of ions to be trapped in the rings.

When all three coils were powered this blow-up was avoided and rings containing about 10^{11} electrons were compressed to a diameter of 5 cm and a minor diameter (the diameter of the electron beam travelling around the ring) of 0.8 cm. The energy of the electrons after compression was about 18 MeV. Observations of the ring behaviour were made by means of a small Faraday cup (5 × 5 mm^2 aluminium) and of gamma radiation from a gold wire (1 mm diameter).

The next aims are to improve the electron beam intensity and to optimize the inflection of the beam into the compressor.

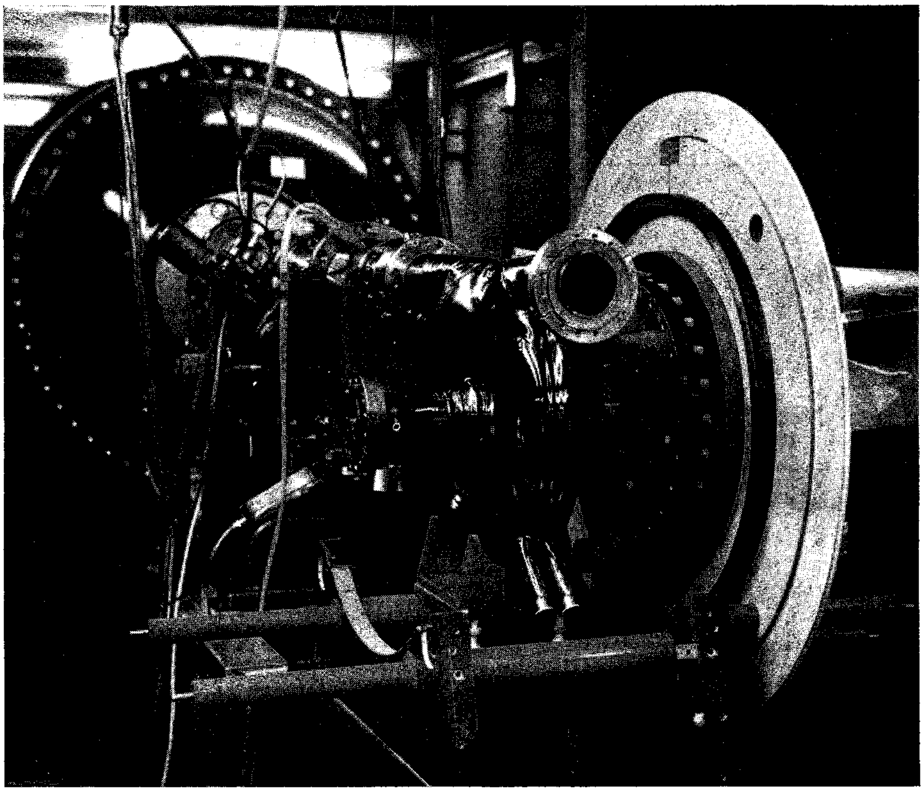
CAMBRIDGE
Success in Bypass Storage Trials

On 22 October long-term stable storage of an electron beam in the Bypass system was achieved for the first time at the Cambridge Electron Accelerator. This is another important step in the CEA electron-positron colliding beam project which is unique in using a loop (Bypass), added to the existing accelerator ring, where the beams can be specially treated before entering the collision region. (The project was described in detail in CERN COURIER, vol. 8 page 289).

The successful tests in October used an electron beam accelerated to 1.4 GeV which was circulated through the Bypass with the magnet ring powered d.c. The beam was stored for 30 minutes (when the test was deliberately terminated) and was entirely stable throughout this time. There was a 1/e decay constant of 10 minutes limited by the machine vacuum.

In earlier trials, the 1/e decay constant was limited to 25 seconds and there was occasional sudden loss of the beam, probably as a consequence of small changes in betatron oscillation frequencies in conjunction with non-linear high-order resonances. The vertical and horizontal betatron frequencies were then 6.8 and 7.1. Before the successful trials began, the vertical frequency was changed (by adjustment of the focusing magnets of the Bypass) to 7.3 so that both frequencies would lie on the same side of the nearest integer. Apparently this change produced a broader band of stable operating conditions.

Installation of the 130 MeV positron linac was completed in September, and positron injection and storage trials are to be attempted by the end of 1969.



The Munich electron ring compressor. The tank in the background is the electron gun and the compressor itself can be clearly seen in the foreground with one bank of the magnet coils on the right. The three coils are single-turn to achieve very fast compression of the rings.

(Photo Munich)

Faculty, students, and technicians toast the end of 20 years of service by the Cornell 2 GeV synchrotron and its predecessors. In helmets, Laboratory director B.D. McDaniel (left) helps R.L. Martin of Argonne National Laboratory start dismantling the accelerator. Argonne will receive the accelerator for use in a fast cycling booster.

(Photo Cornell)

CORNELL

2 GeV closes down

On 3 November, the Cornell 2 GeV electron synchrotron was closed down. This machine was the third in a line of synchrotrons built at the same site each successive accelerator taking over many of the components of its predecessor. The first, a 300 MeV machine, came into operation in 1949 and was responsible for much of the pioneering work on pion photoproduction leading to the discovery of the first pion-nucleon resonance. In 1955, its successor came into operation at 1 GeV as the world's first alternating gradient synchrotron. This machine opened up the field of electron-nucleon scattering to synchrotrons, and pion photoproduction experiments were among the first to indicate the correct energy and quantum numbers of the second resonance. Finally, in 1964 the magnet ring was replaced again to raise the energy to 2 GeV. Since then the accelerator has been active in meson photoproduction and electron scattering experiments.

The 2 GeV machine still has a future, but not at Cornell. It has been dismantled and shipped to Argonne National Laboratory to be reincarnated as a fast-cycling booster for the ZGS proton accelerator.

Meanwhile, half a mile away from the site of the 2 GeV machine, its successor the Cornell 10 GeV electron synchrotron has already been operating for two years. Many of the first experiments have been completed and published: forward rho and phi photoproduction, wide-angle bremsstrahlung, muon pair production and neutral kaon photoproduction. Currently taking data are experiments on rho and phi production by polarized photons, omega photoproduction, backward positive pion photoproduction, eta photoproduction, and proton Compton scattering. A tagged photon beam has been developed and is being used to investigate neutral meson production. An external electron beam is nearing completion and will make possible coincidence measurements on inelastic electron scattering.

BROOKHAVEN

First 7 foot pictures

The first tracks, of cosmic ray particles, were recorded in the 7 foot hydrogen bubble chamber at Brookhaven on 29 October and tests continued until 8 November. The photographs showed high quality bubble images and uniform sensitivity throughout the chamber volume.

Adequate track quality could be achieved throughout the chamber with normal operating conditions and the measurement precision approaches that of smaller chambers. Improvements and additional tests are needed to eliminate spurious bubbling from the baffle that isolates the expansion piston from the chamber, to achieve operation at 1 s repetition rate (the tests so far have been at a 10 s rate), and to increase the helium refrigerator capacity for the magnet cooling. The magnet is designed for operation at 30 kG but was limited to 10 kG during the tests using gas cooling.

No elaborate investigation of bubble growth and heat loads was possible because the spurious bubbling caused self-pressurization of the chamber and thus allowed only one set of conditions for track sensitivity. Also when the magnetic field was applied some trouble arose at about 3 kG when the fringe field affected the electro-hydraulic servo-valve controlling the static piston position. Magnetic shielding will be added to overcome this problem.

New Journal

A new international journal with the title 'Particle Accelerators' begins publication in January 1970. The journal is edited by J. P. Blewett of Brookhaven (from whom further information concerning contributions and subscription rates may be obtained) and the Editorial Advisory Board has representatives from Europe, USA and USSR.

'Particle Accelerators' will be published four times a year and will include papers (theoretical and experimental) on topics ranging from particle orbit theory to all aspects of machine design and engineering. There will also be a topical 'News and Views' section.

