CERN COURIER

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European Organization for Nuclear Research

CERN, the European Organization for Nuclear Research, was established in 1954 to '... provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, theoretical and experimental, in the field of sub-nuclear physics. This branch of science is concerned with the fundamental questions of the basic laws governing the structure of matter. CERN is one of the world's leading Laboratories in this field.

The experimental programme is based on the use of two proton accelerators — a 600 MeV synchro-cyclotron (SC) and a 28 GeV synchrotron (PS). At the latter machine, large intersecting storage rings (ISR), for experiments with colliding proton beams, are under construction. Scientists from many European Universities, as well as from CERN itself, take part in the experiments and it is estimated that some 700 physicists outside CERN are provided with their research material in this way.

The Laboratory is situated at Meyrin near Geneva in Switzerland. The site covers approximately 80 hectares equally divided on either side of the frontier between France and Switzerland. The staff totals about 2600 people and, in addition, there are over 400 Fellows and Visiting Scientists.

Thirteen European countries participate in the work of CERN, contributing to the cost of the basic programme, 197,5 million Swiss francs in 1968, in proportion to their net national income. Supplementary programmes cover the construction of the ISR and studies for a proposed 300 GeV proton synchrotron.

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CERN News

Letter of Intent from Germany

The President of the CERN Council, Dr. G. Funke, has received a letter dated 4 September from Dr. G. Stoltenberg, Minister for Scientific Research of the Federal Republic of Germany, declaring the readiness of his country, in principle, to participate in the construction of a new European high-energy physics Laboratory. Coming in addition to the favourable responses of Austria, Belgium, France and Italy, the letter of intent from Germany means that further steps can now be taken with the confidence that the new Laboratory will be agreed in the coming months. Only the United Kingdom of the thirteen Member States of CERN has so far declared its unwillingness to participate and plans are well advanced to adjust the project to take account of the UK withdrawal.

The letter from Germany speaks of the successful work being done at CERN which has given Europe an outstanding position in the field of high-energy physics and of the exemplary co-operation of high-energy physicists which enables national and European projects to be considered as a single programme.

After a thorough examination of the 300 GeV project, the government acknowledges its importance for the future of high-energy physics and in particular for European co-operation in science and technology. The government therefore declares its intention to participate in a big new European accelerator Laboratory and believes that the project leader should be chosen and a site selected. This declaration is put forward with the understanding that some aspects will be clarified before the final decision is taken.

These aspects include the implications of the UK withdrawal. The German government awaits information from CERN on possible alternative programmes which would retain the scientific value of the project without imposing a heavier financial burden on participating countries than was originally planned. The government also looks for strict financial control over the construction of the Laboratory to en-

Contents

Cover photograph : Ploughing through the ISR canyon following the heavy rain early in September. The vast construction work on the intersecting storage rings site continues to schedule. (CERN/PI 166.9.68)

The Minister for Scientific Research, Dr. G. Stoltenberg, who sent the letter of intent from the Federal Republic of Germany, photographed (centre) during his visit to CERN in April, 1966. On the left is Professor V. Weisskopf and on the right, the Director General, Professor B. Gregory.

Mr. G. Medici, Italian Minister of Foreign Affairs (centre, wearing hat) photographed on the site of the intersecting storage rings during his visit to CERN on 6 September.

sure that the project is completed within the agreed price estimates. In the context of the limited financial resources of the Member States, priorities need to be established among the various programmes of CERN. The German government is also concerned about the participation of industry in the new project.

Now that a letter of intent from CERN's biggest contributor has been received (the Federal Republic of Germany contributes 23.3 % of CERN's present budget) it is expected that other countries who have been awaiting the views of the major partners, will now be able to take their decisions. The next steps forward will be clarified at the Council Meeting which begins on 2 October.

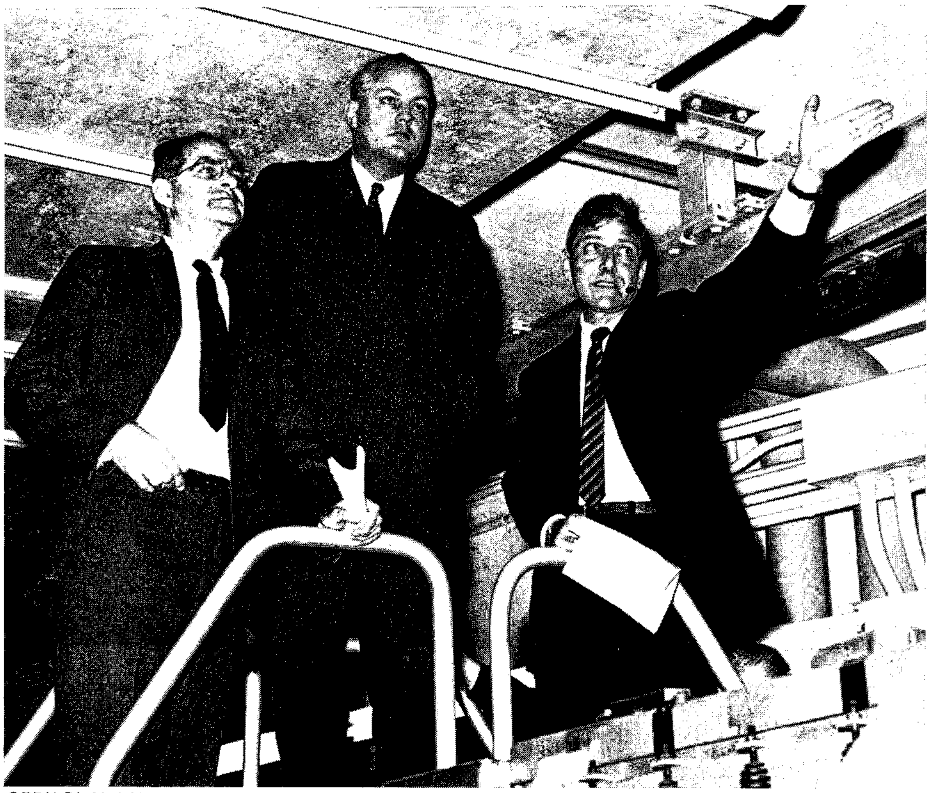
Go forth and proliferate

On 6 September, the Italian Minister of Foreign Affairs, Mr. G. Medici, visited CERN. With him was Ambassador G. Smoquina, Head of the Italian permanent mission to the international organizations in Geneva who represents his country on the CERN Council. In the absence of the Director General, the Minister was welcomed by three Directors (Professor G. Cocconi, Dr. M. G. N. Hine, and Dr. K. Johnsen) and by Professor E. Amaldi, Chairman of the European Committee for Future Accelerators, ECFA.

