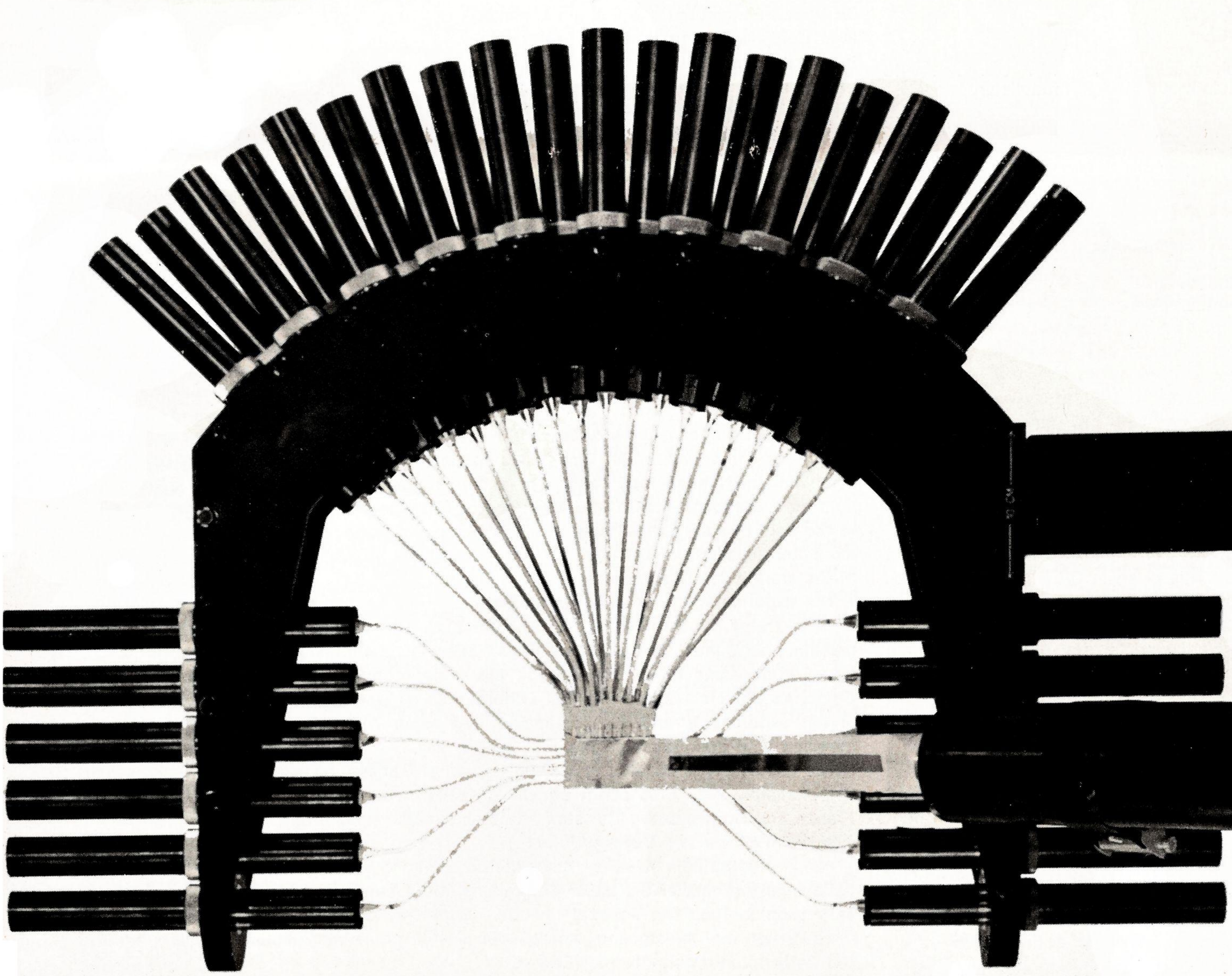
CERN COURIER

No. 3 Vol. 7 March 1967

European Organization for Nuclear Research



Cover photograph: A hodoscope developed for an experiment on large-angle scattering; three such hodoscopes will be used to determine the directions and momenta of incoming particles. At the centre of the symmetrical array are three layers of plastic scintillator which give a flash of light when traversed by a charged particle. The thin light pipes fanning out from the scintillators carry this light to photomultiplier tubes where it is converted into an electrical signal. Two of the layers are independent strips 3 mm wide, arranged to give the horizontal and vertical position of the particle, while the third opens an electronic gate to pass the signals to an on-line computer. (CERN/PI 207.1.67)

Contents

Tribute to Professor Oppenheimer . . 43

CERN News 44
- New buildings
- Again no asymmetry
  A further result from the investigation of the decay of the eta meson
- Computers
- Accelerator shut-downs
- Aid to Castel del Bosco

News from abroad 47
- Helium chamber
  Commissioning of the world's largest helium bubble chamber at the Rutherford Laboratory
- Cybernetic model
  A computer-controlled 1 GeV accelerator in USSR
- USA

Book reviews 48
- Relativistic theory of reactions

Organization of the organization . . 49
  A description of three aspects of organization at CERN — the Council and its Committees; internal organization; organization of the selection procedure for experiments on the accelerators

CERN News contd. 53
- Concerts
- Colloquia
- Conferences

Comment

A new result from the experiment on the decay of the eta meson is reported on page 45. It is a further indication that, to the best limits of accuracy which have been achieved to date, there is no evidence for the violation of charge symmetry in electromagnetic interactions.

We are, for the present, back in the situation where the two powerful forces controlling the behaviour of particles, the strong force and the electromagnetic force, obey the laws of symmetry for charge, parity and time. Only phenomena involving the weak force are in disarray.

The electromagnetic force is well 'understood' and its observed phenomena are well-behaved according to that understanding. Considerable progress has been made in recent years towards an understanding of the strong force, though this may be an illusion since its phenomena are so complex that simplifications can be bought fairly cheaply. With the weak force, however, in terms of our present knowledge of its phenomena, we start with comparative simplicity, and yet in this simplicity we see the fundamental symmetries violated. It seems likely that something new will come up here before long.

Now as in the past, several experiments around the proton synchrotron are grappling with different aspects of the weak interaction. A further investigation of charge-parity violation in the decay of the long-lived K meson is under way using the new slow extracted beam, e_3. Of particular interest is also the new series of observations of neutrino interactions which are scheduled to begin in April. Gradually, we might hope to approach the situation where our lack of understanding of the weak force no longer stems from any lack of observations of the phenomena upon which to base our understanding.

CERN COURIER is published monthly in English and French editions. It is distributed free of charge to CERN employees and others interested in the progress of 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: Bernard Bauer

Advertisements: Micheline Falciola

Photographs: Gérard Bertin

Public Information Office
CERN, 1211 Geneva 23. Switzerland
Tel. (022) 41 98 11 Telex 2 25 48

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

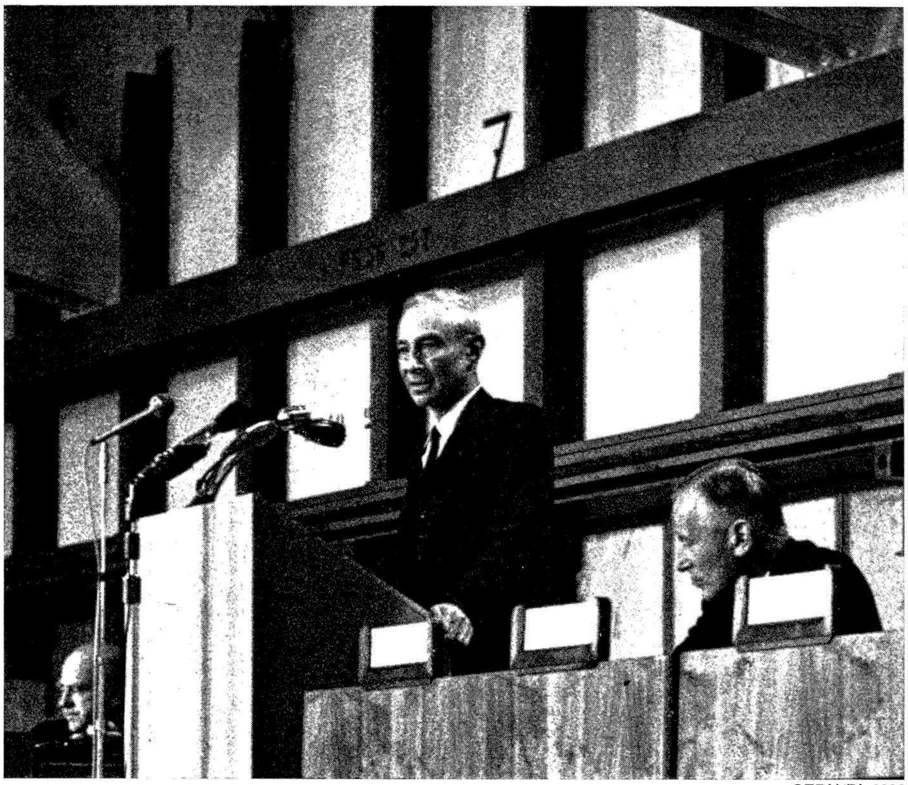
CERN, the European Organization for Nuclear Research, was established in 1954 to '... provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, 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 mainly 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), which will allow experiments with colliding proton beams to be carried out, are under construction. Scientists from many European Universities and national Laboratories as well as from CERN itself take part in the experiments and it is estimated that some 700 physicists outside CERN are provided with their research material in this way.

The Laboratory is situated at Meyrin, Canton of Geneva. Switzerland. The site covers approximately 200 acres about equally divided on either side of the frontier between France and Switzerland. The staff totals about 2300 people and, in addition, there are over 360 Fellows and Visiting Scientists.

There are thirteen member States participating in the work of CERN. The contributions to the cost of the basic programme, 172.4 million Swiss francs in 1967, are in proportion to their net national income. Supplementary programmes cover the construction of the intersecting storage rings and preliminary studies on a proposed 300 GeV proton synchrotron for Europe.

Tribute to
Professor Oppenheimer



CERN/PI 2096

Professor J. R. Oppenheimer died on 18 February. He was a physicist who had achieved world-wide renown for his part in the production of the atomic bomb and the dramatic events which followed ten years later. He was also a theoretical physicist who made several important contributions to physics and had considerable influence on the progress of physics in his own country and abroad.

Robert Oppenheimer was born in New York on 22 April 1904 into a wealthy and highly cultured family. His early years were spent in an environment where his lively mind was given every encouragment and opportunity to develop. He was surrounded by books and paintings and had a small laboratory built for him when he was still very young. At the age of 5 he started a collection of rocks and was admitted to the New York Mineralogical Club when he was only 11 years old.