1. The 7 foot hydrogen bubble chamber at Brookhaven which took its first pictures at the end of October.
2. A photograph of an electron shower in the beam plane of the 7 foot chamber.
(Photos Brookhaven)
3. An actual size bubble chamber photograph from the 12 foot hydrogen chamber at Argonne which operated for the first time in October. E.G. Pewitt, Project Director for the chamber, is indicating an interaction produced by a high energy particle from the ZGS. The chamber's superconducting magnet was not in operation for these tests and the track curvature comes from the use of fish-eye lenses.
(Photo Argonne)

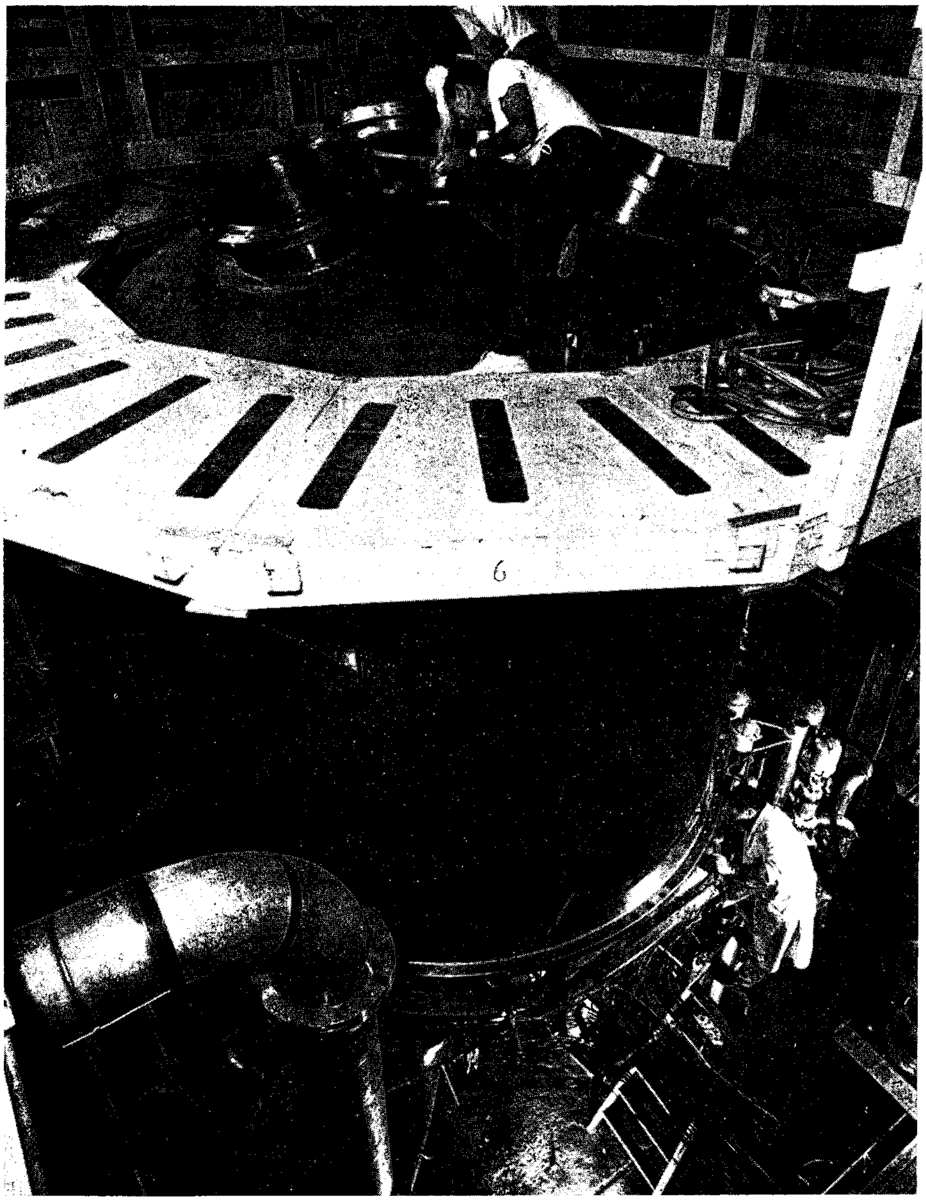
ARGONNE

First 12 foot pictures

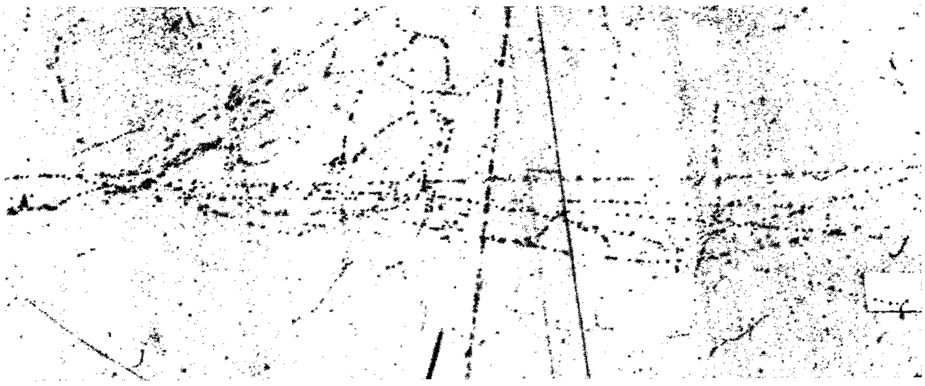
On 13 October the 12 foot hydrogen bubble chamber at Argonne National Laboratory took its first pictures of particle tracks. This was the first attempt to sensitize the chamber and the tracks were of cosmic ray particles. On 17 October a beam was available from the 12.5 GeV Zero Gradient Synchrotron (ZGS) and interactions of particles from the accelerator were then recorded.

For several days the chamber was operated under a variety of conditions in an effort to gather as much information on the behaviour of components as possible. During this time the large superconducting magnet of the chamber, which was successfully tested a year ago (see CERN COURIER, vol. 9, page 43), was not in operation.

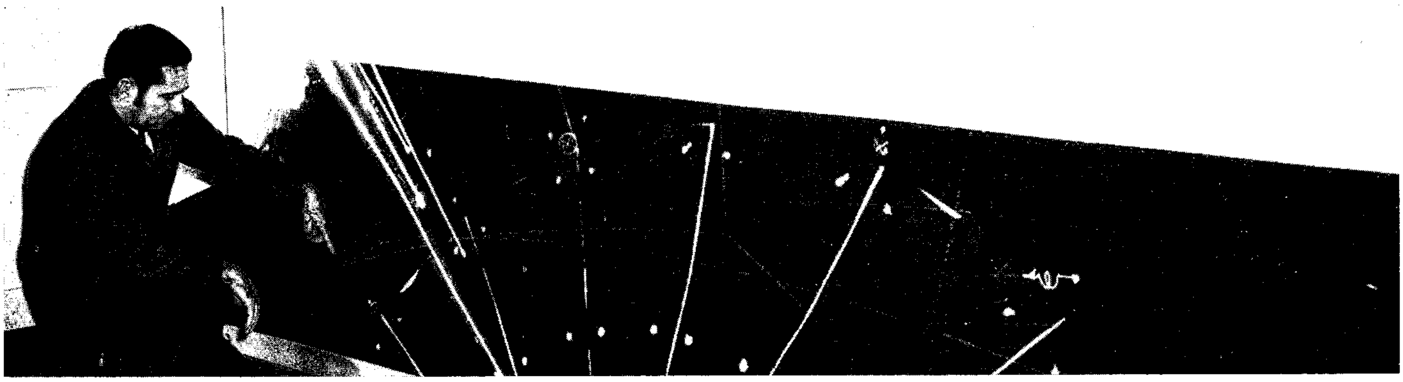
Early next year the first attempt will be made to bring all the chamber systems into operation together ready for the first physics experiment. This experiment, which plans to take 500 000 pictures, will investigate neutrino interactions in hydrogen. If all goes well the chamber will then be filled with deuterium for a further million pictures of neutrinos on deuterium. Of particular interest in this second run is the interaction of a neutrino with a neutron giving a muon and a proton, of which it is expected to collect over 1000 examples. The analysis of this data is expected to increase greatly the knowledge of the behaviour of the vector and axial vector form factors in the weak interaction.



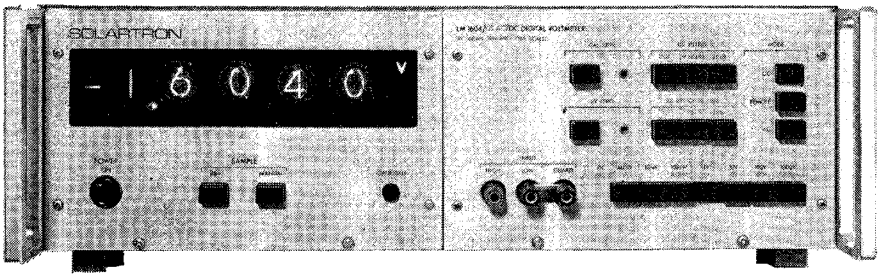
1.

