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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

The European Organization for Nuclear Research (CERN) came into being in 1954 as a co-operative enterprise among European governments in order to regain a first-rank position in nuclear science. At present it is supported by 13 Member States, with contributions according to their national revenues : Austria (1.96%), Belgium (3.85), Denmark (2.09), Federal Republic of Germany (22.86), France (18.66), Greece (0.60), Italy (10.83), Netherlands (3.94), Norway (1.48), Spain (1.68), Sweden (4.25), Switzerland (3.20), United Kingdom (24.60).
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The character and aims of the Organization are defined in its Convention as follows :

' The Organization shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of its experimental and theoretical work shall be published or otherwise made generally available.'

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The cover photograph might be entitled ' spring-cleaning operation ', though it was taken in January and the men do not work in a hospital ! In fact, the picture shows some cover plates from the vacuum chamber of CERN's synchro-cyclotron being cleaned inside a concrete enclosure set up in the ' proton ' experimental room of the accelerator during the long shut-down early this year. As the plates were radioactive, the cleaners had to wear overalls, masks, goggles and gloves, and their stay inside the enclosure was carefully controlled. The photograph illustrates one aspect of the varied work carried out during the shut-down, which is discussed in an article beginning on page 44.

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Last month at CERN

New advances during March included the announcement of the discovery at CERN of another new ' particle ', the experimental proof that another kind did not exist (or at least was extremely rare), and the most extensive use so far, anywhere, of fully automatic equipment for scanning and measuring spark-chamber photographs.

The **new particle,** found by a collaboration between CERN and the Collège de France, has been named C^0. It is formed by the annihilation of an anti-proton and proton, has a mass of 1230 MeV and a lifetime of about 10^{-20} second, and disintegrates into a neutral kaon, a positive pion and a negative pion. The **non-existing particle** is the ' quark ' or ' ace ' (see last month's *CERN COURIER*, p. 26). No trace of it at all was found in the CERN experiment, which was ideally suited to its detection if it exists. The only remaining possibility is that it has a very high mass. The analysis of the spark-chamber photographs was done by the **Hough-Powell device** (HPD), connected directly to the IBM 7090 computer. Over 200 000 photographs, each containing two views of each of nine spark chambers, were analysed 200 times faster and more accurately than by using the normal hand-operated digitizing apparatus.

Further details about all these events, as well as on the spark-chamber conference mentioned below, will be given in later issues of *CERN COURIER.*

From 3 to 6 March, an **' Informal meeting on filmless spark-chamber techniques and associated computer use '** was held at CERN. This assembled nearly 90 experimental physicists or engineers, some 20 representatives from European and American industrial firms, and people at CERN for a discussion on the latest developments in the use of spark chambers as detectors of nuclear particles. Instead of having to scan and measure thousands of photographs of spark patterns for each experiment, the physicists expect that soon it will be quite normal to have fully automatic equipment connected to a computer to give immediate results. The main techniques covered by the meeting were :

— ' vidicon ' sytems, using a television camera to view a more-or-less conventional chamber ;
— wire chambers, in which a set of fine wires, each threading some kind of ferrite core, is used instead of a flat plate as one electrode of the chamber ;
— sonic chambers, which use microphones to detect the noise of a spark and to locate its position in the gap.

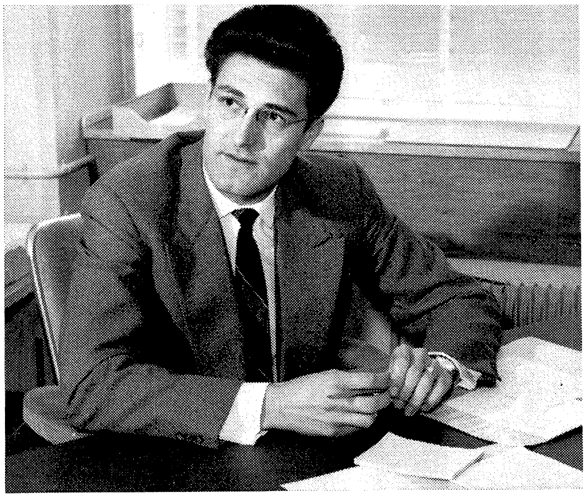
The **proton synchrotron** had another extra-long run, operating continuously from the early afternoon of 11 March until the evening of 26 March. The accelerator was then shut down until the end of April. Most of the run was devoted to the neutrino experiment and to pion and proton interactions in the 81-cm Saclay/École Polytechnique hydrogen bubble chamber. For this, in each cycle a small fraction of the accelerated protons, with a momentum of 20.8 GeV/c, was directed on to target M60 by means of the rapid beam deflector, and the rest continued to accelerate to 24.6 GeV/c before being directed on to the external target by means of the fast-ejection system. The c_8 beam, derived from the target M60, was also in use for test purposes. For the ' quark ' experiment, occupying two days, the proton momentum was 27.5 GeV/c and the o_5 beam (a new modification of the ' o ' series, accepting particles from target M60) was arranged to transmit pions of momentum 20 GeV/c, or ' quarks ' of one-third that momentum.