The Minister toured the site and talked to many CERN staff. He was in Geneva for a Conference on the non-proliferation of nuclear weapons and at the end of his visit to CERN he linked the two, saying : 'I am quite convinced of the significance of this enterprise (CERN) in the framework of our general policy for peace and progress. This initiative is extremely important at a moment when we are supporting the Treaty for the non-proliferation of nuclear weapons. We do not like to proliferate bombs; we do believe, however, it is very important to proliferate scientific initiative. This is the positive policy of the Italian Government'.

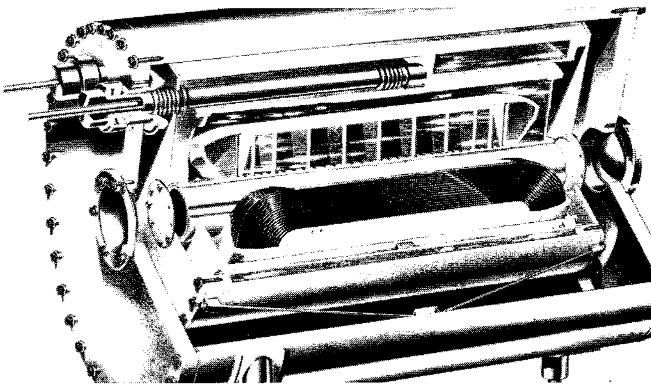
Computer shut down

At the beginning of September, CERN's main computer — the CDC 6600 — was shut down to carry out some additions and modifications.

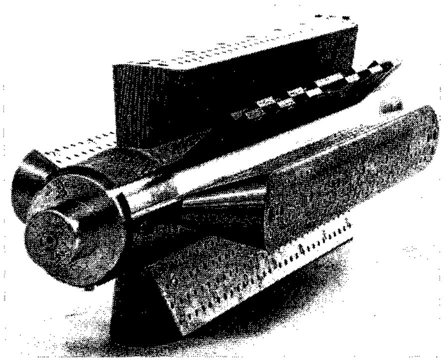


CERN/PI 33.4.66

CERN/PI 64.9.68



1. *CMP 68-584*



2. *CERN/PI 217.2.68*

3. *CERN/PI 105.9.67*

It was agreed in March 1966 with Control Data that the CERN machine, which was the third of its type to be produced, would be brought into line with the later production models. Among other things, this will ensure that the logic, the structure of the main chassis and the wiring is identical to the standard machines, so that all the detailed improvements which are constantly being made can be easily applied at CERN by the CDC engineers. This had become increasingly difficult on a non-standard machine.

The major change concerns the modification of the memory access logic and the addition of memory instruction decoding logic which CDC introduced to allow the use of extended core store (ECS) with the 6000 series computers. The use of an ECS would greatly increase the effective memory capacity of the computer and detailed studies are now going on at CERN to estimate what increase in through-put of programmes could be expected with an ECS. Such an addition has already been made to the CDC 6600 complex at Brookhaven National Laboratory.

However, ECS is only one of several alternative ways of improving the central computing facilities and a careful examination is being made of these alternative steps to find the optimum way of increasing the computing capacity at CERN. Some way of increasing the capacity will be needed to cope with the relentless increase in demand, through to such time as the next generation of computers has evolved. An examination of the future situation has started both in terms of an analysis of the need and of a preliminary consultation with a variety of computer manufacturers as to what the feasible parameters of the next generation of machines might be.

The CDC 6600 is scheduled to be back in full service at the beginning of November. In the meantime, the CDC 6400 and 3800 remain in operation and some computing time is being used on a 6500 computer outside the Laboratory at Zurich.

Quadrupole success

On 22 August, the first tests were carried out on a completed pole of the superconducting quadrupole being built for CERN at the Oxford Instrument Company, U.K. The tests went very well and indicate that the design specifications for the quadrupole will be easily exceeded.

As reported in CERN COURIER vol. 8, page 24, the project involves CERN and Culham Laboratory in addition to the manufacturers. CERN (group led by A. Asner) designed the uniform current density superconducting quadrupole with the nominal parameters — 10 cm diameter, 70 cm long, field gradient 5.7 kG/cm, maximum field at coil 50 kG, overall current density 110 A/mm². Culham (group led by D.N. Cornish) have been particularly concerned with the cryogenic aspects. Oxford Instrument Company (work led by J. Williams) received a contract from the Ministry of Technology to construct the quadrupole to gain experience of superconductivity techniques, using niobium-titanium composite superconductor (sixteen Nb-Ti wires embedded in 1.5 x 4 mm² copper strip) produced by Imperial Metal Industries.

The quadrupole will come to CERN on long-term loan to be used on an external

1. A drawing of the superconducting quadrupole being built at the Oxford Instrument Company for use at CERN. (Photo Culham Laboratory)

2. The four pole cores which were sent from CERN to be used in the construction of the superconducting quadrupole.

3. A full-scale copper-wound model of a pole produced at CERN to develop the coil winding technique.

proton beam or a secondary particle beam as part of a superconducting lens doublet. The second lens, probably using niobium-tin superconductor is being designed at CERN.

Construction of the quadrupole began in March 1968 and a full-scale copper wound pole produced at CERN was sent to Oxford to be used as a model in the winding of the first pole. This is now complete and tests began on 22 August. A current of 1000 A was passed through the coil (compared with the design figure of 825 A) without difficulty and without causing any quenching. This indicates that currents of 900 to 950 A will be feasible in the completed quadrupole, leading to field gradients up to 6.5 kG/cm with current densities of about 125 A/mm².

Following this success, the remaining poles will be wound in the next three months and at the beginning of 1969 the quadrupole will arrive at CERN for final tests in the cryogenics laboratory of the Track Chambers Division.

Professor Amaldi Professor Weisskopf Birthday greetings

It is a pleasure to extend our good wishes to two physicists celebrating their sixtieth birthdays this month — Professor Edoardo Amaldi on 5 September and Professor Victor Weisskopf on 19 September. Both have played a major part in the life of CERN.

Professor Amaldi was born at Piacenza in Italy. He received his Doctorate in physics in 1929 and did research at a variety of centres in Europe and the USA before settling in 1950 to direct the Institute of Physics at the University of Rome. In 1952, he became the first Secretary General of CERN, when it existed as an interim organization, until 1954 and was Deputy Director General until the middle of 1955. He is a regular member of the Italian delegation to the CERN Council and a member of the Scientific Policy Committee.