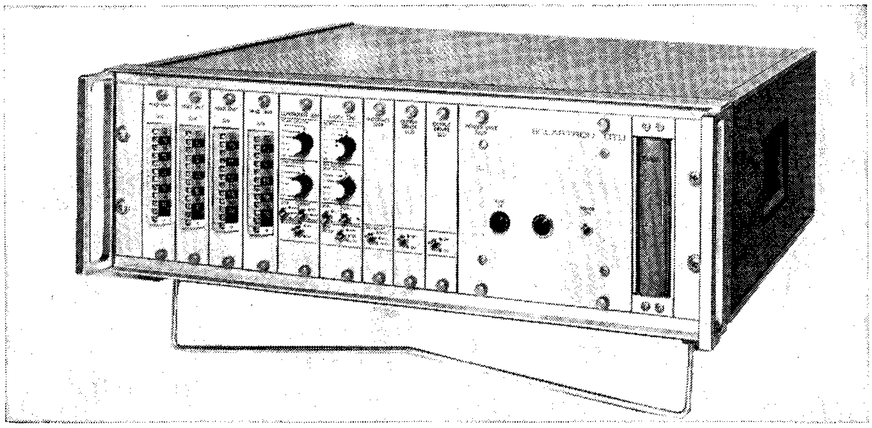


2.



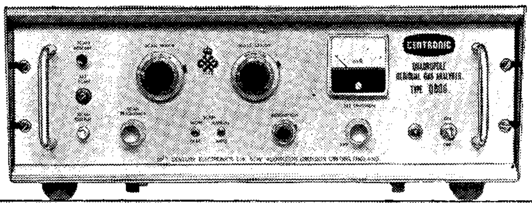
3.


SOLARTRON
-1.6040 V



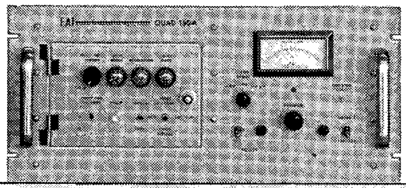

BY
AIR MAIL
P.
43-74-03

CENTRONIC SHOWCASE



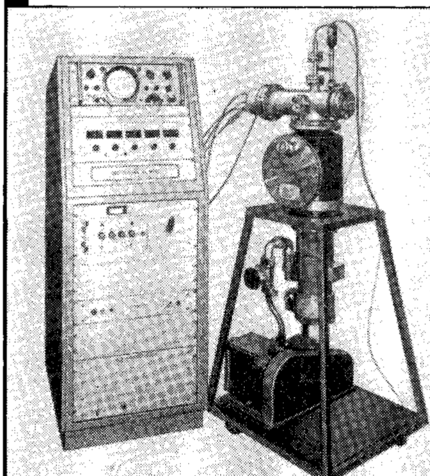
Q806

The first British designed and built quadrupole residual gas analyser. Mass range 1 to 100, unit mass resolution at Mass 100. Variable scan rates and sweep width. Controllable resolution. Sensitivity better than 10^{-12} torr for nitrogen. Pressure range 10^{-4} torr and lower. Bakeout temp 400°C.



Q150A

Mass range 1–150 and 10 to 300. Sensitivity 5×10^{-14} torr for nitrogen. Unit mass resolution at Mass 300. Variable scan rates 130 millisecs to 10 minutes. Pressure range 10^{-4} torr and lower. Bakeout temp 400°C.



Q250A

Illustrated here on gas chromatograph sampling system for effluent analysis. Mass range 1 to 800 in four ranges. Sensitivity 100 amp/torr for nitrogen multiplier output. Resolution greater than 150 in 1 to 150 mass range, unit mass resolution at Mass 800. Variable scan rates 500 millisecs to 6 minutes per a.m.u. Pressure range 10^{-4} torr and lower. Bakeout temp 400°C.

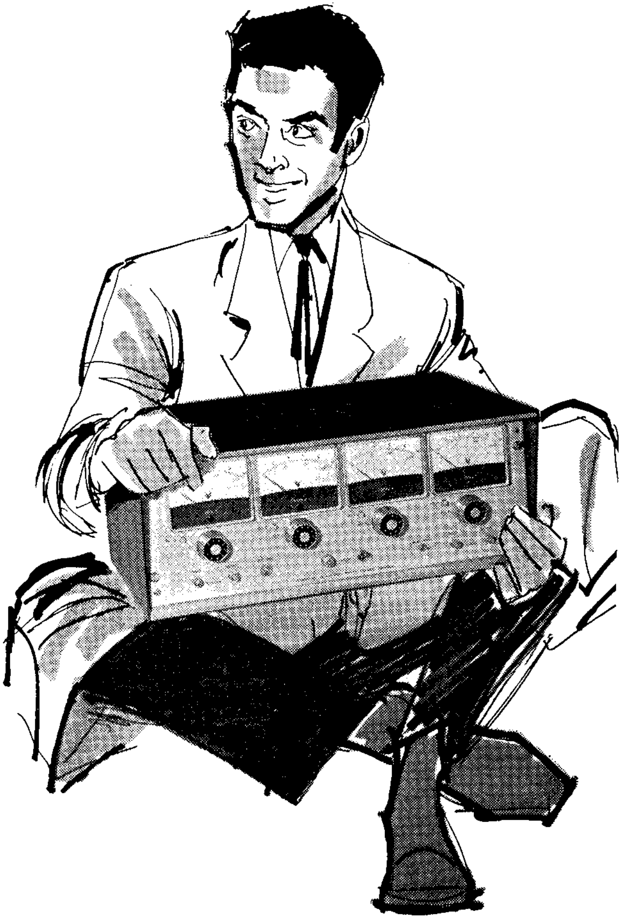
CENTRONIC 20TH CENTURY ELECTRONICS LTD

Centronic Works, King Henry's Drive, New Addington
Croydon, CR9 0BG, England. Telephone Lodge Hill 2121

Have you seen my collection of Quadrupole Mass Spectrometers?

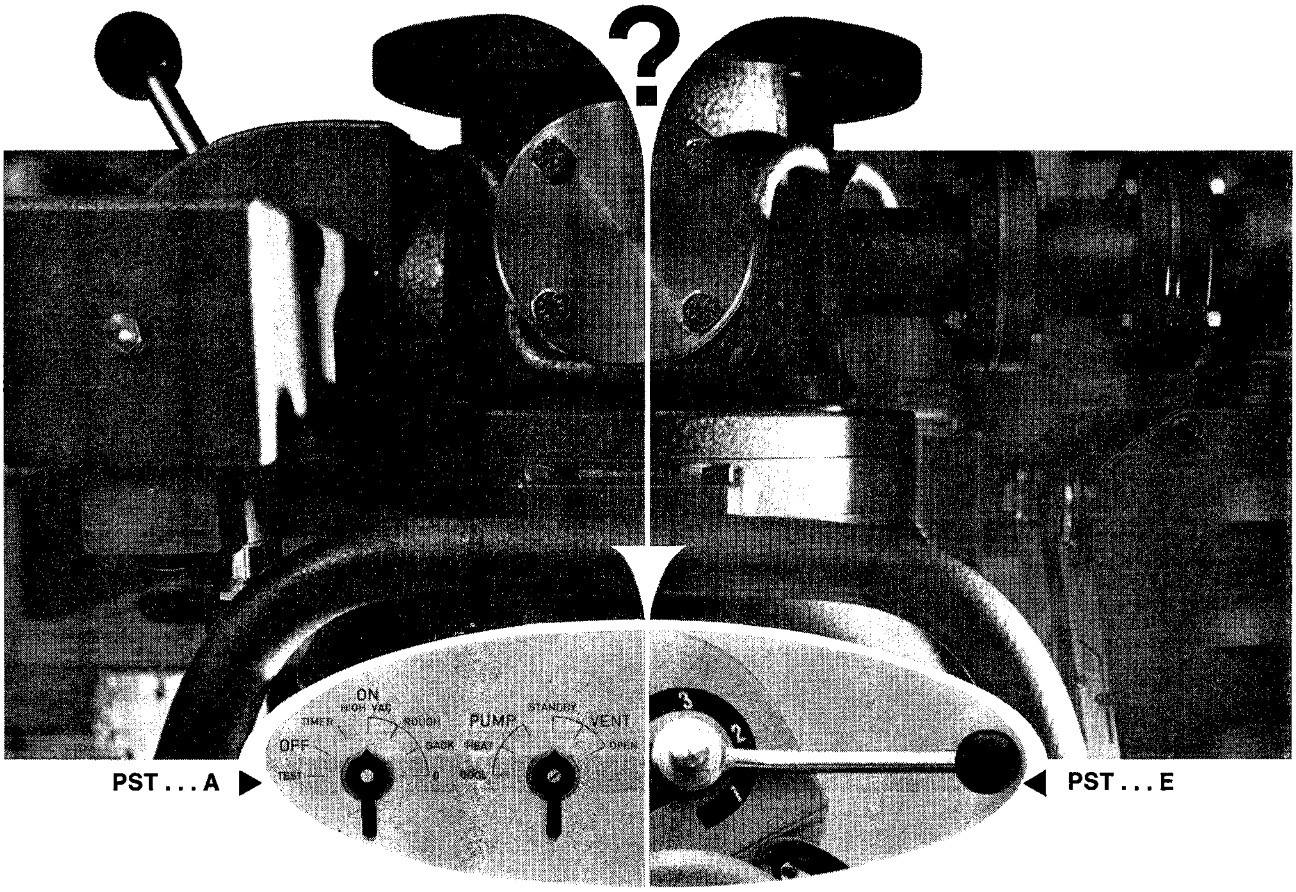
These residual gas analysers are from the Centronic family of vacuum products and analytical instruments . . . sensitive, fast, rugged, reliable . . . can be trusted to work under the most exacting conditions! For Process Control I've added the Selective Peak Monitor . . . just pick your peaks and let the Monitor do the work*. Not enough room to show the accessories but I'd like to mention the custom built Sample Inlet Systems, Readout Equipment, Data Process and Computer Interface Equipment . . . and pretty soon I'll be adding some more Quads to my collection. If you're interested in any product why not write for the new "Products Catalogue"?