Some delicate emulsion exposures were carried out for a group from the University of Rome studying small-angle proton-proton scattering using the internal beam and a thin polyethylene target. For these the synchrotron had to be run at low intensity ; when the accelerator

Continued on p. 47

WHO'S WHO IN CERN

Pierre A. ZUMBACH



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Head of the Social Welfare Section

Pierre Zumbach was born in Geneva in August 1930 and, even if his name has a Germanic ring about it, comes from an old-established Geneva family. It was his great-grandfather who first settled in the city, attracted from his home in the Bernese fore-Alps by Lake Geneva and the developing watch-making industry.

After completing his secondary and university studies in Geneva, Pierre Zumbach was awarded a degree in social and economic sciences in 1952. While still studying, he had shown an ever-growing interest in educational and social problems, and as a student had taken an active part in various youth movements. Then, during a visit to Yugoslavia, he learnt of his appointment as Director of a welfare office founded 20 years before by protestant circles in Geneva. Given the task of re-organizing this institution, he transformed it into a welfare centre providing such services as legal and social advice, an employment bureau, an accommodation bureau, and liaison between various welfare institutions. He also helped to found new holiday camps and a home-help service.

Right from the beginning, close contact was established with the official bodies responsible for social and educational problems. This led the way to Pierre Zumbach's appointment, at the end of 1955, as 'tuteur général' for the canton of Geneva, a post which he held for eight years. As part of his duties he carried out numerous surveys and missions abroad — in Belgium, France and the U.S.S.R.; then in Cameroun, on behalf of the United Nations; finally, for the Swiss service of technical co-operation, in Algeria and again, at the beginning of this year, in Cameroun.

As 'tuteur général' he devoted himself to reorganizing the official service for the protection of children, applying with good effect the results of comparative studies in other parts of Europe. In 1962 he published a book on the theme 'Parents of to-day' (*Parents d'aujourd'hui,* Éditions de la Baconnière), which set out some practical considerations of current educational ideas and gave a lead for the formation of parents' associations. In passing, it should be added that Pierre Zumbach also found time to marry and now has three children.

Already in 1961, sent by the Geneva authorities to Toronto, Canada, for a period of study to complete his doctoral thesis, he had found himself more and more interested in the problems of community life. In another context, he had always considered that the life of Geneva was seriously threatened if the large proportion of foreigners living there contributed only to its economic prosperity. He is convinced that foreign residents, whether temporary or permanent, have much to offer to the cultural and social life of Geneva and that Geneva will not be able to survive and prosper without increasing its efforts to welcome and maintain close ties with them, adopting more readily this role of a clearing house for human relations in the centre of Europe.

So it was that Pierre Zumbach came into contact with CERN and became interested in the post of Head of the Social Welfare Section, formed to provide the greater attention, new approach and modern methods necessitated in matters of social welfare by the rapid increase in the Organization's staff.

Dr. Zumbach took up his duties on 17 February. He has given himself three or four months to become familiar with CERN, after which he intends to draw up a detailed list of matters he considers in need of attention. At the moment, he sees two main classes of problems:

1. Individual and family problems

He wishes to make it clear that the Welfare Service, which is part of the new section, is available to all. Every guarantee is given that the problems dealt with will be treated in the strictest confidence. The Welfare Officer, Mrs. L. Favre, looks after the enquiries, under Dr. Zumbach's supervision. The types of problem that arise will show in what way the service might be improved, but it seems that the need for home helps is becoming very acute in many CERN families. What steps could be taken to help mothers who are overloaded? Could a mutual-aid service be developed inside CERN? Or must professional services be used?

2. Problems of interest to the whole CERN community

Both within the Organization (welfare services) and in its external relations (contacts with the communities of Geneva and the neighbouring regions in France), Pierre Zumbach feels, subject to a more thorough study, that the wives of staff members could play a very useful part in inducing CERN people to take a keener interest in certain social activities in Geneva.

The Social Welfare Section is attached to the Personnel Division. Pierre Zumbach hopes also to work in close co-operation with the Staff Association, its president and its committee, especially the member responsible for welfare matters. He is in a position to study current problems from a practical point of view. He is also greatly interested in the efforts of the Residents' Association of the Satellite Town at Meyrin, which he considers one of the promising experiments in developing community life in Geneva. He is anxious that the section under his charge should become an information centre for welfare, scholastic and educational matters. For that reason he wishes to maintain close contacts with all the official and private bodies in Geneva and the Pays de Gex.

Pierre Zumbach has remarked on the interest shown in social questions by a large number of people in CERN, but he has a feeling that this interest could be more effective if it were more co-ordinated. This is why he hopes to benefit from the opinions, remarks and experience of all those who are willing to offer information and, all being well, to promote with his new section a more lasting collaboration. As he says, 'the results to be obtained in the future do not depend on magic formulae (and even less on the efforts of a single person), but much more simply on *team work,* tackling the problems realistically and forcefully' ●