In 1922, he went to Harvard, initially intending to make his career in chemistry. He studied chemistry and physics and also learned Latin, Greek and Dutch, finally graduating 'summa cum laude' in 1925 having completed four years work in three. Then began several important years in Europe which was the hot-bed of atomic and nuclear physics at that time. He went first to work under Rutherford at Cambridge University in the UK, and from there, at the invitation of Born, to Göttingen in Germany where he received his Doctorate in 1927. He returned briefly to the USA to Harvard and Caltech, returning to Europe to the University of Leyden, Netherlands, and ETH Zurich, Switzerland. In 1929, he joined Caltech at Pasadena and the University of California at Berkeley, becoming Professor in 1936, and was associated with both centres until 1947. He then became Director and Professor of Physics at the Institute for Advanced Study, Princeton. He retired as Director in 1966.

A crucial time in his life, which led to fame far beyond the field of physics itself, was the period 1943 to 1945 when he was chosen to be Director of the Los Alamos Scientific Laboratory, to lead the work on the production of the atomic bomb. There he displayed a genius for organization. Because of his broad and deep scientific understanding of all the aspects of the project he was able to weld together the abilities of a brilliant group of scientists to produce the atomic bomb in a remarkably short time.

From 1946 to 1952 he was Chairman of the General Advisory Committee of the US Atomic Energy Commission but his high position in forming US scientific policy came to an abrupt end following an investigation by the Atomic Energy Commission, which culminated in the removal of his security clearance. This sad affair has been discussed extensively elsewhere and will not be covered here. In 1963, he was effectively reinstated in public esteem when he was awarded the Fermi prize, the highest honour at the disposal of the Atomic Energy Commission.

During his life, Oppenheimer made several outstanding contributions to theoretical physics, for example: in 1927, in collaboration with M. Born, he developed the theory which separated the motions of the electrons and of the nuclei in the quantum theory of molecules; in 1938 and 1939 he worked with R. Serber and G. Volkoff on the possibility of 'gravitational collapse' using general relativity theory (this original work is currently one of the basic ideas in attempts to understand the recently discovered quasars); in 1947 and 1948, with H. Lewis and S. Wouthuyzen, he evolved one of the first theories of multiple meson production in very high energy proton collisions.

Nevertheless, though his work was distinguished in its originality and diversity, by comparison with some other scientists of less standing and influence, his creative contributions were limited. What was exceptional was his grasp of what was going on in science. Few scientists had his wide, and still deep, knowledge of physics. His incredibly quick mind absorbed new ideas like blotting paper. Following his years in Europe, he was described as the man who almost single-handedly carried quantum theory to the United States, and his brilliance as a teacher helped form many of the great American theoretical physicists.

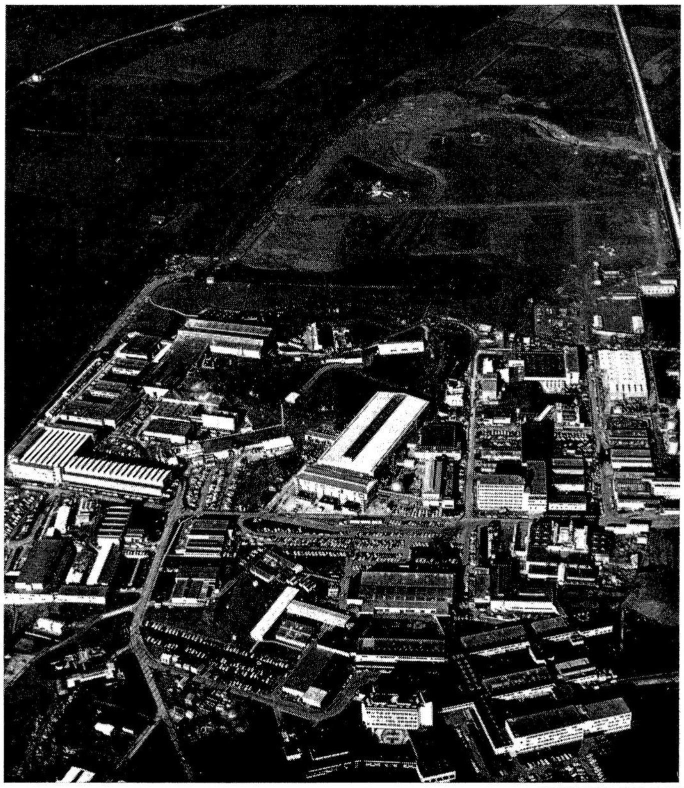
After the Second World War, Oppenheimer felt deeply the need to re-open the world-wide exchange of scientific information, which had been so badly curtailed during the war and he did all he could to bring this about. He holds a place in the history of CERN for the important part he played, in the years 1947 to 1949, in the discussions which led to the idea of European collaboration in high-energy physics. This was recognized at the ceremony of the inauguration of the proton synchrotron when Oppenheimer was one of the two non-Europeans (the other being Professor E. McMillan, Director of Berkeley) in the select group of people invited to give an inaugural address (see photograph above). More recently, he was also a member of the Scientific Council of the International Centre for Theoretical Physics in Trieste.

Despite failing health, Oppenheimer tried hard to be a physicist to the end. He was present at the Berkeley Conference in September 1966, and though obviously a sick man, he attended all the plenary sessions and contributed to the discussions. His broad knowledge and insight, his influence and his burning interest in the progress of physics will be sadly missed.

CERN News

Two aerial views of the CERN site: on the left, June 1955; on the right, February 1967.

CERN/PI 01.6.55



CERN/PI 257.2.67

New Buildings at CERN

A glance at these two photographs will show you that great changes have taken place on the CERN site in twelve years. One of the factors which has contributed most to this alteration is the large number of new buildings which have been put up during the time.

We therefore felt that it would be interesting at the beginning of 1967 to find out what new construction work was completed in 1966, what the new buildings are being used for and what items the Technical Services and Buildings Division has on its drawing boards for the future. The 1966 construction budget covered commitments worth 10.9 million Swiss francs, 70 % of which was for civil engineering and 30 % for technical installations.

The main construction work actually finished during the year and put at the disposal of the users was the neutrino area, i.e. the tunnel and adjoining buildings for the neutrino beam (the first experiment began this month). Then there were the extension to the offices and experimental hall for the AR Division, offices and laboratories for the Health Physics Group, and the extension to the buildings of the NPA Division. Alterations to the main restaurant in the Administration Building created some nice problems for those responsible because of the need to avoid disturbing normal running while the work was in progress.

Finally, improved shielding was erected on the roof of the Synchro-Cyclotron, and extensions were added to the Main Workshop, to Adams Hall and to the SC Cooling Hall.

A number of projects begun in 1966 have just been completed or will be completed in the course of 1967; for example, the six-storey building known as Laboratory 14 is being handed over to the Track Chambers and Nuclear Physics Divisions. Underground experimental halls for the ISOLDE project have also been finished this month. In connection with the latter it is of interest to note that the synchro-cyclotron was shut down on 28 March in order to install the beam and will be running again for tests on 15 April. Laboratories 18 and 19 and hall 169 will be handed over to the NPA Division in June, at which moment the extension work in connection with the main generator and its adjoining buildings will also be completed.

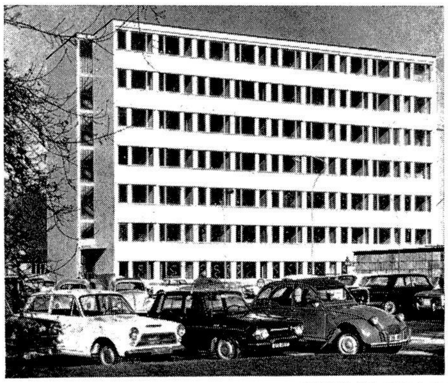
Also in progress are the extension to the main power house (one of the two new boilers came into operation in January), the new telephone exchange (where the buildings will be finished in 1967 though the technical installations will not be completed until 1968), the access road to the West site and various supply networks for electricity and fluids.

Finally, the SB Division has drawn up plans and designs for work about to begin or which has already begun. These are, in particular, for the buildings to house the Gargamelle bubble chamber (near the neutrino area) which will be completed in November, for the new « Jura » electricity substation where work has recently started, and for the extension to the surface treatment shop where work will soon begin.

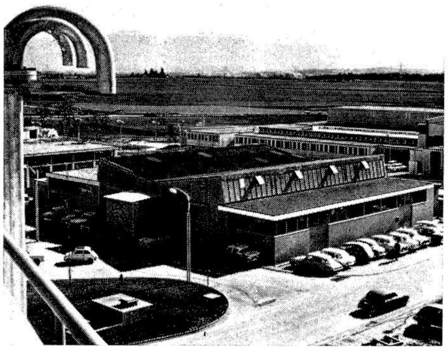
To conclude, here are three significant figures: about 200 workmen were engaged on the various constructions in 1966;

Top photograph: The six-story building, called Laboratory wing 14, which has recently become available for occupation by the Track Chambers and Nuclear Physics Divisions.
Below: A general view of Adams Hall, taken following the completion of extensions to the building.

Another aerial view, this time of the site for the intersecting storage rings. The lorries, carrying away the earth being carved out of the ring tunnel, cut a weird pattern in the snow and mud.



CERN/PI 373.2.67



CERN/PI 381.2.67

CERN/PI 310.12.66

12 million Swiss francs have been allocated to the building budget for 1967; 2500 work requests for a total value of 5.5 million Swiss francs were fulfilled by the SB Division and charged up to the divisions concerned.

Again no asymmetry

Measurements on the decay of the eta meson into two charged pions and a gamma were reported by a team from CERN, ETH and Saclay in Physics Letters, 20 February. From an analysis of 1620 events, they found no evidence of the violation of charge symmetry in the decay.

The experiment at the CERN proton synchrotron which examined the decay of the eta meson into three pions was reported in CERN COURIER, vol. 6, p. 171. It gave one of the most important results of 1966 — that there is no evidence of the violation of charge symmetry in the electromagnetic interaction. This symmetry had been put in doubt by the results of a previous experiment carried out in the USA. The CERN/ETH/Saclay team based their result on the analysis of a large number of observations (10 600) of the decay of the eta meson into a positive, a negative and a neutral pion. Because the eta meson and the neutral pion are their own antiparticles, any deviation from charge symmetry in the decay would be expected to show up as a difference in the behaviour of the positive and negative pions. No difference was observed.

The eta meson can also decay into a positive pion, a negative pion and a gamma. The gamma is its own antiparticle and therefore observation of the behaviour of the positive and negative pions in this decay can also be used to test charge symmetry. The team who carried out the experiment on the decay into three pions, were able to distinguish examples of decay into two pions and a gamma, among the data they had collected. 1620 events were selected from the measurements carried out using the HPD flying spot digitizer, which analysed the spark chamber photographs taken in the experiment, and the CDC 6600 computer.

Comparing the energies of the positive and negative pions in each of these 1620 events gave a value for the asymmetry (the number of times the positive pion is more energetic, minus the number of times the negative pion is more energetic, divided by the total number of events) as + 1.5 % with an error of ± 2.5 %. In other words, these measurements of another decay in which violation of charge symmetry in the electromagnetic interaction could be expected to appear, confirm the previous result that no violation occurs.

