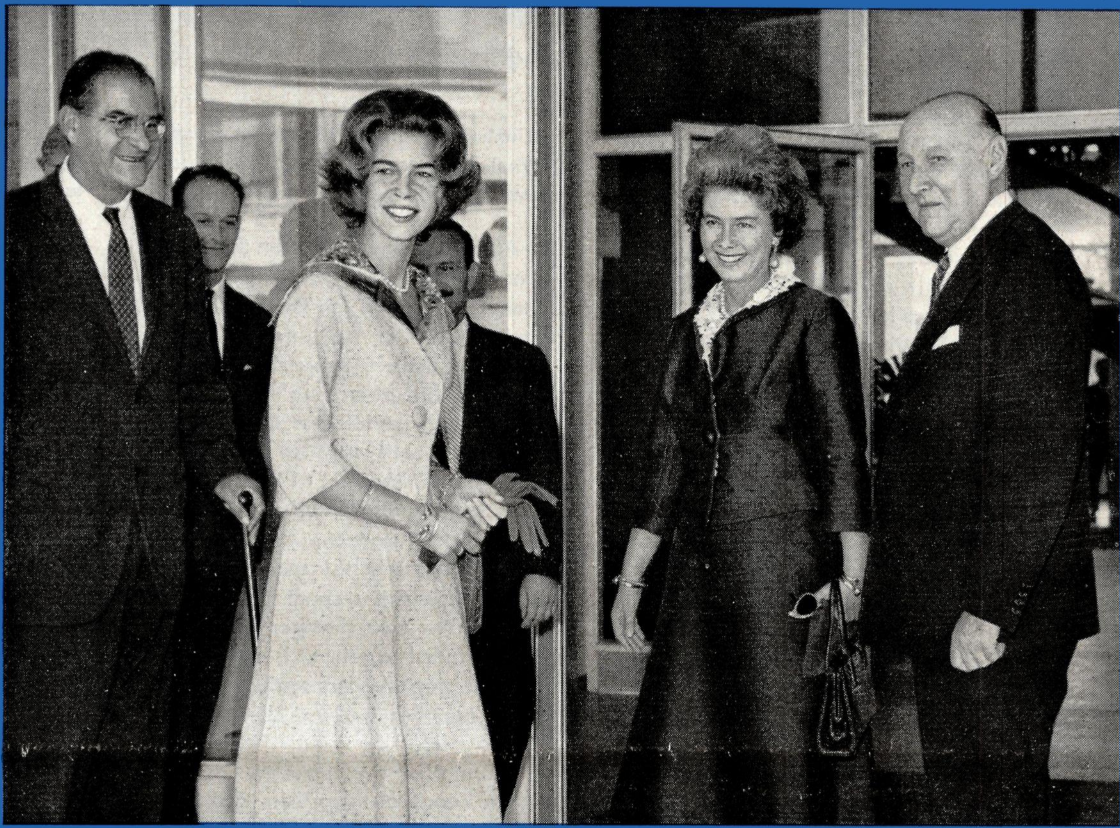
CERN COURIER



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VOL. 2

October 1962

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 (1.90%), Belgium (4.07), Denmark (1.95), Federal Republic of Germany (19.15), France (20.81), Greece (0.60), Italy (9.90), Netherlands (3.77), Norway (1.58), Spain (4.21), Sweden (4.15), Switzerland (3.23), United Kingdom (24.68).
The budget for 1962 is 78 million Swiss francs.

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.'

Last month at CERN

On 20 September, CERN was honoured by its second Royal visit this year, when **H.M. Queen Frederika of Greece** and her daughter, Princess Irène, spent the whole day at Meyrin (see p. 3). 'I have learned a great deal', Queen Frederika wrote in a letter of thanks to S.A.ff. Dakin, CERN's Directorate Member for Administration. 'I was very much impressed by the co-operative spirit among all the scientists, no matter what the nationality. What a wonderful example to be studied and learned by all of us !'

At the **proton synchrotron** the first full month of the shut-down period saw many changes. At the East junction, the first pneumatic drill penetrated the tunnel wall on 4 September, while on the other side of the ring two major jobs were being carried out in preparation for next year's **neutrino** experiments. The careful alignment of the accelerator ring magnets was disturbed for the first time, when magnet unit no. 1 was removed so that the vacuum chamber in the adjacent magnet could be replaced. The new chamber, which has a larger radial aperture, is required for the **fast ejected-beam system** which will be installed in the next shut-down. All existing shielding over a large area of the South hall was removed, and installation begun of more than 4000 tons of iron ingots, to provide the dense shielding necessary to stop all particles except neutrinos from reaching the bubble-chamber and spark-chamber detectors which will be used in the experiments. Preparatory work was also being done in the target area for the installation of beam-transport equipment needed for the ejected proton beam.

Most of the existing **beams** were dismantled, and work begun on setting up the new ones. In the beam k_2 (see CERN COURIER **2** No. 7, p. 2) the Cresti electrostatic separator was replaced by a new 3-metre separator made by NPA Division. The separated antiproton beam (m_1) was being rebuilt to include two of the CERN 10-metre separators — one inside the ring shielding as well as the existing one outside. This new beam, which will be known as m_2, is designed to produce separated beams of K-mesons as well as of antiprotons or pions.

Both the 81-cm Saclay/École Polytechnique **hydrogen bubble chamber** and the CERN/E.T.H. **cloud chamber** were moved to the North hall.

These are only a few of the many jobs carried out, but we hope to give further details in a later issue.

During September also, work progressed rapidly on the new hall, 120 m long, 42 m wide and 20 m high, being erected on the apron in the **East experimental area,** which is now expected to come into limited use next year. Installation was completed of the generators for supplying power to the bubble-chamber magnets and beam-transport equipment in this area, and tests were carried out using the newly completed magnet for the CERN 2-m chamber as load.

Building work continued also on many other parts of the site (see pages 6 and 7 of this issue), and excavations were begun for Laboratory 4, adjoining the Library wing.

Among other activities at the **synchro-cyclotron,** a visiting team from the University of Durham carried out an experiment on the scattering of 300-MeV negative pions by various nuclei. Nuclear emulsions placed in a magnetic field were used to detect the scattered particles and to provide information on their energies.

Many members of the CERN staff attended **conferences** or gave **lectures** in various countries during the month, and the following notes are representative rather than comprehensive :

Four members of the MPS Division **(J. Geibel, P. Germain, H.G. Hereward, G. Munday)** and two nuclear physicists **(R. Armenteros, B.J. Hyams)** visited Brookhaven National Laboratory from 9 to 14 September. There they had informal discussions with their colleagues of the alternating gradient synchrotron on problems of common interest connected with the future exploitation and development of the two machines (AGS and CPS). Much of the talk centred on plans for ejected beams and neutrino experiments; the AGS people hope to have their fast ejection system in operation in July 1963. Although nothing strikingly new emerged, a lot of interesting information was exchanged at first hand, and they hope

Continued on p. 9

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The cover photograph was taken at the entrance to the Administration building on 20 September, just after the arrival of H.M. Queen Frederika of Greece for a day's visit to our Organization. From left to right are Prof. V.F. Weisskopf, Director-general, H.R.H. Princess Irène, H.M. Queen Frederika, and Mr. J. Willems, President of the CERN Council.

Photo credits : photos at top of pp. 8 and 9 by K.-M. Vahlbruch ; all others by CERN/PIO.

CERN COURIER

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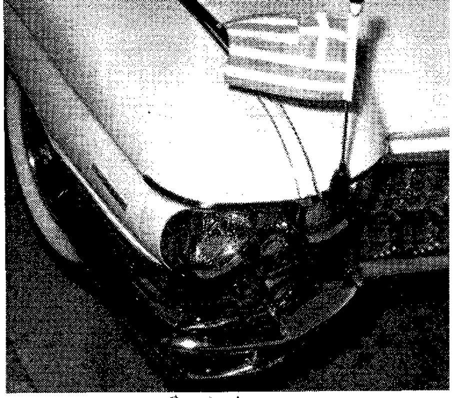
A Queen at CERN



Visit of H.M. Queen Frederika of Greece, 20 September

On the morning of Thursday, 20 September something special was afoot at CERN. In brilliant sunshine, next to the route de Meyrin two guards were engaged in hoisting the flags of the thirteen Member States. The red pilot jeep left its garage and headed for Geneva. Cleaners were busy all over the site.

Her Majesty Queen Frederika of Greece was coming to visit CERN.

The Queen, whose interest in physics is widely known, had expressed her desire to spend a whole day at Meyrin to see the laboratory and to talk to the men and women who run it.

Her Majesty arrived at 10.40 a.m. in a long white car bearing the blue and white flag of Greece. She was accompanied by her youngest daughter, Princess Irène, who was the first to be seen, alighting eagerly from the car. The royal party consisted of Admiral P. Leloudas, High Chamberlain, Prof. Th. Kanellopoulos, Scientific Director of the Greek Atomic Energy Commission and former staff member of CERN, Mr. A. Vlachos, Permanent Delegate and Consul-general of Greece in Geneva, Mrs. Vlachos, and Mr. A. Petropoulos, Consul.

Mr. Jean Willems, President of the CERN Council, welcomed the Queen on the steps of the Administration Building and escorted her to the Director-general's Conference Room. Here the President told Queen Frederika what a great pleasure it was to welcome to Meyrin the Sovereign of 'a noble country which has played an active part in CERN from the very beginning'.