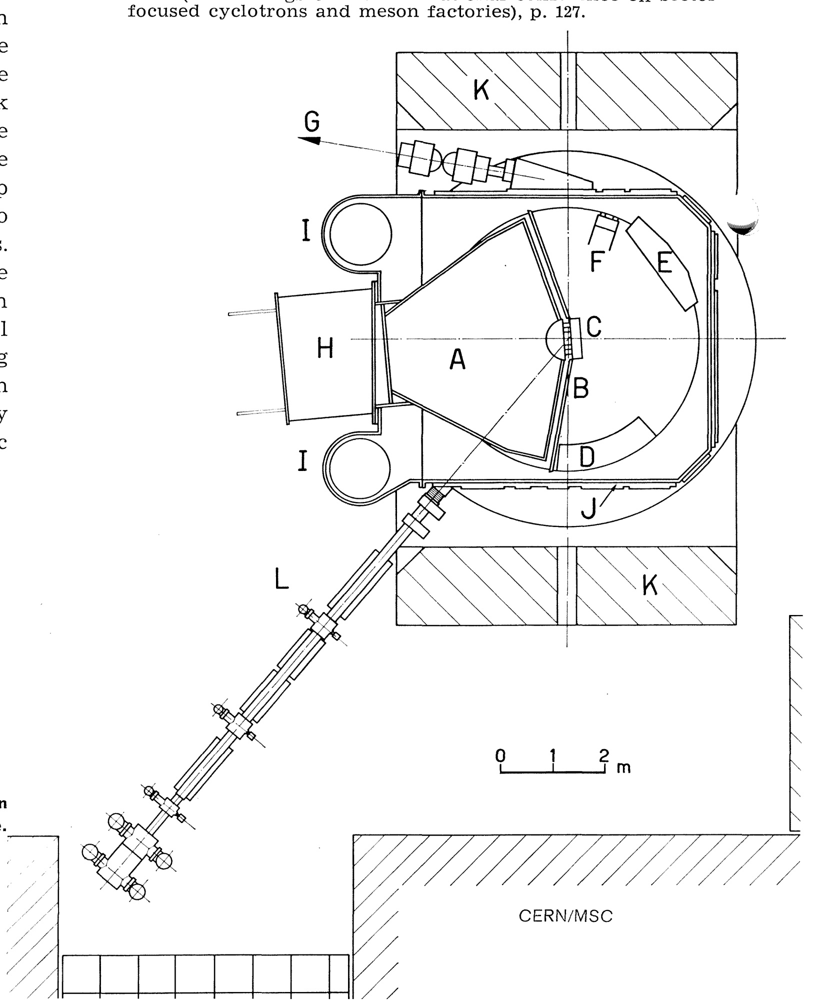
Shut-down at the SC

An account of some of the changes made to the CERN synchro-cyclotron during January and February 1964. The first part includes a brief explanation of the way in which high-energy protons are produced by the accelerator, and of the polarized-proton source, to be installed later on. The final section outlines some experiments aimed at increasing the intensity of the secondary beams produced by proton bombardment of internal targets.

As briefly mentioned in 'Last month at CERN' in the February issue of *CERN COURIER,* the Organization's 600-MeV synchro-cyclotron was shut down for several weeks at the beginning of this year, partly for routine maintenance but mainly to enable work to be carried out on a number of alterations to the machine.

SC Operation

Before going into details, it may be as well to recall the principal features of the acceleration system of the synchro-cyclotron (see fig. 1). Protons produced in the centre of the machine spiral outwards, in a horizontal plane, under the joint influence of the magnetic field and the accelerating electric field. During aprroximately half of each revolution the protons travel inside the 'dee', a hollow metal box so named because in early cyclotrons its top and bottom faces were shaped rather like a capital letter D. Facing the edge of the dee is the 'dummy dee', forming essentially a plate across the middle of the magnet gap with a central horizontal slot through which the protons pass (on the right in fig. 2). The dee is extended backwards out of the magnetic field and the end forms effectively one part of an electrical condensor, the other part being the prongs of the giant tuning fork (2 metres wide and 55 cm long) connected to the radiofrequency high-voltage supply. The dummy dee is earthed, as is one terminal of the radiofrequency supply : the voltage between dee and dummy dee thus oscillates from positive to negative at the frequency of the supply, with the result that protons always go from a more positive to a more negative voltage in crossing the gap and are thereby accelerated. Movement of the tuning-fork prongs varies the frequency of the accelerating voltage betweeen about 30.1 Mc/s and 16.4 Mc/s, keeping the voltage reversal between dee and dummy dee in step with the increasingly longer time taken by protons to complete half a revolution as their energy increases. In this way 55 bursts of protons are produced by the accelerator each second. These are either directed on to a target inside the machine or ejected as an external beam. The whole of the accelerating system, including the tuning fork, is housed in a stainless-steel vacuum tank, the pressure being kept at about 10^{-6} torr (nearly a thousand million times less than normal atmospheric pressure) during operation.



A = dee
B = dummy dee
C = position of liquid-nitrogen tanks
D = pulse lengthener (stochastic C)
E = regenerator
F = magnetic channel
G = external beam
H = housing for tuning fork, etc.
I = vacuum pumps
J = vacuum tank
K = magnet yoke
L = position of polarized-proton source

1. Simplified plan of the synchro-cyclotron showing some of the main components and the future position of the polarized proton source.

Polarized-proton source

The major task during the shut-down was to make preparations for the installation at a later stage of the polarized-proton source, under development in the MSC Division.*

A fundamental property of every proton is its 'spin', a concept of quantum mechanics analogous to the spinning of a top about its central axis. In a normal proton beam the axes of spin are oriented in all directions, but in many cases experimental results (of proton-proton scattering, for example) could be interpreted much more clearly if all the axes were parallel and all the protons spinning in the same direction. The polarized-proton source is aimed at producing such a 'polarized' beam.

