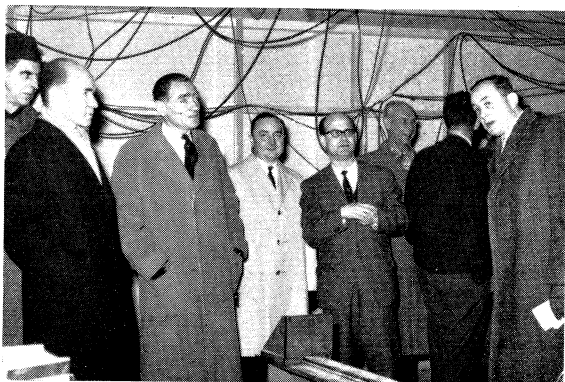


CERN



No 15
WINTER 1960

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

VICTOR F. WEISSKOPF

On 12 September, Prof. Weisskopf arrived at CERN. At present a member of the directorate responsible for research, he will on 1 August, become fourth Director-General of the Organization, thus succeeding to Dr. J.B. Adams, who will then return to the United Kingdom as director of the Culham laboratory for plasma physics research.

* * *

Victor Frederick Weisskopf was born in Vienna on 19 September 1908.

He studied under Max Born and James Franck at the University of Göttingen,

where he obtained his doctorate in physics in 1931. His thesis was devoted to the "fundamental theory of the interactions of light with atoms".

In 1931 Victor Weisskopf began his travels round the Universities, which helped to make him "a citizen of the world", a scientist freed from the restriction of frontiers and such conventional concepts.

Weisskopf was therefore in Leipzig in 1931, acting as an assistant to Heisenberg, and a year later he was in Berlin as assistant to Schrödinger. He spent his summers at the Institute for Theoretical Physics directed by Niels Bohr in Copenhagen.

During the early 1930's the difficult situation developed in Central Europe, resulted in the exile of many thousands of Europeans. Victor Weisskopf was also drawn into the migratory movement. During the latter part of 1932 he accompanied his colleague Placzek to the Institute of Physics and Technology at Kharkov in the USSR. There they both took part in theoretical research under the direction of L. Landau.

Weisskopf returned to the West in 1933. Until 1935 he was assistant to Wolfgang Pauli at the Federal Polytechnic Institute (ETH) at Zurich. He then rejoined Niels Bohr in Copenhagen to take up an appointment as research associate, working on the theory of radiation and nuclear structure.

Then, as many other European physicists, Victor Weisskopf joined in the move across the Atlantic: at the end of 1937 he accepted an appointment as professor at the University of Rochester. He remained there until 1943.

The United States at war then decided to use the full scientific potential in the country. Now naturalized, Prof. Weisskopf went once more West, to New Mexico. His destination was a lonely place, a flat desert punctured by violet mesas, sprinkled with sparse sagebrush: Los Alamos.

There began a crucial period for Prof. Weisskopf and for most of the physicists who had taken refuge in the Allied camp.

Until the end of 1945 Weisskopf took part in the "Manhattan project", an enterprise which still disturbs the spirits of a great many scientists. To-day, the man his Los Alamos colleagues nicknamed "the oracle", still maintains that his time there was devoted to the "application of nuclear energy".

In October 1945, Victor Weisskopf was offered an appointment to teach physics at the Massachusetts Institute of Technology in New England. This new position marked the end of his journey westwards and the beginning of his return towards the East and his native Europe, the old world which always seems to apply an irresistible attraction on the great minds it has produced.



V. Weisskopf taught at M.I.T. until 1960 and at the same time supervised research on nuclear and elementary particles structure. During the past 15 years he has been a frequent visitor to Europe. In 1950 and 1951 he was guest professor at Sorbonne University and at the Zurich Polytechnic Institute where, 20 years before, he had done research with Pauli.

Prof. Weisskopf first came to Meyrin on 9 August 1957 as a guest professor. He stayed for a year with the Theoretical Studies Division and took part in research work on the 600 MeV synchrocyclotron which CERN was then putting into operation.

He was therefore no stranger to CERN matters when his name was proposed as a member of the directorate in charge of research. Victor Weisskopf who always encouraged international co-operation, accepted this appointment. M.I.T. granted him a leave of absence and on 12 September he returned to Meyrin. From January onwards the scientific life of the Organization will have become his main preoccupation.

* * *

Victor Weisskopf's main interest is theoretical physics and he has published a number of articles on this subject and on philosophical matters. However, his major work is a 900 page book: "Theoretical Nuclear Physics", written in co-operation with John M. Blatt. First published in 1952 the book has been translated into Russian and despite the progress made in the past 8 years, remains in the words of a theoretician, "extremely popular with nuclear physicists".

Prof. Weisskopf is a corresponding member of the French Academy of Science, a member of the National Academy of Science in the U.S. and until the end of 1960, he was President of the American Society of Physics. In recognition of his work he was awarded the Planck medal by the German Society of Physics in 1960 ●

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The cover photograph shows part of the CERN installations with the 28 GeV proton synchrotron in the foreground. The inset photograph was taken on 8 December 1960, when members of CERN Council visited the installations of CERN.

The 18th session of the Council, held at Meyrin on 8 and 9 December, was attended by 45 delegates from the member States of CERN and from Spain, which was to be unanimously admitted as a member of the Organization in the course of the meeting.

The discussions opened under the presidency of Mr. François de Rose, delegate of France and at the close of the session, Mr. Jean Willem, delegate of Belgium, was elected to succeed him. Accord-

ing to the Convention, Mr. de Rose could not be re-elected after three years as President, and a new President therefore had to be appointed by the Council.

One of the main points on the agenda of the session was the **Progress Report** by the Director-General and the Divisional directors. The former gave a summary of the Organization's work during the past year and of the work that CERN could envisage for the future: this appears elsewhere in this issue.

The **Proton Synchrotron Division** report presented an account of the work of the five groups in the division. The report of the **Machine Group** gave the characteristics of the accelerator; the number of protons it accelerates has increased from 2×10^{10} protons per pulse at the beginning of 1960, to 3×10^{11} protons per pulse. The PS machine time went up from 610 hours during the first quarter of 1960 to 842 hours in the fourth quarter. Machine efficiency, calculated by dividing the actual accelerating time by the scheduled time, is about 83 %.

(Continued on page 6)

The last three numbers of the year have been amalgamated into one issue which covers the last quarter of 1960.

We apologize to our readers and friends for this change. We hope the many people who have been concerned about the fate of the "CERN COURIER" will forgive us if we say once again that the CERN Public Information Office went through a difficult period in 1960. The disappearance of Jack MacCabe last April set in train a series of events which are still having repercussions now.

Next year we hope to have overcome all the after-effects of 1960, which was a hard year for CERN in general and for the Information side in particular.

Until then we shall have to resign ourselves to the fact that the "CERN COURIER" will only be published once a quarter.

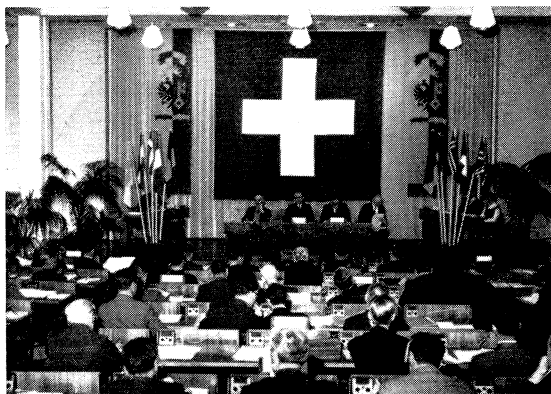
This will deprive our CERN readers of up-to-date news about the activities of their Organization and will reduce the amount of detailed information which the "CERN COURIER" carried every month to the four corners of the earth.

We much regret this decision and, while asking our 3000 readers to make allowances for our difficulties, we should like to thank them for their understanding and their interest in CERN affairs.

R.A.

The "CERN COURIER" hopes that 1961 will bring its readers happiness, prosperity and success.

ARTER AT CERN LE TRIMESTRE DERNIER AU CERN LAST



Opening meeting of the Intergovernmental Conference on Space Research.

During the last three months two long-runs have been made with bubble chambers on the large **28 GeV synchrotron**. One of these lasted 96 hours, from 24 to 28 October: during this experiment the 32 cm hydrogen bubble chamber took 62 000 photographs of interactions produced by 24 GeV protons and a further 24 000 produced by negative pi mesons.

Several European laboratories—German, British, and Italian, as well as CERN—have undertaken the scanning of this mass of documents. The new 709 computer installed at CERN will be of enormous help in handling the astronomical quantities of data resulting from the analysis of the bubble chamber photographs.

Various experiments have been conducted or completed with the 600 MeV **synchro-cyclotron**. Most of these were

They leave CERN

The last quarter of 1960 saw the departure amongst others, of the following people who had contributed to the development of CERN, some of them over many years:

● **Knut Olof Fredriksson** was one of the three staff members with the longest service. He first worked on the magnet of the synchro-cyclotron as an electrical engineer in August 1952. At that time the University of Upsala in Sweden entrusted him with this study on a part-time basis. In November 1954 Fredriksson arrived at Cointrin where CERN had some pilot installations. He was first responsible for planning the layout of the SC buildings in co-operation with the site architect, then was in charge of developing the SC vacuum system and finally became chief of the group responsible for the operation of the 600 MeV accelerator. Knut Fredriksson left Meyrin on 22 November and is now working with a firm of consultant engineers in Stockholm.

● **Jan C. Kluyver** was awarded a CERN fellowship in 1956, which enabled him to do some nuclear research on the accelerators of the University of Liverpool. He arrived in Geneva in August 1957 and was attached to the synchro-cyclotron as an experimental physicist. The most recent work of his group concerned the decay electron energy spectrum of mu-mesons. Jan Kluyver returned to the Netherlands

on 25 October. He now holds the chair of experimental physics at the Zeeman Laboratory in the University of Amsterdam, the chair which had been occupied by Prof. C.J. Bakker before coming to CERN.

● **Alec W. Merrison** came to CERN in March 1957, also from the University of Liverpool. As an experimental physicist he directed the group which in 1958 established by means of the SC, the direct decay of the pion into an electron. Alec Merrison left CERN on 23 September last. At present he holds one of the two chairs of experimental physics at the University of Liverpool.

● **Valentin L. Telegdi** returned to the United States on 5 November and resumed his functions as professor of physics at the Enrico Fermi Institute for Nuclear Studies in the University of Chicago. He came to CERN in October 1959 as a National Science Foundation Fellow. A specialist in mu meson physics, he was one of the physicists who took part at CERN in the difficult experiment to measure the anomalous magnetic moment of the mu meson.

DERNIER AU CERN LAST QUARTER AT CERN LE TRIMESTRE

concerned with fundamental research in pi and mu meson physics. In one of the experiments, known as "g-2", the magnetic moment of the mu meson was measured with unprecedented accuracy. This experiment promises to be of capital importance for particle physics.

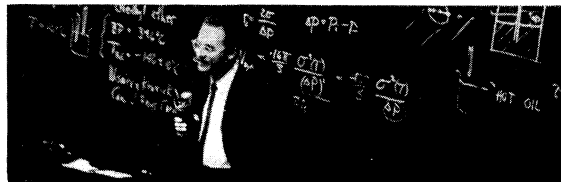
Preparations have been made for the incorporation of a "vibrating target" in the SC during the course of 1961. Its vibrations are synchronized with the accelerating frequency of the protons, and it will give longer pulses of particles than previously.

The main items discussed by the **Scientific Policy Committee** which met at CERN on 4 and 5 November were nuclear emulsion experiments, nuclear physics experiments performed with the SC and PS, new developments in the field of data handling and CERN's long-term programme.

During this period, 4 transport planes arrived at Geneva airport with the 19 tons of electronic equipment which go to make up the new 709 computer. By using this electronic computer the **Data Handling Division** will be in a position to satisfy the increasing demand for computing in connection with experiments performed at CERN.

At the beginning of November the first tests of the **1 m heavy liquid and propane bubble chamber** took place. The bubble chamber was filled with freon 12 for the tests which began on 6 November. The 84-ton magnet was put in position; it is intended to produce an intense magnetic field round the chambers. After the chamber had been filled and heated, two operational tests took place: from 8 to 18 November and from 11 to 18 December.

The first test showed the sensitivity of the chamber to a



COLLOQUIA, LECTURES, SEMINARS

Every week since October there has been a colloquium, a lecture or a seminar on high energy physics in the main auditorium. Other related subjects are also dealt with. In any event every meeting is of interest to physicists. Sometimes the talks are on problems directly related to those of CERN.

Here are some of the subjects discussed so far :

13 October	"Some remarks about special and general relativity"	by Prof. V. F. Weisskopf
27 October	"Cristallography of liquids"	by Prof. J. D. Bernal
3 November	"Pi-pi correlations from antiproton annihilation" . .	by Prof. G. Goldhaber
8 November	"The van Allen radiation belts"	by Prof. R. Karplus
17 November	"Comments on theories of elementary particles" . .	by Prof. R. E. Marshak
24 November	"The origin of cosmic rays"	by Prof. B. Peters
1 December	"Regeneration of K_0^1 mesons and the $K_0^1 - K_0^2$ mass difference"	by Dr. F. Muller
2 December	"Masers"	by R. L. Garwin
19 December	"Elementary particles in bubble chambers"	by Prof. D. A. Glaser

In addition to these meetings, obviously intended for a specialized audience, some information lectures have been organized for the whole staff. Those given by André Martin on the subject "Atoms and Electricity" are proving a great success with many "Cernites".

ERNIER AU CERN LAST QUARTER AT CERN LE TRIMESTRE

source of radiation ; during the second it was possible to take a few photographs of tracks left in the freon by cosmic rays.

The **anniversary** of the initial operation at full energy of the CERN synchrotron was marked on 24 November by a programme on Swiss Television. This lasted about ten minutes and reviewed the events at the PS during the past year ; it also showed some of the activities of the Health Physics Section.

From 28 November to 1 December a meeting of capital importance for Europe took place at CERN. Delegates from 11 European countries met at an intergovernmental conference to discuss the procedure for creating an organization modelled on CERN, which would make it possible for our continent to undertake a programme of **space research** com-

parable with those of the United States and the Soviet Union.

Further construction work has been started ; the synchrotron ring junction was begun on 16 December at the level of survey pillar No. 6. This is where the particle beams to be exploited in the East experimental area will be extracted.

The **Site and Buildings Division** has also started large scale work in the East area, where the bubble chamber and generator buildings are gradually changing the landscape in the neighbourhood of the PS ring.

Among all the engineering work done by the **Central workshop**, mention should be made of the complete machining of the 170 cm cloud chamber, the construction of the pneumatic platforms for installing the big magnet necessary for the "g-2" experiment as well as the machining of a device

The **Engineering Group** concentrated mainly on the construction of the one-metre propane chamber and of the two-metre liquid hydrogen chamber, and also on the commissioning of the electric power supply and the cooling water supply for the new experimental equipment.

The **Accelerator Research Group** devoted its main effort to developing apparatus which might reach the operational stage in the not too distant future, i.e. a model of storage ring for accelerated particles. The group has also studied micro-wave power sources for a radio-frequency particle separator.

The **Propane Bubble Chamber Group** assembled its chamber and carried out preliminary tests with it; it also took delivery of the beam transport equipment, and continued its work on electrostatic separators and fast and slow ejection systems.

The **Hydrogen Bubble Chamber Group** performed experiments on negative pions and protons at 25 GeV, as well as ionization measurements. The group continued development work and testing for its two-metre chamber; its liquid gases section produced about 10 000 litres of liquid hydrogen and about 60 000 litres of liquid nitrogen.

Prof. G. Bernardini then gave a brief account of the life of the **Synchro-cyclotron Division** in 1960. He drew special attention to the satisfactory progress made with the experiment on the anomalous magnetic moment of the muon. This fundamental experiment—called “g-2”—has already been envisaged by five other laboratories; however, CERN is likely to be the first laboratory where it will succeed (*).