He then presented to the Queen the members of CERN who were present on her arrival : Prof. V.F. Weisskopf, Director-general, 'to whose drive CERN owes its dynamism', Mr. S.A.ff. Dakin and Dr. M.G.N. Hine, Members of the Directorate for Administration and Applied Physics respectively, and Mr. R. Anthoine, Head of the Public Information Service.

There followed an introductory talk on CERN, given by the Director-general, the Queen asking frequent questions concerning both the technical and scientific aspects of the organization's work.

From the roof of the Administration Building the Queen and her party had a first general impression of the site, lying at their feet in the September sunshine.

The visit to the laboratory then began with the proton synchrotron — of 28 thousand million electronvolts and the biggest nuclear-physics instrument in Europe. A. Asner showed the Queen the large generator, the main component of the d.c. power supply for the 100 electromagnets of the accelerator. The shut-down of the machine had occasioned a thorough overhaul of all its components, including the generator ; this had been completely dismantled and its components were open to inspection just as they would be at a technical exhibition. It was a pleasant surprise for the technicians here to see such a distinguished and unexpected observer taking an interest in their work.

Passing through the rectifier room and the control room, the party arrived in the neighbouring target area of the synchrotron. Here P.H. Standley explained the operation of the big accelerator to the visitors. To facilitate the installation of the fast ejection system for accelerated particles, magnet unit no. 1 had been moved inwards from the ring, and the visitors were thus able to see in detail the ring beam supporting the accelerator, the vacuum tank, and the electromagnet itself.

Before entering this target area, where the residual radioactivity after experiments is at its highest, the Queen and her suite received from Christian Raffnsøe

1

Queen Frederika, followed by her daughter Princess Irène, is greeted by Prof. V.F. Weisskopf on her arrival.

2

P.H. Standley shows the Royal visitors the generator room of the proton synchrotron.

3

the usual film badges for measuring the radiation received. Incidentally, this was found to have been under 1.5 millirem, or 3300 times less than the authorized annual dose.

The visitors then went to the main control room, where three Greeks from the MPS Division — B. Agoritsas, A. Cheretakis and C. Patatoukidis, after being presented to their Queen, talked to her about their life at CERN. Passing through the counting rooms, the visitors reached the 'visitors' platform' above the South experimental hall. There Prof. Preiswerk explained the layout of the secondary particle beams which were to be installed ready for the resumption of experiments on 23 October. A small group of members of the CERN staff had gathered in the South hall, and while the Queen had an excellent general view of the hall, interested spectators had a good opportunity of observing the royal party.

Her Majesty the Queen then went into the workshops of the South hall, where H. Faissner and F. Krienen showed her the components of the spark chambers intended for neutrino physics. This new branch of physics seemed to be of considerable interest to the Queen. She had already asked Prof. Weisskopf a great many questions on the subject during his introduction ; later, Prof. Preiswerk gave a long account of the recent experiments at Brookhaven. In the South hall, G. von Dardel, co-ordinator of neutrino research at CERN, showed the Queen the shielding for the detectors — shielding consisting to a large extent of iron billets

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belonging to the Swiss Government and lent to CERN to help in the performance of future experiments.

By means of enlargements of track photographs, the use of bubble chambers in nuclear physics was explained to Queen Frederika and Princess Irène by J. Trembley. F. Pénet was also at hand to show the 81-cm Saclay/École Polytechnique chamber which was about to be brought into the North hall.

C. Ramm then gave the visitors details of his 1-m heavy-liquid chamber which is to take part in the next neutrino experiments, after which the royal party went through the linac hall and the synchrotron inflection area towards the North hall. On their way they had a look at the Faraday cage, one of the accelerating cavities, a pick-up electrode, and survey pillar no. 3.

After an aperetif, a lunch was given at CERN in honour of the Queen. The other guests, apart from CERN personalities, were Mr. P. Gottret, representing the Federal authorities, Mr. A. Ruffieux, 'Conseiller d'État' of the Canton of Geneva, and Mr. L. Billy, Vice-president of the 'Conseil administratif' of the City of Geneva.

Lunch was followed by an informal discussion for an hour or more in the Pauli Library, when the Director-general and other senior members of the staff answered the Queen's questions on physics. The need to start the afternoon programme broke into a lively debate on the clock effect of relativistic speeds.

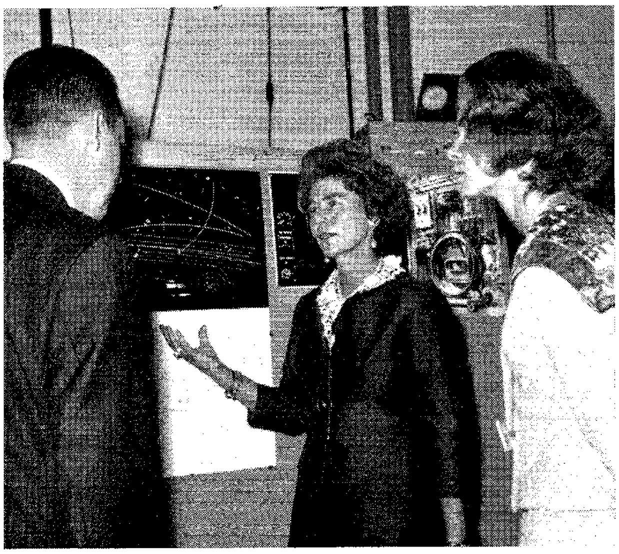
The afternoon started with bubble chambers again, and the Queen expressed her admiration of the enormous electromagnet for the 2-metre hydrogen bubble chamber being constructed by the TC Division. T. Ball and J. Trembley talked to their visitors about the characteristics of the chamber, which for some time will be the biggest in the world.

The impressive windings of the electromagnet were under power, providing the necessary load for testing the new d.c. generators in the East area. So that the resulting magnetic field should not interfere with the visitors' watches, they were invited to hand these to G. Ubertin during this visit to the East bubble-chamber building.

At the 600-MeV synchro-cyclotron, forming the next stage of the royal tour of CERN, Queen Frederika was greeted by P. Lapostolle and E.G. Michaelis. By means of plans of the accelerator and its experimental rooms, displayed in the proton room, they explained the operation of this, the first accelerator to be commissioned at CERN. The Queen then went inside the massive concrete shielding surrounding the machine. The accelerator was shut down that day, and its various components could thus be inspected. In the nearby neutron room several experiments were in preparation, and the Queen was most interested in the focusing lenses, the electronic counters and the other experimental equipment placed in position ready for use in the evening.

A. Apostokalis, a Greek experimenter who had come to CERN as a member of a team of visiting scientists from the British University of Durham, was presented to the Queen near the counting room where he was preparing an experiment on pion scattering.

In the Data Handling Division, Queen Frederika was welcomed by J. Bofilias, a Greek student working in the Division. After this, accompanied by D. Wiskott and



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R. Budde, the Queen witnessed the scanning and analysis of track-chamber photographs taken in tens of thousands by cloud, bubble or spark chambers. She then paid a brief visit to the Mercury electronic computer. Time was passing quickly and it was then nearly 4.30 p.m., when the weekly seminar was due to begin. The Queen had especially asked to be enabled to enter fully into the scientific life of CERN and to attend such an occasion.

There were about 200 physicists at the seminar, and there was a burst of spontaneous applause when Prof. Weisskopf announced the presence of the Queen. Prof. L. Van Hove had chosen as his subject for the first seminar of the academic year : 'Some reflections after the 1962 high-energy conference', and the Queen paid the greatest attention to the lecturer and the subsequent discussion.

The royal visit ended outside the Pauli Library, after the Queen and Princess Irène had signed the CERN Visitors' Book. Mrs. Digonnet-Pastroudis offered a bouquet to Queen Frederika, and all the other Greek members of the staff were presented to her: A. Agoritsas, B. Agoritsas and his wife, J. Bofilias, A. Cheretakis, Ch. Patatoukidis, Miss N. Ponzetta and Miss A. Xantopoulos.

Towards 6 p.m. the physicist queen left for Geneva by car, smiling and graciously waving to those who had the honour of acting as her guides at CERN on Thursday, 20 September 1962 ● **R. A.**

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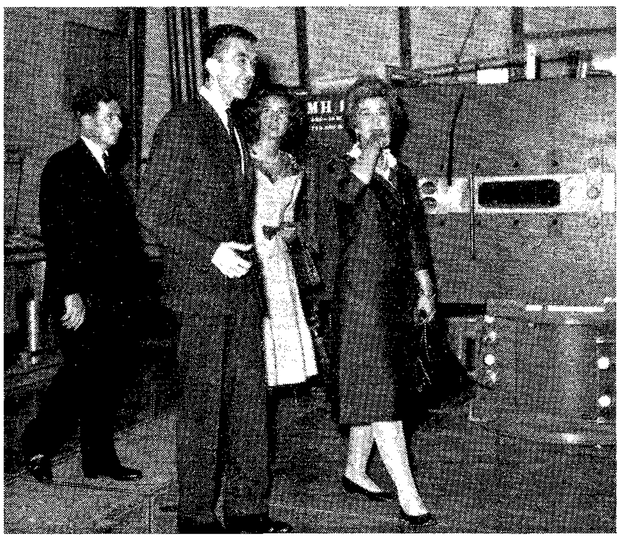
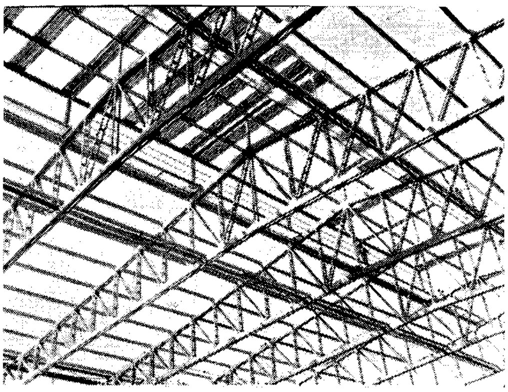
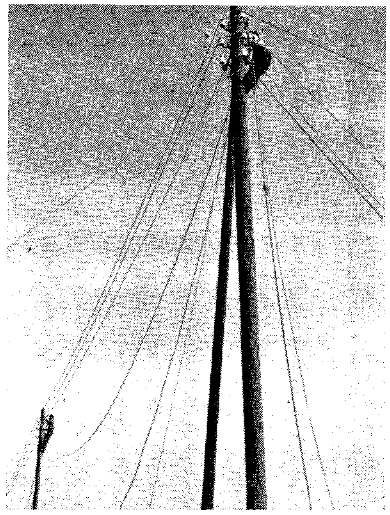