**With a Selective Peak Monitor the spectrum of a Quad Mass Spectrometer can be scanned over its whole range, and selected mass peaks picked at random from any part of the mass range with simultaneous display. The standard unit is for four channels, although units for more channels are available.*



Swiss Agents : *HIGH ENERGY AND NUCLEAR EQUIPMENT S.A.*
— 2, chemin de Tavernay - GRAND-SACONNEX - *1218 GENEVA* - Tél. (022) 34 17 07/34 17 05

How can you concentrate to the full on your Vacuum Process and regard Vacuum Production as a side issue ?



This is quite simple . . . install a BALZERS high vacuum pumping unit, type PST.

PST . . . A automatically controlled. With the two switches provided set the pumping process required (this can include heating or cooling the vacuum chamber, also switching on the pumping unit at a pre-selected time) and wait until the required working pressure is reached.

PST . . . E single lever operated. The required mode of operation is selected by actuating a single lever, which controls sequential operation of the solenoid vacuum valves via a multi-pole type switch, so that errors of operation are avoided.

Other features:

— a wide range of accessories allows the simply constructed basic model to be adapted to the application;

— multi coolant baffle for use with either water or liquid nitrogen as required;

— effective safeguards to avoid the effects of breakdowns in electrical power, water or compressed air;

— individual components (pumps and valves) are all BALZERS traditional quality, carefully matched to each other to give optimum design, and assembled with care, guaranteeing a high standard of efficiency, long life and low operating costs;

— all pumping units are tested, ready for connection, and under guarantee.

Manufacturing and Sales programme

Type	pumping speed [3] l/sec.	Ultimate pressure [1] Torr.
PST 60 E 6[2]	17	$< 2 \times 10^{-6}$
PST 60 E	17	$< 8 \times 10^{-7}$
PST 260 E	90	$< 5 \times 10^{-7}$
PST 900 E	315	$< 5 \times 10^{-7}$
PST 900 A	315	$< 5 \times 10^{-7}$
PST 1900 A	700	$< 5 \times 10^{-7}$
PST 5000 A	2150	$< 5 \times 10^{-7}$

¹) with LN_2 cooling, ultimate pressures in the range of 10^{-8} Torr. from PST 260 E.

²) air cooled

³) for air above the plate valve

Special pumping units. We also design and build special pumping units to suit the application, and with pumping speed agreed with the customer.

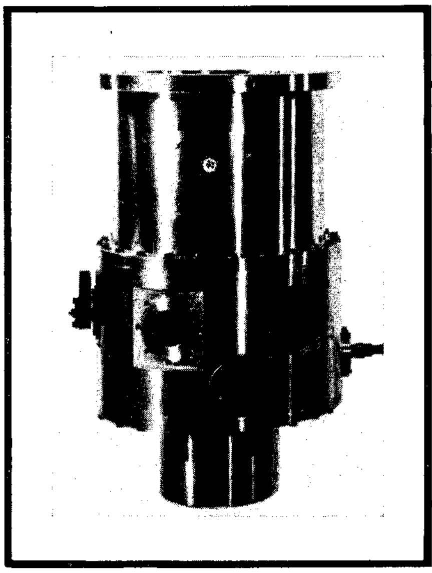
If you will contact us we will be pleased to give you any further information or advice.

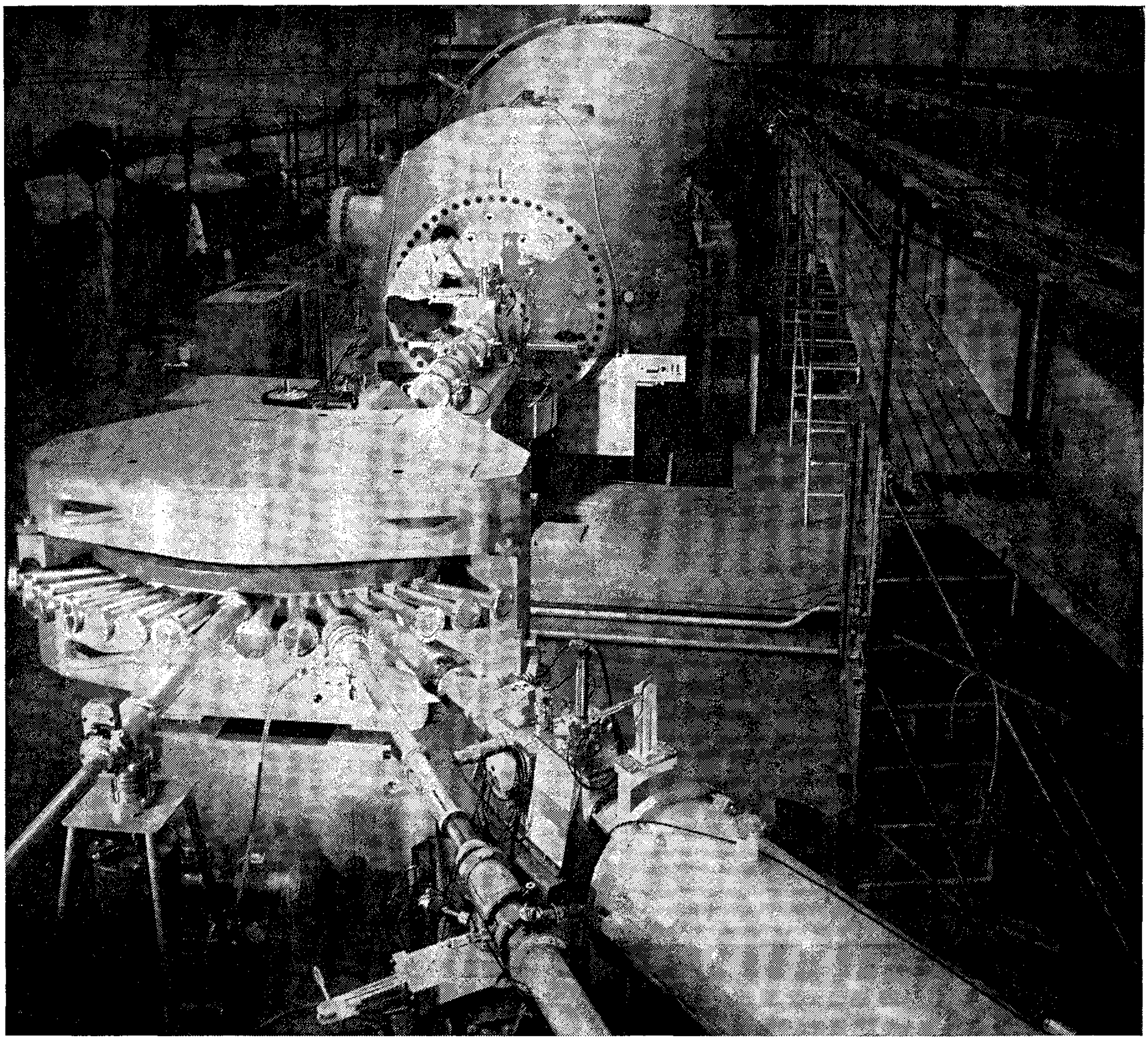
BALZERS®

BALZERS AKTIENGESELLSCHAFT
für Hochvakuumtechnik und Dünne Schichten
FL-9496 Balzers · Principality of Liechtenstein

United Kingdom:
BALZERS HIGH VACUUM LIMITED
Berkhamsted, Herts.,
Telephone: Berkhamsted 2181

P 21-08e DN 1557





PENSEZ-VOUS VRAIMENT QUE NOUS NE CONSTRUISIONS QUE DES ACCELERATEURS.....