In recent years, Professor Amaldi has been prominent in evolving the plans for the future of high-energy physics in Europe. He was Chairman of the first European Committee for Future Accelerators, ECFA, which presented in 1963 the report (popularly known as the Amaldi Report) recommending the construction of a 300 GeV accelerator. He also chaired the revised ECFA which reiterated this recommendation in 1967.

Professor Amaldi's energy and youthful thinking are such that the news that he has reached 60 years is generally received with astonishment.

Professor Weisskopf was born at Vienna in Austria. He achieved his Doctorate in 1931 having studied at that hot-bed of physics at that time — the University of Göttingen. He then did some outstanding research in theoretical physics at centres in Europe, USA and USSR. He became Professor at the University of Rochester in 1937, moving in 1945 to Massachusetts Institute of Technology.

He returned to Europe and became the fourth Director General of CERN in 1961. His status as a physicist and his sensitive grasp of human affairs were an invaluable asset in those days when CERN changed from constructing its big machines to doing research. It was during his period of office, until the end of 1965, that the broad lines of policy which underlie CERN's present activities were largely worked out.

Professor Weisskopf took up his position at MIT again in 1966 becoming Head of the Physics Department. He also chairs an advisory panel on high-energy physics set up by the US Atomic Energy Commission. In addition to his physics and administration, he is also giving a great deal of time and energy to public relations on behalf of pure science. In the prevailing atmosphere with regard to pure research he sees this as a vital task. It is one which he is well equipped to undertake for his sincerity and fluency as a speaker and a writer are exceptional.

CERN still sees Professor Weisskopf often and holds him in special affection. He is a member of the Scientific Policy Committe and works at CERN for some time each summer. During his latest stay, he lectured on the theory of superconductivity and was received by a packed auditorium with a warmth reserved perhaps for no other person.

Recently, Professor Weisskopf's health has not been good and we add to our birthday greetings our wishes for a quick recovery to full health.

To both Edoardo Amaldi and Victor Weisskopf we wish many more years of active and happy life in physics — for themselves and for us, because we still need them.

Housing more power

(This information is extracted from an article prepared by M. van Aerschot.)

To cope with the ever increasing demands and to prepare for the coming into operation of the equipment on the intersecting storage rings site, the 'Power House' at CERN is undergoing extensive modification and enlargement.

The Power House, operated by the Technical Services and Buildings Division, is not, in fact, an electric power station, as its name would imply. From the early days of planning the CERN site, it was designed to house:

— boilers to provide heating for all buildings
— the stand-by diesel engine to ensure electric power in the event of mains failure
— compressors to supply compressed air
— the sub-stations to distribute the normal 18 kV power and the emergency power.

The demand for these supplies has grown steadily since those early days and now has come the major expansion of the site into France. All the general power supply installations have had to keep pace and a considerable enlargement has become necessary to serve the ISR, the large European Bubble Chamber, etc...

It was a fortunate choice which originally located the Power House close to the frontier so that now it stands virtually equidistant from the eastern, western and southern boundaries of the site.

Figure 1 shows the Power House as it has become in 1968. The area it occupies has increased by some 150 % in ten years, from about 2 000 m² to about 5 000 m². The plan of the Power House complex (Figure 2) gives an idea of the arrangement of the building. Now follows a brief description of the Production and

Figure 1 : The Power House in August, 1968, photographed from the Geneva-Lyon road. (CERN/PI 257.8.68)

Distribution Station and the Electrical Power Distribution Station.

Production and Distribution Station

Boilers

The boilers feed the heating and hot water systems in all the CERN buildings. The saturated steam generated is converted into superheated water and pumped to all parts of the site.

To keep up with the demand, the power of the equipment has been increased, in the way shown in Figure 3, up to 33 Mkcal/h for 1968 (approximately equivalent to a power of 40 MW).

With the boilers now installed, it is estimated that further increases will not be necessary for another ten years or so. Nevertheless, space has been reserved in the extension to the Power House for one additional boiler, which would bring the total number to eight. The maximum heating power available on the site is governed by the heat-exchange capacity of the steam-water transformer, which has a ceiling of 55 Mkcal/h, equivalent to about 65 MW.

Diesel engines

A diesel-powered emergency generator intended to supply electricity to critical points if the mains power failed was installed at the end of 1956. At that time it was intended to operate also during periods of peak demand if this were likely to give any appreciable saving. Its power was based on estimates made by the various Divisions and a diesel engine to give an effective power of 1520 HP at a speed of 300 rpm, with a 1320 kVA three-phase alternator, was selected.

The emergency power needed has increased and, after ten years, this generator set was inadequate to meet the requirements. In 1966, therefore, the problem was reconsidered. Selection was difficult in view of the wide variety of power sources, including low-speed or high-speed diesel engines, gas turbines, steam turbines and floating-piston generators, combined with the intention of possibily using the set continuously at peak periods. Finally, mainly for reasons of economy, low-speed diesel engines burning oil, generating a constant supply of power were chosen.

By the end of 1968, two new sets will be in service each consisting of a four-stroke diesel engine delivering 3500 effective HP at a speed of 428 rpm, with a 3080 kVA synchronous three-phase alternator with a nominal voltage of 6300 V. These two units will operate in parallel with the existing one so that the Power House will be capable of supplying a total power of some 7500 kVA.

Compressors

As soon as the first laboratories and workshops were set up, it was essential to have a supply of compressed air available. Consumption has rapidly increased. There was a particularly large increase in 1961 when the 2 m hydrogen bubble chamber building was equipped with two thirty-ton cranes, whose motors operate on compressed air to ensure safe operation in a hydrogen atmosphere. Two compressors were brought into service in 1957. A third was added in 1961 and by 1965, four were in operation. In view of the probable increase in compressed-air consumption, it is intended to add even more powerful units in the future. The compressed-air