'Charge conjugation in $\eta \rightarrow \pi^+ \pi^- \gamma$', R. A. Bowen, A. M. Cnops, G. Finocchiaro, P. Mittner, J. P. Dufey, B. Gobbi, M. A. Ponchon, A. Muller. Physics Letters, 20 February 1967.

Computers

The CDC 6400 computer, which is scheduled to arrive at CERN about the middle of April to become CERN's large secondary computer, began its acceptance test at the factory in Minneapolis on 13 March.

Another computer scheduled to arrive at CERN in April, is the IBM 1800. It will be used in connection with the proton synchrotron for data collection and control during operation of the accelerator.

The area around Florence during the floods in November last year. The CERN Staff Association has organized help for reconstruction work in the village of Castel del Bosco, 50 km from the city.

At its meeting on 16 February, the Finance Committee approved the purchase of an IBM 360-30 to be used for Administrative Data Processing (the ADP project; see CERN COURIER, vol. 6, p. 157). It is hoped to bring the computer to CERN in June of this year. It will be used initially for stores accounting and then for general accounting, personnel statistics, etc. and for providing forward planning management information.

The Data Handling Policy Group has been reformed, under the chairmanship of M. G. N. Hine, to serve as a coordinating body on computing matters within CERN and to make recommendations to the Board of Directors on computing policy. Other members of the Group are R. Armenteros, W. Baker, R. Böck, A. Burmeister, R. Hagedorn, C. Lovelace, G. R. Macleod and H. Øveras.

Accelerator shut-downs

A month's shut-down of the proton synchrotron, initially scheduled to begin in March, has been postponed for three weeks to coincide with major work on the electricity mains to be carried out by the Services Industriels de Genève. It will now start on 17 April and continue until 17 May.

The first experimental run with the new neutrino beam-line (see CERN COURIER, vol. 6, p. 211) is scheduled for the week preceding the shut-down. The fast extracted proton beam for the beam-line was operated for the first time on 19 January and the last of a series of tests prior to the experiments, to optimize the neutrino flux to the heavy liquid bubble chamber, began on 16 March. The April issue of CERN COURIER will include an account of some of the experiments currently in the programme of the PS.

The synchro-cyclotron also has a shutdown in April, principally for installation of the new underground beam-line which will take proton beams from the SC to the ISOLDE laboratory. This beam-line comprises two 15 ton bending magnets and twelve quadrupole lenses. The shut-down will take place from 2 to 15 April and other work to be carried out includes installation of new rectifiers for beam-transport equipment and modification of the electrical supplies to the SC to cater for the increased requirements.

Aid to Castel del Bosco

On November 4, 1966 the world press agencies flashed the first news of the terrible floods which, in a few hours, were to devastate a large part of Tuscany in the north of Italy and to make Florence look like a bombed city.

Everyone certainly remembers what the fourth of November and the following days were like: more than a hundred dead, besides the missing and the injured; the many buildings damaged; the general suffering and tragedy as well as the individual grief. Help flowed in at once from all over Italy, from Europe and as far afield as America, as a result of collections made to meet the most pressing needs. At that time CERN staff made its contribution through the Red Cross, the Italian Consulate in Geneva and other emergency-relief organizations to bring aid to the victims. The time for emergency aid is now over, but there remains much to be reconstructed which was swept away or damaged by the flood waters.

CERN is anxious to be associated more directly in this second phase of relief. International aid has been concentrated generally on Florence and on the restoration of its damaged master-pieces, so it seemed more useful to choose a small village whose name has never been in the headlines. The choice fell on Castel del Bosco, a small hamlet in the province of Pisa, about 50 km to the west of Florence, on the banks of the Arno, which for a week was buried under more than three metres of water and debris. Its five or six hundred inhabitants, mostly small farmers and craftsmen, lost almost everything they possessed, and above all they no longer have a school or a dispensary. It is precisely this school and dispensary that CERN has decided to help reconstruct.

The mayor of Castel del Bosco has sent to the CERN Staff Association a detailed estimate amounting to ten thousand Swiss francs of the equipment needed for both the school and the dispensary. The Staff Association has therefore organized a collection among its members starting at the beginning of March.

A little ceremony is planned during which a cheque for 10 000 Swiss francs will be handed over to the mayor of Castel del Bosco who will come to CERN specially for the occasion.

News from abroad

Helium chamber

Commissioning of the largest liquid helium bubble chamber in the world was successfully completed at the end of February at the Rutherford Laboratory, UK. The chamber has been under construction since 1963 as a joint project between the Department for Nuclear Physics of Oxford University and the Rutherford Laboratory.

The chamber contains 200 litres of liquid helium and is 80 cm long in the beam direction. It is unusual in design in that the magnetic and optical axes are vertical. A 70 ton magnet with a hexagonal yoke provides fields of 22 kg over the chamber volume.

There are two special problems associated with large volume helium chambers. The first concerns the possibility of turbulence due to the slow velocity of pressure waves in liquid helium; this can blur the tracks of bubbles formed in the wake of the charged particles. This has been avoided by using an expansion system which applies the pressure changes through the movement of the whole of a side wall of the chamber, which is attached by a bellows (about 0.6 cm of movement gives the required expansion of the chamber volume). Plain pressure waves are produced which do not break into turbulence. The second problem is to maintain temperature stability at the temperatures near absolute zero which are necessary to keep the helium in the liquid state (the chamber operates at —268° C constant to ± 0.05° C). Many novel refrigeration problems had to be solved in the construction of a refrigerator-liquifier which is attached to the chamber magnet. The principle feature of the refrigeration cycle is the use of expansion turbines, with bearings lubricated by helium gas, running at speeds of up to 350 000 revolutions per minute.

The chamber will be used for experiments on the 7 GeV proton synchrotron Nimrod. The helium nucleus, which is the target for the incoming particle beams from the accelerator, has a very symmetrical arrangement of its four nucleons (two protons and two neutrons). The nucleus has zero spin and this makes it particularly useful for some types of experiments.

Further news from the Rutherford Laboratory: On 28 February work started on the construction of a new large experimental hall at Nimrod. This will be the third experimental area at the machine.

Cybernetic model

A 1 GeV proton synchrotron model is nearing completion at the Radiotechnical Institute in Moscow. It is intended to test the design parameters of a cybernetic (or computer-controlled) 1000 GeV accelerator. The research, which is being led by the Director of the Institute, Academician A. L. Mints, does not, of course, mean that the USSR is in any way committed to the construction of a very high energy machine.

In 1962, two papers were published by a group led by A. L. Mints, on the possibility of 'auto-correction' of the magnetic field in accelerators designed for very high energies. The idea is that a series of beam monitoring devices arranged around the accelerator ring will feed information on the behaviour of the beam in the ring directly to a computer. The computer will calculate any deviations of the beam and the required adjustments to the magnetic field to return the beam to its ideal state. Correction signals will then be sent by the computer to the magnet power supplies. It is estimated that the process from observation to correction will take about 1 ms.

If this system of control proves feasible, it could relax the requirements on accuracy in construction and positioning of individual elements and reduce the size of the vacuum chamber in the accelerator ring with corresponding reduction in the size of the magnets.

The word 'cybernetic' (from the Greek word meaning 'steersman') means the study of communication and control systems in living beings and machines, in which feedback plays an important part. It was probably used in scientific literature for the first time by Maxwell 100 years ago in a study on feedback mechanism.

'Use of Autocorrection Principle for Magnetic Field in Cyclic Accelerators designed to produce very high energies', Atomnaya Energiya, February 1962.

'Circular High Energy Accelerators with a Self Adaptive Magnetic Field', Soviet Physics Doklady, May 1962.

Both reports by E. L. Burshtein, A. A. Vasilev, A. L. Mints, V. A. Petukhov and S. M. Rubchinskii.

U.S.A.

An advisory panel on high-energy physics has been set up by the US Atomic Energy Commission to help foster a 'vigorous and productive national high-energy physics programme'. Professor V. F. Weisskopf, Director General of CERN for five years up to the end of 1965, has been elected chairman of the panel. The other members are R. L. Cool, E. C. Fowler, L. M. Lederman, E. J. Lofgren, G. E. Pake, W. K. H. Panofsky, R. G. Sacks, K. R. Symon, R. L. Walker, R. R. Wilson, C. N. Yang.

Professor Weisskopf became Head of the Physics Department at the Massachusetts Institute of Technology (MIT) on 1 February.

Professor M. Gell-Mann, who has made outstanding contributions to the theory of particle physics has been selected as the first holder of the Robert Andrews Millikan Chair of Physics at the California Institute of Technology. Professor Gell-Mann has been associated with Caltech since 1955.

The MURA (Mid-Western University Research Association) team hopes to feed the first electron beams into the 200 MeV electron-positron storage ring at Wisconsin in the near future. The magnet ring and the vacuum chamber (to give a vacuum of 10^{-9} torr) are assembled and tested. They are initially hoping to store about 1 A of electrons eventually increasing this figure to about 10 A.

Book reviews

Relativistic theory of reaction

by J. Werle (Amsterdam, North Holland Publishing Company, 1966).

Since the great days of the break-through by quantum mechanics, no spectacular progress has been made in physics. In the last few decades, we have been confronted with a puzzle, large parts of which have been pieced together, but — although there are many such parts in which a picture is taking shape they are disconnected. In this situation, it is extremely useful to be aware of some regularities in the overall picture — strict and approximate rules which apply not only to those parts we think we understand but, more importantly, which we have good reason to assume valid even where we know next to nothing. These rules are of the kind that say that the shadows in disconnected parts of a sunlight landscape should all lie on the same side — there should not be early morning in one part of the puzzle and late afternoon in another. Also, we know from the parts already pieced together that we are unlikely to encounter beings like those populating the paintings of Hieronimus Bosch — if in composing a new part we find a man with six legs, we would start again.

The beauty of this book is that Werle tries to bring out all these rules; he fixes the coordinate frame into which the puzzle has to be fitted (until further notice, of course). It is an aesthetic pleasure to see this frame with its many beautiful symmetries, but it would be tedious if there were not a few irregularities, approximate symmetries and broken rules; just as a hand-made Persian carpet is more fascinating than the exactly-woven product of a machine.

Physics is a science and an art and this book exhibits one of the most striking features of both — the duality of *form* and *content.* When one of them is missing, art or science ceases to be. It is largely a matter of personal taste, of education and of many unconscious influences whether one puts more weight on form or on content. I am one of those who rate form higher and I would like to have written this book, because it is an exposé on the form in which physics has to be cast.

There is a second reason a book about form should have an exemplary form itself — and it has. It is well organized, clear in style and well thought out. And a third reason: if I had written this book, I would know its contents by heart (which I should do, but don't).

Here I end my personal view and make the general claim that this book presents the indispensible tools of a modern high-energy physicist. Many of them have a good chance of remaining indispensable for some time. All the rules of the game are laid down in seven chapters:

I. Vector Spaces and Linear Operators
II. Groups and Group Representations
III. General Principles of the Relativistic Theory of Reactions
IV. Description of Free Particle States
V. Transition Amplitudes, Cross Sections and their Partial Wave Expansions
VI. Selection Rules
VII. Relations between Different Reactions.