Beginning at the top of page 4, these pictures show Queen Frederika and her daughter deeply interested in a plan of the SP South hall layout, on the visitors' platform overlooking the hall (3), discussing neutrinos with G. von Dardel (4), and talking to J. Trembley about hydrogen bubble chambers (5). Leaving the East bubble-chamber building, the Queen retrieves her watch from the care of G. Ubertin (6) and enjoys an amusing explanation given by T. Ball – recognizable in the background (left to right) **are J. Trembley, Mrs. Vlachos, and Mr. A. Petropoulos (7). Escorted by P. Lapostolle** (centre) **and E.G. Michaelis, Queen Frederika and Princess Irène begin their tour of the SC (8). Finally, at the end of a full day, they say good-bye to Prof. Weisskopf (9).**



CERN's new buildings

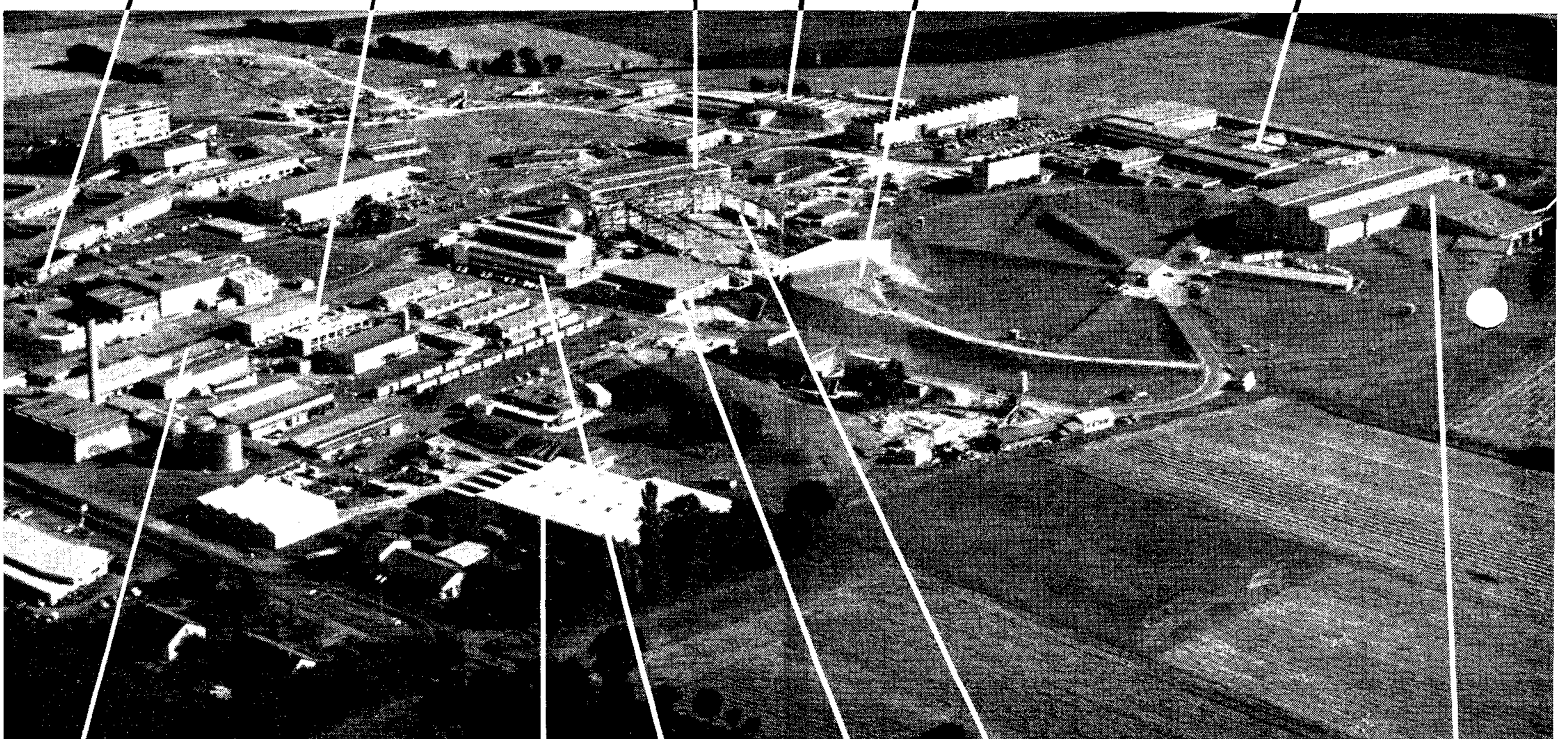
Some recent pictures

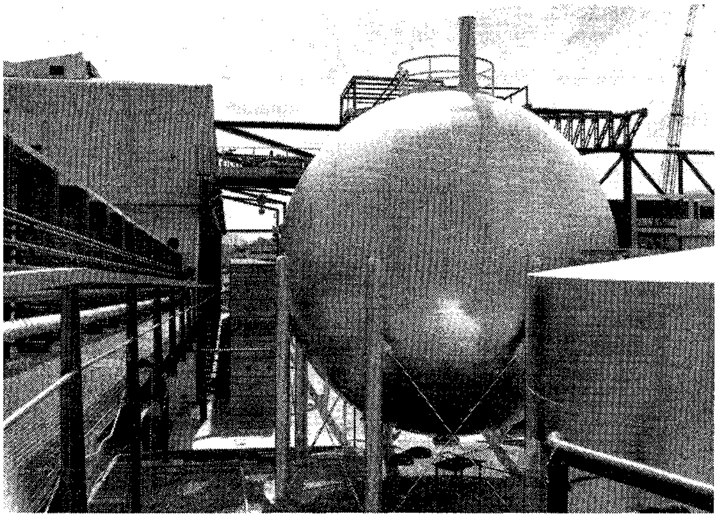


Completion of the two accelerators at CERN by no means ended the activities of the builders on the site, and nearly three years after the first beam was obtained in the proton synchrotron the Site and Buildings Division is still hard at work. Full exploitation of the accelerators and the development and use of new detection equipment implies a growth in the number of people working in the Organization, and whether they are permanent staff or visitors they need accommodation. New experimental areas, development laboratories, offices, are all needed, and as fast as funds become available the gaps on the site are being filled.

The aerial photograph below was taken towards the end of August, and comparison with the one published in CERN COURIER last May gives an idea of the changes that have been made in the course of the past year.

The two heading pictures show (left) the pattern made by the girders forming the roof of the hall on the apron in the East area and (right) the traces of cables being installed to take a temporary power supply to the workmen's canteen.





The hydrogen safety sphere for the large bubble chambers is now finished in gleaming silver paint. To the left is the bridge connecting the control and bubble-chamber buildings, while in the right foreground is one of the hydrogen gas holders. Work on the hall on the East apron can be seen in the background.