Ce peut bien être en effet votre opinion, tant il est vrai que nous sommes très connus pour nos accélérateurs Van de Graaff. Mais ceci ne signifie pas que nous ne puissions rien faire d'autre.
Tout au contraire! Nous développons constamment la gamme de nos produits, ainsi que nos installations de production, de contrôle et d'engineering.
En plus de nos produits standard, nous réalisons les équipements désirés par les clients, c'est-à-dire le type de produits "once only". Nous sommes bien outillés pour travailler les matériaux les plus difficiles et nous avons l'occasion d'éprouver nos techniques sur des modèles compliqués.
De nombreuses années passées dans le domaine de la physique nucléaire nous ont rendu vos problèmes familiers.

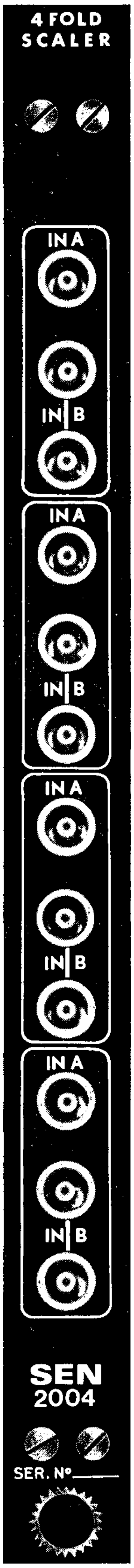
Voulez-vous connaître notre meilleur atout de vente? Nous travaillons en étroite collaboration avec nos clients, ce qui vous permet d'obtenir un produit de haute performance. Si vous aussi, vous avez un problème particulier, demandez-nous de vous rendre visite: Amersfoort - Hollande est si près! Etre chez vous n'est qu'une question d'heures.

HIGH VOLTAGE
ENGINEERING
(EUROPA) N.V.
AMERSFOORT, HOLLANDE

• accélérateurs • sources de neutrons • mesure de champ magnétique par RMN • aimants sur commande • alimentation de puissance en semi-conducteurs • chambres à vide, pompes, vannes et plomberie • aimants d'analyse et de routage • moniteurs de profil de faisceau • irradiations à façon • étude des méthodes et des installations d'irradiation • fours et cryostats Mössbauer • chambres à diffusion.

Type 2004 FOUR-FOLD CAMAC SCALER

The type 2004 four-fold scaler is a simple, general purpose CAMAC scaler with 16 bit capacity. Low price was the main design objective. Thus, useful functions only have been incorporated and the input specifications are those readily obtainable with current TTL technology.



DESCRIPTION AND SPECIFICATIONS.

1. Input

Each scaler has a 50 ohm input (IN A) and an unterminated dual connector input (IN B). Both inputs accept fast NIM pulses or levels and enter an AND gate. Thus, either input A or B can be used as count input or as gate input. While using A cas count input, B may be left open. Input B allows bridging connection of a gate line for reduced fan-out requirements.

- Scaling Rate: typically 40 MHz
- Input Pulses, A or B: 12 ns pulses are typically required, -200 mV is max. "O", -600 mV is min. "L",
- Maximum Amplitude: -2 V, diode limited
- Connectors: LEMO RA 00 C 50

2. Overflow outputs

Overflows are brought out separately on the back of the module. Nim pulses of approximately 1 μs duration are produced. Individual overflow outputs may be very useful for triggering a "Direct Memory Increment"- module.

3. CAMAC Functions Used in the Module

Function 0: Read the scaler selected by the subaddress, Clear the corresponding overflow flag, Produce a Q-response for the duration of the Camac cycle.
Function 2: Read the scaler selected by the subaddress, Reset the scaler, Clear its overflow flag, Produce a Q-response for the duration of the Camac cycle.
Function 25: Increment all 4 scalers, Produce a Q-response.
Function 8: Test L. This function produces a Q-response if the scaler selected by the subaddress has its overflow set **and** its L enabled.
Function 17: Write a 4 bit mask. This 4 bit mask -written from the W1 to W4 lines- enables the individual sources of L request.
Clear and initialize: Reset all scalers, Clear all overflow flags and set the L-mask at 0000.
Inhibit: Close the input gate of all 4 scalers.

The L-mask register is a particulary powerful device when the L signal is used as a computer interrupt request. Managing nested interrupt service routines is much easier because priority assignment is under program control.

4. Physical

Single unit CAMAC module, fully shielded construction.

SEN
ELECTRONIQUE

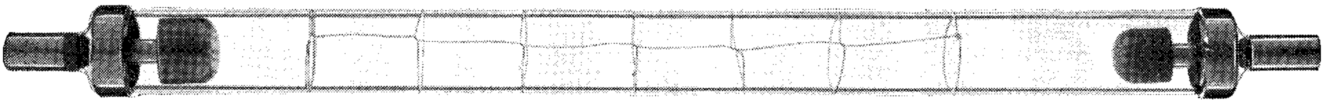
Representatives throughout Europe and The United States

31 Av. Ernest-Pictet - 1211 GENEVA 13 / Switzerland - Tel. (022) 44 29 40

Don't take our word for it—test EEV flash tubes against the equivalents you're now using and learn why other users think so highly of those made by EEV. Incorporating extra heavy duty electrodes, EEV flash tubes are renowned for their reliability, long life (up to 10^6 flashes) and high conversion efficiency. EEV liquid-cooled and air-cooled xenon flash tubes for pumping laser rods offer a wide range of input energy levels and they are capable of operation at high repetition rates.

Full details of the range are available on request—but if your application calls for a flash tube that is not in the present range, tell us your requirement because we can probably make it for you.

Outstanding in quality, reliability and performance



EEV flash tubes

Type	Energy input per flash max. (J)	Arc length (mm)	Bore diameter (mm)	Typical operating conditions Voltage (kV)	Series inductance (μH)	Flash rate	Trigger voltage (kV)
XL615/7/3	600	76	7.0	2.5	400	1 per 15 sec.	12–16
XL615/9/4	1500	102	9.0	2.5	400	1 per 30 sec.	12–16
XL615/10/5.5	3500	140	10.0	2.5	400	1 per 30 sec.	16–20
XL615/10/6.5	5000	165	10.0	2.5	800	1 per 2 min.	20–25
XL615/13/6.5	10000	165	13.0	2.5	800	1 per 2 min.	25

Send for full details of the complete range of EEV flash tubes.

English Electric Valve Co Ltd
Chelmsford Essex England Telephone: 61777
Telex: 99103 Grams: Enelectico Chelmsford
Represented by:
Roschi Telecommunication A.G.
Giacomettistrasse 15, P.O. Box 63. 3000 Bern 31,
Tel: (031) 44-27-11 Telex: 32-137

I am interested in EEV flash tubes for.................................... (application).
Please send me data sheets on your full range.