(*) At the time of printing, the “g-2” experiment had met with full success. The next number of the *CERN COURIER* (1st quarter 1961) will give details of this important achievement.

Prof. Bernardini also said that next year the activity of the SC would be centred round **mu meson physics**. He then gave some details about the muon channel “which seems to be the best in the world”. Very pure muon beams are necessary for muon physics. At present the SC provides them in the form of secondary particles at 270 MeV/c and the counters detect 60 muons/cm²/second over a surface of at least 100 cm², contamination by pi mesons being only 2/10 000.

After having also pointed out that a new field might soon be opened up by the production of **polarized proton beams**, Prof. Bernardini spoke of the determination of the **polarization of the positron** and of the experiments performed in the SC by groups of visiting scientists.

Dr. Kowarski, Director of the Scientific and Technical Services Division (**), emphasized the importance of instruments for the evaluation of photographs, on account of the great number of data provided by the bubble chambers. In this field CERN has been able to supply useful information to the laboratories of the member countries. It has been constructing and developing IEPs since 1956 and the latest prototype made will be much faster, without involving the application of radically new principles which would take too long to develop.

IEP techniques involve programming, viz. the development of procedures for exploiting **electronic computing** facilities and particularly the 709, which CERN received at the end of the year.

Speaking of the two main tasks of the **Theoretical Studies Division**, Prof. van Hove said that the first consists in carrying out fundamental research in all branches of theory which are

(**) Now known as the “Data Handling Division”.

of importance to high energy physics. The second task is that of providing physicists with theoretical data and useful advice.

Prof. van Hove also said that the theoreticians had concentrated on problems connected with the proton synchrotron. There are difficulties in this respect, because theoretical physics gives relatively little information about events occurring at the energies reached by the PS. It was therefore necessary to elaborate various hypotheses on which to base the work. Speaking of the theoreticians joining CERN, he said that instead of choosing their own research subjects, they would be requested to participate in a given research programme in order to assist the experimentalists.

In his report on **Administration**, Mr. Dakin dealt mainly with the housing problem in Geneva and said that a great many CERN staff members devote between 30 and 40 % of their salary to their rent alone.

Mr. Mallet reported briefly on the work of the **Site and Buildings Division**, and pointed out that the delegates could see for themselves the progress of work during their visit to the building sites. He explained that the work had been seriously hampered by the bad weather experienced in the summer and autumn. In six months the rainfall had been 100 mm more than the normal rainfall for the whole year, he added.

A photograph is said to replace a thousand words, and this also applies to direct visual examination of the problems discussed in Council. The delegates were therefore invited to see the progress made in the construction of the laboratory. The East experimental area, the propane bubble chamber building, the PS South generator building, the PS experimental facilities, the new 709 computer and some of the synchro-

QUARTER AT CERN LE TRIMESTRE DERNIER AU CERN LAST

—the Panofsky screw and its vacuum tank—which the “g-2” group will soon be using.

There were 1736 visitors to CERN during the last quarter of 1960; among them the new British Ambassador to Switzerland, accompanied by Mrs. Paul Grey, on 6 December; 196 doctors who met in the CERN auditorium on 8 October for an oto-neuro-ophthalmological congress and, on 30 October, 31 delegates from the European Radiodiffusion Union.

The CERN Council held its last session of 1960 on 8 and 9 December. Many important decisions were taken, from the appointment of the new President of the Council to that of the future Director-General, including the voting of the 1961 budget, the internal re-organization of CERN and the admission of Spain as the 14th member State.

A discussion concerning the experiments being performed or contemplated at CERN by means of **track chambers** was held on 21 December between 81 physicists, representing all the European laboratories concerned. An account was given of the work so far done at CERN in this field with the CERN 32 cm hydrogen chamber and the 1 m propane chamber of the Ecole Polytechnique in Paris. A working party was then set up, after which there was a report about the experimental facilities which will become available at CERN in 1961.



cyclotron installations were shown to the Council delegates during their visit.

The questions discussed during the first day of the 18th session of the CERN Council also included the appointment of the future Director-General, the new organization, the composition of the directorate and the accession of Spain to CERN. In the evening, the members of the

Council were shown the CERN film "Matter in Question".

On the following day, 9 December, the discussions mainly concerned the 1961 budget and international co-operation. The session closed with the election of the Officers of the Council and its Committees.

The results of these important discussions are given elsewhere in this issue ●

In 1960, scientific research at CERN has progressed at an unabated pace both with the synchrotron (in the foreground of this picture) and the synchro-cyclotron (centre rear). The article on the opposite page gives a summary of the progress reports presented by the Division leaders of the Organization at the 18th Session of the Council.

« GeV or BeV? »

Herbert Steiner, a fellow from the University of California is to be credited with the best definition of the "GeV" heard so far :

« GeV, said Steiner during a lecture, means Genevavolt while BeV certainly comes from Berkeleyvolt. »

He has a point there. However, it should not be forgotten that in the language of nuclear physics these two symbols mean exactly the same thing :

GeV is the usual abbreviation in Europe of "Gigaelectronvolt" viz. one thousand million electronvolts (10^9 eV)

BeV is the abbreviation used only by the Americans when referring to the same quantity of a thousand million electronvolts. The "B" comes from "billion" : 10^9 in the U.S.A., 10^{12} in Great Britain.

so :

$$\text{GeV} = \text{BeV} = 10^9 \text{ eV}$$

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Cover photograph : ATP ; **inset** : CERN - GB ; **page 2** : CERN - PIO ; **page 3** : CERN - GB ; **page 5** : CERN - RA ; **page 7** : ATP ; **pages 9, 11, 12** : Lou Ouzer ; **page 15** : CERN - PIO ; CERN - GB ; G. Klemm ; **page 18** : R. Sterchi ; CERN - PIO ; CERN - GB ; **page 21** : CERN - GB ; CERN - RA ; CERN - GB ; X - University of Liverpool ; CERN - RA ; **page 24** : X - Princeton ; **page 25** : CERN - GB ; **pages 26, 29** : CERN - PIO ; **page 30** : CERN - GB ; CERN - RA ; CERN - GB.



Who, when, where, how?

The high energy physics commission of the International Union for Pure and Applied Physics (IUPAP) met on 26 and 29 August at Rochester. One of its tasks was to decide about its future composition. Its members are elected for a limited period and the chair was vacant as a result of the tragic death of Prof. C. J. Bakker in April 1960.

Since September, the commission, under the chairmanship of Prof. V. I. Veksler (U.S.S.R.), consists of the following:

- R. E. Marshak (US), Secretary ;
- D. Blokhintsev, who succeeded I. E. Tamm as member for the USSR ;
- E. M. McMillan (US), who succeeded W. K. H. Panofsky ;
- G. Bernardini, European member who succeeded C. J. Bakker ;
- L. Leprince-Ringuet, who succeeded R. E. Peierls as European member ;
- H. Yukawa (Japan), seventh member of the commission, which until then had only six members.

On the agenda was the question of how often big conferences on physics should be held. Henceforward **«research conferences»** will be held every two years. The same will apply to the **«accelerator conferences»** ; which will be held in the intervening years.

According to this system the next accelerator conference will take place in September 1961 at Brookhaven while, in July 1962, CERN will organize the next research conference : "the Eleventh International Conference on High Energy Physics". Since each of these conferences is to be held successively in the United States, Europe and U.S.S.R., the 1963 conference on accelerators will probably be held in the Soviet Union.

Why should big scientific conferences be held less often? This question was worth asking Prof. R. E. Marshak who is visiting CERN for a year. "This is due, he remarked, to the growing complexity of high energy physics and also to the ever-increasing time needed to carry out significant theoretical or experimental research."

IUPAP has, however, no objection to smaller meetings being held between the big ones. The Union would support smaller gatherings in Asia, in Western or Eastern Europe or in the United States. This attitude is due to a keen desire among all scientists for international co-operation, whether official or not.

As for **conferences on instrumentation**, it is generally thought that they should take place at the same time as conferences on research. The decision rests however with the institution organizing the latter, which can always ask a neighbouring institution to take charge of the instrumentation conference.

Another item on the agenda of the commission dealt with the number of participants to be invited to a given conference. The ideal figure would be between 250 and 300, half of the participants to be from the organizing continent and the rest from the two others.

The question of building a very big accelerator capable of accelerating particles to kinetic energies of the order of several hundred GeV was also touched upon. A report on the unofficial meeting which took place subsequently will be given in the next issue.

Big international conferences on high energy physics :

Title	1959	1960	1961	1962
1. Research conference (results in theoretical and experimental physics)	July Kiev	Aug. Rochester	—	July CERN
2. Accelerator conference (construction of big accelerators)	Sept. CERN	—	Sept. Brookhaven	—

Conferences on research have the same attraction for high energy physicists as a motor show for road users.

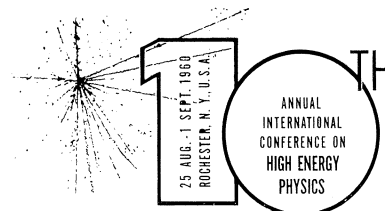
R. E. Marshak is responsible for having organized these big meetings of physicists. "We wanted to further international co-operation, he said, and to optimize the use of high energy physics equipment in the world."

Thus a tradition begun in the 1930's at the physics congress in Zurich, at the Solvay Institute in Brussels or in other capitals of scientific thought, was revived in the United States.

The first post-war conference took place at Rochester in 1950. It received the backing of local manufacturers who were prepared to help pure research, at a time when it still received scant official support. The situation has certainly altered since then : the United States now devote some 70 million dollars per annum (300 million Swiss francs) to high energy physics alone and this amount might be doubled in the next three years.

It is not surprising, therefore, that the Rochester conferences had steadily been growing in importance. There is plenty of evidence to this effect.

Firstly, the number of subjects dealt with has swelled to such an extent that after ten years it has become necessary to hold not one conference but three major meetings. This number might even be increased to four.



Secondly, in view of their interest the great "Rochester conferences" have been recognized by an international non-political body: the International Union for Pure and Applied Physics, (IUPAP).

Finally the number of young or experienced physicists wishing to take part in the conferences has so increased that the organizing committee now has to limit its invitations to about three hundred. These are sent to physicists from all over the world. One last feature shows the international nature of these meetings which are attended by ardent supporters of international co-operation. Since 1958, it has become customary to hold meetings successively in the United States, Western Europe and the U.S.S.R. This is why the "Rochester conferences" have since taken place at CERN and Kiev.

Fifteen CERN scientists

This year for its tenth session, the Rochester conference—or rather one of its offshoots, the "research conference"—had come back to its place of origin: Rochester.

There, from 25 August to 1 September, 335 scientists met under the auspices of IUPAP and, for the first time, of the National Academy of Sciences of the United States. The conference was also supported by eleven other American official and industrial bodies.

Fifteen CERN physicists visited the shores of Lake Ontario on this occasion: A. Amati, G. Bernardini, A. Citron, G. Cocconi, G. von Dardel, G. Fidecaro, G. Filthuth, Y. Gold-

schmidt-Clermont, R. Hagedorn, J.C. Kluyver, A. Lundby, A.W. Merrison, C. Peyrou, J. Prentki and Y. Yamaguchi.

For a whole week these European ambassadors of science mixed with other distinguished scientists from famous and far-away laboratories, ranging from the Novosibirsk Institute of Physics to the E.T.H. in Zurich, from the University of Chile to that of Kyoto, from the Institute for Advanced Study at Princeton to the Fysiska Institutionen at Lund, from the Akademia Gorniczo-Hutnicza at Krakov to the Weizmann Institute at Rehovoth.

The conference proceedings were published very rapidly. In fact, proofs of the reports were already being read at CERN in November. The proceedings have actually been printed in Geneva, where the editors were able to find the most rapid service and the equipment necessary for printing the mathematical formulae in which the papers abound.

Although a large volume of proceedings has been published, a summary accessible to everyone may none the less be of interest. The "CERN COURIER" has therefore collected the remarks of the CERN physicists who were present at Rochester and incorporated them in this article.

Unusual planning

The exact name of the conference on research may in the future be "Conference on High Energy Physics and Particle Physics". At pre-

sent it covers some fields of low energy physics: weak interactions, for instance.

It is generally agreed that the conference was remarkably well organized. "It was the best organized conference I have ever attended" stated Prof. W. Heisenberg, Nobel prize winner for Physics, after the meeting. At Rochester, two new elements were much in evidence, according to R.E. Marshak: scientific secretaries and rapporteurs. The first—there were 36 of them—were young physicists for whom this job was a means of taking an active part in the conference; their task was to speed up the production of the proceedings. The ten rapporteurs played the part of "scientific reporters" as it were; they attended all the early sessions and reported on them at the subsequent plenary sessions. Guy von Dardel said of them: "They overcame the one drawback of the conference: the two days of simultaneous sessions".

What was this drawback? Each of the first two days of the conference was divided into four simultaneous or "parallel" sessions, held in different places. One dealt with the experimental aspects of "strong pion-nucleon interactions", the second was related to theoretical aspects of the same subject, the third to "strong interactions of strange particles" and the fourth to "weak interactions". The papers presented at these sessions had mostly been prepared on request, although some of the shorter ones were proposed by their authors.

One person could not therefore listen to the reports of, say G. Bernardini presenting the neutrino ex-

periment planned at CERN, in the fourth session, and the paper on nucleon-antinucleon interactions read at the same time by W. A. Wenzel in the first session.

As A.W. Merrison jokingly remarked before leaving CERN: "It was so well organized that you could miss only 25% of the conference if you didn't go to it at all."

9 = 23

In any case, whatever the system adopted, it would have been quite impossible to hear all the reports. Some 60 scientists had been asked to report on their work, while a further 200 contributed a paper for the proceedings. It therefore seems that Rochester 1960 struck a happy medium and gave the research scientists a chance of presenting their respective contributions to an audience of specialists among specialists. The solution for the others lay in attending the plenary sessions held in the morning of the four following days where the rapporteurs summarized the four parallel sessions.

Finally the afternoons of these last four days were devoted to talks requested by the organizers on the following general subjects: "the structure of elementary particles", "new results at superhigh energies", "theories of elementary particles".

"By these methods, said R.E. Marshak, we managed to hold 23 sessions in the time it would normally have taken to hold only 9."

Like all human undertakings the conference is nevertheless not perfect. The restriction of the number of participants is perhaps one of the tricky points. The scientific secretaries made up for this to a certain extent. However, some physicists think the situation is unsatisfactory. One of them said in this connection: "Results are often due to teamwork and only one member of the team takes part in the conference and presents the results. This means that young physicists do not receive full credit for their work". It might be argued on the other hand, that a member of a group would not omit to give the names of his fellow workers in his report. Yet, another remark was: "the closed conference does not allow young physicists to come into contact with their colleagues from other laboratories and get the very desirable feeling of participating in a large scale human effort."

Perhaps more frequent and more highly specialized meetings open to all, which IUPAP would favour, would provide the answer.

One more remark: "Why accept reports already published? They should be omitted to give us more time for discussions between members of different laboratories."

Nothing new in the West

Physicists all agree that no extraordinary discovery was mentioned at Rochester. This may be a consequence of the present ultra-rapid means of communication. Whatever the reason, according to a CERN scientist, "Rochester gave an idea of the kind of experiments we should do".

Among the many results presented, scientists had plenty of opportunities to single out for closer scrutiny, the particular experiments they were interested in. However, several points stand out clearly from the observations made by theoreticians and experimentalists.

DREAMERS

"Men understand the world in different ways. The main difference lies in this, that some men are more abstract minded, and they naturally think first of unity and of God, of wholeness, of infinity and other such concepts, while the minds of other men are concrete and they cogitate about health and disease, profit and loss. They invent gadgets and remedies; they are less interested in knowing anything than in applying whatever knowledge they may already have of practical problems; they try to make things work and pay, to heal and teach."

Most of the information brought back from Rochester can be classified under the heading of one or other of the three interactions by which, in addition to gravity, nature is governed: "strong", "electromagnetic" and "weak" interactions. Other data dealt with the "intrinsic properties" of particles or with certain theoretical developments likely to help investigation in that field. They will be mentioned below under separate headings.