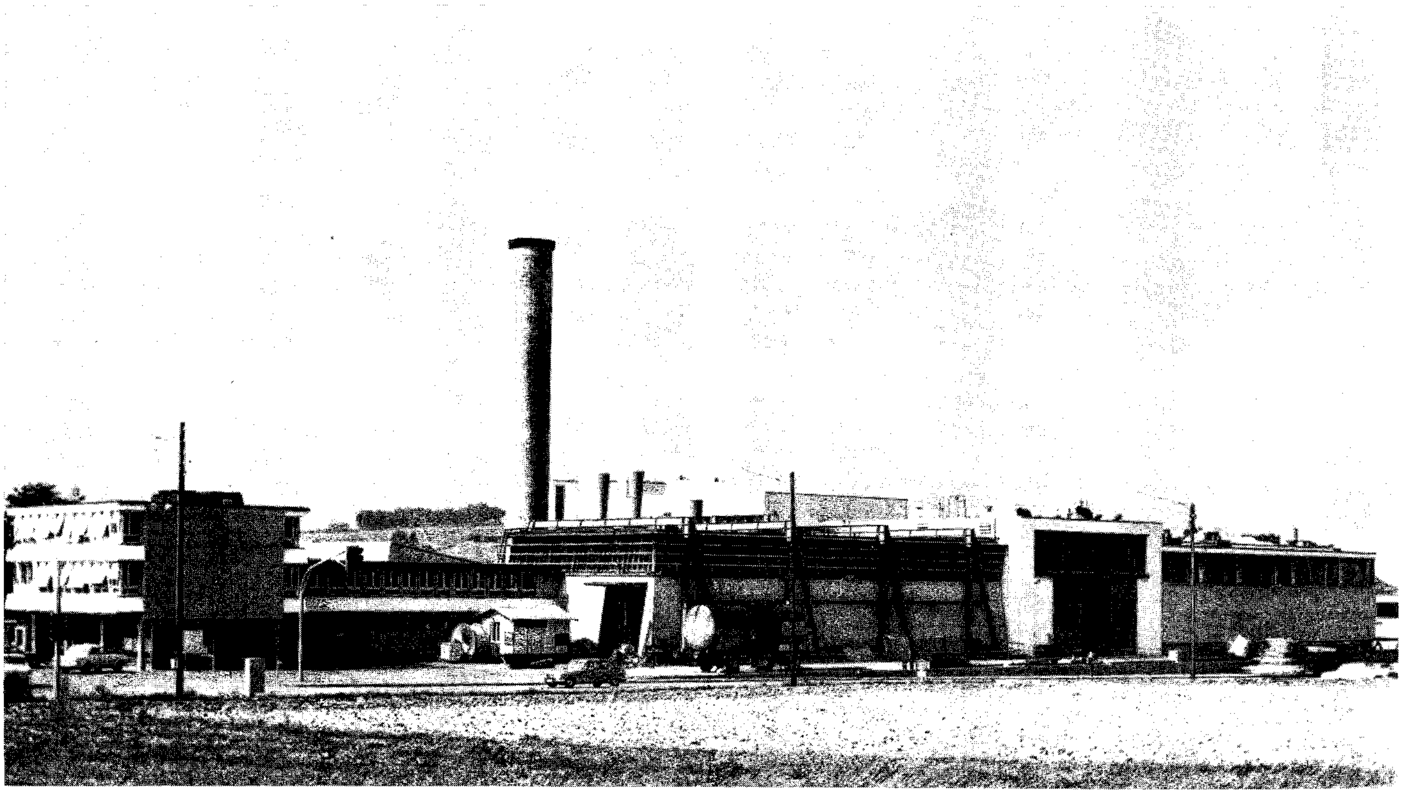


Figure 1

Figure 2 : Plan of the Power House and its main components
A : Previous production and distribution station
B : Previous electrical distribution sub-station
C : Extension to the production and distribution station
D : Extension to the electrical distribution sub-station
1-7 : Boilers
8-9 : Steam-water transformers
10-12 : Diesel engines
13-16 : Air compressors
17-19 : Heavy-oil storage reservoirs

generating set will then consist of four 700 m³/h units, with a total power at the shaft of 360 HP, and two units, each of 1700 m³/h, with a total power at the shaft of about 550 HP.

Electrical Distribution Station

The annual consumption of electricity at CERN has increased virtually steadily, the only break having been in 1966, when the proton synchrotron was shut down for some considerable time. For example, the consumption for 1960 was 23 565 049 kWh, and for 1967 was 118 152 000 kWh. In 1967, the electric power consumed at CERN came to more than 11 % of the power taken by the whole of the Canton of Geneva.

However, it is not simply the increase in total consumption that constitutes the problem facing the local electricity authority, the Services Industriels de Genève (SIG) and those responsible at CERN, so much as the increase in the maximum power required. Figure 4 shows the increase in maximum power since 1956.

Until 1966, this power came from a three-phase supply at a voltage of 18 kV from the SIG Station de la Renfile. It was limited to a maximum of 24 MVA but the demand exceeded this limit during 1965.

With the completion in the autumn of 1965, of the SIG 130/18 kV transformer sub-station at CERN and of the CERN 18 kV main station, both located close together at the eastern end of the site, CERN had a reliable 130 kV supply from the Verbois 130 kV distribution station on the right bank of the Rhône beside the Verbois hydroelectric station. The 130/18 kV transformer sub-station is arranged to take three 30 MVA tranformers, two of which are now in service. The third should be installed and ready within a few months.

At present, all electricity consumed at CERN also passes through Station I, known as the Salève 18 kV distribution station, installed in the building marked B on Figure 2. Since the equipment in the Salève station is incapable of redistributing a power higher than 45 MVA and since there are no further output cells available at this station, construction of a new 18 kV distribution station called the 'Jura 18 kV distribution station' was considered in 1963. Its purpose was to distribute all the electrical power, 90 MVA, from the main 18 kV station and also the power from the three generator sets referred to earlier. The power provided by the generator sets, at a voltage of 380/220 V in the case of the first one and 6300 V in the case of the two new ones, will be increased to 18 kV in transformers arranged in cells attached to the Jura station, indicated by the letter D on Figure 2.

This station is housed in a three storey building. The basement contains input cables and sets of transfer bars enabling any one of the twenty-four output cells to be fed by any one of the six input cells, the latter corresponding to six 15 MVA connections with the main 18 kV station.

The ground floor is taken up entirely by high-voltage cells distributing the 'normal' power supplied by the SIG and the 'emergency' power supplied by the generator sets. A coupling line enables current to pass from the normal cells to the emergency cells and, if necessary, vice-versa.