To obtain an ordinary proton beam, as in the present use of the accelerator, hydrogen gas is fed to the centre of the machine, where the molecules are broken into atoms and ionized by electrons in the 'ion source'. (Protons are the nuclei of hydrogen atoms — atoms that have lost their corresponding electrons.) To produce polarized protons, on the other hand, much more complicated apparatus is required, which will have to be mounted outside the cyclotron vacuum tank. The

* See, for example : L. DICK, Ph. LÉVY, J. VERMEULEN, Characteristics of the CERN polarized-proton source, CERN 63-19 (Proceedings of the international conference on sector-focused cyclotrons and meson factories), p. 127.

first stage of the polarized-proton source consists of a radiofrequency discharge in hydrogen gas, which splits up the molecules but does not lead to much ionization. After this, the atoms stream out through a 'Laval nozzle' in the form of a jet and then pass through a set of powerful quadrupole magnets some 6 metres long. In the non-uniform field of these quadrupoles the atoms behave in four slightly different ways, depending basically on the relationship between the spin of the nucleus and that of the orbital electron of each one. In two cases the paths of the atoms diverge whilst in the other two they converge to a focus. The two focal spots are in different places, so that a diaphragm inserted at the end of the magnet enables atoms of only one state to be selected.

At this point, after the source has been installed, the atoms will enter the gap between the magnet poles of the SC. Since the atoms are all of the same kind, the action of the magnetic field will be the same on each one, aligning all the spins in the same direction. Then, at the centre of the machine the atoms will again be ionized by collision with electrons, leaving polarized protons ready to be accelerated.

To achieve good results, the atomic beam has to arrive precisely at the centre of the accelerator, and the ionization has to be carried out in a region of very low temperature. This is to reduce the number of residual molecules of water that are present in the tank even at low pressure, so that they cannot act as a competitive source of unpolarized protons.

It is proposed to keep the central part of the accelerator at this necessary low temperature by two tanks filled with liquid nitrogen, fastened to the dummy dee and connected by twelve sapphire rods, each 20 cm long and 2 cm in diameter, to two small auxiliary dee electrodes inside the main dee. The sapphire rods are good conductors of heat, which means that the auxiliary dees will also be kept at low temperature, but poor conductors of electricity, so that the radiofrequency voltage applied to the dees will be prevented from appearing on the liquid-nitrogen tanks. To make these changes possible, the whole of the former dummy dee was removed during the shut-down and a new one, manufactured in CERN's central workshop, installed in its place. This new dummy dee is in six parts (three above and three below the central aperture) and the two central parts can be removed for the installation of the liquid-nitrogen tanks. Because the tanks themselves will be quite heavy, special supporting rails had also to be installed on the magnet poles, to facilitate their insertion and removal and to support the upper one during operation.

To allow the polarized protons to be fed into the central area, holes were cut in the dee and dee liner, and a new cover plate had to be manufactured for one of the ports in the side of the vacuum tank, containing the appropriate apertures with temporary covers. This was installed during the shut-down. Also, the future path of the polarized protons outside the cyclotron was determined by optical aligment and suitably marked. Foundation pads were set into the floor, ready to receive the whole apparatus when it is ready.

After other work had been completed and the machine reassembled, various tests were carried out on the modified system. In particular, when mock-ups of the liquid-nitrogen tanks were installed in the centre section of the dummy dee, it was found that there was no diminution in the accelerated beam current.

CERN/PI 47.2.64

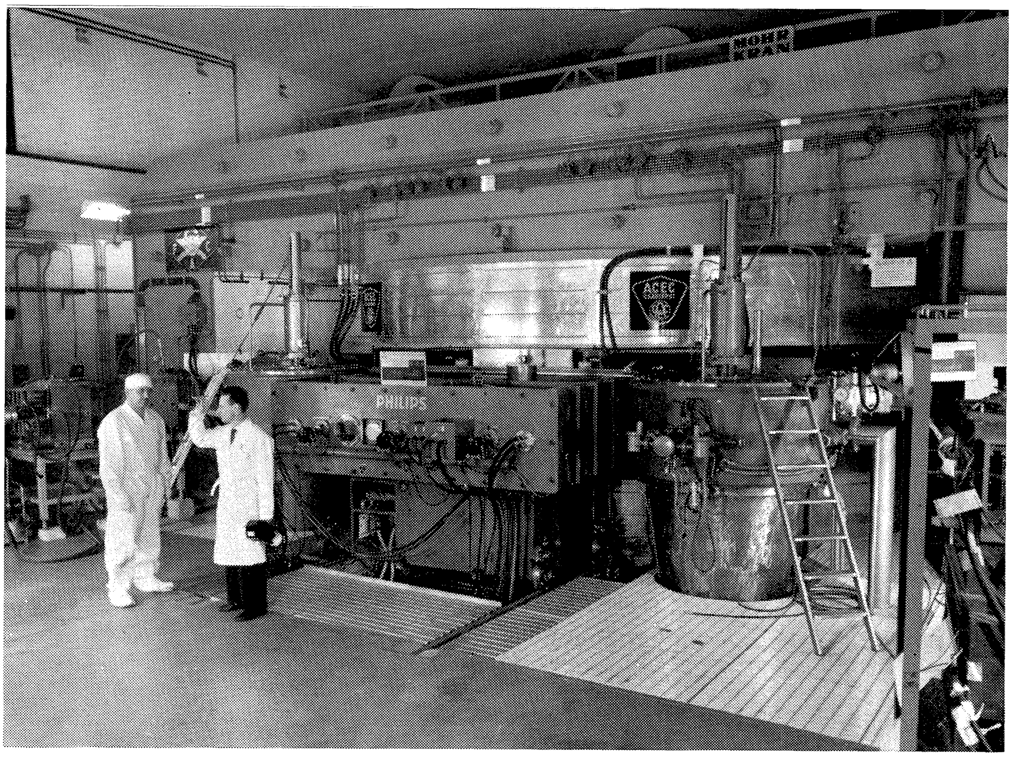
2. Because of the radioactivity inside the cyclotron vacuum tank, work there has to be carried out quickly and accurately. This is not helped by the narrowness of the gap between the two magnet poles, as this picture shows.