Weak interactions

are the phenomena brought about by the incredibly small forces associated with spontaneous decay and transformation of most of the elementary particles.

Some people consider that very few new results in the field of weak interactions were announced at Rochester. However, the theoretician Jacques Prentki thinks that "one of the positive results of the conference" was the presentation of experiments attempting to verify various phenomenological rules, especially those related to charge (isotopic spin and strangeness). The experiments showing the validity of these rules concerned the measurement of the so-called "branching-ratio"—the relation between the different types of decay of strange particles (*Berkeley*).

Various experiments on neutrinos were proposed. "This kind of research is very fashionable" said Heinz Filthuth. This is not a new

CERN papers read at Rochester

Two CERN physicists, Prof. G. Bernardini and Prof. G. Cocconi, had been invited to give papers at Rochester about the work of the Organization.

Prof. Bernardini described "The programme of neutrino experiments planned at CERN" at one of the simultaneous sessions on weak interactions. Prof. Cocconi gave a "Progress report on the work with the 25 GeV proton synchrotron", at a plenary session on results obtained at very high energies.

In addition to these two papers, a certain number of reports were submitted to the simultaneous sessions, such as that of C. Peyrou and a group of 22: "Strange particle production in 16 GeV negative pion-proton interactions observed by means of the CERN hydrogen bubble chamber"; that of G. Fidecaro's team on "A redetermination of the Panofsky ratio"; of Arne Lundby and his group on "Particles produced by 24 GeV protons"; of M. Cini and S. Fubini on "One-dimensional representation for low energy pion phenomena" and three papers giving the results of experiments performed by G. von Dardel's group with protons accelerated to various energies by the synchrotron.

"The first are called dreamers (if worse names are not given to them); the second kind are recognized as practical and useful. History has often proved the shortsightedness of the practical men and vindicated the "lazy" dreamers; it has also proved that the dreamers are often mistaken.

"The historian of science deals with both kinds with equal love, for both are needed; yet he is not willing to subordinate principles to applications, nor to sacrifice the so-called dreamers to the engineers, the teachers, or the healers."

*From George SARTON's
"A History of Science"
1952*

idea at CERN since C. N. Yang, Nobel prize winner for physics, lectured brilliantly on this subject in the summer.

The neutrino is an elementary particle with no charge, whose mass is very probably nil and which only interacts very weakly with other particles.

The experiment planned at CERN will use beams of high energy neutrinos produced by the 28 GeV synchrotron. According to Prof. G. Bernardini, the first result of this experiment will be to prove the existence or non-existence of a new particle, the heavy boson, and then to determine whether there are one or two types of neutrino.

In the field of weak interactions, Daniele Amati also quoted **"the hypothesis of vector current conservation"** (Caltech) which makes it possible to predict the mean life of the mu meson produced by beta decay, the commonest weak interaction. The predictions in these theories have been proved correct experimentally to within 4%. This percentage of error has given rise to serious arguments: some scientists consider that there is real disagreement between experimental results and theory, while others think that some of the theoretical calculations are unsatisfactory.

To an outside observer this is a good illustration of the close interdependence between experimental scientists and theoreticians.

Among the results considered to be of great interest from the point

of view both of theory and experimental technique, is the measurement of difference in mass between **K^0_1 and K^0_2 mesons**. The most recent tables give the mass of these two strange particles as 497.1 ± 0.8 megaelectronvolts. (In relativistic mechanics, mass can be expressed as energy—i.e. in MeV—according to Einstein's law). Several laboratories (Berkeley, La Jolla, Wisconsin) have measured this difference in mass and found it to be of the order of 10^{-5} eV or a hundred thousandth of an electronvolt. This is said to be "the greatest accuracy ever achieved when measuring differences in mass".

One of the results of this observation was to establish with unprecedented accuracy the "rule of selection concerning strangeness for non-leptonic decay".

Strong interactions

are responsible for the cohesion of particles inside the atomic nuclei.

In this field, Arne Lundby described as "very important for interpreting the main elementary interaction", the existence of the "pion-pion" interaction brought to light at Berkeley. When a proton strikes a deuteron, a nucleus of helium 3 is produced whose spectrum shows that in many cases two pions (pi mesons) with a relatively well defined energy are emitted. This may mean the existence of a two-pion resonant system. Nevertheless the theoreticians consider this to be only a preliminary experiment—it would be important to try to confirm it by other similar experiments, which could be undertaken by CERN.

The production of only two pi mesons, when a proton and its antiparticle, the antiproton, are annihilated, has also been observed at Berkeley. Two cases have been noted in the course of 24 000 interactions, in most of which five pi mesons were created. This case of two observations out of 24 000 events clearly illustrated the random nature of certain physics experiments.

As regards CERN's work, a specially good reception was given to the preliminary numerical results obtained in calculating pion-nucleon scattering, i.e. the study of collisions between these two kinds of particles.

C. Peyrou, like many of those who took part in the Rochester conference, drew attention to the discovery of a **resonance in the pion-hyperon system**.

In physics, "resonance" denotes the excited state of a system. Such states have been observed, for instance, after a collision between a nucleus and a nucleon. Photographs produced by American bubble chambers seem to indicate the existence of an **excited hyperon state**: an excited sigma particle could thus decay in about 10^{-23} second into a lambda particle and a pion. "This phenomenon calls for work in the Theoretical Studies Division", said J. Prentki and D. Amati who, with P. Meyer and Y. Yamaguchi, and with A. Stanghellini and B. Vitale respectively, have published papers on pion-hyperon resonance, in the "Physical Review Letters".

Although it is still too early to form an idea of the importance of these studies, it is nevertheless probable that they will throw some light on the mechanism of strong interactions and especially on the characteristics of strange particles. So



far there is only fragmentary evidence, but the lambda-pion resonant state could be similar to the nucleon-pion resonant state already discovered some time ago. The existence of this excited state could, for instance, clear the way for some experiments to determine the "relative parity" of the sigma and lambda hyperons. This question has puzzled the theoreticians for some time, and so far no experimental answer has been found, although several laboratories, Berkeley and Columbia for instance, are competing in this field. The term "parity" used above, denotes the symmetry of some inherent properties of the two particles concerned.

Electromagnetic forces

are still called "intermediate" because their intensity is between that of strong and weak interactions. Few comments were made on this subject.

The electric and magnetic **form factors** of the proton and to a certain extent, of the neutron, have been measured with greater accuracy. Measurements have been made in at least two laboratories (*Cornell, Stanford*) by the elastic scattering of electrons on nucleons. "In order to form a picture of these observations" explained Yves Goldschmidt-Clermont, "it can

Intrinsic properties

of particles gave rise to a great many results or comments which were of particular interest to physicists.

In this field Guy von Dardel spoke of a remarkable experiment (*Lawrence Radiation Laboratory*) on **polarization and the magnetic moment of the antiproton**, obtained by repeated elastic scattering. "Polarization" in nuclear physics means the separation of the particles of a beam according to the direction of their "spin". The "magnetic moment" denotes the magnetic force produced by the body envisaged. Information



Eight Nobel prize winners were present at the Rochester conference. From left to right on this photo : Emilio Segré (1959 winner), Chen Ning Yang (1957), Owen Chamberlain (1959), Tsung Dao Lee (1957), E. M. McMillan (1951), Carl D. Anderson (1936), I. I. Rabi (1944), Werner Heisenberg (1932).

The proton-proton scattering cross section (the possibility of scattering of protons colliding with other protons) have been measured more and more accurately for particles of energies up to several hundreds of MeV. Polarization effects by double or triple scattering have been observed (*Berkeley, Harvard, Harwell, Yale*). Other measurements of cross sections up to 16 and even 25 GeV (*CERN*) have been made for collisions with protons, mesons and antiprotons.

Under the heading of strong interactions at Rochester, the Russians presented the results of interactions of pi mesons of about 7 GeV with protons, which were very similar to observations, made at CERN at an energy of 16 GeV.

be said that electric charge is distributed inside the proton right up to the centre, while the electric currents responsible for magnetism remain more on the periphery". Furthermore, it is interesting to note that even the neutron seems to have a charged "core".

Antiproton double scattering was studied at *Berkeley* by means of the large 189 cm bubble chamber.

In addition, a large number of laboratories gave a considerable amount of information about the phenomenon of "**associated production**", according to which a pion-proton collision produces either a lambda-hyperon and a kaon (the new name of the k meson) or a sigma hyperon and a kaon.

so far obtained shows that the antiproton has a magnetic moment of opposite sign to that of the proton. Experiments have thus once more confirmed theoretical predictions, namely those made by P.A.M. Dirac in 1930 at Cambridge in the course of a "brilliant mathematical development".

Finally, from the experimental point of view, special mention should be made of the efforts made to determine the **mean life of the pi-zero** : of the order of 10^{-16} second. It was stated that measurements had been made in two separate laboratories with greater accuracy than ever before, i.e. at the Naval Research Laboratory using the emulsion technique, and at Caltech, using counters.

A DIRECTORATE FOR CERN

And what of the work in the U.S.S.R. and the countries of the East? Soviet Union laboratories markable reports and 37 scientists from the East came to Rochester to spread or listen to the good news. Some of the most remarkable work, according to G. Fidecaro, concerned the measurement of a characteristic of the mu-meson—its helicity—by means of 1 GeV cosmic rays.

At Kiev, during the previous conference, Soviet scientists announced the possibility of the existence of a new particle decaying into a k meson and a π meson. At Rochester, in spite of the care taken in performing experiments likely to confirm the existence of the D-particle (*D for Dubna*), no new positive evidence was presented. In the opinion of the Russians themselves, it is possible that the original observations were spurious.

The theoretical point of view

In addition to the results given under the general headings listed above, the theoreticians also draw attention to some methods of great interest to the esoteric world in which they move.

Daniele Amati thus talks about a demonstration of the Mandelstam representation (*Laurence Radiation Laboratory*) "it was the most important theoretical contribution made at Rochester", he said.

R. Hagedorn gave a lecture on the same subject, which he entitled ironically "what Hagedorn did not understand at Rochester". A joke? Certainly, but it amused the 40 physicists to whom he spoke of the above demonstration, a mathematical process for dealing with scattering amplitudes.

Among the theoretical work reported on, von Dardel was most impressed by that of *Stanford University* concerning a phenomenon of interest to CERN. This is the case where a particle entering into "peripheral collision" with a nucleus, only transfers to it a small part of its energy. Stanford also reported on work on the cross section of gamma beams. If the suggested theoretical values were confirmed it would be possible to produce with electron accelerators, beams of collimated secondary particles of greater intensity than those obtained with the existing proton accelerators.

Very high energies

One afternoon of the Rochester conference was devoted to the presentation of new results at very high energies.

Observations made by means of the CERN synchrotron were, in the opinion of many, "received with

great interest". Keen discussions arose mainly in connection with the **production of deuterons**. It will be remembered what interest was aroused in scientific circles by the observation in May 1960, that the impact of 25 GeV particles on a target produced among other secondary particles, light element nuclei such as deuterons (a proton "stuck" to a neutron), tritons (two neutrons and one proton) and helium 3 nuclei (two protons and one neutron). The existence of these composite nuclei was also confirmed later at the *Saclay* laboratory, in France.

Measurement of cross sections at very high energies—"cross section" means the probability of a given process—also attracted attention. The results obtained at CERN in this field were confirmed as regards the k meson by similar measurements made by means of the 10 GeV Dubna synchrophasotron.

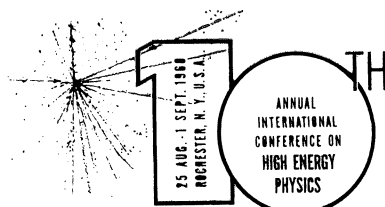
Finally, the results of experiments with the 32 cm hydrogen bubble chamber also proved interesting "a few hours' work round the big CERN accelerator provided excellent information about how particles and antiparticles are produced in the targets".

Words?

Speaking of Rochester, a European physicist humourously quoted Hamlet, Act II, scene 2: "words... words... words!"

It should not be concluded from this that the conference was of scant use. The above outline can only give a very sketchy and often subjective idea of the meeting and of the outstanding points to be found in about a hundred reports. However the fact remains that although the Rochester conference did not reveal any great discovery, it nevertheless contributed to increasing the knowledge of high energy physics phenomena. In addition—and many made the same comment—"such a meeting is justified not only by the papers presented but also by the contacts established with research scientists from other laboratories".

This confrontation of the work and ideas of Europe, the U.S.S.R., the United States and other parts of the world, will shape the future development of research in the coming months and even in the coming years ●



Since 1 January 1961 the Director-General is being assisted by the directorate in the discharge of his increasingly heavy duties. In addition to organizing scientific experiments, there are many technological and administrative problems to be solved; accordingly the idea of a directorate had been put forward some time ago.

The directorate will be responsible for the general management of the laboratory and for general scientific and technical matters. It will act as a liaison between CERN's three internal committees—the Management Committee, the Nuclear Research Committee, and the Technical Committee—on the one hand, and the Council and its Committees—the Committee of Council, the Scientific Policy Committee and the Finance Committee—on the other.

The directorate has five members: the Director-General, Chairman; two members for research, a member for administration and a member for applied physics. The vice-chairmen are one of the members for research and the directorate member for administration.

The *Director-General* of CERN is at present Dr. John B. Adams, who has been at the head of the Organization since April 1960.

He will be returning to Great Britain on 1 August 1961 and Prof. V. F. Weisskopf will then take up his duties as the new Director-General of CERN.

The two directorate members for *research* are:

— Prof. G. Bernardini, who came to CERN in 1957 and who until now has been director of the synchro-cyclotron Division;

— Prof. V. F. Weisskopf.

The directorate member for *administration* is Mr. S. A. ff Dakin who first joined CERN in 1954.

The directorate member for *applied physics* is Dr. M. G. N. Hine who has been at CERN since 1953, when he began to work on the design and construction of the 28 GeV proton synchrotron.

PARTICIPANTS

Delegates from 13 member States of CERN met at Meyrin on 8 and 9 December 1960 for the 18th Session of CERN Council, the supreme body which takes all important decisions concerning the life of the Organization.

Mr. F. de Rose, representative of France, presided over the discussions in which the following delegates took part :

Austria :

Prof. W. Thirring
Prof. F. Regler
Dr. E. Treu
Mr. E.M. Schmid*

Belgium :

Mr. J. Willems
Prof. J. Franeau

Denmark :

Prof. J.K. Bøggild
Mr. O. Obling

the Federal Republic of Germany :

Prof. W. Heisenberg
Dr. A. Hocker
Prof. W. Gentner*
Prof. W. Jentschke*

France :

Prof. F. Perrin
Mr. F. Neumann

Greece :

Prof. T. G. Kouyoumzelis
Mr. J. Tsambiras
Mr. P. Economou*

Italy :

Mr. G.B. Toffolo
Prof. E. Amaldi
Dr. C. Albertario*
Dr. C.C. Bertoni*
Dr. L. Ottieri*

the Netherlands :

Mr. J.H. Bannier
Prof. J. de Boer
Mr. C.E.I.M. Hoogeweegen*
Prof. S.A. Wouthuysen*

Norway :

Mr. S.C. Sommerfelt
Prof. H. Wergeland
Mr. M. Huslid*

Sweden :

Dr. G. Funke
Prof. I. Waller

Switzerland :

Prof. P. Scherrer
Mr. A. de Senarclens
Mr. S. Campiche*
Mr. R. Bieri*

the United Kingdom

Sir John Cockcroft
Dr. T.G. Pickavance**
Mr. H.L. Verry**
Mr. G. Hubbard*

Yugoslavia :

Mr. D. Baum
Dr. A. Moljk
Mr. B. Komatina*

Spain (as observers) :

Mr. J.-M. Aniel-Quiroga
Mr. C. Sanchez del Rio
Mr. P. Temboury

* Advisers

** Alternates

CERN in

In February 1960, the CERN proton synchrotron was inaugurated with all the dignity appropriate to such an important occasion in the life of the CERN laboratory. Amongst the hundreds of guests were four Ministers : Prof. Balke, Minister of Atomic Energy of the German Federal Republic ; Mr. Cals, Minister of Education, Arts and Sciences of the Netherlands ; Lord Hailsham, Minister for Science of the United Kingdom and Mr. Medici, Minister of Education of Italy. The world of science was represented by Professors Niels Bohr, Francis Perrin, Edoardo Amaldi, Sir John Cockcroft, Edwin McMillan, J. Robert Oppenheimer, W. Heisenberg, P.M.S. Blackett and many more. The presence of over one hundred press correspondents showed the interest aroused by this ceremony all over the world. The speeches of Mr. de Rose, the President of the CERN Council, Prof. Amaldi, the Chairman of the Scientific Policy Committee, Prof. McMillan and Oppenheimer, were replied to by Professor C.J. Bakker, Director-General of CERN, on behalf of the staff of the whole laboratory.