NAME ____________________ POSITION ____________________

COMPANY ____

ADDRESS ____

____

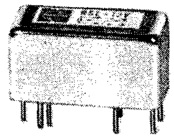
TELEPHONE NUMBER ____________________ EXTENSION ____________________

AP 356 CC6

RELAIS

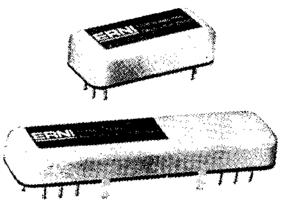
ERNI

Relais «Reed», conception nouvelle, REL R-10



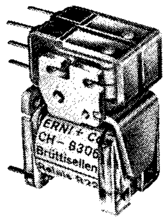
☐ Relais miniature polarisé
☐ Encombrement 10×10×20 mm
☐ 1 double contact inverseur au rhodium
☐ Temps de réponse extrêmement court
☐ Compensé en température
☐ Exécution mono- ou bistable, 1 ou 2 bobines
☐ Prix modiques

Relais «Reed», types ARID et ERID



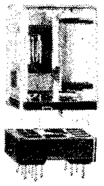
☐ Pour courant continu
☐ Contacts «Dry-Reed» ou mercure
☐ Jusqu'à 6 contacts de travail ou inverseurs
☐ Commutation très rapide
☐ Haute sensibilité
☐ Connexions pour circuits imprimés

Relais microrupteurs type REL 20



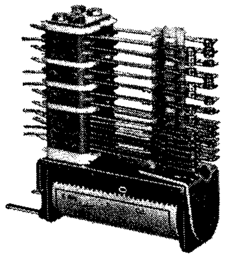
☐ Pour courant continu ou alternatif
☐ Faible encombrement 20×20×24 mm
☐ 1 ou 2 contacts inverseurs 6 A 250 V ∿
☐ Connexions :
par soudure
par clips (p. ex. AMP-110/0,5) pour circuits imprimés

Relais miniatures REL 40



☐ Contact simple ou double
☐ 2 à 6 contacts inverseurs
☐ Haute fiabilité
☐ Pour courant continu ou alternatif
☐ PRIX TRÈS MODIQUES
☐ EXÉCUTIONS COURANTES LIVRABLES DE STOCK

Relais industriels REL 60



☐ Utilisation universelle
☐ Contacts 6 A 250 V ∿ jusqu'à 20 lames
☐ Contacts 0,5 A 60 V ∿ jusqu'à 30 lames
☐ Contacts en différents matériaux
☐ Adaptés à toutes exigences
☐ Exécution pour courant alternatif avec redresseur
☐ Embrochable, sur demande

ERNI+Co. Elektro-Industrie
CH-8306 Brüttisellen-Zürich
Telephon 051/931212
Telex 53 699

ERNI

Natural and synthetic rubber

Plastic materials

Power transmission elements

Sealing specialists (GACO)

Agents & distributors:

Angst+Pfister

GENEVA
ZURICH
MILANO

GREETINGS AND BEST WISHES FOR CHRISTMAS AND THE COMING YEAR FROM THE DIRECTORS AND STAFF OF **H.E.N.E.S.A.**

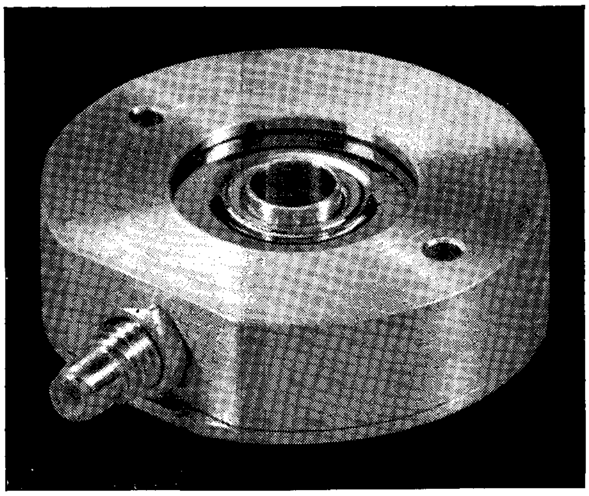
HIGH ENERGY AND NUCLEAR EQUIPMENT S.A. specialise in the supply of equipment for routine and experimental work in High Energy, Nuclear, Applied, Health and Medical Physics. The Life Sciences including Nuclear Medicine and Radiotherapy, Computer Centres, etc. and can supply everything from a plastic scintillator to a small cyclotron, a simple portable Placenta Detector to high precision Cobalt 60 5 MIN. treatment equipment to replace Radium for cervex cancer and mould therapy, a gold plated Printed Circuit to a small high speed Digital Computer or off line magnetic tape controlled Incremental Plotters, Microfilm Printers etc.

During 1970 we shall widen the scope of our advertising but take space in the COURIER in MARCH and SEPTEMBER only. Please note our new telephone No's (022) 98 25 83 and 98 25 82.

GENEVA, 2, chemin de Tavernay, Grand-Saconnex, 1218 Genève

MADRID, 16, Alberto Alcocer, Telephone 250 40 26

If our annular detectors are as good as this...



Silicon Lithium Drifted Annular Detectors

Standard Grade

Model Number	Resolution—keV at 20° C		Thickness (mm)	Active Area			Hole Dia. (mm)
	Electron	Alpha		O.D. (mm)	I.D. (mm)	Area (mm²)	
NEA 120-1	28	54	1	16	10	120	5
NEA 120-2	28	66	2	16	10	120	5
NEA 120-3	36	78	3	16	10	120	5
NEA 120-5	60	90	5	16	10	120	5
NEA 240-1	32	74	1	20	10	240	5
NEA 240-2	34	86	2	20	10	240	5
NEA 240-3	50	98	3	20	10	240	5
NEA 240-5	68	110	5	20	10	240	5
NEA 340-1	40	74	1	23	10	340	5
NEA 340-2	38	86	2	23	10	340	5
NEA 340-3	62	98	3	23	10	340	5
NEA 340-5	86	115	5	23	10	340	5
NEA 110-1	30	56	1	20	16	110	9
NEA 110-2	30	68	2	20	16	110	9
NEA 110-3	38	80	3	20	16	110	9
NEA 110-5	62	92	5	20	16	110	9
NEA 215-1	34	76	1	23	16	215	9
NEA 215-2	36	88	2	23	16	215	9
NEA 215-3	52	100	3	23	16	215	9
NEA 215-5	70	112	5	23	16	215	9

Selected Grade

Model Number	Resolution—keV at 20° C		Thickness (mm)	Active Area			Hole Dia. (mm)
	Electron	Alpha		O.D. (mm)	I.D. (mm)	Area (mm²)	
NEA 120-1A	15	38	1	16	10	120	5
NEA 120-2A	16	42	2	16	10	120	5
NEA 120-3A	22	45	3	16	10	120	5
NEA 120-5A	30	48	5	16	10	120	5
NEA 240-1A	21	45	1	20	10	240	5
NEA 240-2A	23	52	2	20	10	240	5
NEA 240-3A	25	56	3	20	10	240	5
NEA 240-5A	36	64	5	20	10	240	5
NEA 340-1A	30	56	1	23	10	340	5
NEA 340-2A	25	63	2	23	10	340	5
NEA 340-3A	32	66	3	23	10	340	5
NEA 340-5A	40	75	5	23	10	340	5
NEA 110-1A	17	40	1	20	16	110	9
NEA 110-2A	18	44	2	20	16	110	9
NEA 110-3A	24	47	3	20	16	110	9
NEA 110-5A	32	50	5	20	16	110	9
NEA 215-1A	23	47	1	23	16	215	9
NEA 215-2A	25	54	2	23	16	215	9
NEA 215-3A	27	58	3	23	16	215	9
NEA 215-5A	38	66	5	23	16	215	9

...you can be sure our conventional detectors are even better!

For details of our complete range, including performance at low temperatures, write to