Magnetic-field measurements

Various studies at CERN and elsewhere have shown that the intensity and quality of the accelerated beam in a synchro-cyclotron is highly dependent on the precise conditions at the centre, where the protons have low energy and need to be guided carefully on to the right orbit. Although the magnetic field of the SC was thoroughly surveyed in 1955-56, during construction of the accelerator, many changes have been made since then, the effects of which have had to be estimated. Moreover, much more accurate measurements are now possible, and so the long shut-down was seized upon as a good opportunity for a new survey of the central area.

The measuring system depended on the 'Hall effect', which arises when a current-carrying conductor is placed in a magnetic field, with the current flowing at right-angles to the field lines of force. A voltage appears across the conductor, perpendicular to both the direction of the current and of the field and with a magnitude proportional to the field. Hall generators of the semi-conducting materials indium arsenide or indium antimonide were used, since they give a large effect. Measurements were made in the mid-plane of the synchro-cyclotron gap, for distances between 0 and 40 cm from the centre and along different diameters, to cover the whole circular area. Eight different settings of the magnet current were used, over the range 1700-2400 A. To eliminate the effects of fluctuations in the overall magnetic field or in temperature, the field at each point was measured by comparison with that at a fixed position in the centre. The difference in the voltages from the two Hall generators was plotted automatically by a recorder, to show the variation of the field along each particular diameter.

At the same time, the absolute value of the field, at a chosen point, was measured to a high degree of accuracy



3. **Radiation control : Rodolph Deltenre, portable radiation monitor in one hand, checks the reading of the pocket dosimeter issued to Marcel Stucki while working inside the machine hall of the synchro-cyclotron. Stretching across the picture is the magnet of the accelerator with one of the two circular excitation coils clearly visible. The housing for the tuning fork and associated apparatus projects from between the coils in the centre of the picture ; to the right is the top of one of the large diffusion pumps, the lower part of which is in the room below.**

by means of a fluxmeter using the principle of nuclear magnetic resonance.

New cables ; electrical and vacuum systems

A great many new cables were laid, for carrying heavy electric currents or small electric signals from experimental apparatus. From the co-axial-cable distribution centre under the SC control room a complete set of signal cables was installed for the new counting room no. 4. In the other direction, special low-loss cables and 30-lead cables for control signals were taken from the distribution centre to the proton experimental room, and some supplementary cables were added for the cyclotron hall. Here also, new cables were installed in preparation for the polarized-proton source. Additional heavy-current cables were put in for beam-transport magnet power supplies, together with a new secondary distribution board. Work was also carried out on the generators for the magnet currents and on the ventilation system of the main generators for the SC magnet. A new alarm system * to show malfunction of any part of the SC was completed.

The system for degassing cooling-water supplies was finished. All the water pumps and vacuum pumps in use were overhauled, and new pump sets were made up for attaching to secondary-beam tubes so that they can be evacuated if desired. Again as part of the preparations for the polarized proton source, for which a better vacuum inside the tank is desirable, a complete set of new vacuum pipes, with lower flow resistance, was installed between the mechanical pumps and the two large diffusion pumps.

Radiofrequency system

With every new improvement in the synchro-cyclotron over the years the amount of associated radiofrequency equipment has increased and the space available has become ever more crowded. During this shut-down, the complex switching system for starting up the equipment was rearranged, and some of it replaced by new units, so as to occupy much less space. Extensive changes included modifications to the main control desk, with a revised arrangement of control buttons and interlock indications, linked with the new alarm system.

Other work, apart from general maintenance, included the installation of more items in the new equipment room first taken into service in 1962, where an improved radiofrequency installation is now more or less complete.

Just before the shut-down, one of the support springs for the tuning fork broke, and so all three were renewed as a precaution. Since the fork was first installed, the minimum gap between the prongs and the stator connected to the dee has been reduced to less than half its original value, because of the greater range of frequencies now required by the accelerator. The position of the fork is thus more critical than before, and was checked again carefully. It is of interest to note that this fork, machined from a solid block of aluminium, has now operated for a total of some 30 000 hours.

Targets

Over the years that the SC has been in use, many different target units have been manufactured and introduced into the machine to act as sources of secondary beams. All these were removed during the shut-down, inspected and repaired.

This work, like much else, was complicated by the fact that the targets were radioactive. To enable them to be handled safely, a shielding enclosure was constructed in the proton room out of concrete blocks and then a whole series of people carried out the necessary work, two at a time, changing every six hours.