Two months later, on 23 April, Prof. Bakker was killed in an aircraft accident whilst visiting the USA. From jubilation and celebration over the success of the proton synchrotron, the laboratory of CERN was plunged into mourning for its Director-General. The tragedy is now past but the period of recovery is only just coming to an end.

For the staff of CERN, the death of Prof. Bakker, the uncertainties about the new Director-General, the internal reorganization of the laboratory, have together produced, quite unavoidably, feelings of anxiety and unrest.

Despite these sad events and greatly to the credit of the staff of the laboratory, to their morale and their loyalty to CERN, the work has

The following article is made up of large extracts from the introduction to the Divisional directors' progress reports presented by the Director-General, Dr. J. B. Adams, at the beginning of the 18th Session of the CERN Council. The photographs on page 15 illustrate the progress of CERN during 1960. From top to bottom: the installation of part of the 4000 km of cables which run underneath the PS ; the piping for evacuating propane behind the South experimental hall

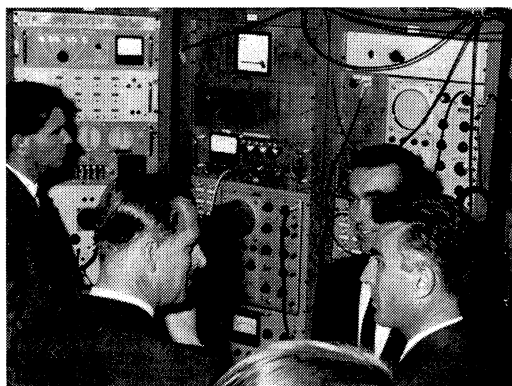
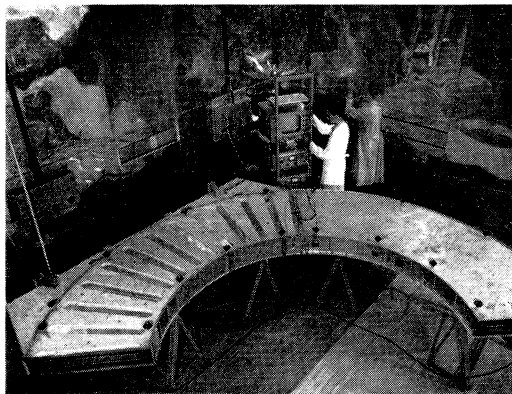
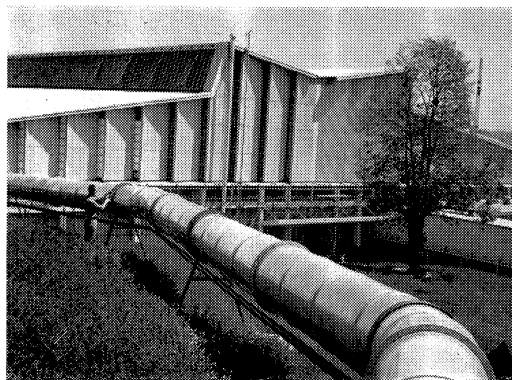
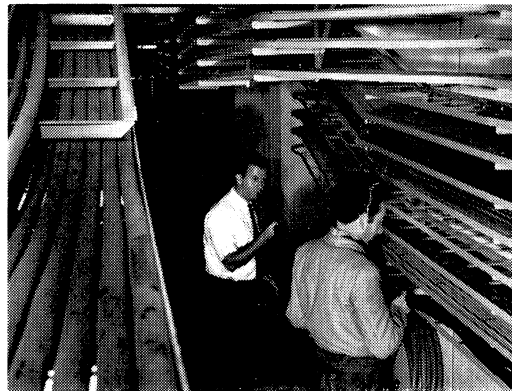
gone on, not just satisfactorily, but at a tempo that has gained for CERN a place in the forefront of the great high energy physics laboratories of the world.

The laboratory at Meyrin attracts many visitors who come to see the installations and the work going on. During the year 1960, 3249 visitors came to the site. The visit of H.R.H. the Duke of Edinburgh was a most memorable one for all the staff of the laboratory.

It is my task, as the present Director-General, to give the Council an impression of what the laboratory has achieved this year. Detailed reports from the Directors of the Divisions of CERN have been written down and will be commented upon later by the Directors. My task would be incomplete without reference to the future, for part of the current work of a laboratory is future planning.

The synchro-cyclotron

the first of our two accelerating machines to come into use as a nuclear tool, has been used so far for two purposes. The first was as a training ground for experimental teams which this year have been carrying out the exploratory nuclear physics work with the proton synchrotron. For the majority of the staff of these teams, the synchro-cyclotron experiments have been their first experience in high energy physics research. That we have been able this year to switch competent teams over to the experimental work with the big machine has been due mainly to the excellent training and experience they gained with the smaller machine. The second purpose of the synchro-cyclotron was to carry out fundamental research in pion and muon physics. Such experiments as the "pion-elec-



of the synchrotron ; part of the new accelerator research equipment ; a picture taken during the visit of the Duke of Edinburgh in April. On page 18, from left to right : the PS inauguration in February 1960, survey work in preparation for the development of the East experimental area of the PS and finally, the new muon channel of the synchro-cyclotron.

tron" decay and the current measurement of the anomalous magnetic moment of the muon, the so-called "g-2" experiment, are, perhaps, the best examples of such work. With the success of the new muon channel this year, the future experimental programme will centre more around muon physics.

However, the synchro-cyclotron is not a unique machine, there are many others in the world, and now that new physicists can join experienced teams on the large machine, we should consider the future of the smaller one. An increase of one or two orders of magnitude in the beam intensity would open up a new field of research in pion and muon physics and put CERN in the forefront of this field. The only attempt made so far in this direction at CERN has been the trials of the stochastic method of acceleration using non-coherent acceleration to overcome the space charge limitations in coherent acceleration near injection. Although this method showed promise at the beginning, the recent trials have only doubled the beam intensity. A much more fundamental modification that could be made to the synchro-cyclotron would be to convert it to a spiral ridge cyclotron operating with a continuous output instead of the present pulsed one. Such modifications have been studied by groups outside CERN and spiral ridge beam dynamics have formed part of the studies of the Accelerator Research Division of CERN. It is our intention next year to work out a project for modifying the cyclotron to a spiral ridge machine and if this looks feasible and promising we will be asking the Council, sometime in 1962, if not earlier, for an extension to the present programme of CERN to carry out such a project. The present budget and staff ceiling of CERN will not be sufficient to cover such a major modification.

The proton synchrotron

which came into operation for the first time at the end of 1959, has been operated throughout the whole of 1960, and more time has become available for nuclear physics experiments as the year proceeded. A steady improvement in beam intensity was achieved in the first six months and starting with 2.10^{10} protons/pulse at the beginning of the year, the intensity was raised to 3.10^{11} protons/pulse by the summer months. The present mean intensity of 10^{11} protons/sec is the highest of any proton synchrotron so far built and the maximum energy of 25-28 GeV can only be exceeded by one other machine in the

world, the Brookhaven 30 GeV AGS which came into operation in the autumn of this year.

Although the time available for nuclear physics experiments this year has been relatively modest: 95 hours in the first quarter, 180 hours in the second, 300 hours in the third and 600 hours planned in the fourth, good use has been made of the remaining operating time to develop target techniques which enable more than one experiment to be run simultaneously, thus doubling or tripling the effective experiment hours. Targets giving short bursts of secondary particles of 200 to 300 microseconds duration

CERN in

and low intensity, for bubble chamber experiments, can be used at the same time as other targets giving long bursts of high intensity of up to 400 milliseconds for counter experiments. This sharing of the accelerated beam between several experiments will be even more extensively used when the North experimental area becomes available.

The South experimental area, the only one available in 1960, which looked so large when it was empty at the beginning of the year, is now packed with experimental equipment. Three bubble chambers, two operational and one in course of construction, occupy the end of the hall in a region that has been modified to be safe for hydrogen and propane use. Liquid hydrogen targets are placed in specially designed houses on the floor of the hall and, together with the bubble chambers and a high pressure ethylene Cerenkov counter, form a remarkably explosive ensemble in one large hall. The safety precautions taken to prevent accidents are stringent and so far effective. Plans for new laboratories, a new workshop, a new apparatus assembly hall and the East experimental area will steadily make available more and more space for experiments with the proton synchrotron, in 1961 and 1962.

At the beginning of the year very few bending and focusing magnets were available for the experiments but by September most of those ordered in 1959 were delivered and 10 megawatts

of d.c. power was available from 30 generators to power these magnets and those of the track chambers. Although no particle separator has been in operation this year, a large electrostatic separator should be ready in mid-1961 capable of going up to 6 GeV/c momentum and a project for a radio-frequency separator for 10-15 GeV/c momentum has been started this year. Meanwhile a relatively small electrostatic separator has been offered by an Italian group and will be installed in February 1961.

Over 100 000 photographs

have been taken this year in the high energy

1960

(continued from page 15)

pion and proton beams of the PS using two chambers, the 32 cm CERN hydrogen bubble chamber and the 1 m Ecole Polytechnique propane bubble chamber. Early in 1961 it is hoped to replace the 32 cm CERN chamber by the 81 cm C.E.A. hydrogen bubble chamber and towards the end of the year the 1.5 m UK hydrogen bubble chamber should be installed in a special building in the East experimental area. Also the 1 m CERN propane chamber should be operating very early next year and a helium bubble chamber is coming to the laboratory from Rome.

Photographs are but the first necessary step in the complicated process of achieving nuclear physics results using bubble chambers. The analysis of these photographs needs further specialized machines and computers. This year three analysing machines, called IEP, have been in operation and the data from these machines have been fed into the Mercury computer. In early November a much larger and faster computer, the 709, was delivered to the site and next year seven analysing machines should be in operation at CERN using the 709 for data processing.

Even these facilities for bubble chamber photograph analysis will not be able to cope with all of the pictures produced by the chambers at CERN, and all over Europe laboratories are setting up similar analysing facilities. This year the photographs have been analysed by teams

in Italy, Germany, France and the UK, as well as by the CERN teams.

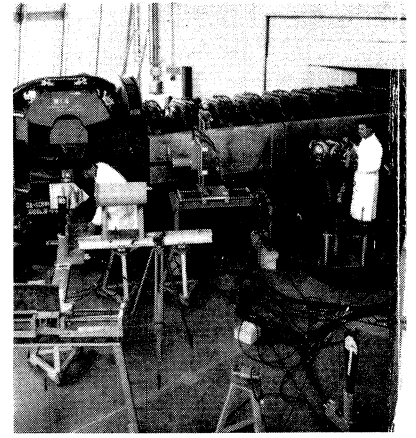
Experiments using techniques other than bubble chambers, counter experiments and emulsion experiments, have been energetically pursued and although in general all experiments have been exploratory and preparatory for later more comprehensive ones, some remarkable results have been obtained. The presence of high energy deuterons, tritons and helium 3 nuclei in the secondary beams of the PS was perhaps the most interesting. The abundance of anti-protons and K particles in the secondary beams from internal targets is also to be noted.

In the second part of this year a great deal of interest has been aroused in the possibility of carrying out neutrino experiments using the high energy particles from the PS. It now looks feasible to set up an experiment, on rather a large scale, to determine whether or not there are two types of neutrinos. This work may well open up a new field of high energy physics.

Theoretical studies

both for the experimental programme and to improve fundamental understanding of the nature of the nucleus, have continued this year. Theoreticians working at CERN have the unique opportunity of being in the midst of very active and exciting experimental work in a new energy range, and the number of young fellows and experienced visitors wanting to participate in these studies bears witness to the interest aroused. Although the total number of CERN staff in the Theoretical Division is only nine, the average population including visitors and fellows has been about forty during the year. Next year the number of CERN staff will be increased to twelve, to give a better balance between staff and visitors.

The problem of the utilization of the two accelerating machines of CERN and the experimental facilities of the laboratory by European physicists from outside CERN has received considerable study this year. CERN has on its staff experimental physicists and theoreticians but working at the laboratory are a large number of non-CERN staff scientists, some paid by CERN through fellowships and some paid by the European laboratories and institutes using their own funds. In 1960, the average numbers of



CERN in 1960

(continued from page 17)

scientists in the various categories were as follows :

	Experimental physics	Theoretical physics
CERN staff (engaged on research programmes) .	60	9
CERN fellows & research associates (paid by CERN funds)	23	25
Ford fellows (paid by Ford Foundation through CERN)	10	5
Visiting scientists (not paid by CERN)	50	0
Total	143	39

All these scientists use the facilities of the CERN laboratory, the administrative services, the technical facilities and the beams of particles from the accelerating machines. They all have to be found space to work on the site and in some cases space has to be found for the apparatus they bring with them. The total represents the scientific effort of the laboratory, and to make this effort effective there must be adequate technical assistance. Outside CERN, but still using the facilities of the laboratory, are the teams in the universities who, in general, do not work at CERN, but who depend on work done at the laboratory, such as the emulsion teams analysing the plates exposed to the particle beams of the proton synchrotron and the teams analysing the bubble chamber photographs. CERN provides interesting fundamental

research work for all these scientists. It is a wonder that the utilization of the laboratory, the choice of experiments and the participation in the research work should raise problems that are not easy to solve to everybody's satisfaction.

During the course of this year, a new system of arranging the research work of the laboratory has been worked out that brings in the external research teams in a more definite manner which we hope will go a long way to solving this problem. Underlying this new system is the idea that distinctions between CERN staff, fellows and visitors should be minimized by the formation of research teams containing all such physicists in proportions appropriate to the experiments being done and the apparatus being used. This system is already working very well with the PS experiments.

The CERN proton synchrotron is an exceptional machine and should be used by the benefit of our European physicists. However, there are other machines in Europe and many of our best physicists are committed to use them in addition to their teaching duties at our universities. Some way must be found to allow these people to participate more freely in the research work at CERN and this may involve modifications to the staffing ideas of the universities. It seems that more senior posts are needed at the universities so that the teaching work can be done while part of the staff are on leave of absence, at CERN, for reasonably long periods. As can be seen from the figures given, CERN already pays for over 60 fellows and research associates and within the present budget no more places can be made available. Furthermore, the amount of technical assistance available for research physicists at CERN is rather small. Therefore, even

effort should be made by the responsible authorities in our Member States to send their best physicists to CERN together with their technicians, and to find national funds to support them in their work. Alternatively, some way must be found for CERN to pay them.

The future of the laboratory

I would like to conclude with some remarks about the future of the laboratory. CERN has been extraordinarily successful. This laboratory has been created from the beginning due to the efforts of the members of the Council, to the support we have received from our member States and very much to the devotion of the staff of our laboratory. We now have two machines in operation and by 1962 the laboratory will be equipped with a vast amount of experimental apparatus to carry out fundamental research in high energy physics. The short term future is obvious enough. We must carry out research of a quality that will justify the fine equipment that we all have worked so hard to build. It is the long term future that concerns me now. The laboratory of CERN as you see it today is the result of plans formulated in 1950. We should now in 1960 be making plans for 1970. I have already mentioned our ideas for modifying the synchro-cyclotron to make it into a far more interesting machine in the future from the nuclear physics point of view. We have also been considering plans for modifying the proton synchrotron.