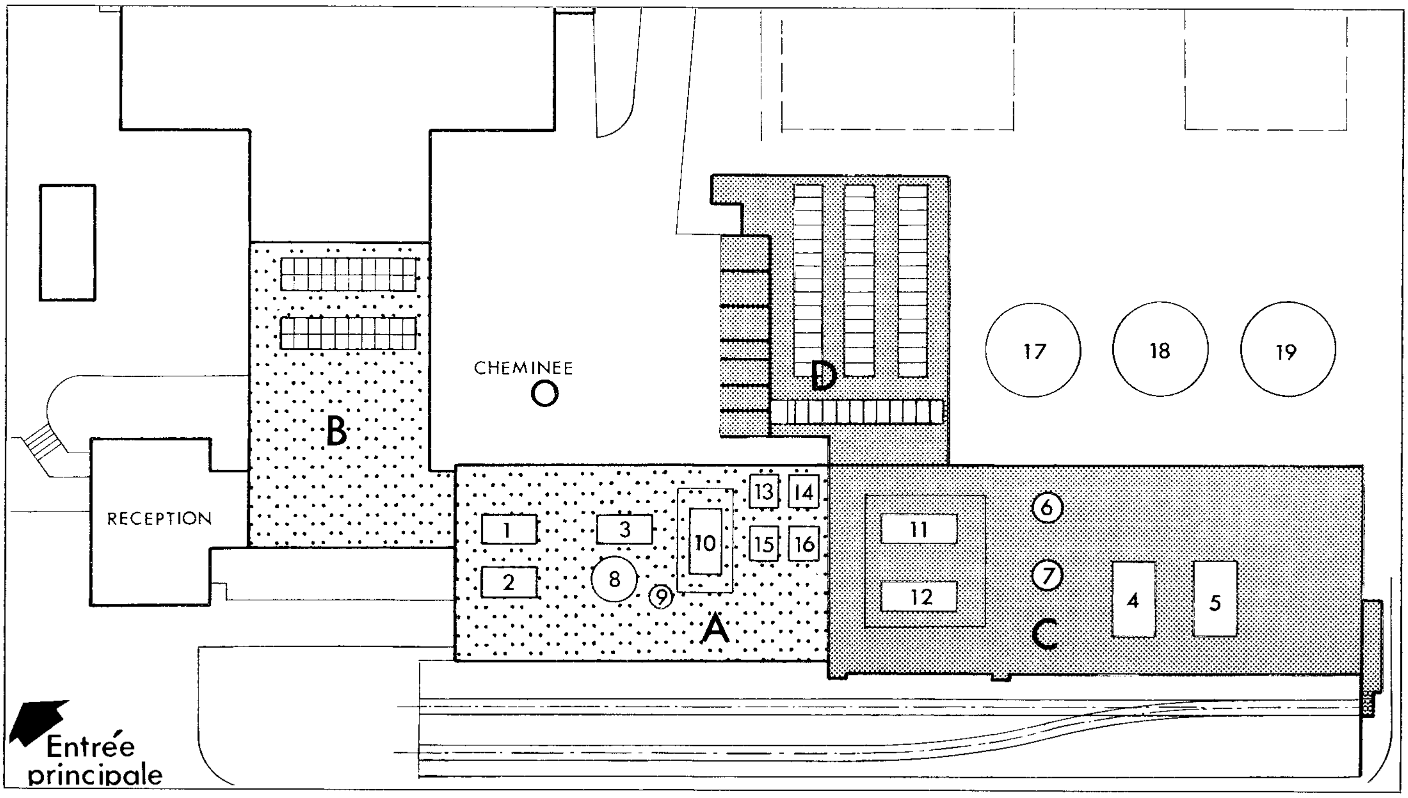


Figure 2

Figure 3 : Increase in the total heating power since 1956

Figure 4 : Increase in highest peak period use of electricity since 1956.

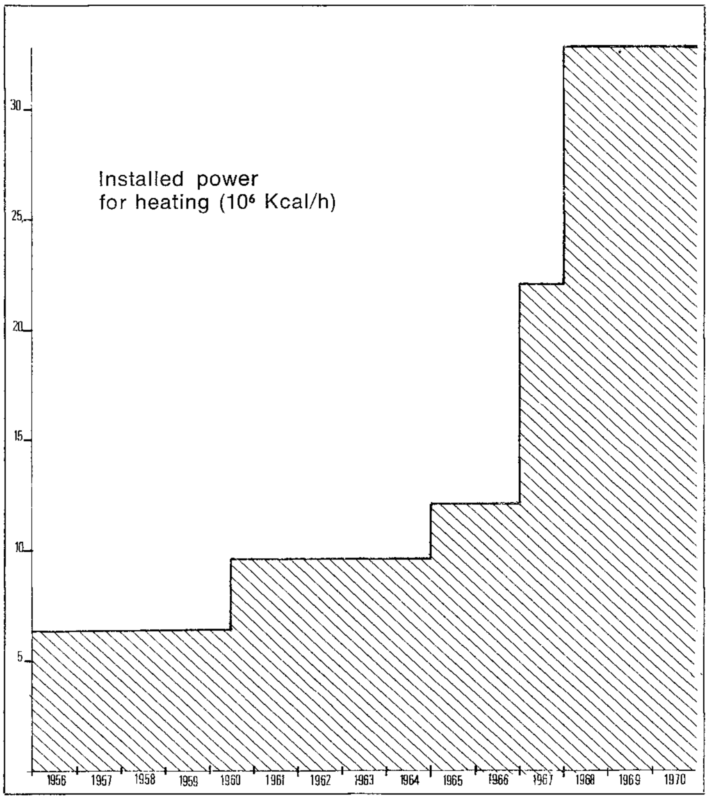


Figure 3

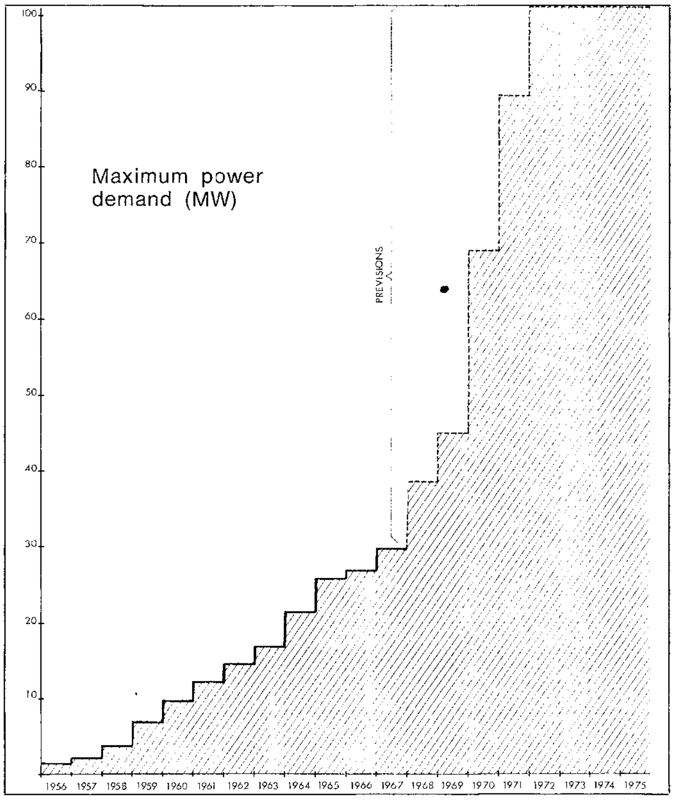


Figure 4

The auxiliary equipment for the station is installed on the first floor where there is also the chassis carrying the high-voltage equipment protection, control, and checking and signaling relays connecting the control room to the high-voltage cells of the Jura, Salève and CERN main 18 kV stations and the SIG 130/18 kV transformer sub-station, and also to the various installations in the Power House.