Radiation control

The whole of the work in or near the accelerator was, in fact, complicated by the residual radioactivity that is always present after the machine is switched off. Because no-one is allowed to receive more than a certain dose of radiation over a given period of time, many of the jobs had to be shared among a number of people and

* F. HOFFMAN, Un nouveau système d'alarme général, CERN 64-7.

everything had to be planned very carefully in advance, with close supervision during the actual shut-down. Fortunately, the intensity of the radiation dies away steadily at a rate that is known fairly well from past experience. Also, records are kept of the dose received by everyone at CERN exposed to radiation. Close co-operation between the MSC groups, Health Physics and the Workshops then enabled the programme of work to be drawn up and when the time came everything went ahead smoothly.

Altogether, 217 men took part in the work, the largest numbers being drawn from the central workshop and the cleaning staff, apart from the various SC groups. Before entering the controlled area, each one was issued with suitable protective clothing, a pocket dosimeter and a film badge. At the end of his allowed period of work (based on his previous total radiation exposure), he was replaced by someone else who carried on with the job. Reading of the dosimeter indicated at any time the additional dose of radiation he had received, and later measurements on the film badge provided a further check. Inside the tank, where, at some places, the radiation intensity was at first high enough to deliver a year's permissible dose in less than an hour, work was not started until nearly a month after the shut-down began. Even so, in the worst areas working periods of only ten to fifteen minutes per week (per person) were permissible. In this way, however, the average exposure during the two months of the shut-down was kept to rather less than 0.6 rem, compared with the maximum value of 3 rem allowed over any period of 13 weeks.

As mentioned above, some parts were removed from the accelerator and dealt with in specially erected enclosures in the proton room. A certain amount of machining of radioactive pieces was also carried out, using portable tools enclosed in plastic covers and aspirators to collect any dust. The activity of these parts was not very high, but the tools are not used for ordinary purposes so as to avoid any possibility of their contaminating apparatus built for experiments.

Besides being responsible for checking people in and out of the controlled area (683 controls in all), the Health Physics Group made periodic surveys for the radiation intensity and checked for radioactive dust in the atmosphere.

Technical development

Although the shut-down proper came to an end on 19 February, the accelerator was not used again for physics experiments until 6 March, the intervening period being used to continue a series of investigations aimed primarily at increasing the intensities of the secondary-particle beams without adding to the accelerated proton current.

It has been found that for low-energy pions the intensity of the secondary beam from an internal target could be practically doubled by using a thinner 'window' in the side of the vacuum tank. The loss caused by the window is due to scattering of pions out of the beam, and some further gain appears to be possible by placing the entire length of secondary beam under vacuum. The strength of the pion beam was shown also to depend strongly on the size of the beam pipe, and it is foreseen that another increase by a factor of three can be obtained by enlarging the pipe diameter from 14 cm to 20 cm. The latter in particular would involve a great deal of alteration to the existing equipment, but it is hoped that these various improvements can be made during the next twelve months or so.

Up to now the 'regenerator' and 'magnetic channel', which together make up the system for extracting the primary proton beam, have been fixed in position inside the accelerator's vacuum tank. To see what effect this equipment has on the intensity of the beam, when the beam is not being ejected but directed on to an internal target, comparison runs of the accelerator were made before and after the pieces were replaced. Whilst the regenerator was found to have no effect, the presence of the magnetic channel was seen to reduce the secondary beam by some 40 %. It is now proposed to modify the mounting of the magnetic channel so that it can be moved into a less harmful region when not in use.

Besides the tests on the modifications for the polarized-proton source, already mentioned, all the target assemblies that had been cleaned and repaired were tested in the accelerator during this time ●

Last month at CERN (cont.)

and the target were properly adjusted the beam had to be cut off, the emulsions introduced into a special vacuum tank and left for about an hour until full vacuum was again achieved, and the beam then brought immediately back on to the target. Only a few beam pulses were necessary to irradiate the emulsion and too many would have created an excessive background. A similar experiment was tried in February, by a mixed group from DESY (Hamburg) and CERN, but they used the fast-ejected proton beam, the extremely narrow spread of which enabled a target of hydrogen gas to be used. Although scheduled as a test, this preliminary exposure was so successful that the results will be included with those of future exposures in the final results. Another emulsion exposure, carried out in March in the o_4 beam, was for the study of hyperfragments produced by negative kaons of momentum 5 GeV/c.

With effect from 1 March, **Pierre Lapostolle,** leader of the Synchro-cyclotron Machine Division since the beginning of 1961, has transferred to the Accelerator Research Division, where he is leading a new Study Group set up to investigate the design of a more powerful **injector for the CERN proton synchrotron.** At present, protons are injected from the linear accelerator with an energy of 50 MeV and many of them are lost during the first few revolutions in the synchrotron, owing to the relatively greater fluctuations in the guiding magnetic field when it has a low value and the appreciably larger effects of repulsion between particles at the beginning of the cycle. To overcome these difficulties, it has been proposed that a new linear accelerator should be designed and installed so that protons can be injected at 200 MeV. Much higher intensities of the final accelerated beam should then be possible.

A successor to Dr. Lapostolle has not yet been appointed, but **Pierre Germain,** in his capacity as leader of the Proton Synchrotron Machine Division, will act also as leader of the MSC Division until June ●

BOOKS

Direct interactions and nuclear reaction mechanisms, edited by E. Clementel and C. Villi (New York, Gordon and Breach, 1963 ; $ 39.50).

This book, of about 1200 pages, contains the proceedings of the conference with the same title held at the Institute of Physics, University of Padua, 3 - 8 September, 1962.

The editors point out that they have tried to compile the proceedings in such a way that they do not appear simply as a succession of the papers presented at the conference, but rather as a comprehensive book on direct interactions and nuclear reaction mechanisms, written, as it were, by the conference itself.