In the Accelerator Research Division, a group is already at work building an electron model of a storage ring system that, if it is successful, could be applied to the PS. A study is being made of what such a modification would mean to the PS, and the preliminary ideas involve a

project whose cost might be as much as twice that of the PS machine itself. By 1963, if the results of the electron model studies are satisfactory, we might be in a position to begin such a project and by 1970 it could be finished. By this means CERN in 1970 would be in possession of another nuclear physics tool that would be unique in the world, allowing experiments to be done with energies in the centre of mass system of 50 GeV. If we do nothing now, Europe in 1970 will again be in third place, with the Americans having a 100 or 300 GeV proton accelerator and a 30 GeV electron linac and the Russians a 70 GeV proton synchrotron and perhaps even higher energy machines. Quite apart from accelerator development, there is the development of experimental apparatus. In 1963, we should have the 2 m hydrogen bubble chamber in operation but this is hardly bigger than the one that has been operating in Berkeley for several years. Also we are planning new analysing machines for the bubble chamber photographs which, if they are successful, will lead to new and costly projects and this by no means exhausts the possibilities.

There are in fact **two ways for CERN to go in the future** : **either** it settles down with a fixed budget and a fixed staff complement to use the facilities it has now planned, which will mainly be available in 1962, adding from time to time such new experimental apparatus as can be afforded within the budget limits and built by the staff available, **or** it can decide to remain in the forefront of high energy nuclear physics adding to the programme of the laboratory such machines, modifications and apparatus as will maintain the laboratory in its present unique position. This second course is inconsistent with the notion of permanently fixed budgets and staff complements ●

The Council of CERN elects its

NEW OFFICERS

On 9 December, at Meyrin, the representatives of the 13 member States of CERN elected the officers of the Council and its Committees.

The CERN Council consists of two delegates from each of the member States. The President of the Council and the two Vice-Presidents are elected annually and may be re-elected on not more than two consecutive occasions. The Council is assisted by a **Committee of Council**, a **Scientific Policy Committee** which has the task of advising about its scientific programme, and a **Finance Committee** which is responsible for helping the Council to discharge its financial duties.

Mr. Jean Willems, delegate of Belgium, was elected President of the Council for 1961. He thus succeeds Mr. François de Rose, delegate of France, who has been President for three years and whose term of office could not be renewed under the rules of procedure of the Council. Mr. de Rose will continue to represent France on the Council.

Prof. Edoardo Amaldi (Italy) and **Mr. Jan Hendrik Bannier** (Netherlands) were appointed Vice-Presidents of the Council.

The Chairman of the Scientific Policy Committee of CERN will be **Prof. Cecil Frank Powell** (United Kingdom) who succeeds Prof. E. Amaldi.

Dr. W. H. Alexander Hocker (Federal Republic of Germany) will succeed Mr. J. H. Bannier as Chairman of the Finance Committee.

"All the members of the Council know that Mr. Willems has a complete mastery of all questions relating to CERN", stated Mr. de Rose. "From the outset he has displayed unflinching interest in the Organization and care for its well-being; the Council can certainly place its fullest trust in him."

In his brief inaugural address, Mr. Willems said that he was ready to continue to give his best to CERN, which he loves and in which he has great faith. Addressing the retiring President, he paid tribute to his intelligence, his sensitivity and his courtesy and was happy to know that the Council would still count Mr. de Rose among its members.

Mr. J. Willems

Prof. E. Amaldi

Mr. Jean Willems was educated at the Collège Royal and the University of Ghent (Belgium).

In 1920, at the age of 25, he was appointed Secretary of the University of Brussels, a post he held until 1928. He was then appointed member of the Council and Director of the "Fondation Universitaire" and the "Fonds National de la Recherche Scientifique" which had just been created in Belgium on the initiative of King Albert. He still directs these institutions in his capacity as First Vice-President.

President of the "Institut Interuniversitaire des Sciences nucléaires", member of the Council and of the Steering committee of the "Centre d'Etudes de l'Energie Nucléaire", Mr. Willems is on the governing body of many other Belgian scientific foundations.

He is also President of the "Academia Belgica", Rome; Vice-President of the "Collège d'Europe"; member of the Council of the "Cité Universitaire" in Paris; Honorary Vice-President of the Belgian American Educational Foundation in New York, etc.

Mr. Willems was one of the members of the study group meeting under the sponsorship of NATO and the Ford Foundation, whose "Report on the Development of Western Science" was published recently.

Mr. Willems was Chairman of the CERN Finance Committee in 1955, 1956 and 1957, and has been Vice-President of the Council since the latter date.

Mr. J. H. Bannier

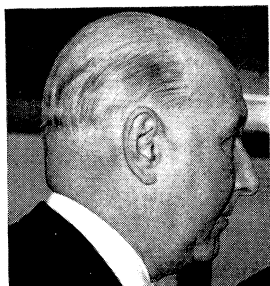
Prof. Edoardo Amaldi was born in Piacenza (Italy), on 5 September 1908. He obtained his Doctorate in Physics in 1929. In 1937 he was appointed Professor of Experimental Physics at the University of Rome and in 1950 he became Director of the Institute of Physics. During this period he frequently worked in various foreign laboratories.

He worked successively on the spectroscopy of atoms and molecules and on the scattering and absorption of neutrons. He then became interested in cosmic rays and particularly in the properties of high energy mesons and other strange particles: hyperons and antiprotons.

Prof. Amaldi played a leading part in developing nuclear physics in Italy. He is one of the pioneers of CERN, with which he has been associated since 1950. As Secretary-General of CERN, when it was created in 1952, he was one of those responsible for drawing up the original programme and budget of the Organization. He has been Chairman of the CERN Scientific Policy Committee since 1958.

Prof. C.F. Powell

Dr. W.H.A. Hocker



Mr. Jan Hendrik Bannier (Netherlands) was born on 13 August 1909.

He studied physics at the University of Utrecht and held several teaching posts between the two wars.

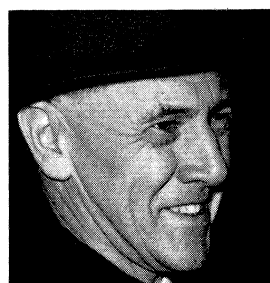
Mr. Bannier was assistant to the Director of Higher Education in the Netherlands in which post he played a part in the establishment of an organization for promoting fundamental research. He has been at the head of this organization since 1948. He is also responsible for the financial side of scientific research in the Netherlands.

Mr. Bannier is also associated with various other scientific ventures. In particular, he has been a protagonist of CERN from the start. In 1951, Mr. Bannier was delegate of his country, together with the late Prof. C. J. Bakker, to the meeting which was to lead to the creation of CERN. In May 1951 he was rapporteur of the first meeting of the Consultants Committee. It is interesting to note that Mr. Bannier was also appointed rapporteur of the "Intergovernmental Conference for Space Research" which was held at CERN at the end of November 1960.

Jan H. Bannier also played an important part in launching the research reactor project for the Netherlands and Norway.

Since 1953, Mr. Bannier has been interested in European co-operation in the field of astronomy; he is likewise concerned with another radio astronomy project within the framework of Benelux. He is also a member of the International Advisory Committee on Research in the Natural Sciences Programme of UNESCO (1960-).

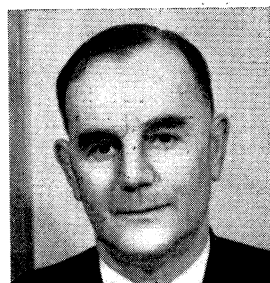
Mr. Bannier was President of the Provisional Council of CERN in 1952-1953, and for the last three years he has been Chairman of the Finance Committee.



Prof. Cecil Frank Powell (United Kingdom) was born on 5 December 1903.

He was appointed Professor of Physics at the University of Bristol in 1948 and still occupies this chair. He has been a member of the Royal Society since 1949. In 1950 Prof. Powell was awarded the Nobel Prize for Physics, for his development of the photographic method in the study of nuclear processes and for his discoveries concerning mesons.

C. F. Powell was in charge of the European expeditions for making high balloon flights from Sardinia in 1952, and from the Po Valley in 1954. He is the author of many papers on the discharge of electricity in gases and on the development of photographic methods in nuclear physics. He has written a book on "Nuclear Physics and Photography" in collaboration with G. P. S. Occhialini.



Dr. W. H. Alexander Hocker (Federal Republic of Germany) is Deputy Director of a department of the Ministry of Atomic Energy at Bad Godesberg. He was born on 29 April 1913.

Dr. Hocker read law, political science and economics at the Universities of Innsbruck, Hamburg and Leipzig and obtained degrees in these subjects. Before presenting his thesis at the University of Leipzig, he was assistant in the Faculty of Law there. He was then made a judge in the Leipzig law-court.

In 1947, he became Head of the Advanced Scientific Study Division at the Ministry of Education for Lower Saxony at Hannover. In 1949 he contributed to the creation of the German Research Association (Deutsche Forschungsgemeinschaft), and subsequently became Permanent Representative of the Secretary-General. In 1956, when the German Ministry of Atomic Energy was created, he was transferred to that Ministry to take charge of research, training and scientific exchanges.



Scientists vs. Secretaries

The "Worm Runner's Digest", Journal of the University of Michigan department of psychology, publishes this article under the signature of Robert Sommer, a scientist from the Saskatchewan Hospital, Canada. The author insists to keep full responsibility for his assertions, but he also emphasizes the fact that he would accept discussions with his contraditors, in the columns of "CERN COURIER".

"In the research race, one good secretary is worth at least two good scientists", writes Robert Sommer. "It is axiomatic that a lab can produce only as fast as its secretary can type. The lab with one scientist and four secretaries is in a more favourable position than the lab with four scientists and one secretary !

"In the latter case, the scientist will spend most of his day peering over the secretary's shoulder seeing whether she is showing favouritism to his three colleagues. There will be intrigues and quarrels to get letters typed, income tax forms filled out, and lead pencils requisitioned. Realistically there is no motivation for the scientist to write if there is no one to type for him.

"In the lab with one scientist and four secretaries our man is in constant turmoil to keep his assistants busy. He feels he must produce so that his harem looks busy. If they start bringing in knitting and learning bridge, his superiors will become suspicious.

But Sommer does not stop here. He has a "law" which in a matter of seconds allows to compute the scientific productivity of a research laboratory :

$$P = \frac{N_s \times A T S}{N S}, \text{ or, in clear :}$$

Productivity equals, number of secretaries by average typing speed, divided by number of scientists.

"One interesting feature of this equation, he notes, is that when the number of scientists becomes zero, productivity becomes infinite. This is probably true, but has never been tested empirically."

Suggesting how this might be researched, Sommer adds, "people have discussed the question of whether a monkey hitting keys at random would ever compose a Shakespearean sonnet. However, this is setting an overly difficult task for the average monkey. If we had asked that our animal type a scientific law, I am sure that he could manage it without too much trouble.

"For example, if a monkey were to punch four keys at random over a long period, he would certainly hit upon $E = Mc^2$ in less time than it took Einstein to reach it.

"If a monkey can do this, we would certainly expect more from our stenos, some of whom can type seventy words a minute. Think of the scientific laws that could be produced if four secretaries typed random letters at top speed. Some readers may feel that the current year's scientific output bears some resemblance to this, but I believe that a normal experiment would still be worthwhile." ●

The International Union of Pure and Applied Physics (IUPAP) recommended that conferences on instrumentation should be held at the same time as conferences on research.

This was why experimental physicists came from the four corners of the earth to Berkeley, in California, from 12 to 16 September ; most of them, like A. Citron, G. von Dardel, G. Fidécario, H. Filthuth, Y. Goldschmidt-Clermont, A. Lundby and C. Peyrou — from CERN — had come via Rochester where they had taken part in the conference on research. Others had come straight from their respective laboratories, like M.G.N. Hine, L. Kowarski, I. Pizer, C.A. Ramm and C. Schmelzer, also from CERN.

The subject matter was less arduous than at Rochester. In an "International conference on high energy physics instrumentation" the subjects are more practical. Whether it is a question of electronic lamps or counters, of bubble chambers or magnetic recording, the "hardware" is always at hand or can be seen in the form of diagrams or photographs.

This practical approach, as opposed to the more ethereal pursuits of nuclear theory, perhaps explains "the more relaxed atmosphere" found on the Pacific Coast by an experimental physicist fresh from his stay at Rochester.

Spark chambers

were much in favour among physicists who went to Berkeley. One of them went as far as saying that "they were the most interesting instruments in the field of particle detection". However, it should be added that data handling — the study of bubble chamber photographs — was also a popular subject.

A spark chamber is an apparatus intended to show the tracks of nuclear particles. Although it is not as accurate as a bubble chamber it has certain valuable advantages over the latter.

In its basic principle, it is somewhat akin to a Geiger counter where the phenomenon observed is produced by the passage of a particle. In cross section a spark chamber shows a succession of parallel plates,

NUCLEAR TECHNOLOGY

rather like a car battery. These plates are connected alternately to the two terminals of a source of high voltage electric power. If the voltage is applied at the moment when a particle is crossing the chamber, a small electric discharge jumps from one plate to another along the track of a particle crossing the gap. The whole apparatus is filled with a gas such as neon or argon.

The photographs of these tracks give a record which is far inferior in definition to those provided by the bubble chambers: the tracks are clumsier and not so clear. However, there are considerable advantages to make up for this lack of clarity.

Among these is the possibility of selecting interesting events. The high voltage which produces the spark between the plates is controlled by a counter — of the Cerenkov type, for instance — placed before the chamber in the particle beam coming out of the accelerator. The counter can be designed to neglect all particles which are considered to be of no interest. In addition, thanks to the electronic devices in the control counter, the sparks can be made to last for as little as half a microsecond. Therefore, it is only during this fleeting fraction of a millionth of a second that the sparks follow the track of the particle through and between the parallel plates. During this short period, the number of stray particles is extremely small. The photograph taken during the microsecond concerned will therefore show practically nothing but the events which are of interest, even though hundreds of thousands of “uninteresting” particles cross the chamber before or after.

Physicists state that this is a great improvement upon the bubble chamber or cloud chamber which are filled with a substance possessing too long a “memory”: the events occurring there last for milliseconds, that is over a thousand times longer than in the spark chamber. This period is quite long enough for the entry into the bubble chamber of particles other than those originally considered to be of interest.

Another of the good points of the spark chamber had already been

taken advantage of in the technique of the multiplate cloud chambers. This was the choice of a high density material, such as lead, for manufacturing the high voltage plates. The number of atomic nuclei with which the particle arriving may produce an interaction is accordingly increased.

For instance, for an experiment on neutrinos with the big Brookhaven alternating gradient accelerator, L.M. Lederman is planning to construct a spark chamber $1.2 \times 1.5 \times 1.8$ m. It will contain material weighing about ten tons. At CERN several physicists are interested in this type of apparatus, in the groups of G. von Dardel, G. Fidecaro, H. Faissner, D. Harting and A. Lundby. In addition, in the Accelerator Research Division, F. Schneider is studying the general properties of the chamber with a view to developing it.

An impressive number of laboratories seem to have rediscovered this sturdy and simple instrument, the spark chamber. One is naturally tempted to ask why it was not exploited sooner. It appears that progress in electronics is responsible for this renewed interest in a relatively old technique. The dead period of the counter controlling the high voltage pulse has been considerably reduced and this offers the advantage, already mentioned, of excellent discrimination in time.

Electronics,

ten years ago, seemed to be on the point of revolutionizing a considerable number of conventional techniques. This has happened to a certain extent, as testified by the above example.

One of the CERN electronics experts, I. Pizer, went to Berkeley. He brought back a report full of ideas on solid state detectors, clipped pulses, zero-crossing, negative resistance region and **tunnel diodes**. These, said I. Pizer, act as rapid switches in electronic circuits.

Although some of our electronics experts are not very enthusiastic about this, the information pinned

up on the door of a well-known electronics workshop is a sign of the general interest in tunnel diodes.