A good indication of the aim and contents may be obtained from the text inside the cover: 'The book deals with those problems of the relativistic theory of reactions which can be solved with the help of model independent methods. Thus only the general principles of the relativistic quantum mechanics and the symmetry properties of the S matrix elements are used throughout the book. Additional dynamical arguments result from some simple and general properties, different orders of magnitude, etc. Such methods are generally believed to have much more permanent value than the numerous, highly restrictive, frequently inconsistent and ephemeral models which are constantly being changed in confrontation with the experimental facts.

The main problems of the relativistic theory of reactions can be formulated as follows:

1. relativistic description of the asymptotic free-particles states
2. convenient parametrization of the S matrix elements, cross sections, density matrices and expectation values
3. investigation of the selection rules and various restrictions imposed by them on the transition amplitudes and on the allowed form of the cross sections, density matrices, etc.
4. investigation of the relations between different reactions
5. calculations of the numerical values of the cross sections, density matrices and expectation values for any particular reaction.

The book deals only with the problems (1-4) leaving aside the most difficult and still unsolved problem (5). On the other hand the solutions of (1-4) presented in the book form a very useful and reliable scheme for a physically meaningful classification, description and interpretation of the experimental facts. Knowledge of this scheme is absolutely indispensable for all 'particle physicists' working in high or low energy physics.

A unified treatment of all the problems mentioned is achieved by the extensive use of the very elegant and powerful group-theoretical methods. The methods of group theory have penetrated nuclear and elementary particle physics very deeply in the last decade and are becoming one of the most powerful tools of modern physics. A compact but quite comprehensive review on the theory of groups and their representations is included. In this way the reader is saved from being constantly referred to other books, papers and review articles for the theorems or special formulae he may not know or may have forgotten.

I cannot claim to have read everything, nor to have checked formulae and tables. There might be printing faults, or inconsistencies in notation or faulty formulae — though I have not seen any obvious ones and judging by the care which obviously went into this book, I do not expect that there are many.

To avoid saying only positive things, let me complain about the meagre index. For example, one cannot find 'adjoint representation' under A or R — though it is of course dealt with in the text, where it is unfortunately called 'contragredient representation' but then the word contragredient does not appear in the index either. A book such as this, which could become a working tool for many people should have an index three to five times bigger. Otherwise it is reduced to a text-book which one has to read through and study, which is worthwhile, but which restricts its use as the reference book it otherwise could be.

R. Hagedorn

Organization of the Organization

A brief account of three aspects of organization at CERN, covering:
- the Council and its associated committees
- the new internal organization
- the process of selection for the experimental programmes at the accelerators.

The Council

The supreme body governing the affairs of CERN is the Council, made up of two delegates from each Member State, who may be accompagnied by advisers. Each State has one vote in Council which it may exercise in all matters where it has a financial stake. In addition to being the governing body of the Organization, the Council Members and their advisers, and the Members of the other Council Committees — the Scientific Policy Committee and the Finance Committee (q. v.) constitute important links with the authorities in the Member States. Heading the Council is the president — Dr. G. W. Funke — who is elected with two vice-presidents for one year but may be re-elected in succeeding years up to maximum of three consecutively.

It is for the Council to agree upon the broad lines of research policy and match these with adequate resources in money and manpower. It is charged by the Convention with adopting the budget, reviewing expenditure and publishing the audited accounts of the Organization. The Council must also approve the Staff Rules, the Financial Rules and the Rules of the Pension Fund, which provide the main framework of administrative policy.

The Committee of Council, which now consists of one member per State together with the Chairmen of the Scientific Policy Committee, the European Committee for Future Accelerators and the Finance Committee, has been specifically charged by the Council with the work preparatory to Council decisions on the 300 GeV project, including the revision of the Convention and the selection of the site. Member States have already expressed the view that both Laboratories should be part of a single organization and that the present Convention should be adapted to accommodate the expansion.

Two permanent committees give specialist advice to the Council; one on scientific policy and the other on financial matters. The need for the Finance Committee (current chairman Dr. W. Schulte-Meermann) was specifically presaged in the Financial Protocol to the Convention.

It is the Finance Committee (FC) that receives the budget and reports on it to Council, whilst at the same time it decides on the form in which CERN's own accounts should be rendered. In day-to-day affairs it must be notified of significant transfer of funds inside the budget and given prior notice of any operations which would involve an excess over the budget. One of its more important tasks is to approve the major contracts (over SFr. 750 000) that are let to industry by CERN, ensuring that these are placed at the lowest tender figure provided always this is consistent with the technical requirements being satisfied.

The Scientific Policy Committee (SPC) presently chaired by Prof. G. Puppi is made up of eminent scientists, chosen in their own right rather than as representatives of a specific State. Its prime activity is to provide Council with the best possible advice on scientific developments and their implications to the organization.

Quite separate is the European Committee for Future Accelerators (ECFA) which was first set up in January 1963 jointly by the Director General (D. G.) and the Chairman of the SPC following the Council meeting the previous month. A wide representation of European physicists was sought under the chairmanship of Professor Amaldi and the result of their deliberations was a report which was passed to the SPC and which made far reaching recommendations as to the new policies and machines needed in Europe including for example the ISR project.

At the beginning of last year ECFA was again reconvened and the Council at its meeting in June this year will be considering a second report which will bring up to date the views of the Committee on

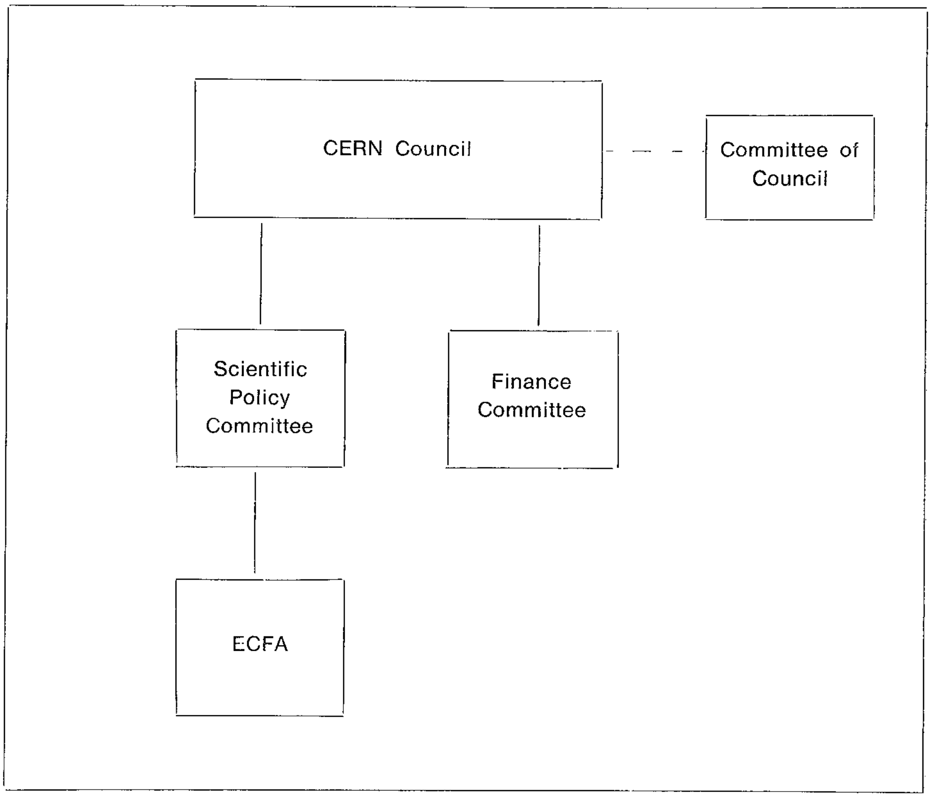
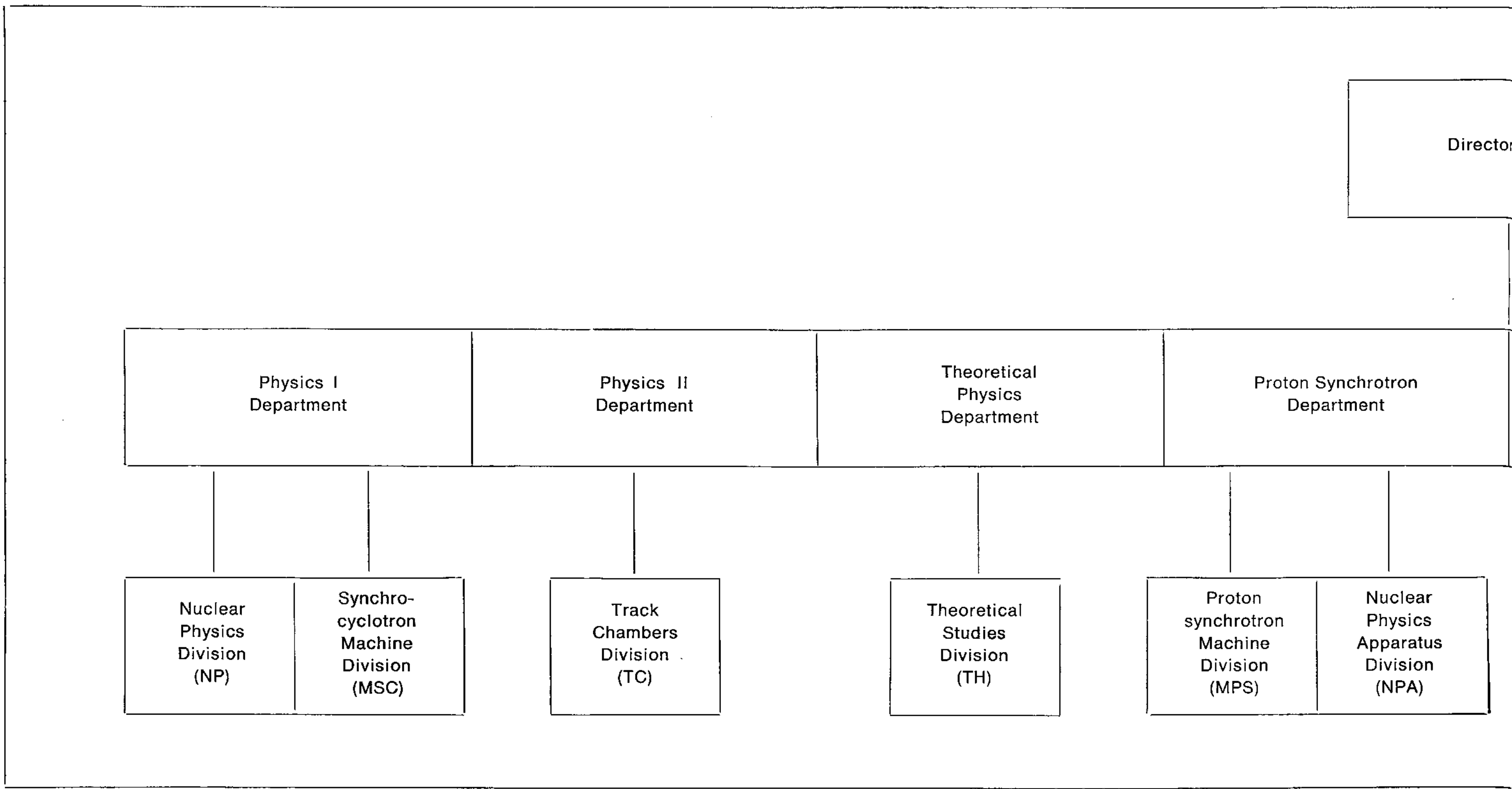


Figure 1 : The CERN Council and its associated committees.