NUCLEAR ENTERPRISES LIMITED

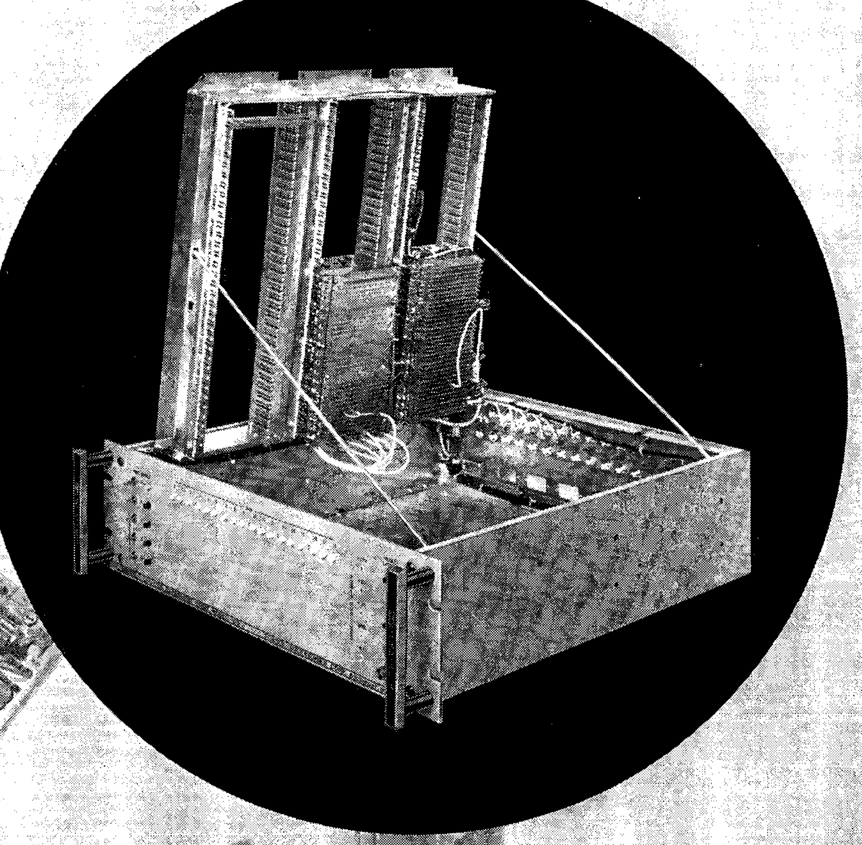
1966

Sighthill, Edinburgh EH11 4EY, Scotland. Telephone: 031-443-4060 Cables: Nuclear, Edinburgh Telex: 72333

Germany: Nuclear Enterprises GmbH, Perfallstr. 4, 8 Munich 80. Telephone: 44-37-35. Telex: 529938
U.S.A. (West): Nuclear Enterprises Inc., 935 Terminal Way, San Carlos, California 94070. Telephone: 415-593-1455
U.S.A. (East): Capintec Inc., 63 East Stanford Blvd., Mt. Vernon, N.Y. 10550. Telephone: 212-252-2440. Telex: 7105680138

Swiss Agents: *HIGH ENERGY AND NUCLEAR EQUIPMENT S.A.*
— 2, chemin de Tavernay - GRAND-SACONNEX - *1218 GENEVA* - Tél. (022) 34 17 07/34 17 05


J. & P. Engineering



Since late 1968,
SAC has been delivering

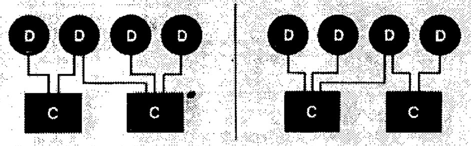
MCEL™

(pronounced "MEKKEL")

(Multiple-Counter Experiment Logic)

a family of IC logic cards and bins for versatile counter/computer interfacing.

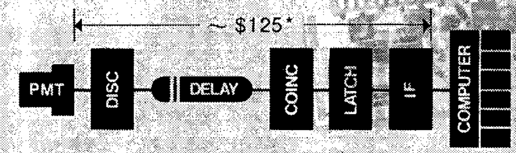
Innovated at UCRL and developed further by SAC, **MCEL** is the broadest and most economical logic system available today for use with large arrays of counters.



Coupled with high-performance low-cost photomultiplier tubes, **MCEL** enables the experimenter to construct hodoscopes of great complexity (at about $125 per channel between counter and computer, including the discriminator) with logic re-routing by computer during experiments to accommodate the increasing sophistication of studies in high-energy physics.

Our **MCEL** library comprises cards* for all logic functions — 80 cards per bin providing an average of more than 400 logic functions.

Special IC cards for complex functions can be supplied.



Rack-mounting bins are 5¼ inches high. All fast inputs and outputs are NIM-compatible level on 50 Ohms. Fast outputs are available to control data-acquisition instruments such as spark chambers. Latches "set" with a 3-nsec pulse-pair overlap. Delay-curve widths can be as low as 4 nsec. Test points and monitor lights show system performance.

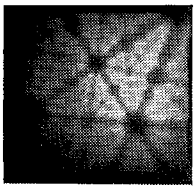
Write for full details about **MCEL**

******constructed with*
Motorola Emitter-Coupled Logic ICs.

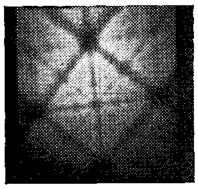
SAC SCIENCE ACCESSORIES CORPORATION
a subsidiary of amperex electronic corporation
65 STATION STREET
SOUTHPORT / CONNECTICUT / 06490 / USA
PHONE 203-255-1526

PROTON SCATTERING MICROSCOPY

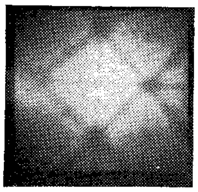
for the dynamic study of single crystals and thin films . . .



Tungsten, single crystal close to (122) orientation



Copper, single crystal close to (100) orientation



1000Å epitaxial film of gold on rocksalt

EDWARDS PROTON SCATTERING MICROSCOPE

puts this new technique into your lab!

The PSM1 Proton Scattering Microscope is a completely new instrument for studying the atomic structure of crystals and crystalline surface layers. Originally developed at the Metallurgy Division of A.E.R.E., Harwell, it is now available for the first time as a commercial instrument.

The technique of proton scattering microscopy has many advantages over conventional X-ray and electron diffraction methods and has rapidly been established as a powerful new crystallographic tool. The main applications of the new instrument are in the study of thin films, epitaxial growth, crystal orientation, crystal structure identification, study of grain boundaries or phase changes etc. and for teaching purposes, but new applications are being added daily.

Special features of the technique, using Edwards PSM1 Proton Scattering Microscope, include:

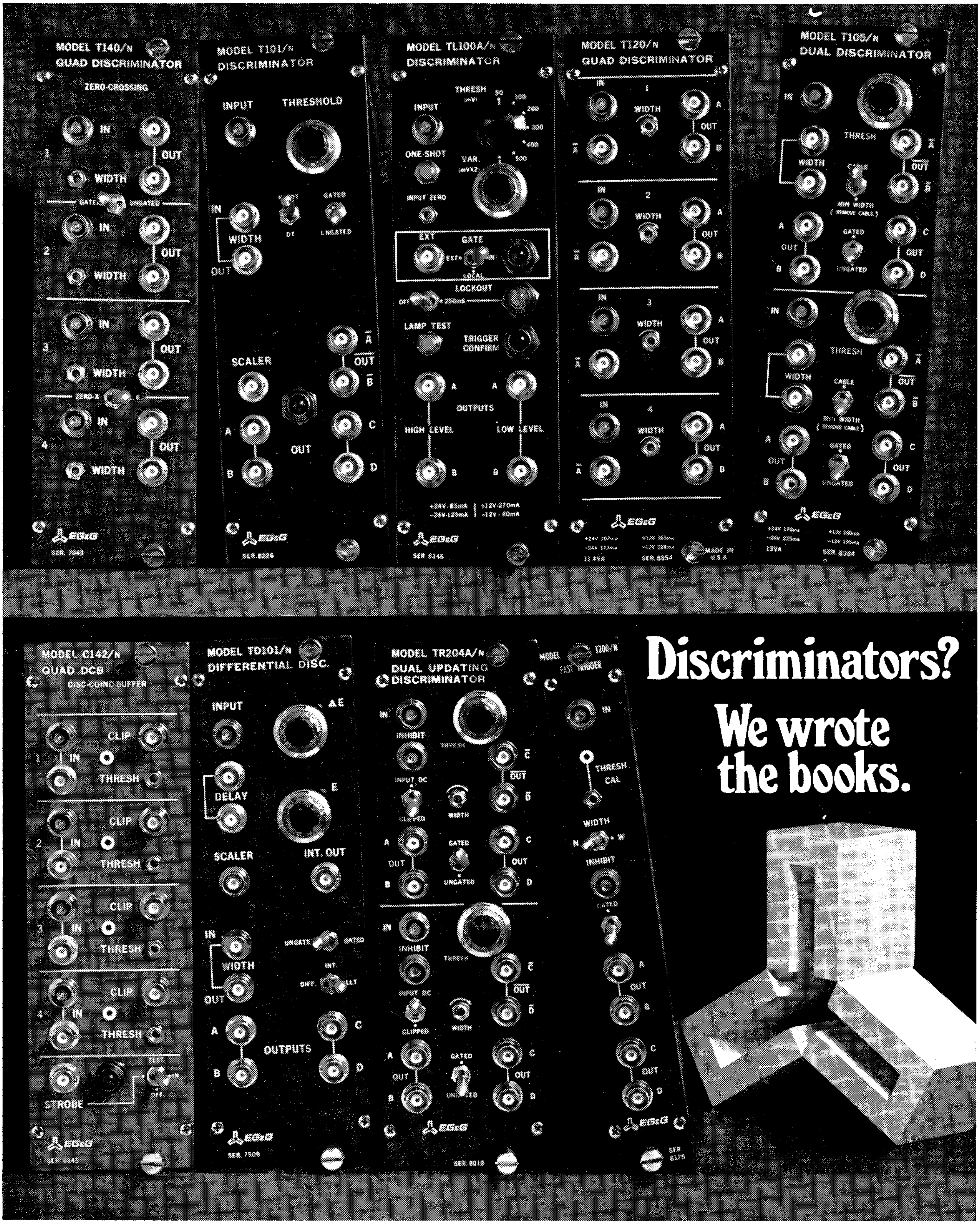
- Dynamic, visual display of magnified crystal structure
- Metallic, insulating or semi-conductor crystalline substances can be studied
- No cameras, film development, dark-rooms, etc. required
- No radiation hazard
- No diffraction patterns, i.e. simple interpretation of picture
- Thin films do not have to be removed from the substrate
- Simple to operate. Ideal for teaching purposes.