At Berkeley, in the opinion of the majority, nobody presented a practical circuit which fully exploited their characteristics. Perhaps fast electronics will soon be in a position to disclose all the advantages of this small apparatus which has taken its place alongside the ubiquitous semiconductor devices.

Solid state detectors

will one day replace photomultipliers, it seems. At present, they have the drawback of low output voltage and can only be applied to low energy detectors.

In the same context, Guy von Dardel also mentioned “spaghetti chambers”. This culinary adjective describes the application of a discovery made a few years ago, which will soon be exploited. This will mean an improvement in **scintillation chambers**, instruments which make it possible to observe directly the trajectory of a particle passing through them, owing to the emission of fluorescent light. In order to be photographed, the phenomenon however has to be amplified by a hundred million. The new optical device uses bunches of small diameter fibres — the “spaghetti” — transmitting the light along their axes, considerably reduces the depth of field necessary for observing an event. This will make it possible to construct large-sized scintillation chambers.

The multiple event recorder

attracted much attention. This apparatus (Berkeley) transfers the pulses of 180 counters on to magnetic tape in 20 microseconds. The counters may, for instance, be arranged to cover a considerable solid angle and detect the events occurring there.

Cerenkov counters

are used to determine some characteristics of particles by exploiting the luminous phenomena to which

Prof. V. F. Weisskopf

4th Director-General

At its session held on 8 December, the Council of the European Organization for Nuclear Research appointed Prof. Victor F. Weisskopf Director-General. This distinguished Austro-American scientist, whose biography is published in this issue of the "CERN COURIER", will assume his new duties on 1 August 1961, for two years. He will succeed Dr. J. B. Adams who will then return to Great Britain to direct the plasma physics laboratory at Culham.

Prof. Weisskopf will be the fourth Director-General of CERN, his predecessors having been Prof. F. Bloch, Prof. C. J. Bakker and Dr. J. B. Adams.

When announcing the new appointment, Mr. F. de Rose, President of CERN Council, pointed out that CERN had become such an important research centre in Europe that it was now able to attract distinguished scientists from all over the world.

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67,7 million Sw. frcs for research at CERN

The CERN budget for 1961 amounts to 67,7 million Swiss francs.

This sum will cover capital expenditure, such as the new experimental equipment to be used with the two particle accelerators at Meyrin. A great deal of intricate and fragile equipment is necessary to perform the many experiments proposed in the experimental physics programme, especially for the 28 GeV proton synchrotron.

Other budget headings cover expenditure on electric power, the accelerators being heavy consumers of power, maintenance charges for the equipment and buildings situated on the 100 acre CERN site, near the French border. They also cover the salaries of over one thousand people.

The 14 member countries will contribute to the CERN budget in proportion to their national income, percentages being as follows:

Austria	% 1.87
Belgium	4.02
Denmark	1.93
France	20.57
German Federal Republic	18.92
Greece	1.12
Italy	9.78
Netherlands	3.73
Norway	1.56
Spain	4.16
Sweden	4.10
Switzerland	3.19
United Kingdom	24.40
Yugoslavia	0.65

Nuclear Technology

they give rise. The Berkeley Conference revealed the increased accuracy of these counters and mainly the gas-filled ones (CERN) for differentiating the particles which are mixed in very high energy beams.

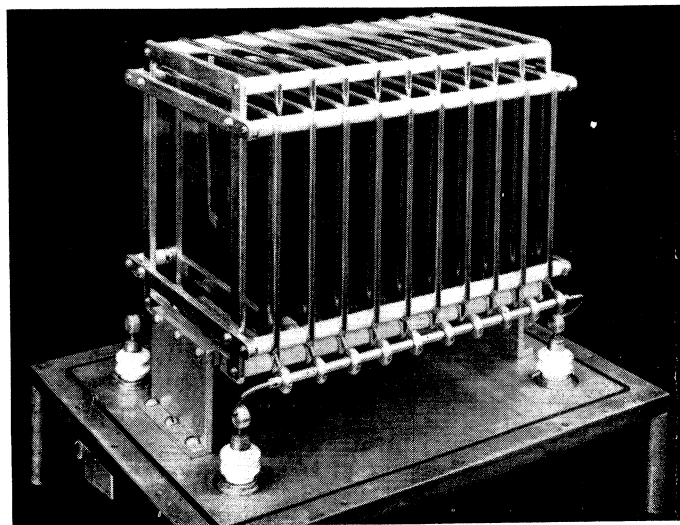
The measurement of track photographs

was much discussed at Berkeley. In this respect, a European physicist said on his return that "a CERN vic-

duced by the bubble chambers. Whence the search for more up-to-date, more automatic apparatus CERN's IEP-X in particular.

The measurement of track photographs entails such complicated techniques that an extra two days were added to the time which had originally been set aside at Berkeley for this subject. These additional discussions dealt with the program-

A view of the inside of a spark chamber similar to that constructed by the G. Fidecaro group. The sparks "jump" from plate to plate when a particle goes through the chamber and can be photographed so as to provide a permanent record of the behaviour of the particle. The chamber shown was constructed at Princeton by J. W. Cronin and G. Renninger.



tory had been announced in measured terms". CERN would be the only laboratory to offer a practical solution at present. The CERN IEP-X seemed to offer the only chance at present of dealing with the avalanche of photographs of particle tracks recorded on miles of film by the bubble chambers.

The details of this technique will not be discussed here; a summary appears on page 26, in the article on bubble chamber data analysis by Lew Kowarski.

According to Yves Goldschmidt-Clermont, who had good reasons to keep in close touch with developments in this field, "electronic computing is now in general use for measuring the photographs obtained from bubble chambers. The great number of laboratories engaged in this work nearly all use coding projectors, which record directly on perforated tape the point co-ordinates measured along the tracks."

These are concrete solutions, indeed. But they are far from sufficient, as they can take care of only a fraction of the photographs pro-

duced by the bubble chambers and future problems.

Bubble chamber:

The analysis of the tracks left in the bubble chambers by the particles which it is wished to study poses very great problems for some physicists. But their colleagues-designers of bubble chambers still continue to improve their equipment.

Perhaps they do so in the hope of spurring on the physicists. Perhaps they want to drown them for ever in a flood of documents... intended ironically enough, to put some order into the complicated structure of modern physics.

Whatever the reason, the bubble chambers are improving. The largest of them, the 180 cm chamber of the Berkeley laboratory, has had its cooling system modified. As a result it produces a photograph every 10 seconds instead of every 12 as in the past. The same laboratory has announced that the construction of a new chamber intended to replace the 40 cm one has begun; it will incorporate a horizontal mirror with illumination from the rear.

Other improvements mentioned for various chambers are connected with saving on cooling, the cycling speed and the use of heavy liquids, such as freon or xenon, and above all the stability of operating conditions.

Cryogenics

is the technique of using very low temperatures. Surprising results have been obtained in this field: in the

ity consumption costing 130 000 dollars. A cryogenic magnet would bring the cost down to the ridiculous figure of about 10 000 dollars! Even these costs would not be due to the consumption of current by the windings but to the operation of the cooling installation. It can be retorted that the saving in electricity would be in part counterbalanced by the

CERN's contribution to the Berkeley Conference

The organizers of the Conference on High Energy Physics Instrumentation had invited three CERN physicists to report on their work to their colleagues who were gathered at Berkeley. Guy von Dardel thus gave his views on "Cerenkov counters", Yves Goldschmidt-Clermont spoke about "Recent Developments in Data Reduction", while M. G. N. Hine described the "Features of the CERN PS of interest to experimenters".

Other papers were also presented. A. Citron dealt with the problem which he had tackled with seven other physicists: obtaining a "High intensity muon beam from the CERN 600 MeV SC". Arne Lundby gave the characteristics of "DISC", the liquid-filled Cerenkov counter constructed by him and his five colleagues. C. Peyrou discussed hydrogen bubble chambers and C. A. Ramm the handling of the PS beam, the propane bubble chamber which is being constructed by part of his group, under L. Resegotti.

Finally, in his capacity as Chairman of the session on the analysis of bubble chamber data, Lew Kowarski gave his views on this subject, which appear on page 26 of this issue.

laboratory it has proved possible to get within a thousandth of a degree of absolute zero (-273° C). On an industrial scale large systems are now being refrigerated to about -260° C.

The physicists have brought back from Berkeley details of sodium magnetic coils, sheathed in stainless steel, cooled to 2° Kelvin (-271° C). What is the point of such a refinement? Economy, since at low temperatures the electric resistance of some very pure metals is extremely low; it can be 10 000 times less than the resistance at normal temperature. The consumption of electric power could thus be reduced to a negligible level on an industrial scale.

Two sets of calculations for the magnet of a large bubble chamber were compared. A conventional magnet would lead to an annual electric-

investments needed for the refrigerating plant. Well, there is no rose without a thorn.

With a metal as cheap as sodium, which can be produced in an extremely pure state, encouraging results have already been obtained using elementary precautions. In the near future, cryogenic magnets will probably be in general use for bubble chambers, focusing lenses and bending magnets.

As was the case for the Rochester Conference, there is no specific conclusion to be drawn from that at Berkeley. It was a meeting of experts in techniques which to-day or to-morrow are or will be vital tools for pioneering the many unexplored fields of nuclear physics.

All contribute, according to their possibilities, to the common effort in the service of science ●



Decisions of the 18th Council:

Spain joins CERN

It was announced at Meyrin after the first day of the 18th Session of the Council that on 1 January 1961 Spain would become the 14th member State of the European Organization for Nuclear Research.

The accession of Spain was unanimously approved by the delegates of the thirteen member States of CERN, viz. Austria, Belgium, Denmark, France, German Federal Republic, Greece, Italy, Netherlands, Norway, Sweden, Switzerland, United Kingdom, Yugoslavia.

Three Spanish observers attended the Council meeting:

- Mr. José Manuel Aniel Quiroga, the Permanent Delegate of Spain in Geneva,
- Prof. Carlos Sanchez del Rio, Head of the Physics and Reactor Division of the Junta de Energia Nuclear, Madrid,
- Mr. Pedro Temboury, member of the Permanent Delegation of Spain in Geneva.

In welcoming them on behalf of CERN, Mr. F. de Rose expressed the Organization's satisfaction at having a new member. "CERN considers the accession of Spain", he said, "as a justification of its aims which are to improve the facilities for scientific research in Europe, and it also regards her accession as a proof that the success so far achieved at Meyrin is appreciated."

Mr. Aniel-Quiroga expressed the satisfaction of his Government at the warm welcome which the Council had given Spain's request for accession. "It is because it realizes the advantages of scientific co-operation on a multi-lateral national scale, he continued, that Spain is joining CERN where States pool their efforts for the furtherance of scientific pursuits which strengthen the bonds between them and contribute thereby to the maintenance of peace. The Spanish Government and people are extremely glad to be in a position to join in such a noble task", said Mr. Aniel-Quiroga in concluding his speech.



Bubble chamber data reduction: **Leave**

Dr. Kowarski is director of the Data Handling Division at CERN, where a group of physicists and technicians led by Dr. Goldschmidt-Clermont, designs and builds instruments for evaluation of photographs obtained from track chambers. At the Berkeley conference, one of the sessions of 14 September was devoted to such machines. Dr. Kowarski was chairman of the session and as such voiced some introductory remarks which seemed worth being submitted to the readers of « CERN COURIER ».

They will appreciate, not only the many professional details of this speech, but also its flavour.

Too slow

A fairly recent speech given by Bradner at the American Physical Society ended on this sentence: "It is evident that we are still a long way from analysing all the good high-energy physics that exists in bubble chamber photos". This state of things of course cannot be tolerated and that's what today's session is about, in a general outline. Tomorrow we shall continue in a more specialized meeting, to which everybody is welcome. On Friday a small group of fanatics will meet by invitation in order to swap some of their crazier ideas concerning future developments.

This afternoon we shall deal mostly with techniques and ideas which are either in actual present-day use by physicists, or in actual existence as prototypes or detailed and realistic schemes. All these efforts may be viewed in a general framework of ends, means and trends and each of us may construct such a framework for himself. The following remarks are offered as an example.

Systems available today are too slow. They can deal with a few tens of thousands of events per year, and their most optimistic developers hope to achieve, in a single laboratory, a capacity of some 100 to 150 kiloevents per year. But a single laboratory may have a few bubble chambers in continuous use and one chamber so used may yield up to a million events per year. Clearly the problem is that of speed, and since human attention and action introduces a rockbottom bottleneck, speed can be achieved either by pouring in parallel through many bottlenecks, or by eliminating them altogether. Either vast armies of slaves armed with templates and desk calculators, maybe even strings of beads, or few people operating a lot of discriminating and thinking machinery. The evolution is towards the elimination of humans, function by function.

Let us see how tasks are divided between the humans and the machinery in today's practice, as it is going to be discussed mainly by Bradner and Goldschmidt-Clermont. The initial store of

Photo above :

The measuring of the co-ordinates of tracks photographed by the bubble chambers may become an entirely automatic process in the not too distant future.

it to the machines

by Lew Kowarski

information is a photograph, a two-dimensional array of black-or-white binary alternatives, most of them white, that is empty. Among the black areas some are just blobs, some are tracks but not even all of the tracks are physically interesting. A human looks at the picture, selects the events, records their shape and their location in the temporal sequence of film frames and spatially within the frame. In this stage, known as "search and sketching", mechanical helps are few; a projector onto a screen, a moving stage or cross hair, maybe a punch for writing down figures on a card ready for the computer.

Humanly-selected tracks

The next stage is measuring: it feeds on humanly-selected tracks and it produces cards or tape on which tracks appear as sets of numerical co-ordinates. Here the main performer is a machine. Once put on a track, it can to some extent see where it goes; a small element of non-human seeing is already there, but a lot of human guidance and supervision is still necessary.

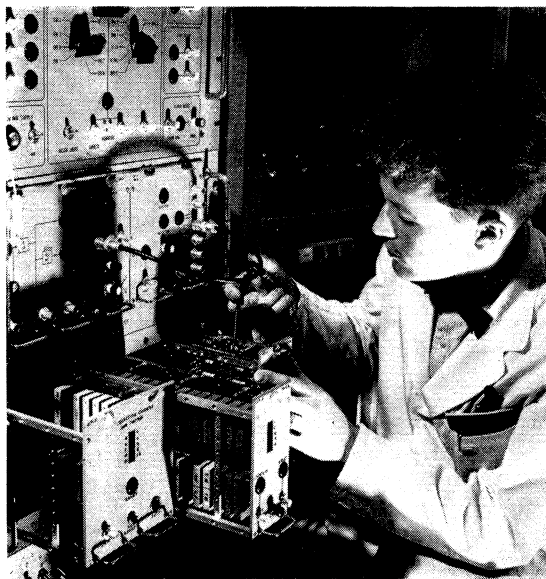
Once the punched cards, or the magnetic tape or what not, are ready, the computer performs all these beautiful logical operations after which the physical information emerges in a form practically ready for the Physical Review Letters and which, in spite of their emotional nicknames — Guts, Fog, Heck and so on — are totally inhuman and therefore mercifully efficient.

But the point worth stressing is this: the inhuman operation takes over at a point in the chain of operations, which is already pretty far removed from the original pictorial store. All, or nearly all, of the seeing is human; all of the selection is human. And yet, scanning devices, which are perfectly capable of transform-

ing pictures into sequences of pulses, do exist; and selections from stored sequences are perfectly feasible. So the immediate solution seems to be: let's scan the picture, store its black-and-white content in the magnetic memory of the computer, and after that let the computer worry.