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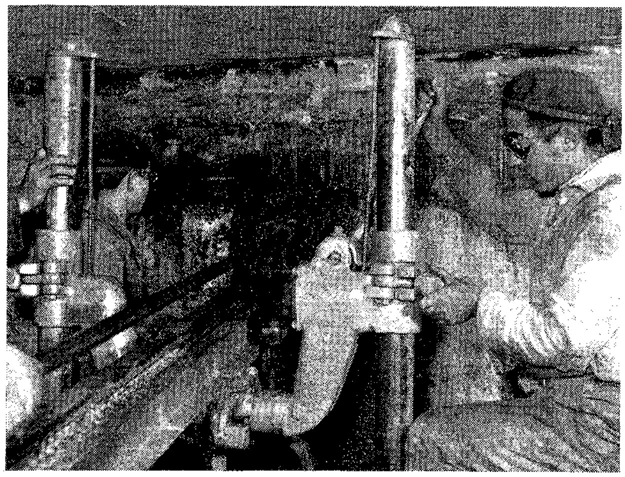
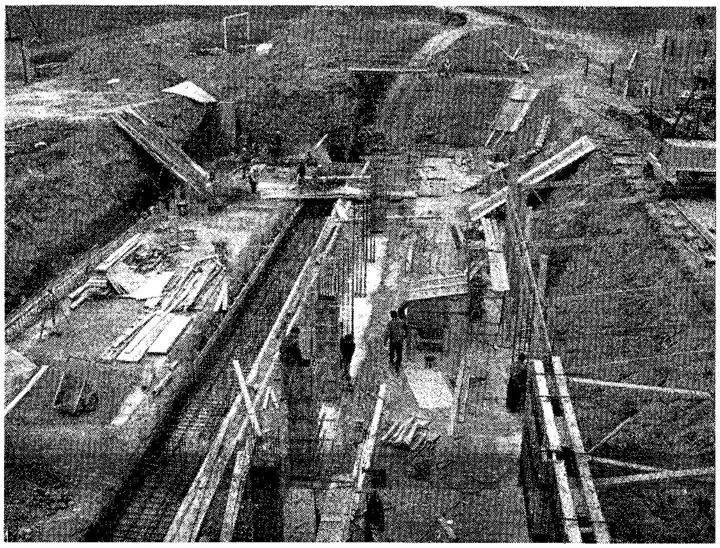
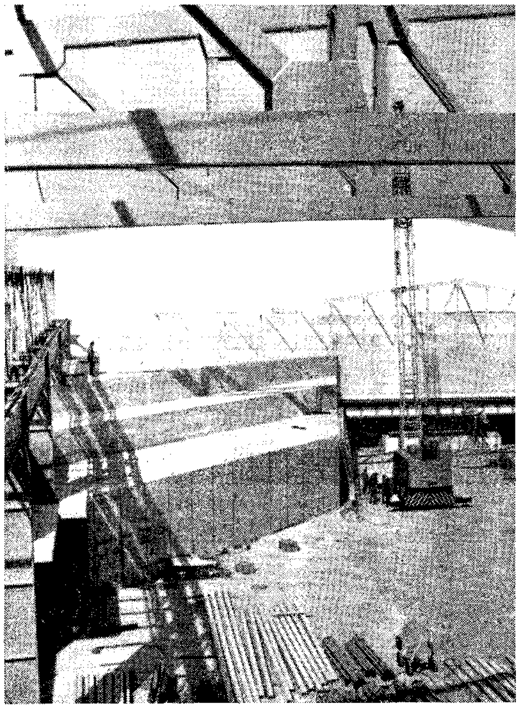


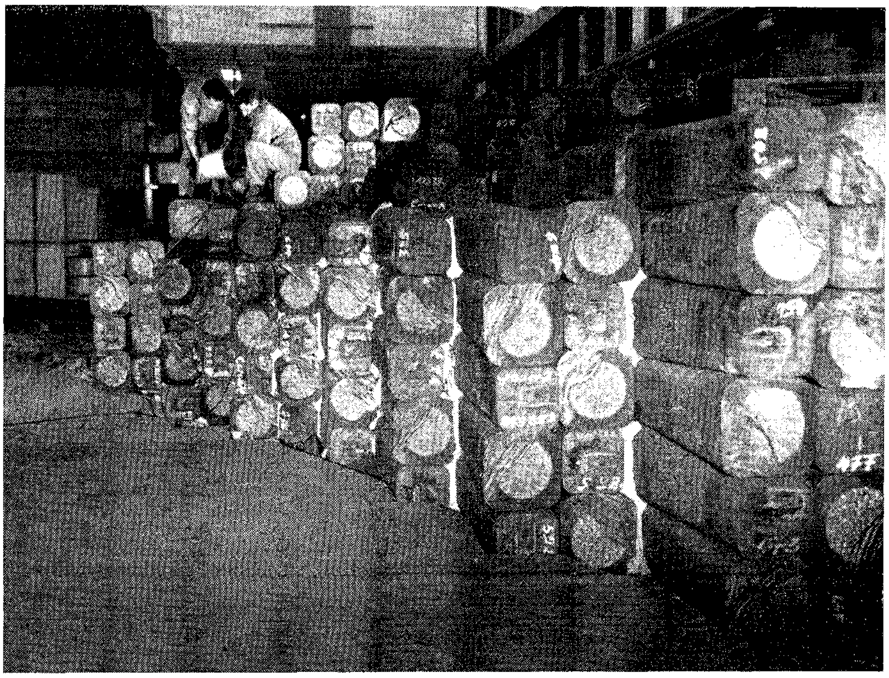
Workers of the Z.C.S.L. contractors prepare for the first bite of the drill into the concrete wall as work starts on the opening of the East junction.



A few weeks after the excavators first moved into the area in front of Laboratory 3, the foundations for Laboratory 4, providing another 3300 square metres of working space on four floors, were well advanced.



The East apron again, showing the concrete retaining structure for the earth covering of the ring, to the left of the beam exit from the new target area.



A different kind of building work : J. Vuatoux (left) and L. Antonioli fill in the gaps between the iron billets being arranged in the PS South hall as shielding for neutrino experiments.

Six months at Dubna

by Karl-Martin VAHLBRUCH, Nuclear Physics Apparatus Division

Under the agreement for the exchange of scientists between Dubna and CERN, I had the opportunity, together with Peter Kirstein (Accelerator Research Division), of working at the Joint Institute for Nuclear Research from February until August this year.

The Joint Institute was founded by its twelve Member States in 1956, following the example set by CERN, and is situated at Dubna, 137 km north of Moscow. Its Director is Prof. D.I. Blokhintsev. Corresponding to CERN's Divisions, the Institute at Dubna consists of five laboratories :

1. High Energies, with a 'synchrophasotron' for 10-GeV protons, under the direction of V.I. Veksler.
2. Nuclear Problems, with a 680-MeV proton synchro-cyclotron. Director, V.P. Dzhelepov.
3. Theoretical Physics, Director, N.N. Bogolubov.
4. Neutron Physics, with an impulse reactor. Director, I.M. Frank.
5. Nuclear Reactions, with a cyclotron for accelerating heavy ions. Director, G.N. Flerov.

The Institute has a total staff of about 2700, whilst the scientific personnel numbers 300 from the U.S.S.R. and 200 from the other Member States. The Chinese are the most strongly represented of these, with a group of 50 ; the group from universities in eastern Germany amounts to 12. Foreign members of staff are looked after by the 'International Department' of the Administration. This helps with such things as housing in Dubna, hotel bookings in Moscow, and permits for travel and residence in other towns of the Soviet Union.

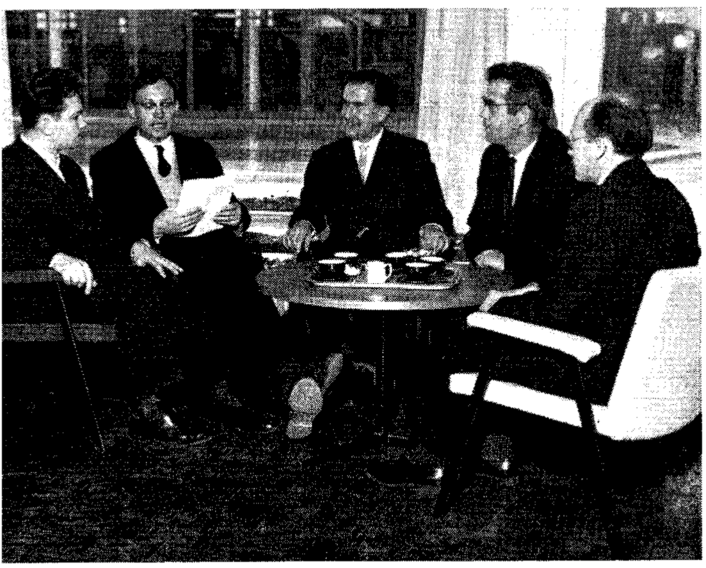
At the Institute, I joined a group under the direction of A.F. Pisarev, in the Laboratory for Nuclear Problems, which has been engaged for some time on investigations into spark chambers and gas-discharge chambers. In the course of this work, the type of chamber proposed by S. Fukui and S. Miyamoto has been further developed up to an electrode separation of 10 cm.

The board at the entrance to the Institute announces its name in twelve languages.

Our main task was the measurement of spin correlation coefficients in proton-proton scattering around 315 MeV. The necessary spark chambers were constructed and the experiment then done at the synchro-cyclotron. Apart from that, we worked on the construction of an image intensifier, consisting of a combination of spark chamber and photocell.

Working at Dubna was really very enjoyable, mainly because of excellent collaboration with the Russian, German and Czechoslovakian members of the team, but also because of the more personal contacts I made with them outside work. The composition of the group had one disadvantage in that everybody spoke better German than I could Russian, so that my knowledge of the language did not progress very much, but on the other hand I was able to learn something in the field of gas-discharge chambers.

Before leaving for Russia, Peter Kirstein and I met our counterparts from the Dubna Laboratory, Vladimir Nikitin (extreme left), **Walter Zöllner** (centre) **and Adolf Mukhin** (extreme right), **who had come to spend a similar time at CERN. Peter Kirstein is second from the left.**



When it comes to obtaining materials, however, experimentalists at the Joint Institute suffer from difficulties that are unheard of at CERN. This is mainly because there are no trade directories or catalogues, and there is little or no direct collaboration or exchange of views between individual scientists and outside industry.