Figure 2 : The internal organization of CERN.



the status and needs of high energy physics in Europe today.

Internal organization

Following the proposal of the Director General, Professor Gregory, the Council adopted a new internal organization for CERN at its session in June 1966.

One of the main features of the organization is the substitution of seven Departmental directors for the four members of the Directorate: two for experimental physics, one for theoretical physics, one for the proton synchrotron, one for applied physics, one for construction of the intersecting storage rings and one for administration. The Directors and the Director General form a Board of Directors which deals with important problems relating to the running of CERN.

All CERN's work is regrouped in seven Departments. The Departmental Directors are appointed for fixed terms and their functions are twofold: they are directly responsible for running their Departments and they help form policy in the Board of Directors.

The Departments are as follows:

1) Physics I, Director: Professor Wolfgang Paul

This Department includes two previously existing Divisions, Nuclear Physics (NP) and Synchro-cyclotron (MSC).

The main task of the Nuclear Physics Division (Leader, Professor P. Preiswerk) remains the carrying out, in collaboration with European universities and Laboratories, of the high energy physics programme at the proton synchrotron and the synchro-cyclotron, using counter and nuclear emulsion techniques. All work done at the synchro-cyclotron, a large part of which concerns research on nuclear structure, now comes under this Department. In addition, the Division is responsible for the design and operation of the beams needed for these experiments and for developing the equipment necessary for research with them.

The MSC Division (Leader, Dr. G. Brianti) is responsible for the work in connection with the operation, maintenance and development of the 600 MeV synchro-cyclotron.

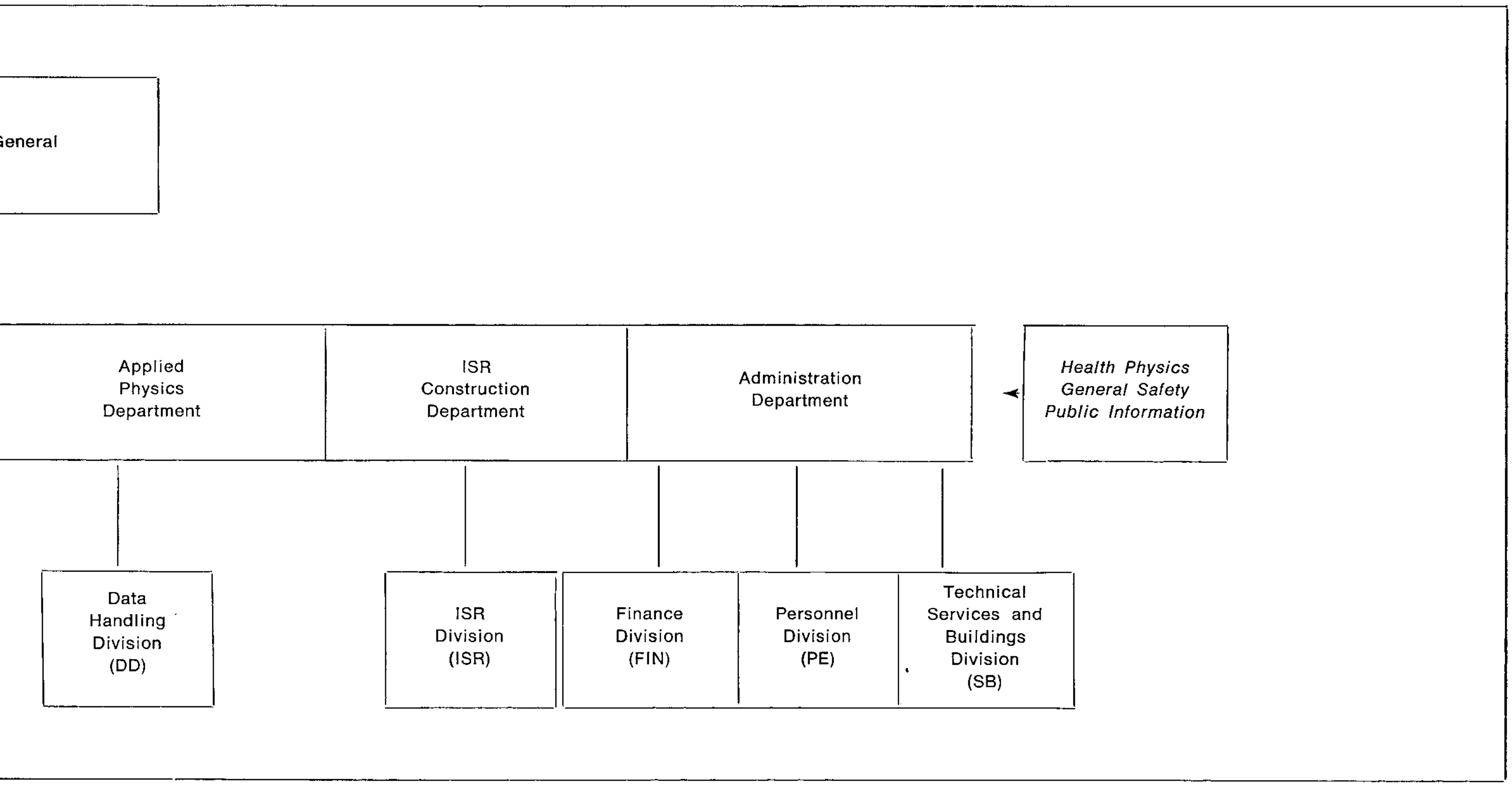
2) Physics II, Director: Professor Ch. Peyrou.

This Department incorporates the functions of the Track Chambers Division (TC). The decision to establish this as a Department took account of the considerable development of research in Europe using hydrogen bubble chambers.

The Department is responsible for the operation, maintenance and development of the hydrogen bubble chambers in service at CERN together with the design and operation of particle beams for the chambers; research work using the chambers; continuation of the studies for a very large hydrogen bubble chamber in collaboration with experts from Germany and France. (See CERN COURIER vol. 7, p. 43.)

3) Theoretical Physics, Director: Professor Léon Van Hove.

The work of this Department which incorporates the Theoretical Studies Division with Dr. J. Prentki as Leader, is devoted to pure research in the theory of particle physics. It also maintains close collaboration with the experimental physicists, to assist them in drawing up their programmes and interpreting their results.



The Theoretical Physics Department is the one at CERN in which more visiting scientists than CERN staff members take part in the work.

4) Proton Synchrotron, Director: Dr. Pierre Germain.

This Department includes the Proton-Synchrotron Division (MPS) and Nuclear Physics Apparatus Division (NPA). The MPS Division (Leader, Dr. P. H. Standley) is responsible for the operation, maintenance and development of the 28 GeV proton synchrotron, including the large improvements programme now under way at the machine.

The NPA Division (Leader, Dr. C. A. Ramm) is responsible for the design and construction of certain equipment necessary for the experimental programme, such as particle separators, the neutrino facilities, etc. It also looks after the operation and development of heavy liquid bubble chambers at CERN and carries out research with these chambers.

5) Applied Physics, Director: Dr. M. G. N. Hine.

This Department includes the Data Handling Division (DD) (Leader, Dr. G. R. Macleod) responsible for the design, construction and operation of equipment for data handling by means of computers. It co-operates closely with the NP and TC Divisions in the experimental programme. The scale of the work done by this Division can be gauged from the fact that CERN has the largest computing centre in Europe. The Department is additionally responsible for much of the forward planning analysis including the preparation of programme costings and is currently heavily engaged upon the 300 GeV project evaluations.

6) ISR Construction, Director: Professor K. Johnsen.

The main task of this Department is to construct the intersecting storage rings which will make possible a new range of experiments using beams taken initially from the PS. In addition, at the present time, the physicists and engineers of the Department are taking part in the studies for the projected European 300 GeV proton synchrotron in collaboration with national study groups.

7) Administration, Director: Mr. G. H. Hampton.

Several Divisions and administrative services are grouped under this Department: Finance (FIN), Leader, Mr. C. Tièche; Personnel (PE), Leader, Mr. G. Ullmann; Technical Services and Buildings (SB), Leader, Mr. H. Laporte and the sections concerned with Health Physics, General Safety and Public Information.

The Director of Administration is also responsible for political relations with the Member States and the host countries (France and Switzerland), Council affairs and relations with other organizations, local communities etc.

To conclude this brief survey of the new internal organization, an Advisory Committee is in being to assist the D. G. which consists of the Departmental Directors, the Division Leaders and a few senior members of the staff. The purpose of this Committee is mainly to provide the CERN management with an overall view of certain general problems. This Committee is designed to improve « horizontal » liaison within CERN.

Experimental Programme

Finally, let us take a look at the organization of the selection procedure for the physics experiments — the different ways of bringing experiments which are proposed to the point where they can be carried out at the PS or the SC.

A proposal for an experiment is usually the result of studies and discussions in a European university, a national Laboratory or a CERN group, often in collaboration. When the proposal is sufficiently advanced, generally after long discussions between many people, and an assessment has been made of the financial implications of the project, the time required on one or other of the machines, and the necessary experimental equipment and staff, it is submitted to one of three Physics Committees of CERN. These consist of CERN physicists and representatives of European universities and national Laboratories.

These three Committees, which meet about once a month, are mainly responsible for considering the scientific merit of the proposals. They also make recommendations on the facilities offered by the accelerators in their respective fields.

The scope of the authority of the Committees was originally divided according to the type of experimental equipment to be used in the experiment, but this distribution was partially modified during 1966. They are now as follows:

Physics I (more commonly called Electronics Experiments Committee) which considers and chooses the proposals for experiments using electronic counters and spark chambers. The Chairman of this Committee is Professor W. Paul (CERN).

Physics II (more commonly called Track Chamber Committee) which considers and selects the proposals for experiments using the bubble chambers at CERN — the 2 m hydrogen chamber, the 81 cm hydrogen chamber and the heavy liquid chamber. The Chairman of this Committee is Professor M. Teucher (Federal Republic of Germany).

Physics III (which groups the former Emulsion Experiments Committee and Nuclear Structure Committee) which considers and selects the proposals for experiments using nuclear emulsions (the number of these experiments has gradually reduced and they now tend to be more complex) and experiments into nuclear structure (the number of these experiments, particularly using the synchro-cyclotron, has considerably increased in the past few years). For the sake of convenience, this Committee also deals with all proposals for the SC, regardless of the type of equipment concerned. The Chairman of this Committee is Professor A. G. Ekspong (Sweden).