The book is divided into ten chapters, each of which begins with one or more 'invited' papers followed by selected research contributions and abstracts of all papers that could not be printed in full because of space limitations. Also included are the discussions following the different papers presented.

Perhaps the best way of giving an idea of the scope of this book is to give the titles of the chapters and some of the respective invited papers. Thus, Chapter I is about 'direct interactions and nuclear structure' and contains, among others, an invited paper by T. Ericson on 'pion capture and nuclear structure'. In Chapter II, the generalized optical model is discussed, with contributions on the distorted-wave theory of direct reactions. Chapter III is entitled 'direct interactions and compound-nucleus processes', including a paper with the same title by H. Feshbach, while in Chapter IV the possibilities for distinguishing direct reactions and compound-nucleus reactions by time-delay measurements are discussed (notably by T. Ericson, R. M. Eisberg and H. Feshbach). Chapter V deals with 'stripping and pick-up reactions'. Chapter VI, 'polarization in direct reactions', includes invited papers dealing with polarized ion-sources (E. Baumgartner) and polarized targets (L. J. B. Goldfarb and D. A. Bromley). In Chapter VII, 'direct interactions and inelastic scattering', there is a paper about inelastic excitation of collective modes, by J. S. Blair, and in Chapter VIII, 'direct reactions between complex nuclei', A. Zucher gives a review of the present state of this field. Chapter IX is called 'direct interactions other than stripping', which is another way of saying that there is no good theory available for the sort of reactions that are discussed, that is, reactions such as (p, α) or (α, n). Finally in Chapter X are collected the reports on 'direct reactions at high energies', which here means energies above 100 MeV. An invited paper by L. R. B. Elton, dealing with the 100 - 200 MeV region, is included, as well as one by A. E. Glassgold covering the 'very high-energy region, that is, above 1 GeV.

It is interesting to note that only one out of the ten chapters (with the exception of Ericson's paper in Chapter I) deals with nuclear reactions at high energies, in spite of the fact that the first direct reactions to be studied were carried out in this region, by Serber and co-workers at the 184-in synchro-cyclotron in Berkeley in 1946. During the last 10 years, however, the overwhelming amount of work in this field has been conducted at lower energies, in the MeV and tens of MeV range, with Van de Graaff accelerators and conventional cyclotrons.

The book finishes with a 'conference summary' by J. S. Blair, in which he points out that although nothing emerged during the conference to shake our basic picture of nuclear reactions — the dominating ideas still being the generalized optical model on the one hand and the statistical theory on the other —, the general picture was one of steady progress.

The layout, printig and illustrations of the book all help to support the impression that it is in fact the comprehensive book in this field that the editors wanted it to be. Unfortunately the price will certainly limit the number of prospective buyers.

Jan Kjellmann

Repair from genetic radiation damage, and differential radiosensitivity in germ cells, edited by F.H. Sobels (Oxford, Pergamon Press Ltd., 1963).

This book gives the papers presented, together with the subsequent discussions, at the International conference on repair from genetic radiation damage held at Leiden (Holland) in August 1962 ; altogether 24 reports were presented by experts in radiobiology. Most of the papers deal with experiments on the mutations caused by irradiation of the cells of certain insects (particularly the 'Drosophila', an insect of the Diptera family, also known as the 'fruit fly'), mice and plant seeds, and also on the possibility of increasing or reducing the frequency of these mutations and of repairing the damage.

Recent studies of the effects of radiation seem to show that biological mutations start with a direct absorption of energy which, in successive stages (molecular impairment or injury of the chromosome, onset of molecular injury, occurrence of spontaneous molecular changes) leads to changes which can be detected. The process can be stopped at any of these stages in different ways, consequently reducing the harmful effects.

The final report by R. Kimball, who sums up the present state of knowledge in this research field, can be read with interest even by those with only a general knowledge of radiobiology.

A. Rindi

International scientific organizations, compiled under the direction of K.O. Murra (Washington, U.S. Government Printing Office, 1962 ; $ 3.25).

Although international scientific collaboration is one of the topics of the day — and not only at CERN where one finds a living example — it is none the less difficult to imagine how many scientific bodies, governmental or otherwise, may lay claim to the title 'international'. Before examining the book under review the reviewer asked himself just this question. The answer is not 'a hundred' but at least 449 — in February 1962, when the manuscript of the book, begun in 1959, was completed. At that time the authors had probably not been told of the creation of ESRO (European Space Research Organization) and ESO (European Southern Hemisphere Observatory).

On the whole this well-bound book of almost 800 pages is an excellent source of information for anyone seeking quick documentation on one or other of the scientific institutions of international character. It must be noted that 'scientific' is given a wide interpretation and includes both technological fields and those related to agriculture and medicine : from the 'Advisory Group for Aeronautical Research and Development' to the 'Zinc Development Association'. Since the work is above all a 'guide to the library documentation, and information services' of the organizations concerned, the reader is also provided with references to the best sources of additional information. Similarly one finds listed under each organization details of its periodical publications and the conferences it holds. In fact, the 449 organizations listed are those that, among the 781 contacted, indicated that they had such information services and conferences. Each entry includes the date of its composition (a useful detail) and the book contains a comprehensive index (preceded by a list of the acronyms used by the various organizations). CERN is included under 'European Organization for Nuclear Research'. Incidentally the list of acronyms provides some mild entertainment : AIL, CAB, FAGS, FIT, SCAR and SITS have not quite the same meaning as one might imagine at first glance !