The second floor of the building is the Control Room, which replaces the one at present housed in the building marked B on Figure 2. The essential equipment of this room will be a row of control and supervision desks for the electricity generating and distributing plant and a row of panels for the supervision and control of the production and/or distribution of the various fluids, i.e. drinking water, industrial water, oil, superheated water, gas and lighting and compressed air. This floor will also contain the Station Operations Manager's office and the rooms for the duty team.

The Power House revised and renovated in this way, will become operational before the end of the year and will be ready in good time to provide the heat, electricity and compressed air required on the ISR site.

It is appropriate to round off this survey by indicating how the contracts for the work involved have been awarded to companies from several of the Member States. The Power House constitutes a fine example of European technical co-operation.

Société Aixoise de Construction, Aix-en-Provence	*France*	*civil engineering*
Firma Muller, Offenburg	*Federal Republic of Germany*	*metalwork*
Termotecnica Industriale, Milan	*Italy*	*steam boilers*
Kloeckner-Homboldt-Deutz AG, Cologne	*Federal Republic of Germany*	*diesel engines*
Siemens AG, Erlangen	*Federal Republic of Germany*	*synchronous alternators*
Société Lyonnaise d'entreprises, Lyon	*France*	*engineering in the relay and control rooms*
Sprecher & Schuh, Aarau	*Switzerland*	*equipment for the relay and control rooms*
Merlin Gerin S.A., Grenoble	*France*	*high-voltage cells*
Société de Construction Electrique A.M.S., Grenoble	*France*	*lighting and power installations*
Nordon Fruhinsholz Biebold, Villeurbanne	*France*	*pipework*
Haelg & Co, St. Gallen	*Switzerland*	*pipework*
Ceretti & Tanfani, Milan	*Italy*	*crane*

Biological effects of radiation

The number of people in contact with artificially-produced ionizing radiation is rapidly increasing. The time when only a few isolated research workers were subject to its effects is now long past. Atomic fission has become accepted almost as part of everyday life. In the medical field, radiation is becoming an essential tool in such work as radiology, the study of the metabolism and functioning of glands, and possibly in reducing rejection reactions to grafts. Its use is increasing also in biology (most of the recent knowledge of life processes has been gained using radiation), mechanics, metallurgy, hydrology, food preservation, etc...

This growing range of useful applications has made it more important to recognize the other side to the coin — the dangers inherent in the exposure of living matter to radiation. The early atomic scientists and radiologists were, to their cost, the first to become acquainted with 'radiation sickness'. But, as the knowledge of the properties of radiation and its biological effects has increased, it has become possible to take precautions against the dangers. The more accurate this knowledge of the risks becomes, the more thorough the precautions that can be taken.

How radiation acts

The action of radiation on living matter originates in the ionization produced by the particles of the radiation as they pass through matter. The ionization liberates active radicals which, in turn, bring about a chemical imbalance. This imbalance can result in a wide variety of biological effects.

Unlike light, ionizing radiation does not stop at the surface. It can penetrate deep into matter and can, in certain cases, be even more biologically active at a great depth than at the surface. As the energy of the particles increases, the ionization can be accompanied by the creation of secondary particles with a very complex ionization range.

Around accelerators generating very high-energy particles, the protection provided in the form of shielding, etc... is based on an extrapolation of the known effects of radiation, allowing a wide margin of safety. There is a danger, however, that these conventional safety measures may lose their effectiveness as energies increase and the interaction between the high-energy particles and matter becomes more complex. Hence the need to examine in advance any new effects that might result from exposure to very high-energy radiation.

The very exhaustive studies already carried out in the field of dosimetry, analysing the entire physical side of radiation, needs to be supplemented by biological studies. In order to understand radiation sickness the intermediate processes in its development (see diagram) have to be studied.

The most sensitive part of the cell is the nucleus, containing the chromosomes, which consist essentially of DNA (deoxyribonucleic acid). The effects, depending on the degree of irradiation of the cell, are as follows :

1) slight disturbance to the metabolism of the cell, which can be repaired
2) abnormal cell reproduction
3) inhibition of cell division (reproduction)
4) destruction of the cell.

Cells which are in the process of division are the most vulnerable, and a relatively small dose is enough to destroy them. For example, the cells of the reproductive organs, those of the heamato poietic system (the production of blood in the bone marrow) and cancerous cells are very sensitive to radiation because of their high rate of reproduction. On the other hand, the cells of the nervous system which do not renew themselves, are much less sensitive to radiation.

The changes produced in the cells by irradiation, affect the organism in a complex way, depending on the nature of the organ which has received the dose and on the type of radiation. The phenomena affecting the organism itself are called somatic, and those affecting heredity are called genetic. Effects produced by sub-lethal doses may appear soon or after very long periods.