The recommendations of these three Committees are then passed on to the *Nuclear Physics Research Committee* under the chairmanship of the Director General, which takes the final decisions concerning the experimental programme and the facilities offered by the two accelerators. This Committee has to take into consideration not only the scientific merit of the experiments proposed, but also their technical and financial implications and whether they are compatible with the other experiments in the programme.

The members of the NPRC are the chairmen of the three Committees mentioned above, and representatives of the CERN Departments concerned, viz.: Physics I, Physics II, Theoretical Physics and Proton Synchrotron Department. These are the directors of these departments and some additional staff members closely involved in the experimental programme. The NPRC meetings are also attended by the PS co-ordinator and, when his presence is needed, by the SC co-ordinator. In addition, a representative of the Rutherford Laboratory is mostly present, and, whenever a senior physicist from Brookhaven is at CERN, he is asked to attend the meetings.

Once the Nuclear Physics Research Committee has approved an experiment or a test aimed at establishing the feasibility of an experiment, the team which generally consists of physicists from national laboratories, European universities and CERN, working in collaboration, can get down seriously to the preparatory work in conjunction with the PS staff responsible for beam lay-outs and other technical facilities. In addition to approving new proposals the Physics Committee and the NPRC regularly review the status and needs of the various experiments in progress. At all stages the Committees seek to further the collaboration between CERN and physicists throughout Europe.

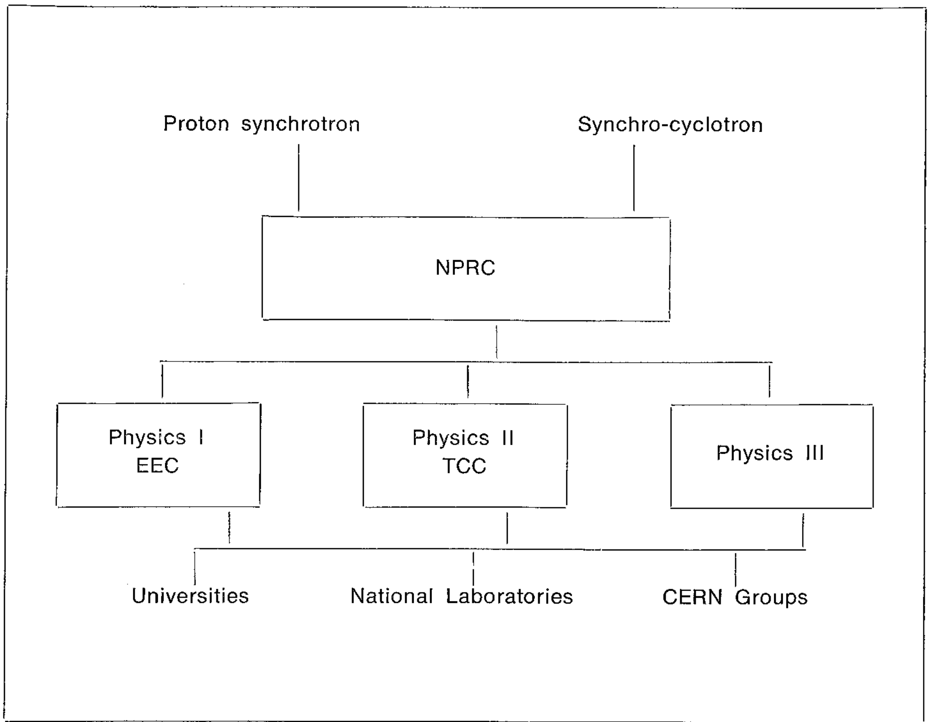


Figure 3: Organization of the selection procedure for the experiments carried out on the two CERN accelerators.

CERN News
continued

Concerts

Two concerts will take place in the CERN Main Auditorium in April:
6 April: Michel Corboz Vocal Ensemble will interpret works by a number of composers including Debussy, Ravel, Poulenc, Hindemith and Monteverdi;
27 April: Ayla Erduran (violin) and Roger Aubert (piano) will play three sonatas by Brahms.

Colloquia

13 April: Professor E. Picciotto, from the University of Brussels, will talk about 'The search for extraterrestrial matter in polar snow' (research in the Antarctic with a discussion of the properties and the possible origin of interplanetary dust particles).

Conferences

A Conference on Elementary Particles, organized by the Institute of Physics and the Physical Society, will be held at University College, London, on 17, 18 and 19 April. Invited speakers from CERN include Professor L. Van Hove on 'Tests of violations of invariance principles', Dr. A. Donnachie on 'The pion nucleon interaction', Dr. A. Wetherell on 'Peripheral processes' and Dr. M. G. N. Hine on 'A future 300 GeV European Accelerator'.

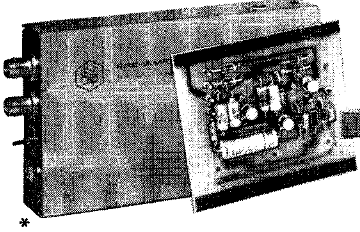
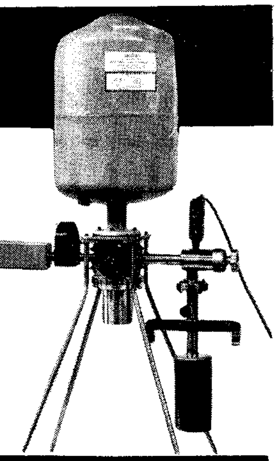
From 3-7 April, the European Conference on Molecular Biology will be held at CERN. Professor Gregory will address the Conference at its opening session as Director General of the host organization.

About 80 delegates are expected — scientists working in molecular biology and diplomats — from the thirteen Member States and three Observer States of CERN. International organizations — UNESCO, OMS, DECP, ESRO, CIUS, the Council of Europe and CERN itself — will be represented. The European Molecular Biology Organization (EMBO), an association of a number of leading molecular biologists, will also be represented.

One of the purposes of the Conference is to move towards the formation of an international organization in this field of research.

GUIDE TO PREAMPLIFIER SELECTION

Choose the most appropriate Preamplifier for your Radiation Detector from this comprehensive range – of course, we can supply the Detector too!

*Preamplifiers NE 5281, 5282 and 5285 can be supplied in box or card form. Preamplifiers NE 5287 and NE 5287A (shown with cryostat) are normally supplied boxed.

TYPE NUMBER	NE 5281	NE 5282	NE 5285	NE 5287	NE 5287A
FUNCTION	A general purpose simple preamplifier for scintillation spectrometry	A general purpose high gain preamplifier for scintillation spectrometry	A general purpose charge sensitive preamplifier for scintillation, gas proportional counters, or semiconductor detectors.	A very low noise preamplifier for use with semiconductor detectors or gas proportional counters.	An ultra low noise preamplifier for use with high capacitance semiconductor detectors, or gas proportional counters.
TYPE	Voltage preamplifier	Voltage preamplifier	Charge sensitive preamplifier	A charge sensitive preamplifier for high resolution spectrometry using 2 paralleled FETs in the input stage.	A charge sensitive preamplifier for high resolution spectrometry using 4 paralleled FETs in the input stage.
GAIN OR SENSITIVITY	+1	+10, +20 or +50	0·035 µV per ion pair. 10 mV per MeV (Si) 12 mV per MeV (Ge) 0·2 x 10^{12} V/C	0·16 µV per ion pair or hole electron pair. 50 mV per MeV (Si) 61 mV per MeV (Ge) 10^{12}V/C All x1 or x5	0·16 µV per ion pair or hole electron pair. 50 mV per MeV (Si) 61 mV per MeV (Ge) 10^{12}V/C All x1 or x5
NOISE PERFORMANCE	70 µV referred to input with 0.7 µs double delay line amplifier clipping (NE 5259 or NE 5260)	60 µV referred to input with 0·7 µs double delay line amplifier clipping (NE 5259 or NE 5260)	Less than 2,500 ion pairs with zero detector capacitance and 0·7 µs double delay line clipping. (NE 5259 or NE 5260)	140 ion pairs at zero detector capacitance and 7 ion pairs per pF. with 1 µs double integration, single differentiation amplifier shaping (NE 5259)	160 ion pairs at zero detector capacitance and 4·5 ion pairs per pF with 1 µs double integration single differentiation amplifier shaping (NE 5259)
LINEARITY	0·1% up to ± 1V	0·1% up to ± 1V	0·1% up to ± 1V	0·1% up to ± 8V for less than 200 pF detector capacitance	0·1% up to ± 8V for less than 200 pF detector capacitance
GAIN TEMPERATURE COEFFICIENT	0·01% per °C	0·01% per °C	0·02% per °C	0·01% per °C for less than 200 pF detector capacitance	0·01% per °C for less than 200 pF detector capacitance
OUTPUT CAPABILITY	±1·5V	±1·5V	+10V −1·5V	±10V	±10V
OUTPUT IMPEDANCE	100Ω	100Ω or adjustable to match cables in range 50-150Ω	100Ω	100Ω	100Ω
RISE TIME	40 ns	Less than 120 ns at gain 50	40 ns at zero input capacitance + 1 ns per pF	30ns at zero input capacitance + 1ns per pF	30ns at zero input capacitance + 0·75ns per pF
POWER SUPPLIES	+24V at 7mA	+24V at 5mA	+ 24V at 10mA − 24V at 10mA	+24V at 50mA −24V at 10mA	+24V at 70mA −24V at 10mA
*PRICE	£35 £25 (card)	£35 £25 (card)	£40 £25 (card)	£115	£155

A wide range of compatible Edinburgh Series modules is available from which complete counting systems or spectrometers may be built and used in conjunction with Nuclear Enterprises detectors and the preamplifiers described above. The Edinburgh Series includes amplifiers, time and energy analysers, coincidence/anticoincidence units, scalers, timers, ratemeters, data presentation and processing units, interface units, test and calibration units, and gain stabilisation systems. Full details of these units and a complete range of systems, scintillation and semiconductor detectors are available on request.

NUCLEAR ENTERPRISES (G.B.) LTD.

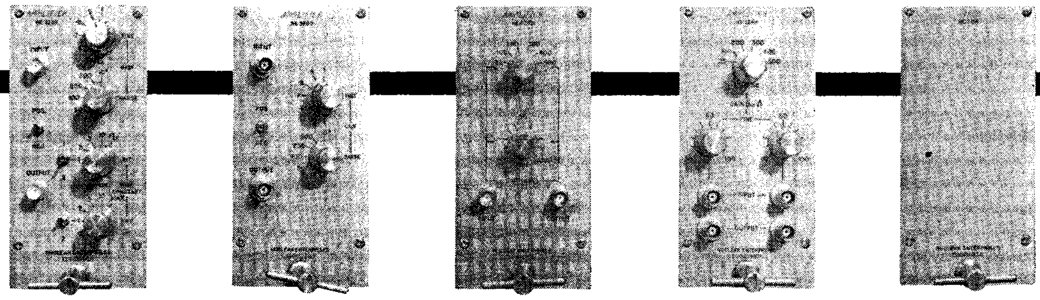
Sighthill, EDINBURGH 11, Scotland. Tel. CRAiglockhart 4060. TELEX 72333.
Cables: 'Nuclear, Edinburgh'

Canadian Associate: Nuclear Enterprises Ltd., 550 Berry Street, Winnipeg 21.