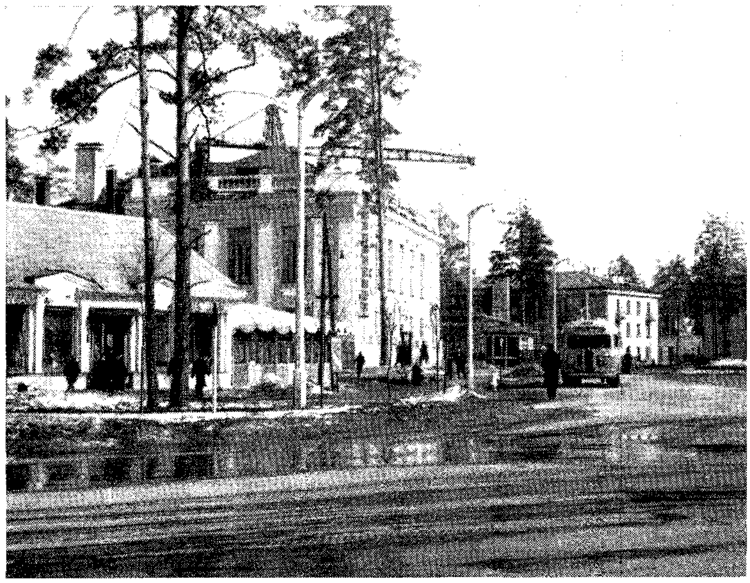
Life in Dubna was not so easy as it is here in Geneva. The flat my wife and I were able to obtain was pleasant, and better than we expected both in regard to size and furnishing. Also the medical care experienced by my wife in Dubna hospital during the birth of our son was good. But there was little variety in the foodstuffs, particularly in the winter months. Dubna is a small town which, apart from its delightful position on the Volga, between the River Dubna and the Moscow Canal, offers only limited possibilities. For shopping and for

Our flat, from which this picture was taken, was in a similar block to those seen here.

concerts, theatres etc. Moscow is, however, only $2^3/_4$ hours away by train, and those working at Dubna automatically obtain a residence permit for Moscow, so that no formalities are necessary for such journeys.

Moscow, with its many museums, its theatres, and department stores, has everything one might expect from a city compounded of old and new and well prepared for tourists. Apart from Moscow, my wife and I visited the monastery at Sagorsk, attending the Easter mass, and spent two days each in Kiev and Leningrad. Permission for these journeys was obtained quite easily.

The Russian winter is long and cold. Temperatures of —20° C are quite frequent, but it is a dry cold which is hardly felt, and a stroll on the frozen Volga adds variety. The snow finally disappeared in April and we were told that the weather would become hot after May. This year, however, we were kept waiting in vain for good bathing weather, and when we returned to Geneva in August it was still (or once again) cool.



A corner of the main street in Dubna, when melting snow left plenty of water.

In conclusion, Dubna's friendly reception, and the good relations established with my colleagues, as well as the interesting work, have combined to make my time at the Joint Institute for Nuclear Research something to look back on with pleasure ●

Last month at CERN (cont.)

to have more such meetings from time to time. Most of the CERN participants also took the opportunity to visit other high-energy laboratories in the U.S.A. before returning.

G. Andersson and **G. Rudstam** presented a paper on the 'Use of radioisotope separation in nuclear reaction studies' at the 'Discussion on nuclear chemistry, fission and other low-energy nuclear processes', held at the University of Oxford from 18 to 20 September. Two other members of CERN's Nuclear Chemistry and Spallation Group, **E. Bruninx** and **A. Stehney,** also attended the meeting. Two papers, an invited one on 'Direct interactions and compound-nucleus reactions from the point of view of time delay' and another on 'Pion capture and nuclear structure' were given by **T. Ericson** (Theory Division) at the 'International symposium on direct interactions and nuclear reaction mechanisms', held at Padua. **A. Zichichi** (Nuclear Physics Division) gave a rapporteur's talk on 'Proprieta delle particelle elementari' at the 48th National Congress of the Italian Physical Society, held in Bologna from 9 to 14 September. At the Autumn meeting of the Austrian Physical Society, in Innsbruck, **R. Hagedorn** (Theory Division) lectured on 'Neue Ergebnisse in der Physik der Elementarteilchen'.

In his capacity as Scientific Adviser to the European Nuclear Energy Agency, **L. Kowarski,** head of CERN's Data Handling Division, collaborated with Dr. W.F. Miller, Director of the Applied Mathematics Division at the Argonne National Laboratory, U.S.A., in the task of organizing and leading an international seminar on 'New trends in the use of digital computers in atomic-energy research and development', which took place at Argonne from 17 to 21 September. The meeting arose out of a report written by Dr. Kowarski last year.

Ch. Peyrou and **J.-M. Perreau** (Track Chambers Division), **L. Montanet, W. Moorhead** and **D. Wiskott** (Data Handling Division), and **B. d'Espagnat** and **J. Prentki** (Theory Division) were invited to attend and give lectures at an informal meeting held at Sully-sur-Loire from 17 to 19 September by physicists from the 'Laboratoire de l'École Polytechnique' and the 'Collège de France'. The meeting was held under the chairmanship of Prof. L. Leprince-Ringuet.

A four-day 'International symposium on higher scientific and technological education', held in Moscow, was attended by **M.J. Pentz,** who presented a paper on 'Scientific and technical training at CERN'. While in Russia he also visited the Lebedev Institute and the Institute of Theoretical and Experimental Physics, in Moscow, the Joint Institute for Nuclear Research, Dubna, the Physical Institute of the Armenian Academy of Sciences, in Erivan, and the Physico-technical Institute of the Ukranian Academy of Sciences, in Kharkov.

A meeting was organized on 28 September by CERN's **Academic Training Committee** to discuss topics for courses for physicists and engineers to be given during the academic year 1962-63. Applied physics and Engineering have been added this year to the existing fields of Theoretical and Experimental physics. It was later announced that the weekly lectures on theoretical physics would begin on 16 October and those on experimental physics on 2 November. One of the lecturers in the latter series will be **Prof. G. Puppi,** who arrived at CERN on 15 September as Directorate member for Research ●

BOOKS

Science in the new nations. The Proceedings of the International Conference on science in the advancement of new states, at Rehovoth, Israel, August 1960. Edited by Ruth Gruber (New York, Basic Books, 1961 ; $ 6.50).

'In the non-Soviet world there are two broad classes of countries : in one, comprising some 400 million people, the average income per head (per year) is about 1000 dollars ; in the other, with some 1000 million people, the average is 100 dollars per head.' In these few words Prof. Blackett starkly put the problem of the second half of the 20th century and provided the keynote of the Conference held at the Weizmann Institute of Science in August 1960. It led to a proposal, by the Governor of the Bank of Israel, that each 1000-dollar country should tax itself by 2 % of its national income to help the 100-dollar countries.

The volume under review is a skilfully edited version of the majority of the papers and discussions of this Conference, which brought together some 120 participants from 40 countries, mainly scientists from the 'rich' countries and statesmen from the new and developing ones. The chief aims of the Conference were to show how science and technology could and should be used to help the new Afro-Asian states and how the host nation, acting as a sort of large-scale pilot project, was trying to solve these problems. Inevitably the field covered was very wide — energy sources ; radiation (uses and hazards) ; food, textiles and oil ; water ; medicine, health and the population explosion ; economics ; education.

From such a welter of information, reported experience and conflicting opinion, one can only select a few highlights in a brief review. In some ways the most disputed question of all was whether the 'poor' states should devote their limited resources in trained and educated personnel and capital to a great leap into the nuclear sciences. Thus Prof. Zacharias of M.I.T. said quite bluntly that 'it is irrelevant to discuss fission power or fusion power. We should not discuss the big accelerators, nor radio astronomy, nor space research, nor that foolishness called space travel, nor monster team researches. They just have no relevance to the problem of the new states'.

One of the most significant figures at the Conference was Dr. Solomon B. Caulker, the Vice-Principal of the Furah Bay University College in Freetown, who put an African view even more powerfully. 'Show me how science can answer the witch doctor. In Sierra Leone eight out of every ten infants die before one year... This is a primary problem : whether typhoid is caused by drinking dirty water or... by someone who has bewitched you... We cannot believe that Nature, God, call it what you like, loves English children or American children or Israeli children any more than African children'.

Repeatedly it was stressed that the utilization of what applied science can offer is basically tied with educational resources. There is no short cut. United Nations Technical Assistance can send scientists as short-term experts but progress can only be maintained by local achievement. And here the statistics are clear and revealing. 'While the U.S. and the U.S.S.R. claim an annual expenditure of 100 dollars per capita of the population for education, Israel and most European countries spend annually about 30 dollars, while the under-developed countries can afford only from 1 dollar to 10 dollars.'

Thus in summarizing the discussions Abba Eban, the President of the Weizmann Institute stated, among others, two important conclusions for the New States. The maximum possible resources must be made available to the educational system, in which science must be given an immediate and important place. Regional centres of research and education must be set up to serve groups of countries which cannot afford such luxuries at this stage. (In this connexion CERN was often quoted as a successful example of such regional co-operation.)

The results of a Conference of this type, however sucessful it was, can only mature over the years. It has pioneered a new approach and is already being followed up by the holding of a more comprehensive meeting at intergovernmental level. In February 1963 a United Nations Conference on the 'Application of science and technology for the benefit of the less developed areas' will be held in Geneva.

H.C.

ERRATUM : The 'Glossary' on p. 4 of the September issue contained an important error of fact. In the description of **bubble chambers** it was stated that the pressure on the liquid is released *after* ionizing particles have passed through, whereas in fact the pressure must be released *just before*. This is why one cannot 'choose' particular particles to be photographed, after they have traversed the instrument, in the way one can with a cloud chamber or spark chamber.