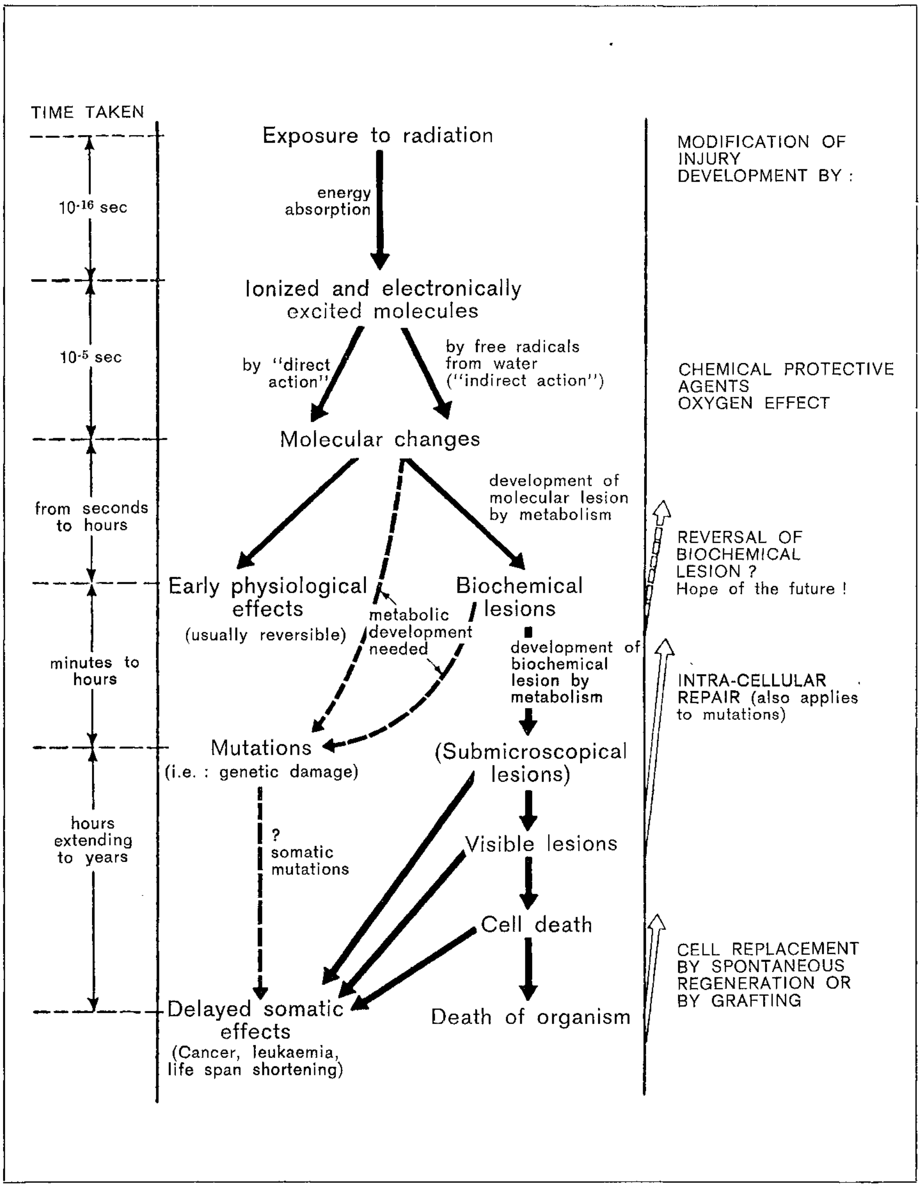
It is difficult to understand all the mechanisms involved in an organism as highly developed as that of a mammal, and the work done in physics and chemistry has to be corroborated by the experimental study of the complex reactions taking place in complete organisms.

A great deal of research has already been done on the induction of cancer, changes in the blood, skin reactions, mutations, metabolic disturbances and effects on micro-organisms and plants. Interest is now being directed towards the study of the effects of small doses and the special features of high-energy ionizing radiation, the action of the environment, separation mechanisms at cell level (repairable and irrepairable effects), immunology, calculations on the distribution of ionization in sensitive points in the cell, and the new problems in the field of protection.

Biological research makes it possible to evaluate the maximum permissible doses, to be applied in protection with a considerable safety margin, to prevent artificial radiation from causing more mutations than are brought about spontaneously in nature.

The concept of biological effect

The dose of radiation received, i.e. the energy absorbed per unit volume of tissue is proportional to the ionization produced, and is measured in *rads* (100 erg/cm^2). For equal doses, however, not all radiation has the same biological effect, since the latter is a function, in particular, of the distribution of the ionization inside the cells (i.e. the linear energy transfer — LET). In order to take into account the way in which the ionization is distributed, a coefficient called the *quality factor,* QF, is applied to the energy absorbed and the number of rads multiplied by the quality factor equals the number of *rems.* However, the rem unit system does not necessarily take account of the features of the biological system itself and it is necessary to define yet another factor, the *relative biological efficiency,* RBE. This takes into account the action of radiation at the biological level.



Scheme from Z.-M. Bacq and P. Alexander

Research programmes

Only quite recently has it become possible to carry out biological and medical research using high-energy particles generated by accelerators. CERN participates in this research in close collaboration with laboratories in Member States. The work is coordinated by the Advisory Committee on Radiobiology set up by CERN in 1964. In general, it is CERN which provides the irradiation facilities (predominently, up to now, at the 600 MeV synchro-cyclotron) and dosimetry, while the biological evaluation is carried out in the Member States. In the context of this overall programme, a series of biological assessments, has been undertaken over the past two years at CERN, by a visiting scientist, G. Buhrer of the University of Geneva, working in the Health Physics Group.

The work of the Group, the majority of whose members are engaged on research as well as on protection systems, is directly related to the requirements of the high-energy physics field, that is to say to protons and neutrons of high energy as well as sub-nuclear particles.

The biological research carried out by Buhrer at the synchro-cyclotron used protons and neutrons. Using protons with an energy of 600 MeV, the research has provided a clearer picture of their relative biological effect which, up to now, has been a subject of dispute. It has also helped to fill gaps in the knowledge of their genetic action and to provide fresh information on the close relationship between high-energy protons and 'conventional' radiation.

Using neutrons with an energy of 400 MeV, work on plant chromosomes and the reproductive organs of mice has just been completed. One of the main results is a measure of the relative biological effect in relation to the depth of tissue penetrated.

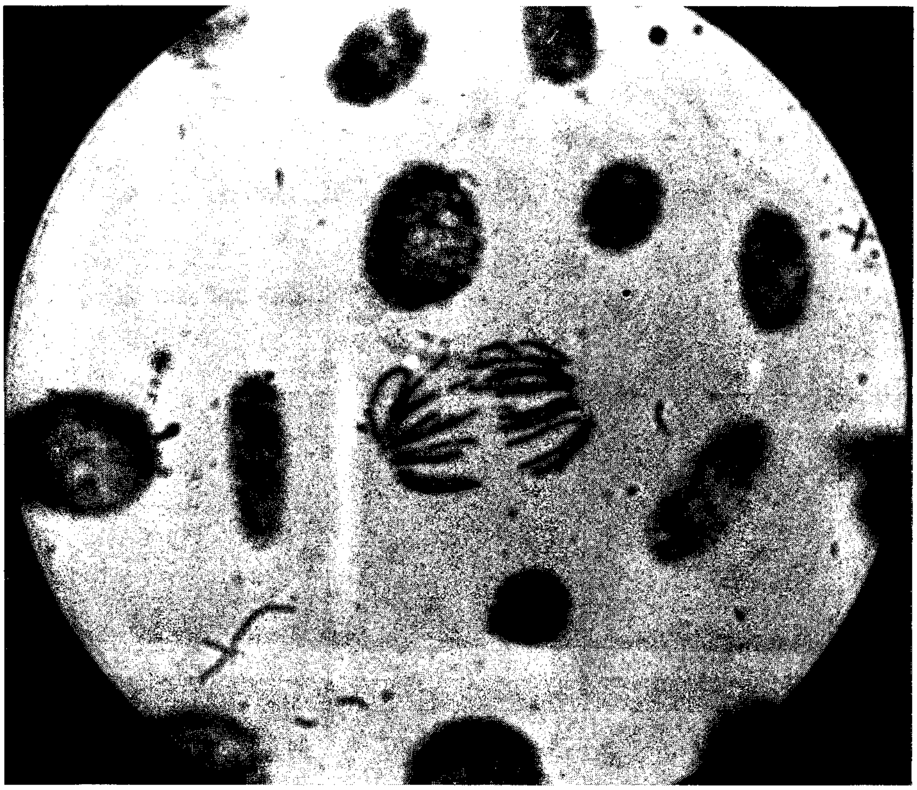
Other research needs to be done on the action of beams of several types of particle over a range of energies on various biological systems. The emphasis will be laid on the formation of nuclear stars resulting from the explosion of the nuclei. This phenomenon can be produced only at high energies, and its effects cannot yet be foreseen.