H

Select your AMPLIFIER from the widest and most flexible range of nuclear instrument modules

EDINBURGH SERIES



TYPE NUMBER	NE 5259	NE 5260	NE 5263	NE 5264	NE 6106
FUNCTION	A low noise linear amplifier with flexibility of pulse shaping to permit optimisation of energy or time resolution.	A low noise linear pulse amplifier with delay line shaping for high resolution scintillation spectrometry	Single channel simple RC linear amplifier	Dual channel simple RC linear amplifier	8 input summing amplifier
GAIN	Positive or negative 4 to 2000 High resolution, fine gain control.	Positive or negative 4 to 2000 High resolution, fine gain control	Negative 2 to 50	Negative 2 to 50	Negative 1
LINEARITY	0.1%	0.1%	1%	1%	0.1%
GAIN TEMPERATURE COEFFICIENT	Less than 0.02% per °C	Less than 0.02% per °C	Less than 0.1% per °C	Less than 0.1% per °C	Less than 0.01% per °C
PULSE SHAPING	Double delay line (0.7μs), or RC single or double integration and differentiation (0.2 to10μs)	Double delay line (0.7μs)	Preset double RC differentiation and integration (normally, 0.5μs)	Preset double RC differentiation and integration (normally, 0.5μs)	No additional pulse shaping
NOISE	Less than 6 μV referred to input with 1μs single integration and differentiation	Less than 30 μV referred to input.	Less than 20 μV referred to input	Less than 20 μV referred to input	Less than 50 μV referred to input with 100Ω resistor across each input
CROSSOVER WALK	Less than ±2 ns (with NE 5159C Analyser)	Less than ±2ns (with NE 5159C Analyser)			
OVERLOAD RECOVERY	5μs for x200 overload	5μs for x200 overload			
PRICE	£250	£210	£75	£140	£60

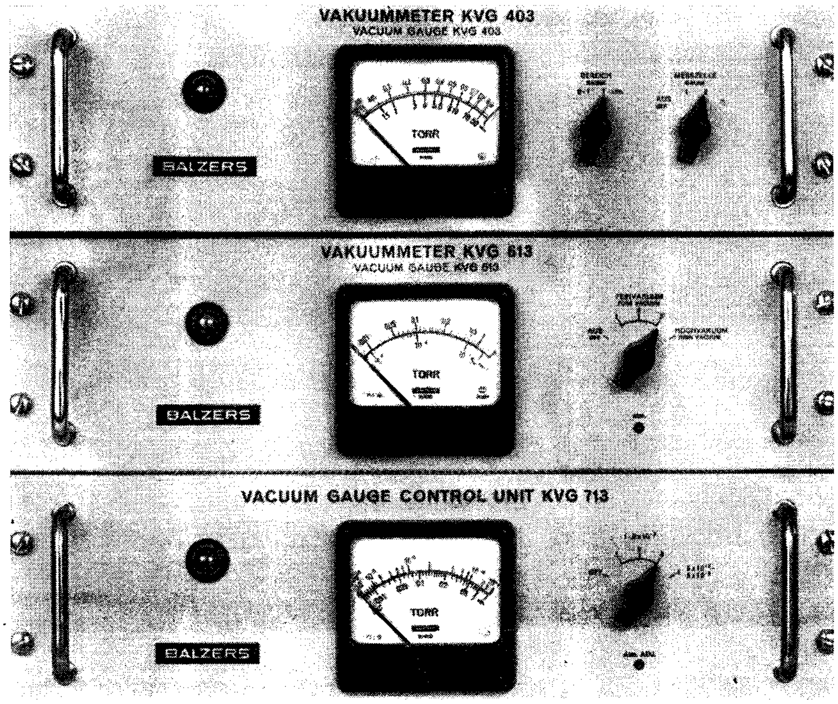
The amplifiers described above form part of the wide range of Edinburgh Series modular nuclear electronics and are fully compatible with other units in the range. The Series includes preamplifiers, time and energy analysers, coincidence/anticoincidence units, scalers, timers, ratemeters, data presentation and processing units, interface units, test and calibration units, and gain stabilisation systems. *Catalogue* containing full details of scintillation and semiconductor detectors, Edinburgh Series units and systems available on request.

NUCLEAR ENTERPRISES (G.B.) LTD.

Sighthill, EDINBURGH 11, Scotland. Tel. CRAiglockhart 4060. TELEX 72333.
Cables: 'Nuclear, Edinburgh'
Canadian Associate: Nuclear Enterprises Ltd., 550 Berry Street, Winnipeg 21.

J

Les nouveaux appareils de mesure du vide comme tiroirs de rack comme appareils portatifs ou comme éléments à incorporer



Avec la nouvelle conception de ses appareils de mesure du vide, éprouvé depuis 20 ans, BALZERS a répondu à deux exigences techniques éssentielles: possibilité d'incorporation dans des racks standard et extension du domaine de mesure du côté du vidé élevé.

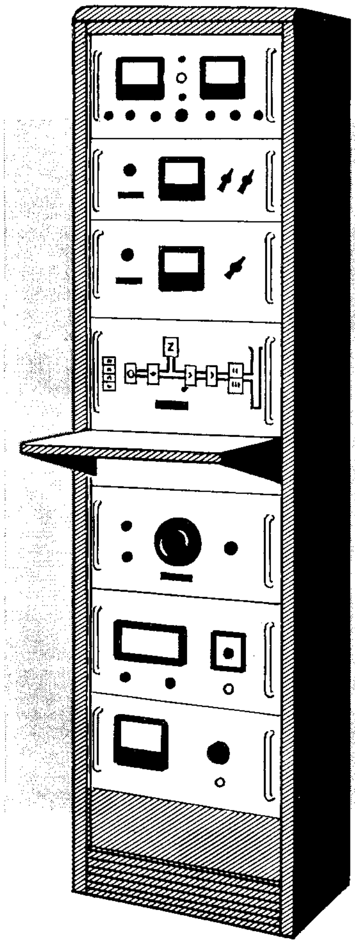
L'adaptation aux nouvelles données techniques était facilement réalisable, par le fait que BALZERS pouvait recourir à ses multiples expériences en la construction des appareils de mesure du vide et pouvait continuer le développement sur cette base.

Par conséquent, les nouveaux appareils de mesure sont le résultat d'une évolution naturelle et d'un développement continu.

Caractéristiques particulières des appareils de mesure du vide

- exécution très soignée;
- apparence et modelage uniforme;
- programme homogène avec peu de types, comprenant le domaine de pression étendu de 760 à 10^{-11} Torr (par exemple KVG 713: de 1 Torr à 10^{-8} Torr);
- lecture: précise et reproductible;
- construction: moderne et robuste, grande sécurité;
- prises de tensions normalisées pour enregistreurs et appareils de réglage;
- en composants détachés pour la disposition individuelle dans des tableau ou installations quelconques;
- présentation en tiroirs de rack de 19 pouces;
- éléments latéraux transformant les tiroirs en appareils portatifs, facilement à superposer.

Le programme de fabrication BALZERS comprend, en outre, dans ce domaine: appareils de surveillance de vide, détecteurs de fuites, spectromètre de masse.

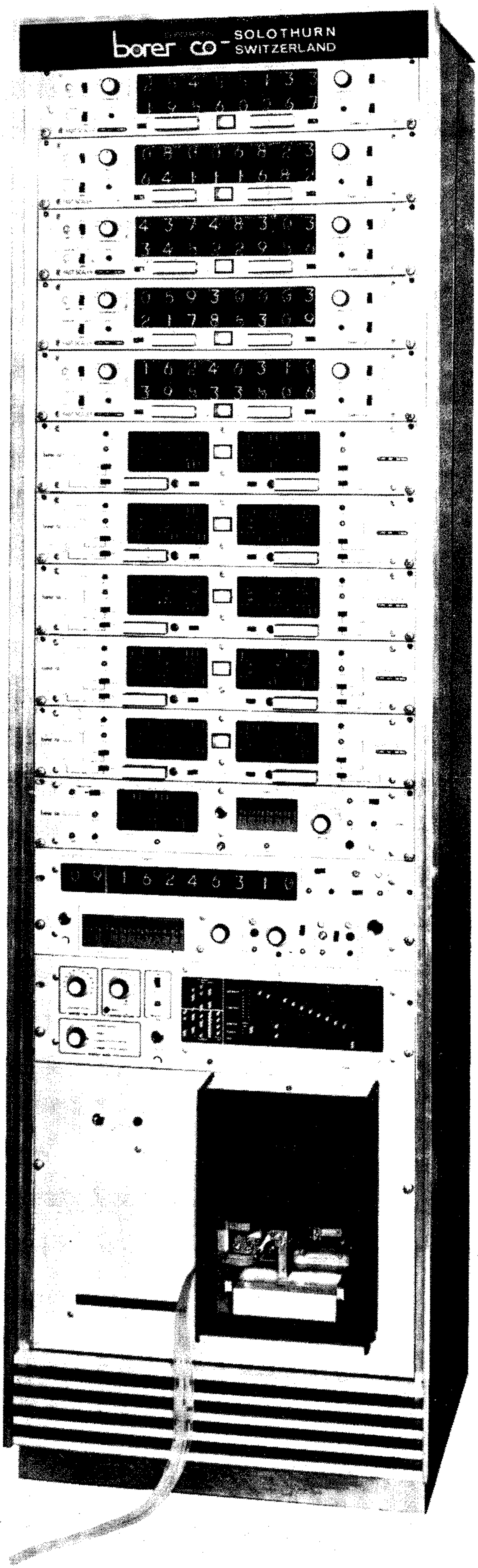


BALZERS®

BALZERS AKTIENGESELLSCHAFT
für Hochvakuumtechnik und Dünne Schichten
FL-9496 Balzers · Principauté de Liechtenstein

En France: S. I. D. E. N. DEPT. BALZERS
12, Rue Léonidas, Paris (14e)

MULTI-CHANNEL SCALER SYSTEMS



The collection and recording of data in nuclear physics experiments is not only time consuming, but also a possible source of error which should be avoided. The Borer Multi-Channel Scaling System fulfills this requirement rapidly and reliably with its versatile equipment having counting rates up to 100 Mc s.

The units making up the system can be used in both high energy and low energy nuclear physics. Each instrument incorporates its own stabilised power supply and can therefore be used independently.