A photo has no wiring

What do we gain by this transfer from the photo to the computer memory? Well, a photo has no wiring behind it. And a physicist is quite ready to toss the whole recognition-and-selection problem into the lap of the programmer and the computer logician. However this abdication is just a lazy dream. It cannot be done: for present-day computers a photo is just too rich a morsel to digest. If we want to define our black-and-white dots with an accuracy of $2\frac{1}{2}$ microns—which is by no means excessive — a square inch



In electronic laboratories automatic instruments are now being designed for future use in the rapid scanning of the large quantities of pictures produced by the track chambers.

of film contains 100 million "bits" of information. Currently available computers offer up to about one million, the TX2 computer at the Lincoln lab goes up to $2\frac{1}{2}$ million, Larc and Stretch... but why should we indulge in daydreaming? There is one way of reducing these hundreds of millions: since black bits are far less numerous than white ones, it may pay to transfer black bits only, in a proper sequence and each with its individual co-ordinate. But even then — shall we transmit all blobs, all lines? Some selection seems still necessary **before** we get to the memory; and then, a totally non-human operation means that our machine must be capable of recognizing the truly relevant visual information.

There is one snag about pattern-recognition machinery, suitable for bubble chamber analysis: it does not exist. It is **feasible** — it is **probably** feasible — and today you will hear about it from McCormick, and also from Thorndike. Since the scanning device must discriminate, it must proceed under the direction of a computer; and since the computer has to see the picture, that is to scan it, we see that scanning becomes a complex process involving a feedback. How to organize this process, what sort of a computer is necessary, or even how many computers, how to achieve accuracy in successive approximations — all these questions have already been considered, and the answers in the form of hardware may come within not too many years. Just now this coming race of thinking machines is represented by just one baby, the TXO. A very brainy baby — but it has a lot to learn. Its keepers, at M.I.T. and Lincoln, have some interesting ideas both on its present possibilities and on the whole concept of learning as it applies to computers; I hope we shall hear from them on Thursday and Friday.

An infant can be helped

In the temporary absence of a radical solution, compromise approaches are possible. An infant can be helped, in its attempts to walk, by a human mentor. It can be carried part of the way, so that only a short easy walk remains to be performed autonomously, or else it can be led all of the way. These two images correspond — in my mind at least — respectively to the Reaper, originated by McCormick and developed here in Berkeley, and the Flying Spot Digitizer, developed by Hough and Powell at CERN. The Reaper is a scanning device which is put in operation after a suitable event has been found and the device has been centered on its vertex. From the scanned region, thus defined, only relatively few black spots are transmitted to the magnetic storage, together with their polar co-ordinates; there is no feedback and the scanning follows a fixed routine. But the routine is such, and the chosen region is such, that most of the stored information is guaranteed to be relevant, and the filtering-off of irrelevancies can be performed easily by the computer.

In the Hough-Powell scheme, the scanning spot flies all over the picture, but transmission occurs only when it hits preselected tracks. The preselection is human, and its guiding hand operates either through rough tracings on an optical mask, as in the IEP-X technique followed at present, or as a set of roughly digitized instructions, as in the forth-coming development anticipated under the name of IEP-X. In both schemes, Reaper and Hough-Powell, the human bottleneck occurs **before** the device takes over. The search-and-sketching stage is shortened somewhat, but not decisively since it remains human; the measuring stage is shortened very drastically, since it is entirely inhuman. These devices are therefore promising mostly in statistical experiments where the chamber acts as a "seeing counter"; for rarer and more sophisticated events, where human search and evaluation have a greater role, their promise is less imme-

Physicists caught napping

diate. They offer, however, a way towards further and gradual extension of the non-human element in the evaluation process and therefore, no less than the more ambitious schemes, which have been mentioned earlier, they provide an important part of the answer to Bradner's anguished appeal.

One last remark. High-energy physicists have been caught napping, and they have to act quickly. What they will initiate in the pattern-recognition field may yet connect with applications which have nothing to do with high-energy physics. This reminder is meant to add some adventurous flavour to our discussions ●

„Matter in Question”

The above is the title of the film made by CERN, which was recently shown to staff members.

“Matter in question” was made on 35 mm Eastmancolor film by Georges Pessis, with the co-operation of the whole Organization. Martial Solal wrote the music for this 25-minute film, which is meant to show the place occupied in the scientific world, and especially at CERN, by fundamental nuclear research.

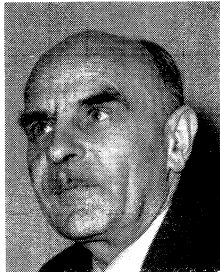
This is the first colour film to be made at CERN and this venture called for much drive on the part of some people... and much patience on the part of others. Some had the task of collecting funds and securing the goodwill of all concerned, whilst others had to show great forbearance.

There are hundreds of subjects at CERN worthy of inclusion in a film. The problem therefore was to gather in a film lasting less than half an hour a selection of pictures that would give an idea not only of the physical dimensions of the Organization but also of its significance and of its scientific role.

It was finally decided to outline briefly the views of scientists throughout the ages about the composition of matter and then to show a few great contemporary scientists in their laboratories.

The film then stresses the need for international co-operation and tells how the idea of CERN was born. After giving an impression of the building period, the pictures and commentary try to explain how the two accelerators work.

The film took over a year to make. The English version has appeared with a commentary spoken by Raymond Baxter of the BBC. The French version, “Etoiles Nucléaires”, was made with the help of Max-Pol Fouchet, a journalist. The film has been shown to the members of the Council and of the staff. It will be leased for general distribution, being then shown to European and foreign universities and institutes, as well as to the general public. It is hoped it will help to make them aware of what is going on in the nuclear field, apart from work on power production ●



Prof. H. Massey to the readers of „CERN COURIER”

"The object of this meeting was to move forward from the stage of preliminary meetings to an official government level.

"Now that the preparatory commission has been set up, it can consider creating a final organization comparable to CERN. In the meantime, there will be plenty of opportunities for informal activities which require neither a budget nor the official sanction of the authorities.

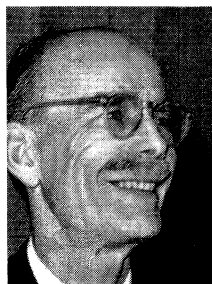
"For instance, British universities engaged in space research have already been acting as hosts to foreign scientists. Co-operation has already been arranged informally for the tracking of satellites.

"Thus, in about two years' time, when the installations will have been built, we shall already be engaged in many kinds of scientific ventures."

PROF. HARRIE S. W. MASSEY
Chairman
Intergovernmental Conference on
Space Research



The lecture given by Prof. Massey on space research was attended by a large part of the CERN staff.



Prof. P. Auger to the readers of „CERN COURIER”

"The conference held at CERN at the end of November was undoubtedly a success. It was held with the intention of drawing up the text of an agreement, and this agreement was actually signed. A preparatory commission can therefore be set up: this is a situation comparable to "stage 1" of CERN in 1950.

"It may take a year before the final organization starts work. However it is quite likely that this stage may be reached in a shorter time—say in 8 months."

PROF. PIERRE AUGER
Secretary
I.C.S.R.

Further European Co-operation

From 28 November to 1 December, CERN was in the fortunate position of being host to what is likely to become a sister organization. It was in the Council chamber of the Organization (see photo on page 3) that was held the first inter-governmental conference organized by the European Study Group for Space Research.

Mr. Max Petitpierre, President of the Swiss Confederation, welcomed to Switzerland the 50 delegates sent by the ten European governments concerned, and also the Spanish observers. Spain was in fact to be admitted to membership of the Group at the same time as Belgium, Denmark, France, Italy, Norway, the Netherlands, the Federal Republic of Germany, the United Kingdom, Sweden and Switzerland.

"Most of our countries would not be in a position to undertake this research on their own, declared Mr. Petitpierre. Close co-operation between their scientists, and the pooling of their financial resources, is therefore a necessity."

The President of the Confederation also said: "The countries of Europe find it difficult to form a single block and to agree about the means of forming such a block. One of the ways is that which you have chosen, namely co-operation, co-ordination and concentration of efforts, in a spirit of mutual trust and understanding, for a purpose common to all."

Speaking in his capacity as President of the CERN Council, Mr. François de Rose said he felt flattered that CERN should have been chosen as the meeting place for the conference.

"This choice is symbolic, he continued, first because the infinitely big and the infinitely small are two worlds full of riddles which baffle man's intelligence and also because the two ventures call for the same kind of arrangements for pure research on a European scale."

The conference appointed Sir Harrie Massey (United Kingdom) chairman and Professors L. Broglio (Italy) and M. Golay (Switzerland) vice-chairmen. Prof. Auger (France) was appointed secretary-general and Mr. J. H. Bannier (Netherlands) agreed to be rapporteur.

The agreement signed in the afternoon of 1 December established a preparatory commission which was to study the possibility of creating a European organization for co-operation in the field of space research. The agreement was signed there and then by 9 of the 10 countries invited—the Federal Republic of Germany signed subsequently—and also by Spain which had just been admitted as a member of the conference. The conference took place in a spirit of mutual understanding and was another step towards closer co-operation. It is reasonable to expect that the final European organization for co-operation in the field of space research may be able to start work at the end of 1961.

On 13 and 14 March, there will be held in Paris the first session of the Preparatory European Commission for Space Research, which Prof. Auger has been requested to organize. This will be another step towards further active European co-operation ●

Space research

"Space research is a very bad description of the sort of things it is intended to describe", said Prof. Massey in his introduction.

"I remember, he added, when it was first made respectable as a term of description, at a meeting of the International Council of Scientific Unions. It was strongly objected to by one of the delegates present. He was a mathematician and he understood that space research was geometry... So, perhaps, I ought to start by explaining what I mean when I say "space research".

Space research is defined arbitrarily but conveniently as being scientific research carried out through observation by instruments which are carried to the point of observation by the use of rocket propulsion. Several sciences or branches of science can be substantially influenced by space research. Here is a non-exhaustive list :

- Physics of the upper air
- Solar physics
- Solar-terrestrial relations
- Meteorology
- Solid earth geo-physics and geodesy
- The study of micro-meteorites
- Cosmic and other radiations
- Ultra-violet and X-ray astronomy in general, infra-red and radio astronomy
- The nature of gravitation
- Lunar and planetary physics
- Planetary biology (if any)
- Large-scale experiments

Why send instruments aloft?

One has to make a case for studying any of these subjects by the very expensive method of space research — if they can just as well be studied from the ground there is no point in sending up instruments. For example, **physics of the upper air**. Here by "upper air", one means the atmosphere above 30 km, since balloons can go up to that distance. Of course, if one knows nothing about the physics of the upper air, one might say, "what on earth is the use of studying the air above 20 miles, there is nothing much left at 5 miles, the height of Everest". Well, this is quite untrue. There is still quite a lot of air at these heights — although there is very much less than at ground level. There are still at 200 km between a million and ten million times as many particles per cubic centimetre as in outer space — and this has important influences on what happens at ground level, for instance on the propagation of radio waves. Many of the phenomena at these heights are due to the effect of the sun's radiation, and much of this radiation is absorbed before it gets to ground level. We cannot understand how the conditions at these heights are produced without sending instruments up there to study this radiation before it is absorbed. We know that this region of the atmosphere is ionized — we should like to know whether the positive ions are molecular or atomic oxygen and nitrogen. It turns out

"What it is and what it is not." This might be an appropriate subtitle to this abridged version of Prof. Harrie Massey's lecture, delivered at CERN on 30 November last.

This was during the intergovernmental conference on space research and the lecture was intended to brief CERN staff on the whys and hows of space research. It drew the largest crowd ever gathered in the big auditorium, including many journalists and persons from outside CERN.

Later, the Public Information Office was swamped by requests for transcriptions of the lecture. This is why "CERN COURIER" now prints this abridged version, published with kind permission from the lecturer.

from mass spectrograph measurements made from a rocket that they are in fact mainly ionized nitrous oxide, which was most unexpected. There is great interest in finding what happens to the corpuscular radiation from the sun which turns out to be concentrated, under the effect of the earth's magnetic field, into relatively narrow regions at about 23° from either magnetic pole. Besides this it has been found that the earth is surrounded by zones of quite energetic charged particles, one extending up to about 1500 km and one up to about 50 000 km, the particles being held in these zones by magnetic trapping.

Now let us turn to **ultra-violet, X-ray, infra-red and radio astronomy**.

It is known that the only radiations from space which can reach the surface of the earth are the visible radiations with a slight spread on either side and a region of the radio spectrum. All optical astronomy is therefore based upon the visual region and the new science of radio astronomy on the radio region, and the latter has already made advances which would have been impossible as long as we relied on visible rays. To get more information we have to send instruments up above the blanketing atmosphere so that for instance we can see what is the X-ray and ultra-violet spectrum of the sun and stars. In fact observations already made by space research methods have shown that the X-ray emission of the sun corresponds to an effective temperature of one million degrees, as compared with the 6000 degrees of its effective visual temperature.

And what can be said about the **nature of gravitation**?

Gravity is a very weak force and one of the difficulties of studying it is that one has not

Space research

(Continued from page 31)

got available a large laboratory with several objects as large as the earth, to do experiments with. With artificial satellites or artificial planets it will be possible to get far enough from the earth to start useful experimentation for instance on Einstein's general theory of relativity.

And planetary biology ?

There is probably not much value in finding out what happens to living matter in the circumstances of space, since these circumstances can to a great extent be artificially reproduced on earth. But it might be very interesting if we ever got to the planets to find out whether living matter there, if it exists, is built out of the same fundamental molecular bricks (DNA and RNA, or deoxyribonucleic acid and ribonucleic acid) as is all earthly protoplasm.

How can one talk of **large-scale experiments** in space ?

An interesting example was the occasion when an atom bomb was exploded at a height of 400 km over the South Atlantic and discharged a cloud of charged particles which were trapped in the earth's magnetic field and formed a belt round the earth which was observed by instruments in an Explorer IV satellite. This was not a very well controlled experiment since the energy and space distribution of the particles could not be controlled — perhaps the next step would be to send up an electron accelerator in a rocket to produce the particles. This would provide a nice problem in miniaturizing !

Vehicles

What sort of vehicles should one use ? One needs a **satellite** for those investigations which require the collection of a lot of data at different times and from different places, as for instance the study of solar radiation and certain meteorological phenomena. A satellite circulating for one month can collect and radio back to earth as much information as could be got by launching 8000 vertical sounding rockets. On the other hand a satellite is extremely expensive and you spend all your money at once. If expenditure and the collection of information have to be spread over years, then one uses **vertical sounding rockets**, which are in any case essential for studies between 30 and 100 km, since owing to atmospheric friction a satellite will not long continue to circulate below 100 km. It would also be essential to check observations below 30 km by balloon flights. There is great need for international co-operation in the launching of the vertical sounding rockets from many parts of the earth including particularly the Arctic and Antarctic, and since there will have to be many flights, the rockets have to be cheap. They would in fact cost from 12 000 to 120 000 Swiss francs. When one has a vehicle, very much more expensive, which can place a satellite, it is only a matter of further expense to go on to vehicles which can visit the other planets — the technical problems will have been largely solved.

To place a satellite into orbit at 150 km it has to reach a speed of 30 000 km/hour, and only a little higher speed (1.4 times as much) is needed to liberate it from the earth entirely. For a given propulsive power, the higher the final speed and the larger therefore the orbit, the less is the weight which can be put into orbit. Chemical fuels are available now which will put a useful load of 4 - 600 kilos into orbit at a useful height, sufficient for example for ultra-violet, X-ray, infra-red and radio astronomy.

Then there has to be a **control system** which can put a satellite into orbit with the speed quite close to orbit speed in a direction within a degree of the horizontal, and this problem has been substantially solved.

There is next the problem of **tracking**. Radio direction finding has been possible up to 25 million km but does not give great accuracy of location. For the latter, optical techniques are necessary.

Then, although for vertical sounding rockets it may be possible to **recover photographic plates and records**, this is much more difficult for satellites because of the problem of re-entering the atmosphere without burning up. Therefore the information must be got back during flight by coded radio signals. This has been done over distances up to several million km.

A technique which is not very glamorous but absolutely essential is that of **data analysis**. The amount of data obtained from a satellite can be absolutely terrifying and the problem of their analysis has not yet been adequately solved.