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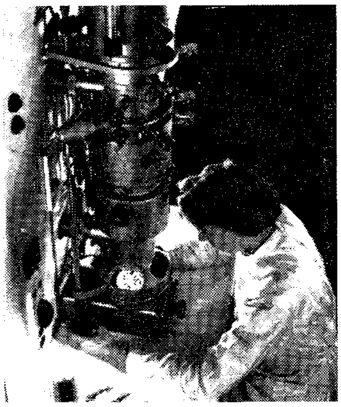

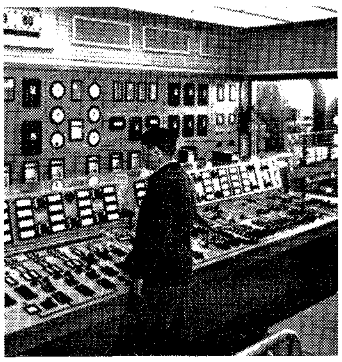

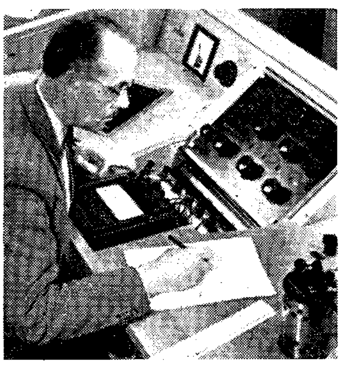

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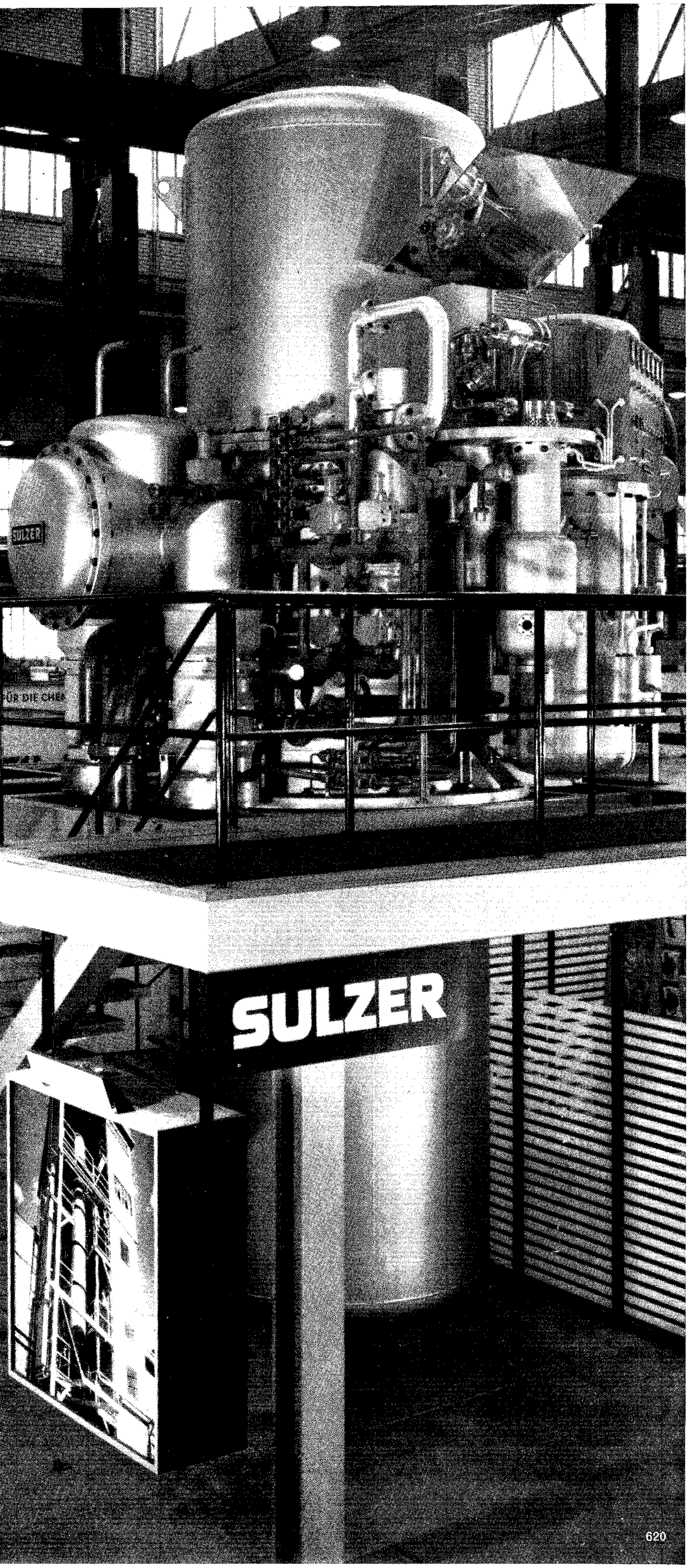

SULZER

Low-Temperature Installation for the Two-Metre Hydrogen Bubble Chamber of the European Organization for Nuclear Research (CERN)

-250°C

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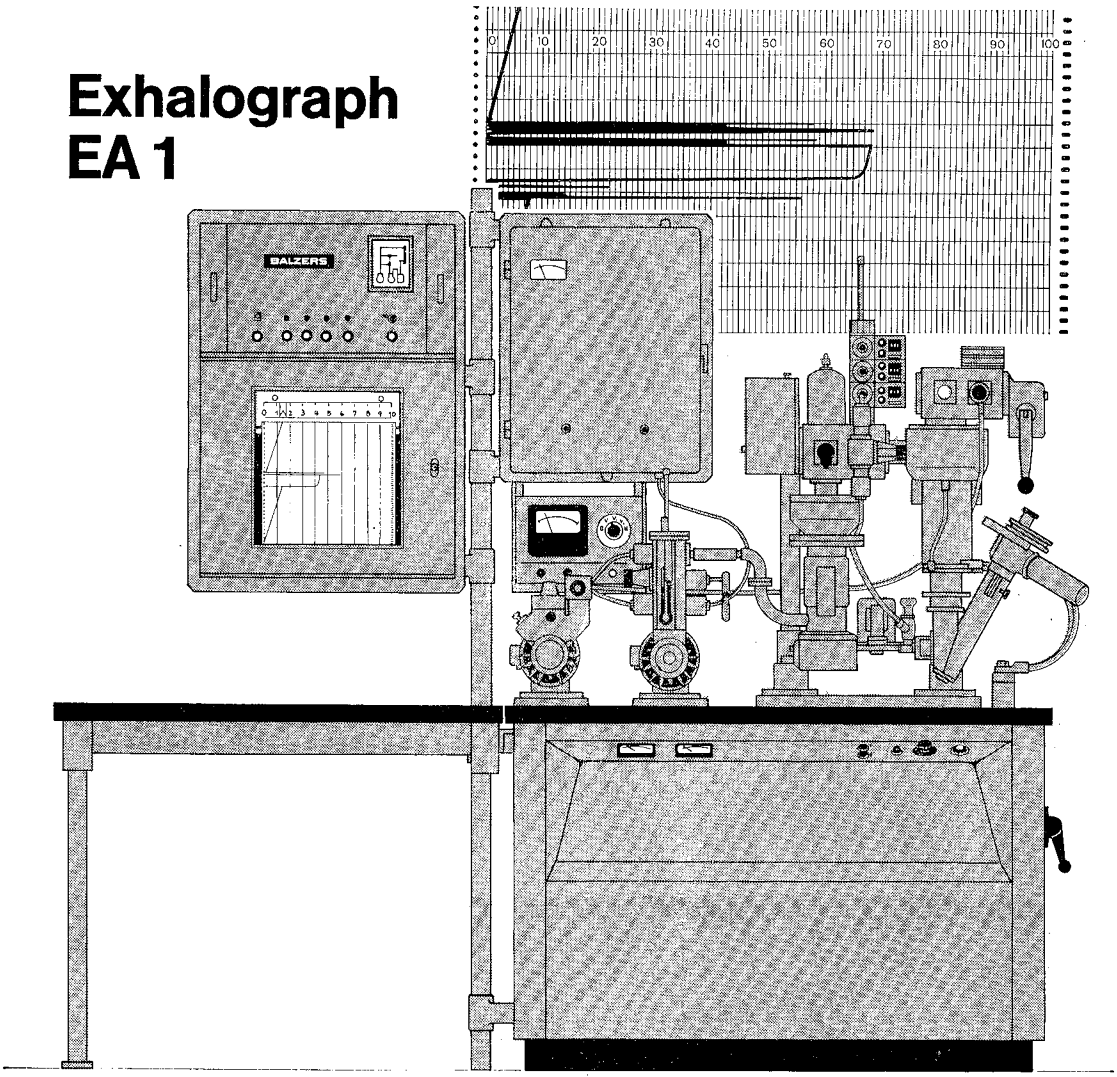

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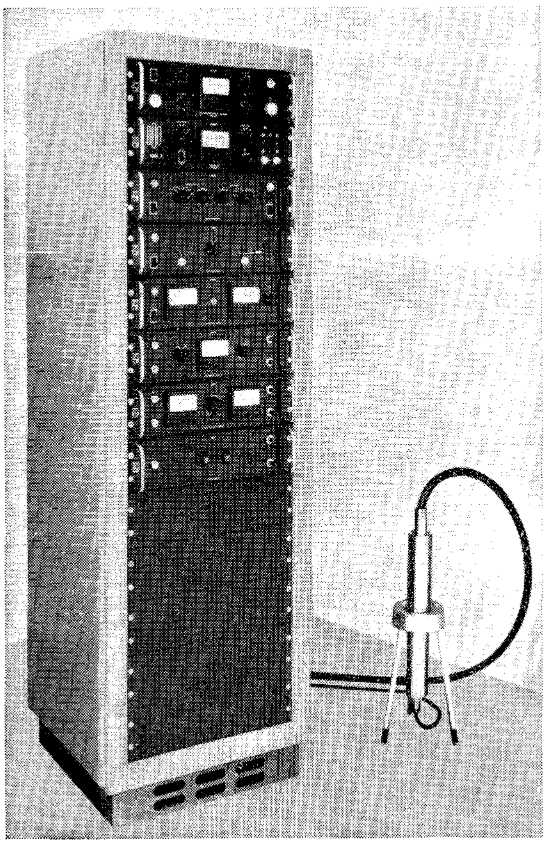