Scalers are available with:

6 or 8 decades

decimal or binary display

2, 20 or 100 Mc/s count rates

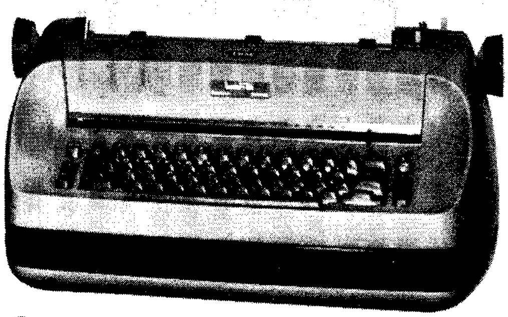
single or double units

flexible data output using teleprinters, punched tape, magnetic tape, output writers, and parallel printers

All units use solid state devices throughout, and all components are of the highest quality.

Borer Electronic Co are the largest manufacturers of scalers in the western hemisphere, and offer the widest range of scaler systems. Present us with your problem—we will provide the optimum solution.

Please ask for latest literature, or for a demonstration.



ELECTRONIC
borer co

Switzerland:
Heidenhubelstrasse 24, Solothurn
Telephone 065/2 85 45

Great Britain:
36 East Street, Shoreham-by-Sea, Sussex
Telephone 4305

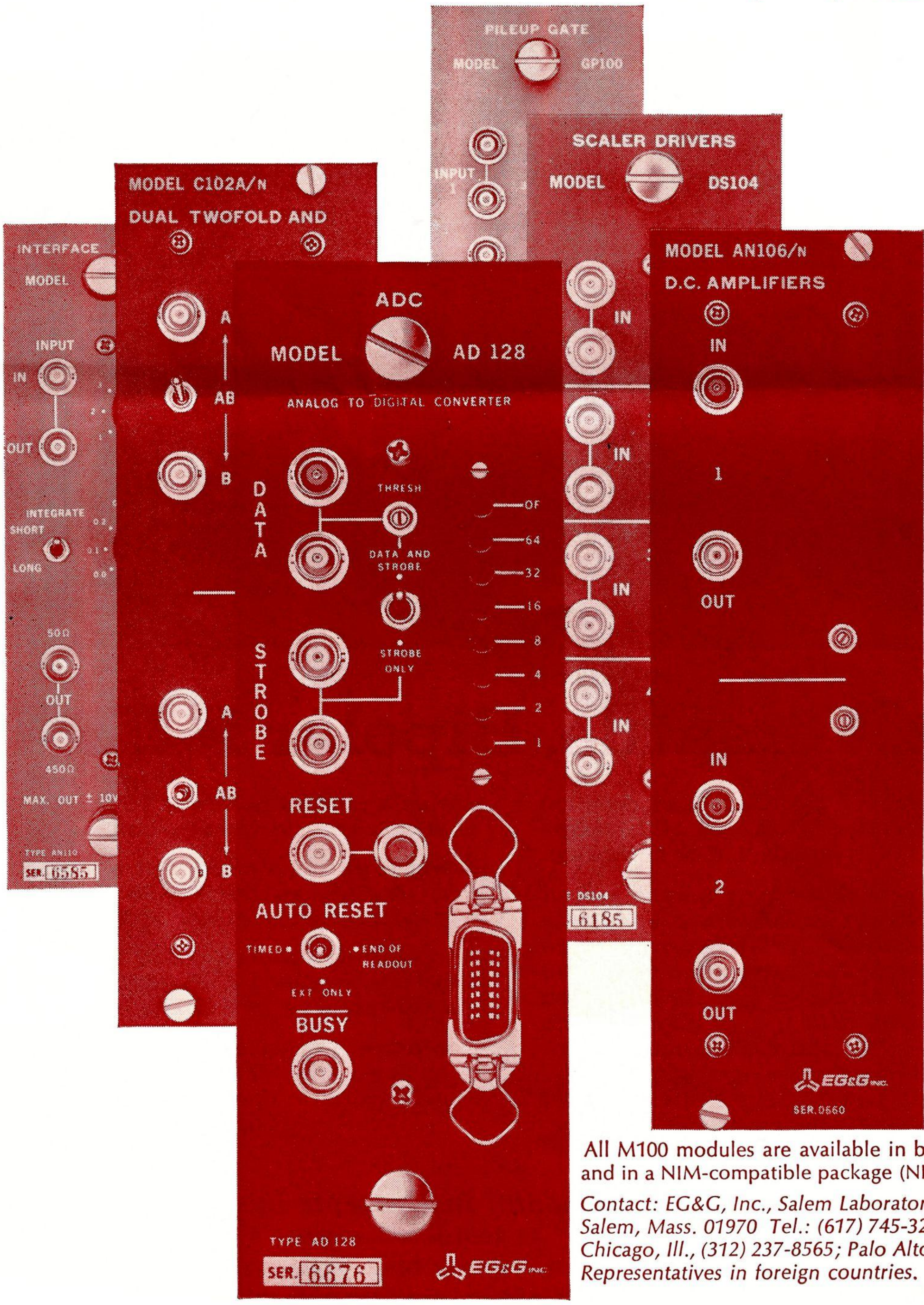
Germany: Verkaufsbüro München
Kaiserstrasse 10, D-8000 München 23
Telephone 34 80 16

France: Sorelia Electronique
25 rue de Normandie, F-92 Courbevoie
Telephone 333 82-96

Italy: DISI Nuclear Corporation
Viale Lunigiana 40, Milano
Telephone 69 10 72

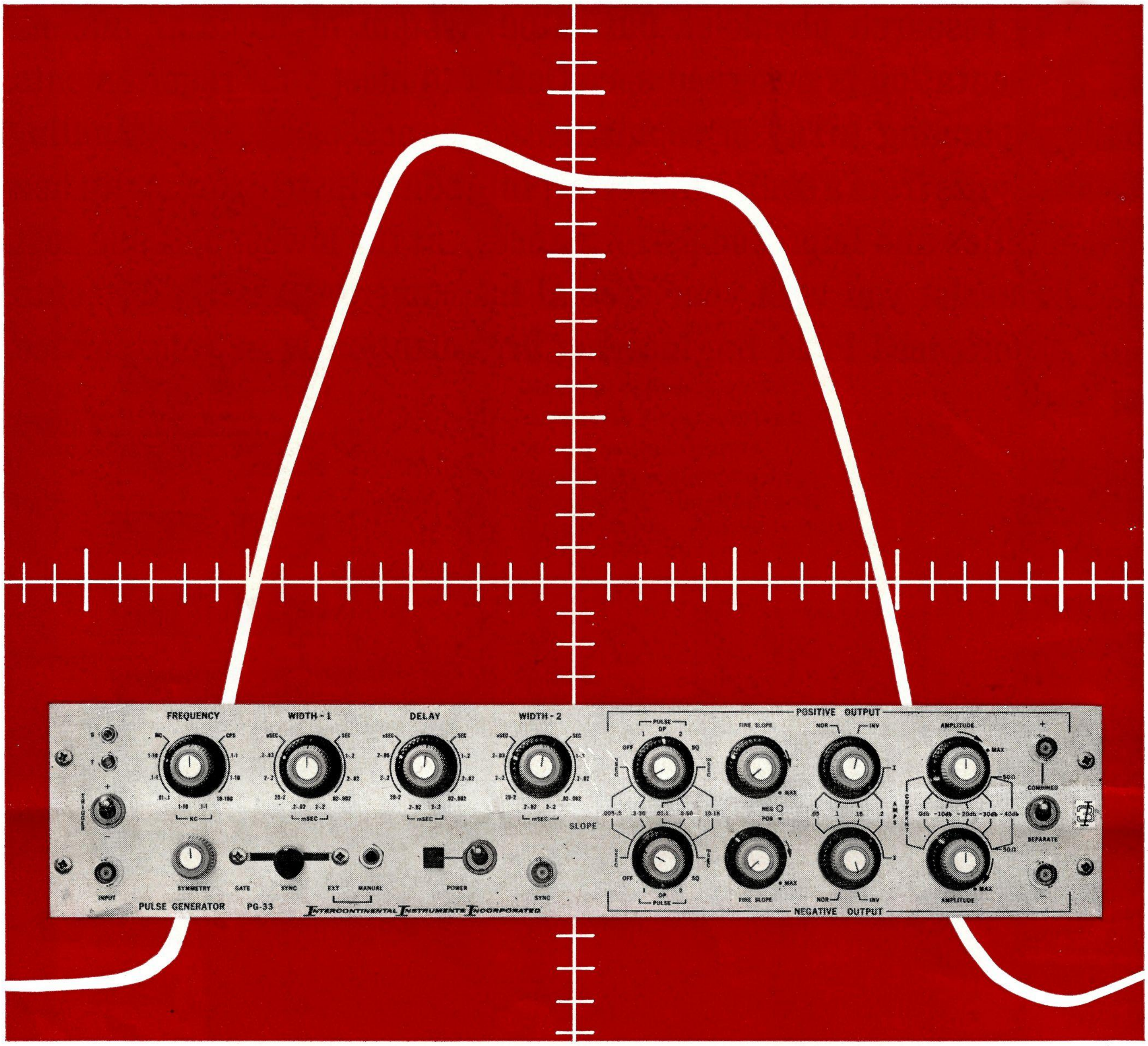
For the research physicist. Our M100 System of modular nuclear instrumentation is designed specifically to meet your requirements. This expanding array of sophisticated, nanosecond, data-handling units results from a continuing effort to produce instruments with new capabilities and improved performance...at the lowest possible cost. Let us assist you with your special instrumentation requirements; our experienced Field Engineering Organization is at your service.

EG&G INC.
NUCLEAR INSTRUMENTATION



All M100 modules are available in both the EG&G package and in a NIM-compatible package (NBS-AEC TID-20893 rev.).

Contact: EG&G, Inc., Salem Laboratory, 36 Congress St., Salem, Mass. 01970 Tel.: (617) 745-3200. Field offices: Chicago, Ill., (312) 237-8565; Palo Alto, Calif., (415) 327-8328. Representatives in foreign countries.



A Fast, Versatile, Bipolar I/E Pulser

The THREE-I Model PG-33 Pulser can produce 5 nanosecond output rise times, has 100:1 slope control and three output modes: I, E or combined.

It has two output channels—plus a sync output for triggering associated equipment. A spectacular variety of pulses and other waveforms can be made to occur at repetition rates from 0.1 Hz to 20 Mhz. If you prefer, trigger or gate it with an external source; single shot too, of course. Each channel can provide DC-coupled normal or complementary outputs, double or single, continuously adjustable for amplitude, positive slope, negative slope, width and delay. Either channel can operate as a current pulser or voltage pulser and the channels can be directly combined.

Along with much more that space does not permit, this makes the PG-33 the most versatile high-performance pulser in its price class.

And all of this occurs in 3½" of rack height, in an all-silicon Bipolar I/E Pulser selling for $1350*. Please feel free to buy one.

Literature is available on request. Demonstrations in your lab or plant arranged with dispatch. Please write or 'phone.

*Prices f.o.b. factory. Slightly higher outside U.S.A.

Intercontinental Instruments Incorporated

An Affiliate of Chronetics

U.S.A.: 500 Nuber Avenue, Mt. Vernon, New York (914) 699-4400 TWX 710 560 0014
Europe: 39 Rue Rothschild, Geneva, Switzerland (022) 31 81 80 TELEX 22266