This volume, prepared by the International Organizations Section of the American National Science Foundation, may be compared with a similar work, *Annuaire des Organisations Internationales,* published by the 'Union des Associations Internationales', Brussels.

R. A.

Also received

The quantum theory of many-particle systems, edited by H.L. Morrison (New York, Gordon and Breach Science Publishers Inc., 1963 ; $ 4.95) - volume 2 of the *International science review series;* reprints of important papers showing the development of the subject from 1954 to 1961.

Nuclear engineering abstracts (London, Silver End Documentary Publications Ltd., 3 issues per year, annual subscription £ 9 9 s. 0 d.) — not just another abstract bulletin containing 'synopses' of the usual kind, but an attempt to provide fully documented summaries of progress in the chosen field ; accelerators, particle detectors, etc. are covered in the section on research tehniques, instrumentation and testing methods ; publications scanned range from specialist journals to daily newspapers, mostly in Europe and the U.S.A. ; each issue covers a specific period of time with a nominal delay of 9 - 12 months, although publishing difficulties have currently doubled this.

Plasma physics and thermonuclear research, vol. 2, edited by C.L. Longmire, J.L. Tuck and W.B. Thompson (Oxford, Pergamon Press Ltd., 1963 ; £ 5) — second volume of *Progress in nuclear energy, series XI* ; a collection of twelve papers, mostly describing progress since 1958 although two of them are previously unpublished notes dating from the 'classified' era of 1954 ; good author and subject indexes and list of contents of volume 1.

Operator techniques in atomic spectroscopy, by B.R. Judd (London, McGraw-Hill Publishing Company Ltd., 1963 ; 77 s.) — a detailed description of the modern theory of atomic spectroscopy, based on the use of continuous groups as introduced by Racah ●

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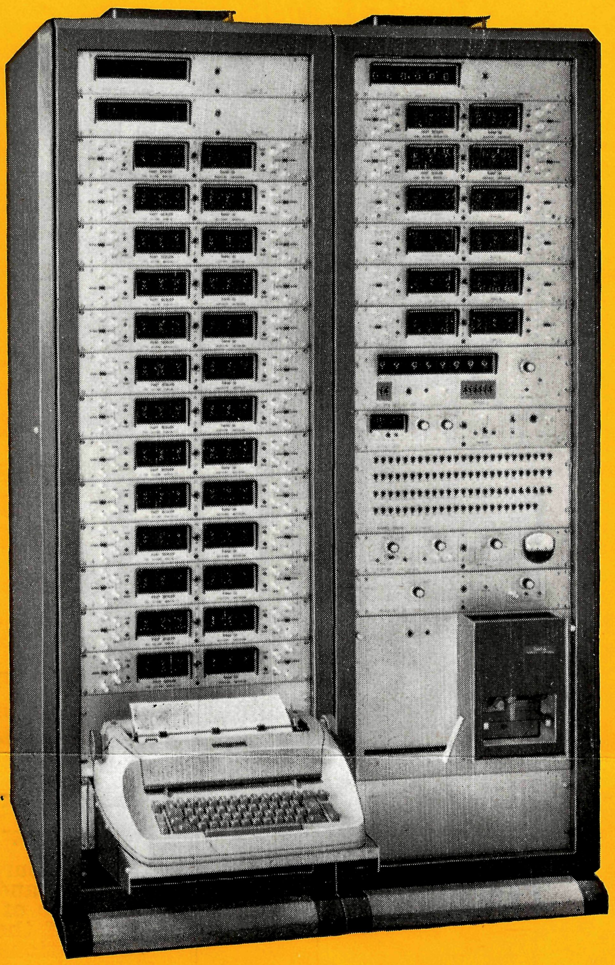

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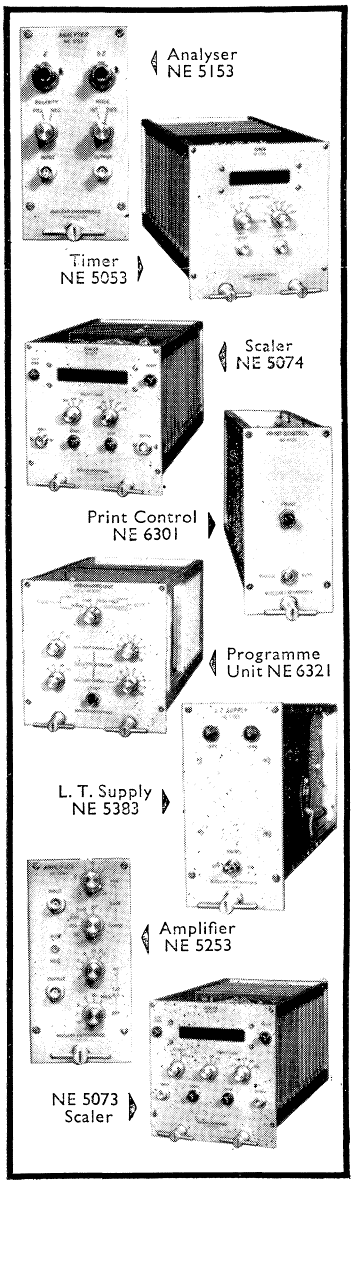

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