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Flexible connections facilitate universal positioning
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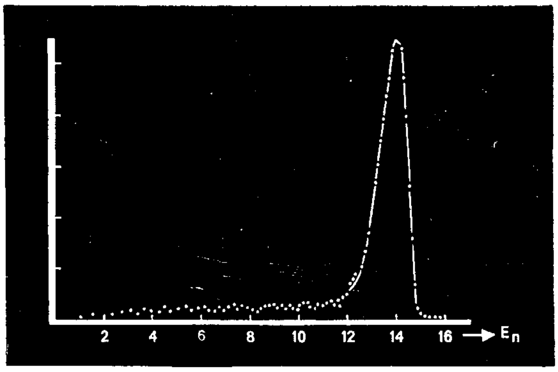
The energy spectrum of the neutrons produced by the Philips sealed-off neutron generator, as measured with a double crystal spectrometer at the Institute for Nuclear Physics (I.K.O.) in Amsterdam. The spectrogram has not been corrected for background nor for neutrons producing a (n,p)-reaction in one detector crystal after having collided in the other. The low energy tail in the spectrum, which has a surface of approx. 26% of that of the peak, is due to the latter effect. The half-value width of the 14 MeV peak is 10%.



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NIELS BOHR

Photo : H. & H. Jacobsen, Copenhagen

A tribute by Prof. V.F. Weisskopf, Director-general, given before the staff of the European Organization for Nuclear Research (CERN) on 23 November, 1962.

Friends and Collaborators,

We are assembled this afternoon to pay tribute to Niels Bohr. Niels Bohr is the symbol, he is the origin, he is the main architect of our work. It was through him, by him and with him that all this on which our work and our existence stands was created. He was a great man. What is greatness? A great man is one who creates a new period, a new way of thinking, and truly he and his life correspond to this definition. The influence of what he started is seen all over in every aspect of our life. Modern science has reshaped our world. It became the determining factor in our thinking, in our culture, even in politics, and it establishes the direction in which mankind will move in the next decades. The real significance of the development which was initiated by Bohr cannot yet be judged by us. We are too close to his life. Only from a distance can one see how much Mont Blanc towers over the other mountains of the Alps

Niels Bohr was born in 1885. His life as a scientist began about 1905 and lasted until today. What a time to be a physicist! He began when the structure of the atom was still unknown, he ended when atomic physics, which he created, had reached maturity. Science, and in particular physics, was not in 1905 what it is now. Let us have a look at physics at that time.

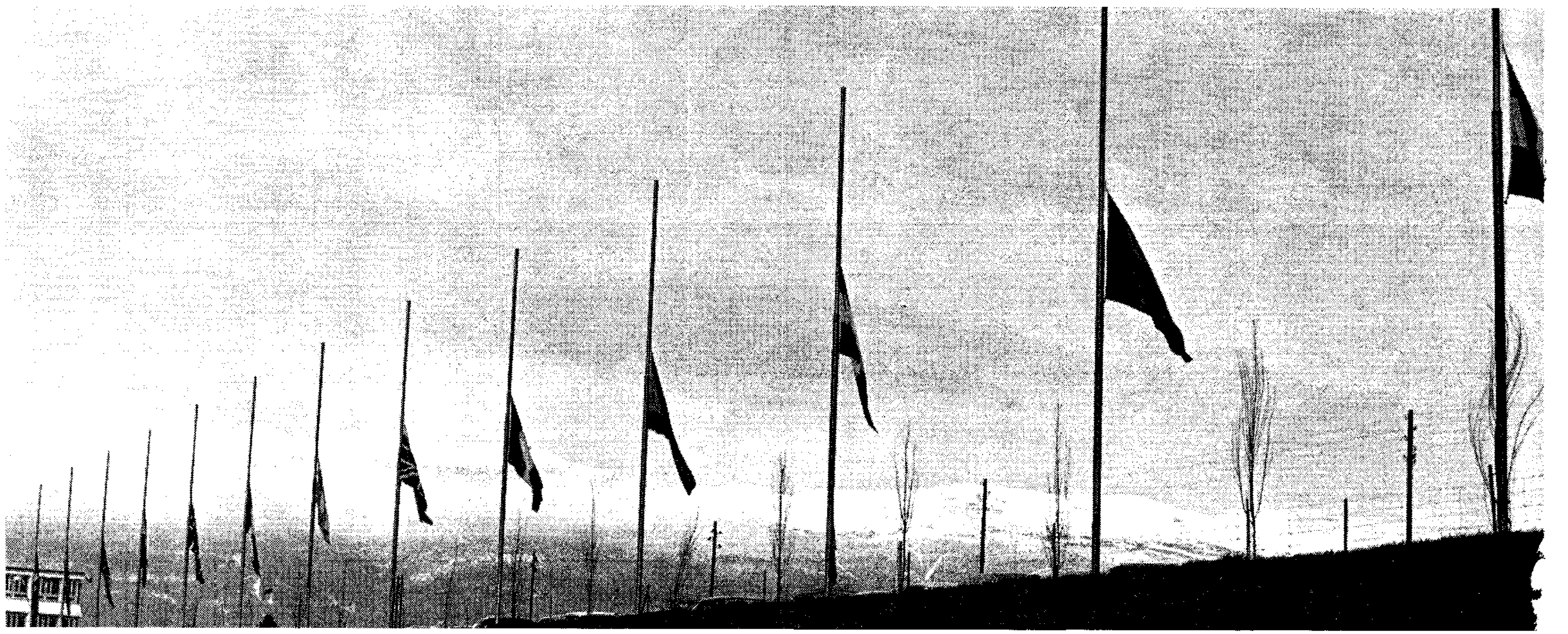
It was an interesting time. It was the year when Einstein published his concept of special relativity, it was a period in which many new phenomena were discovered, but not understood. It was the time — a few years later only — of Planck's great discovery of the quantum of action. Only very few people at that time had noticed Planck's new paper, let alone understood what it meant. It was a time when chemistry and physics were wide apart. Chemistry, on the one hand, was the science of matter and its specific properties. The atom was a concept of chemistry — the atoms of gold, of oxygen, of silver : different specific entities whose existence was noted, but not understood. Physics, on the other hand, was a science of general properties, of motion, of strain and stress, of electric and magnetic fields, and the two sciences were far apart. One was not yet able to answer the question : 'Where do the properties of matter come from ?'. Bohr had the great luck to be there at the beginning, or perhaps we should say, mankind had the great luck that he was here at that turning point.

The work of Niels Bohr can be divided into three periods. In each one he exerted a tremendous impact on the development of modern science, in three different ways, at three different times. The first one is the decade from his meeting with Rutherford in 1912 to the year 1923. It began with the publication, in the year 1913, of his work on the quantum orbits of the hydrogen atom. He proposed to explain the unexplained properties of the atom by introducing the concept of quantum states — a concept which was already prepared by Planck and Einstein, and which he applied to the structure of the atom. There is hardly any other paper in the literature of physics from which so many new ideas and discoveries grew. There is hardly anyone so revolutionary. His concept of atomic quantum states was apparently in complete contradiction to the picture of the planetary system which followed from the experiments of Rutherford. But this was a contradiction containing in it the answers to the most fundamental questions

This famous paper marked the beginning of a series of new insights. In the ten years following the publication, many previously ununderstandable things fell into place ; the structure of the spectra of elements, the process of absorption and emission of light, the reasons for the periodic system of elements, the puzzling sequence of properties of the 92 different atomic species. It was the period in which quality, the specificity of chemical substances, was reduced to quantity, to the number of electrons per atom. All this rested on Bohr's quantum assumption, at that time still a provisional hypothesis. Bohr's contemporaries, however, took the allowed and forbidden quantum orbits of the electron quite literally, although Bohr warned them in his papers and at meetings that this could not be the final explanation, that there was something fundamental to be discovered first, in order to understand really what was going on in the quantization of the atom.

We now come to the second period of his work : the years 1923 to 1932. This was the great period in which the quantum was fully understood. It was a heroic period without any parallel in the history of science, the most fruitful and most interesting period of modern physics. There is no single paper by Niels Bohr himself which characterizes this period as did the 1913 paper in the first period. Bohr found a new characteristic way of working. He did not work as an individual alone, he worked in collaboration with others. It was his greatest strength to assemble around him the most active, the most gifted, the most perceiving physicists of the world. At that period, we find with Bohr at his famous Institute for Theoretical Physics, in Copenhagen, people such as Klein, Kramers, Pauli, Heisenberg, Ehrenfest, Gamon, Bloch, Casimir, Landau and many others. It was at that time, and with those people, that the foundations of the quantum concept were created, that the uncertainty relation was first conceived and discussed, that the particle-wave antinomy was for the first time understood. In lively discussions, in groups of two or more, the deepest problems of the structure of matter were brought to light. You can imagine what atmosphere, what life, what intellectual activity reigned in Copenhagen at that time. Here was Bohr's influence at its best. Here it was that he created his style, the 'Kopenhagener Geist', the style which he has imposed on physics — a style of a very special character. We see him, the greatest among his peers, acting, talking, living as an equal in a group of young, optimistic, jocular, enthusiastic people, approaching the deepest riddles of nature with a spirit of attack, a spirit of freedom from conventional bonds, and a spirit of joy, which can hardly be described. As a very young boy, when I had the privilege of arriving there, I remember that I was taken a little aback by some of the jokes that crept into the discussions, and this seemed to me a lack of respect. I communicated my feelings to Niels Bohr and he gave me the following answer : 'There are things that are so serious that you can only joke about them'.