For further details of the PSM1 Proton Scattering Microscope, please ask for Publication No. 13872.

Edwards

Edwards Instruments Limited A member of the BOC group
Manor Royal, Crawley, Sussex, England
Telephone Crawley 28844 Telex 87123 Edhivac Crawley

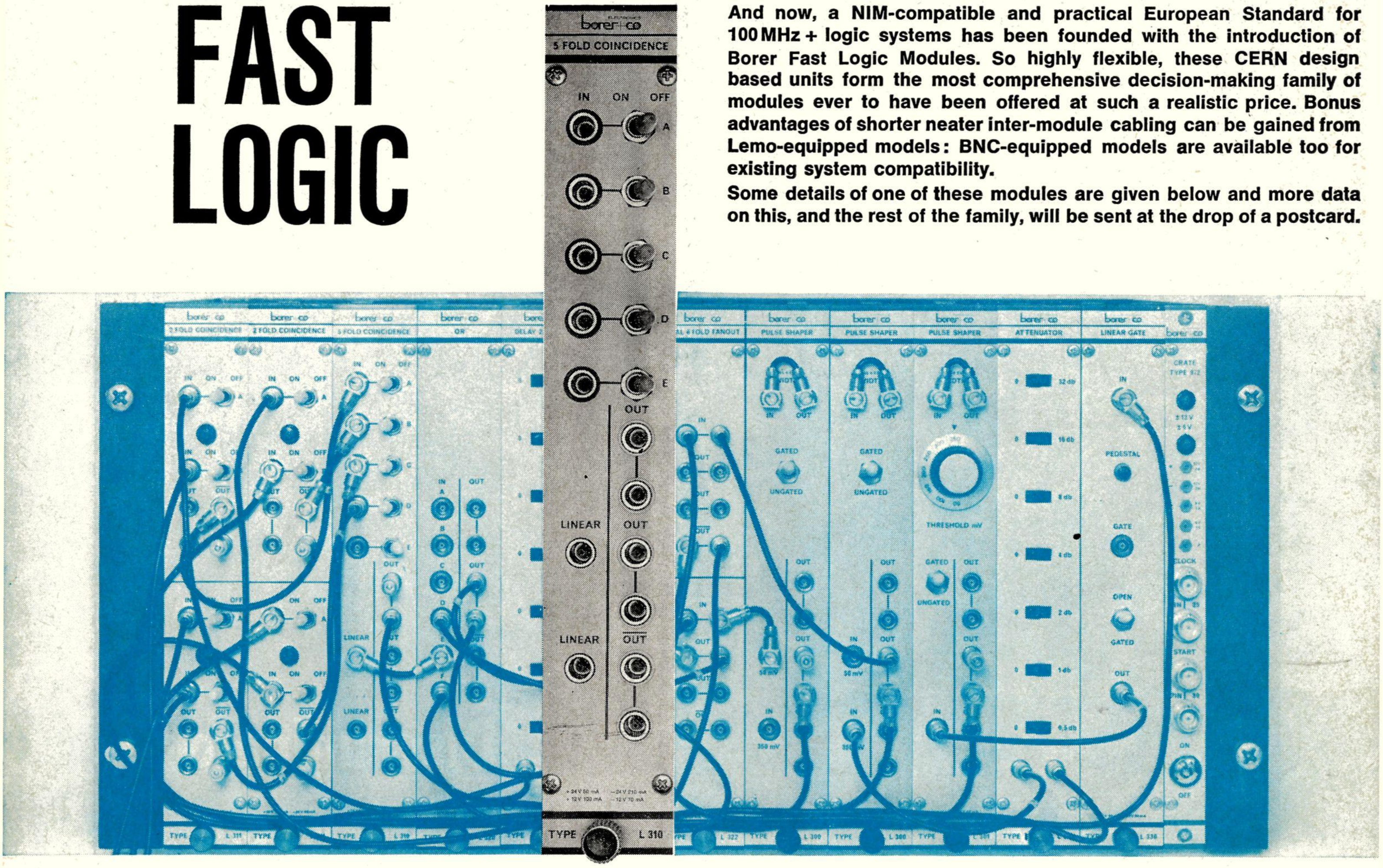
P2555


Discriminators?
We wrote the books.
MODEL T140/N QUAD DISCRIMINATOR
MODEL T101/N DISCRIMINATOR
MODEL TL100A/N DISCRIMINATOR
MODEL T120/N QUAD DISCRIMINATOR
MODEL T105/N DUAL DISCRIMINATOR
MODEL C142/N QUAD DCB DISC-COINC BUFFER
MODEL TD101/N DIFFERENTIAL DISC.
MODEL TR204A/N DUAL UPDATING DISCRIMINATOR
MODEL T200/N FAST TRIGGER
EG&G

FAST LOGIC

And now, a NIM-compatible and practical European Standard for 100 MHz + logic systems has been founded with the introduction of Borer Fast Logic Modules. So highly flexible, these CERN design based units form the most comprehensive decision-making family of modules ever to have been offered at such a realistic price. Bonus advantages of shorter neater inter-module cabling can be gained from Lemo-equipped models: BNC-equipped models are available too for existing system compatibility.

Some details of one of these modules are given below and more data on this, and the rest of the family, will be sent at the drop of a postcard.



Inputs	Impedance		50 ohms ± 2 %
	Reflections 'ON'		20 % max (capacitive)
	Reflections 'OFF'		15 % max (inductive)
	Voltage		– 700 mV typ. – 600 mV min. } for coincidence – 100 mV max. for anti-coincidence
	Overlap	LIN	2 ns min. for singles 2 ns min. for 5-fold
		OUT,$\overline{\text{OUT}}$	1.5 ns min. for singles 1.25 ns min. for 5-fold
Linear outputs	Impedance		High, 16 mA current sources. Unused outputs need not be terminated.
	Rise Time		1.8 ns max.
	Fall Time		2.0 ns max.
	Width, equal to		(Overlap + 1.0) ns for singles (Overlap — 1.0) ns for 5-fold
	Rate		200 MHz max.
	Propagation delay		6 ± 0.75 ns for singles Decreases by 0.5 ns max for 5-fold
	Feedthrough		± 15 mV max for n-1
Logic outputs	Impedance		High, 32 mA current sources, unused outputs must be terminated.
	Width	OUT	8.5 ± 1 ns
	Width	$\overline{\text{OUT}}$	9.0 ± 1 ns
	Rise time	OUT	1.5 ns max.
	Fall time	OUT	2.2 ns max.
	Rise time	$\overline{\text{OUT}}$	2.0 ns max.
	Fall time	$\overline{\text{OUT}}$	2.2 ns max.
	Rate		Greater than 50 MHz
	Propagation delay		10.5 ± 0.75 ns for singles Decreases by 0.5 ns max for 5-fold

Great Britain: 35 High Street, Shoreham-by-Sea
Sussex BN4 5DD
Tel: Shoreham-by-Sea 5262 Telex: 87274
Germany: Verkaufsbüro München, Kaiserstrasse 10
8000 München 23
Tel: 34 80 16
France: Numelec, 2 Petite Place, 78-Versailles
Tel: 951-29-30

ELECTRONICS
borer co

Switzerland: P. O. Box, 4500 Solothurn 2
Tel: (065) 4 88 21, Telex 34228