Instruments

The instruments in the satellite have to be capable of working over a wide range of temperatures or the temperature inside the satellite must be controlled. There must be independent sources of power, such as solar cells. All these, and such problems as arranging for radio aerials to be protruded or unwrapped at the right moment, for the instruments to be correctly directed with respect to the stars (an accuracy of 30 seconds of arc may be a minimum), the problem, if one is to do radio astronomy with the satellite, of being able to unfold in space aerials as large as that at Jodrell Bank, are dealt with by the large new and complicated subject of satellite engineering.

It must be emphasized that there is a tremendous amount of research of the greatest scientific value, and involving a colossal and interesting job of technological development, to be done in the area, less than a thousand km into space, which is well within the reach of principles and techniques already established. This may not be romantic, but it is most important.

For most of these purposes there is little point and many disadvantages in having a **man** in the vehicle. The advantages of the human brain in its ability to take flexible decisions would be of little use, since the data would not be available in the spaceship, or not be comprehensible without a computer, which could not be carried in the spaceship. A space pilot would have to depend to such an extent on automatic control and complete reliability that he would become himself pointless. This may be disappointing, and there may be other reasons for putting men into space, but for the sort of research talked about here, man is unnecessary aloft ●

Stanford superaccelerator

The U.S. Atomic Energy Commission announced on 29 December that it had authorized negotiations to provide the architect-engineer-manager services for the proposed 10-20 GeV linear electron accelerator at Stanford University, Palo Alto, California, to the extent authorized by the 86th Congress. The work, which would be performed under a cost-type subcontract under the Stanford University prime contract with the Commission at an estimated cost of \$ 300 000, involves master planning of the facility and design of initial buildings.

The 86th Congress authorized \$ 3 000 000 for design and engineering for the project. The major part of these funds is to be used by Stanford University for further research and development related to the accelerator components. If Congress gives full authorization for the project, it will involve expenditure of over \$ 100 000 000.

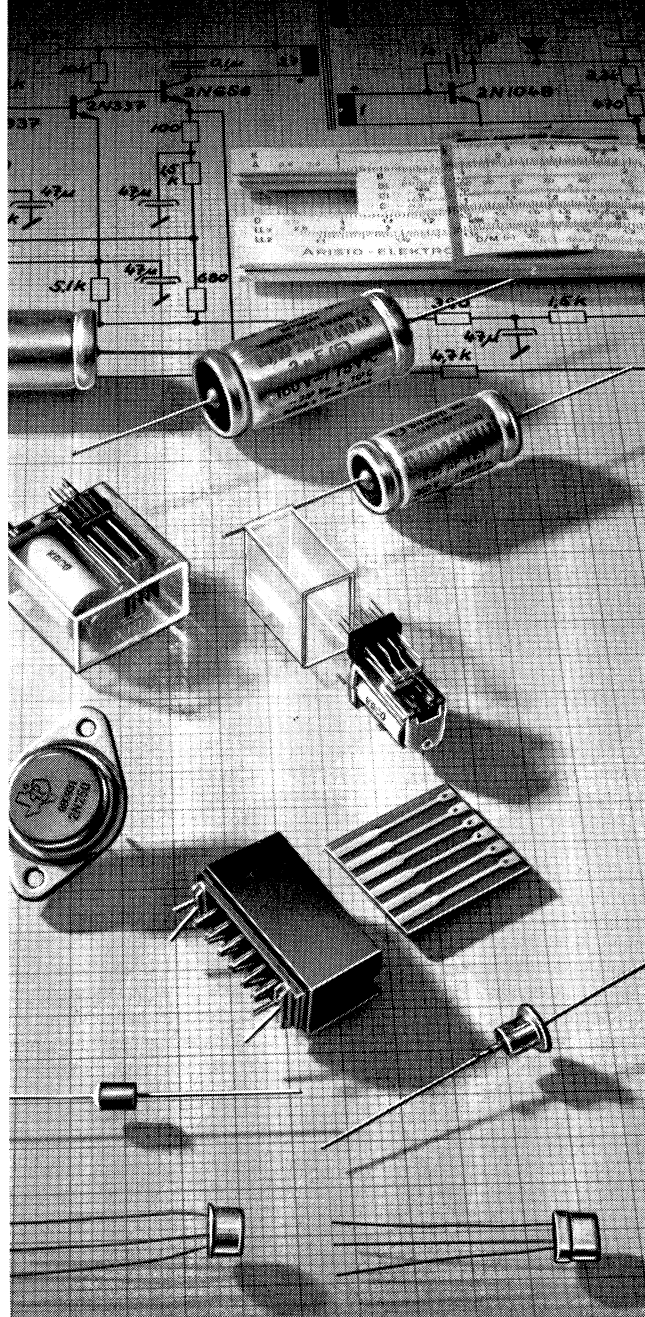
Sixty-eight firms, encompassing many well-known in the field, were invited to submit proposals on the work on the accelerator project. Altogether thirty-three proposals were submitted.

In May 1959, it had been announced that the accelerator is planned for construction near the Stanford campus. The apparatus would be enclosed in two parallel tunnels, each nearly two miles long and covered by 35 feet of earth. On the basis of preliminary estimates, the project would cost about \$ 100 000 000 for construction, \$ 18 000 000 for research and development, and approximately \$ 15 000 000 a year to operate after completion. The Commission would finance the project, and Stanford would operate the machine.

The accelerator should be capable of producing 10 to 20 GeV initially, and 45 GeV eventually.

The Stanford project would be established as a national facility for research, to be used by scientists from other institutions as well as those at Stanford. As at CERN, a procedure would be established for screening proposed experiments and scheduling the use of the huge machine ●

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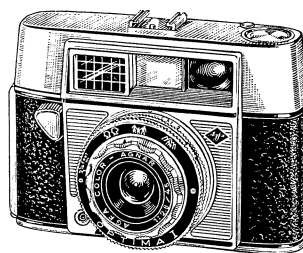
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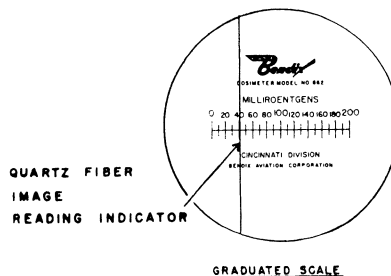
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623	0 - 1000 R
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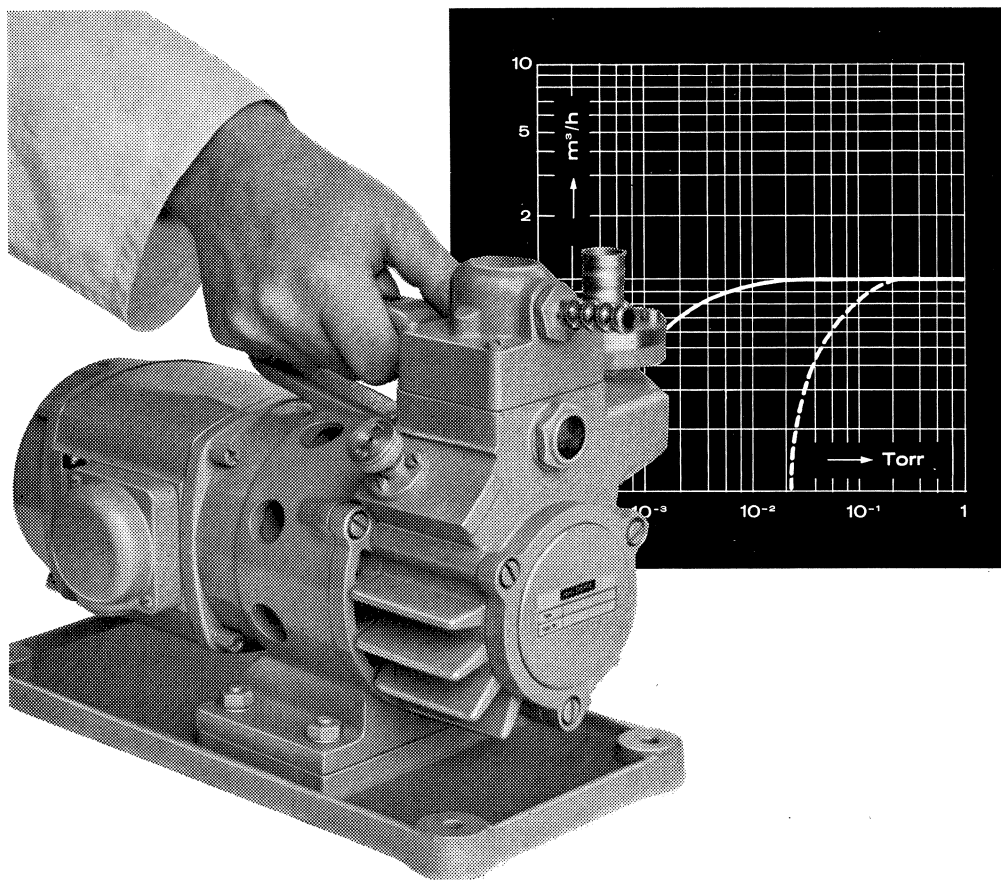
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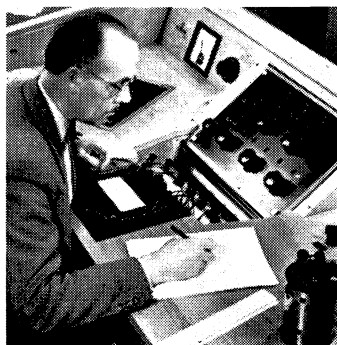
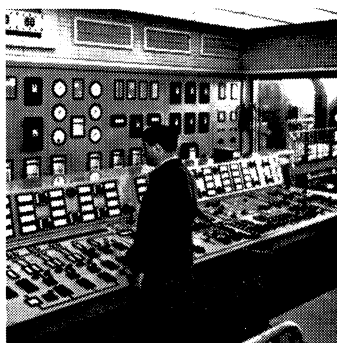
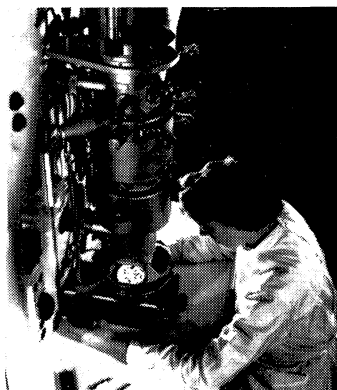
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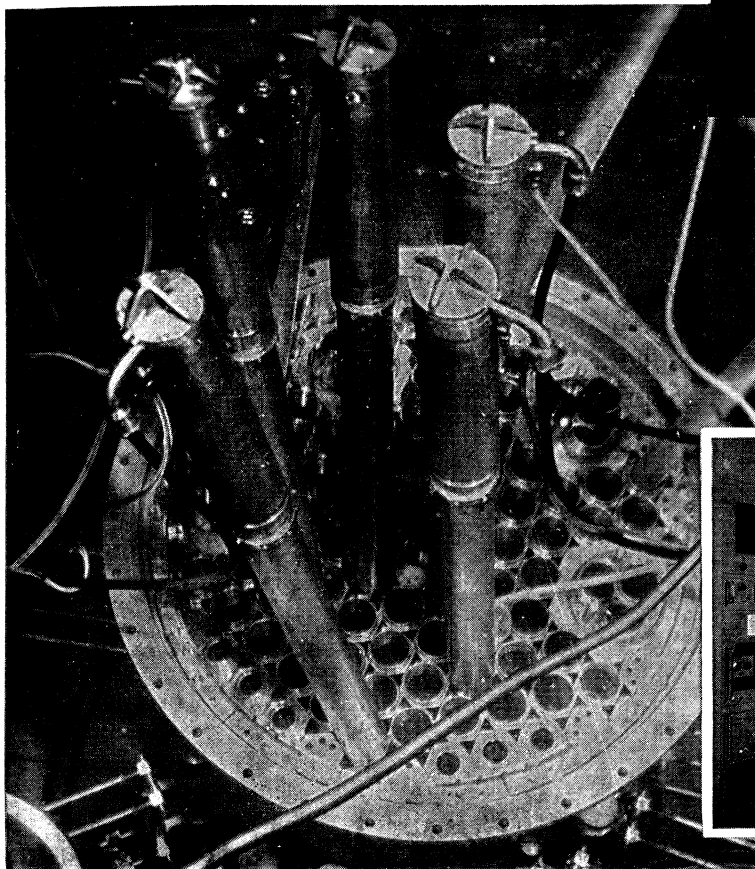
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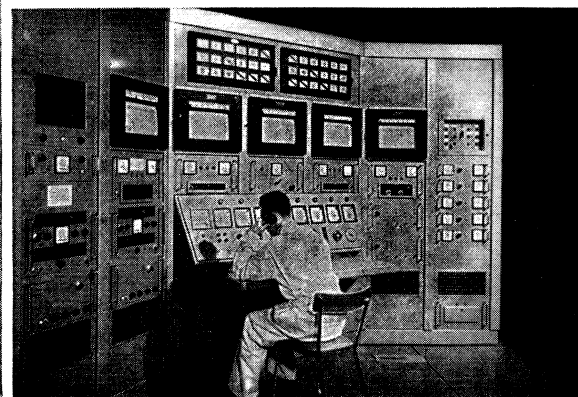
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Nuclear control panel of BRO2 operated at Mol by the CEN (Centre d'Etudes Nucléaires).



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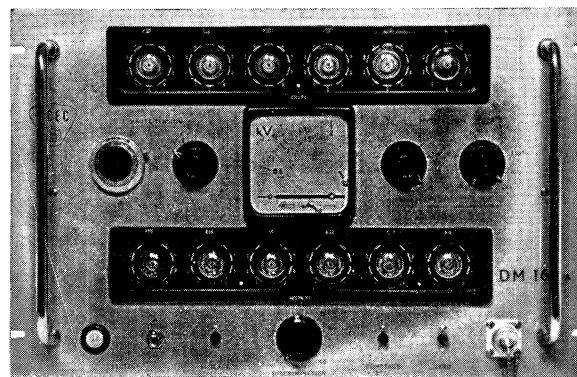
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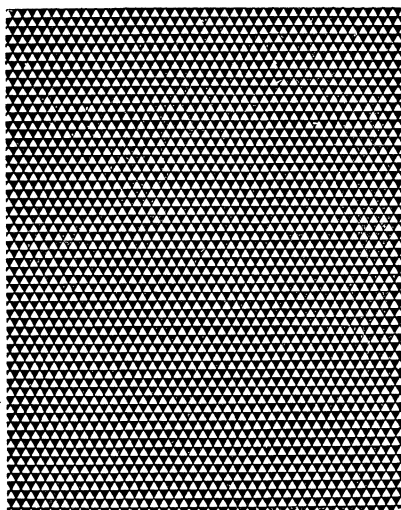
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ACEC have published an illustrated catalogue describing the nuclear measuring instruments which they manufacture and will be pleased to send you a copy free of charge on request to ACEC-CHARLEROI - Belgium

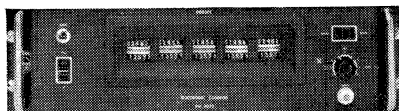
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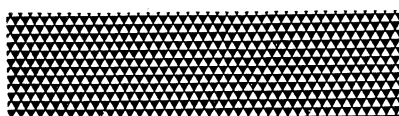
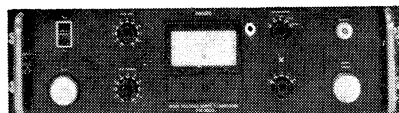
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RESOLVING TIME: 0.5 μ sec (first binary scaler)

INPUT SENSITIVITY: G.M.-counters: 0.5 V_{p-p}

Scintillation detectors: via built-in amplifier with adjustable attenuator: 5 mV_{p-p}

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Linear count rate meter for direct connection of G.M.-counters, scintillation - or proportional detectors

MEASURING RANGES: 300 - 1000 - 3000 - 10 000 - 30 000 c.p.m.

ACCURACY: 2 % of full scale

TIME CONSTANT: 0.1 - 1 - 3 - 10 - 30 - 100 sec.

INPUT SENSITIVITY: G.M.-counters: 0.5 V_{p-p}

Scintillation detectors: via built-in amplifier with adjustable attenuator: 5 mV_{p-p}

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PW 4042



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