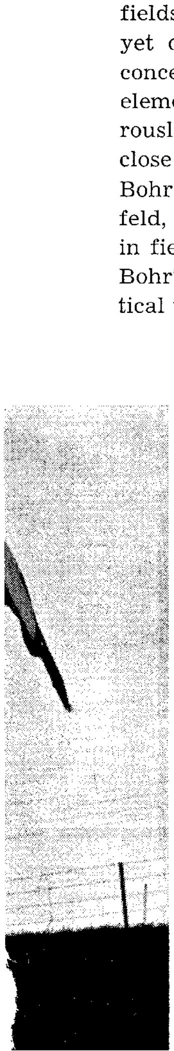
In that great period of physics, Bohr and his disciples touched the nerve of the universe. The intellectual eye of man was opened on the inner workings of Nature that were a secret up to this point. The concept of quantum state was cleared up, its fundamental wholeness, its indivisibility which, however, has that peculiar



way of escaping ordinary observation because the very act of such observation would obliterate the conditions of its existence. Bohr, whose penetrating analysis contributed so much to the clarification of these problems, called that remarkable situation 'complementarity'. It defies a pictorial description in our accustomed classical terms of physics, but it reveals a much richer world than our classical experience has led us to expect.

Once the fundamental tenets of atomic mechanics were settled, it was possible to understand and to calculate almost every phenomenon in the world of atoms, such as atomic radiation, the chemical bond, the structure of crystals, the metallic state, and many others. Before that time, this world was full of forces, electric, adhesive, chemical and elastic ; then, all these forces were reduced to one : to the electromagnetic force. In the course of a few years only, the basis was laid for a science of atomic phenomena which grew into that vast body of knowledge known to us today. Never before have so few done so much in so short a time.

Then follows the third period of Bohr's work : the time between 1932 and 1940. The year 1932 was an important year in the development of physics. In that year, the neutron was discovered, the positron and artificial radioactivity found, and also the first particle accelerator was put into use. Bohr's Institute, now well known all over the world, became the centre of theoretical physics. After the solution of the fundamental problem of the quantum, theoretical physics went on in two new directions. One was the application of the quantum concepts to fields, to electromagnetic fields, and, later, to nuclear fields. This attempt is not yet quite completed today, and many deep problems concerning the structure of the sources of fields, the elementary particles, are still unsolved. It was vigorously pursued during that period in Copenhagen in close collaboration with Pauli, Dirac and Heisenberg. Bohr himself, in a famous paper published with Rosenfeld, established the physical basis of the new concepts in field quantization. This work is a typical example of Bohr's concern with the physical content of mathematical theories.



The other direction of research in this period was towards the exploration of the innermost part of the atom, the atomic nucleus. In the previous periods, the nucleus was considered only as the massive centre of the atom. In the third period, the structure of the nucleus was a subject of interest, since more and more facts were known about phenomena connected with the innermost part of the atom. These facts were quite puzzling at the start, but, under Bohr's active leadership, it was soon discovered that the same laws of quantum mechanics also govern the world within the nucleus. One was facing, however, a more complicated problem because of the appearance of new and much stronger forces which hold the nucleus together, the nuclear forces. When the world of physicists was puzzled by the enormously large number of quantum states found in nuclear reactions, it was again Bohr's concept of the so-called 'compound nucleus' which made it possible to understand how the large number of states is connected with the strong interaction between the constituents of the nucleus. Bohr's work, and the stimulation from the discussions at Bohr's Institute, created a new science of nuclear structure which led to the understanding of nuclear phenomena, and also of a problem of old standing : the source of energy in the sun and in the stars.

We now reach 1940, the beginning of the Second World War. What follows now in the life of Bohr is, in some ways, even a greater testimony to the greatness of this man. What follows now can no longer be told in purely scientific terms. Bohr was not only a great scientist, he also was a man of unusual sensitiveness and feeling for the world in which he lived. The relation of science with the world of men was for him an important question. He was aware, earlier than many others, that atomic physics is, and would be, a decisive part in civilization and in the fate of mankind — that science cannot be separated from the rest of the world. The events of world history brought home this point earlier than expected. Already in the 1930s, the ivory tower of pure science was broken. It was the time of the Nazi régime in Germany, a stream of refugee scientists came to Copenhagen and found help and support from Bohr. He asked some to stay with him at that time ; James Frank, Hevesy, Placzek, Frisch and many others found a haven in Copenhagen where they could pursue their scientific work. But not only this, Bohr's Institute was the centre for everybody in science who needed help, and many a scientist got a place somewhere else — in England, in the United States — through the help of Bohr's personal actions. Then came the years of war ; Denmark was occupied by the Nazis in April 1940 ; pure science was at an end. Bohr was in close connection with the Danish Resistance. He refused to collaborate with Nazi authorities. Soon he was forced to leave Denmark, he had to escape to Sweden, and then came via England to the United States

There he joined a large group of scientists in Los Alamos who, at that time, were working on the exploitation of nuclear energy for war purposes. He did not shy away from this most problematic aspect of scientific activity. He faced it squarely as a necessity, but at the same time it was his idealism, his foresight and his hope for peace that inspired so many people at that place of war to think about the future and to prepare their minds for the tasks ahead. He helped us to see that, in spite of death and destruction, there is a positive future for this world of men transformed by scientific knowledge. But he did more than that. He came into contact with people in power ; he saw Roosevelt, he saw Churchill. He did many things that today would look naïve. We all were naïve at that time when we hoped that the bomb would be abolished after the war, and that a durable peace would be established immediately, but it is this naïveté that carries the hope and the strength for a peaceful future. Today, we should be aware that it was that attitude, and the discussions and activities which took place because of this hope, that contributed to the realities of today, and perhaps to the fact that we are still alive and we can still look with some confidence to the future.

Photo : M. Benarie, Tel-Aviv

Then came the post-war years : from 1945 to the end. Physics had a different aspect. The war had made it obvious, by the most cruel of all arguments, that science is of the most immediate and direct importance to everybody. This had changed the character of physics. Physics became a large enterprise : large numbers of people, large machines were necessary to carry out physical research. Bohr recognized this as a logical continuation of what he and his friends had started. The new insights which he found were greater than the ivory tower of the universities in which some people wanted to contain this knowledge. He saw that out of these ideas would develop a great thing which could encompass all fields of human activities, and so he saw the necessity of physics on a large scale, on an international scale. In no other human endeavour are the narrow limits of nationality or politics more obsolete and out of place than in science. Therefore Bohr was always aware of the leading rôle science must play in creating a lasting bond across national and political boundaries, in creating the beginning of a supernational society of human beings on earth. This is why he was actively engaged in the creation of international scientific centres : the Scandinavian centre, NORDITA in Copenhagen, and last but not least, the centre in which we are working here. CERN exists because of Niels Bohr. It was Niels Bohr's personality, Niels Bohr's weight and Niels Bohr's work that made this place possible. There were other personalities who started and conceived the idea of CERN. The enthusiasm and the ideas of the other people would not have been enough, however, if a man of his stature had not supported it, and not only supported it, if he had not participated actively in every important act of founding and developing, if he had not sat together with the others and worried about every detail. That was Niels Bohr.

The greatness of this man comes out in this period more than in any other. Bohr in his sixties was fully aware of the new developments in physics, of the new phase which began a decade ago, when the availability of high-energy beams made it possible to go beyond the structure of the nucleus and to explore the structure of the constituents of the nucleus, the world within the proton and the neutron. This new stage of our science is nothing else but the continuation of the great wave that he had started. Bohr was aware of this, and that was why he had put all his enthusiasm, his zest for life, his positive attitude in support of this new development and, in particular, in support of the new upsurge of fundamental physics in Europe. I remember only a year ago an example of how much he cared for the details of what was going on at CERN. He was asked for help because of some budgetary difficulties. He came and did a great deal to alleviate the situation ; after the meeting, which took the whole day, when everyone was tired, he asked one of the members to go for a walk with him, and he spent two hours in the rain of Geneva explaining his views of the present situation. It is hard to understand how a man of this age could have had this energy, this enthusiastic interest in life ; but it was a necessary condition to be able to do what he did. It was he who gave us this tremendous expansion of our vision of reality, which shook the world to its foundations, but it was also his spirit of optimism and enthusiasm which will enable us to overcome the dangers we face.

With Niels Bohr's death an era disappears — the era of the great men who created our science. But it was Niels Bohr himself who helped to create the basis for the continuation of his spirit into the future ; our institution, CERN, is a testimony to this. It puts us under the obligation to continue what he wanted to do.

His death symbolizes his life. It was only two weeks before his death that he came back from a vacation, fully recovered from a slight stroke he had a year ago, and his doctors told him that he could go ahead and work as usual. So he did and he was very well, and even on Friday, two days before his death, he chaired a meeting of the Danish Royal Academy of Science ; on Sunday he planned to have a party of friends at his house. He was happy and healthy, but when he lay down in the afternoon for a little rest, he did not wake up. That such a life was, and could be lived today, should be a great encouragement to all of us ●

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