Conclusion

In addition to the uses of radiation which were mentioned at the beginning of the article, the time has arrived when astronauts and pilots flying at high altitude are subjected to high levels of ionizing radiation of cosmic origin. This has particular relevance to the work around accelerators since the radiation at high altitude has substantially the same composition as can be produced at the accelerators. It is therefore very important to know precisely the biological effects of the radiation ; at present, this knowledge can be obtained only by work around accelerators. (It is significant that the USA space agency, NASA, have built a synchro-cyclotron specifically for this purpose.)

The research done in this field has already cleared away a lot of misconceptions. The information obtained has made it possible to improve the methods of protection against radiation, to develop more effective medical treatment, and to reduce the danger of genetic damage to persons exposed to small doses. Furthermore, it has now been found that the organism can, to a certain extent, spontaneously repair somatic and genetic lesions, since some of the DNA contained in the chromosomes can be restored by a repair mechanism inside the cell which eliminates the damaged part. It has even been possible to demonstrate that animals previously exposed to a sub-lethal dose acquire some immunity to 'lethal' doses. In some cases very small doses can even prolong life, whereas, in general, exposure to radiation shortens life.

The research work already carried out has helped to remove certain superstitions which followed the tragic and spectacular manner in which humanity first came face-to-face with nuclear armements. Further increases in our knowledge, even if they do not remove the danger completely, will at least enable it to be estimated correctly.



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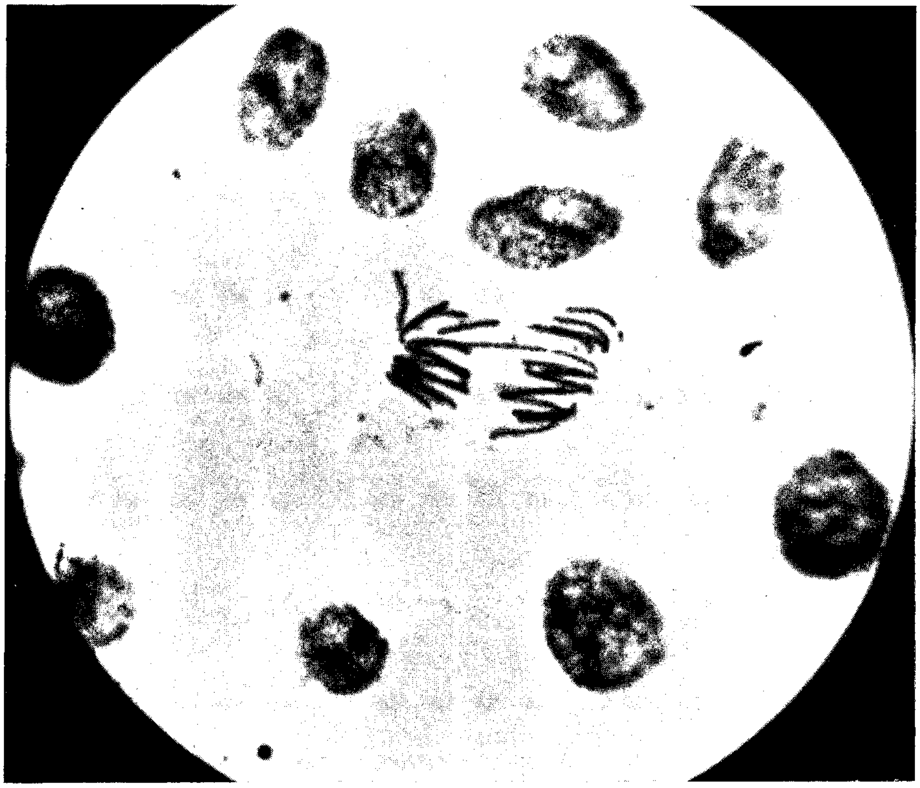


2.

Photographs from an experiment done at CERN on the irradiation of plant tissue (vicia faba) by a high-energy neutron beam (400 MeV).

1. *At the centre can be seen an irradiated cell in the course of division. The chromosomes show signs of lesions, mainly in the form of breaks.*
2. *At the centre there is another cell in the process of division which has also been injured by radiation. Some broken chromosomes are visible, but the main effect of the radiation here is the presence of a bridge of an abnormal type joining the two sets of chromosomes and inhibiting the normal development of the cell. The other cells, in the compact state, which can be seen in both photographs, are not in the process of division.*

Round the table at Vienna

During the Vienna Conference, several of the leading figures in European high-energy physics as well as Professor R. Wilson, Director of the USA 200 GeV Laboratory, came together to answer a series of questions on the future of the field.
A report on the Vienna Conference itself — the 14th International Conference on High-Energy Physics — will appear in the next issue.

To what extent is the 200 GeV USA National Accelerator Laboratory competitive, and to what extent complementary, to the European 300 GeV project?

Professor Wilson:

The USA team is extremely keen to see a comparable Laboratory in Europe which would provide that element of competition and collaboration which has been so helpful with the two machines of about 30 GeV. This has been of great value to us and, I think, to the whole physics community. Two people working on the same problem always seem to be somewhat keener and more agressive and perhaps even a little more honest than a lone worker. Both groups benefit from a competitive situation and from the knowledge that there is another comparable team able to comment in an expert way on what is going on. Moreover, people are then a little more restrained in putting their results forward which also adds to the overall efficiency.

To what extent could the USA machine carry the future load of physics in the 200 GeV region?

Professor Wilson:

In one respect there are cost limitations but, in any case, if we are to get all the answers we are looking for, we need the best efforts on both machines. I would also repeat that you get better results from two machines than from just one.

If the worst came to the worst, could the American project in fact accommodate a significant overseas participation?

Professor Wilson:

The answer is — with money 'yes', without money 'no'. Without money we cannot even accommodate our own regional interests. We could increase the intensity of the machine, I suppose, but there is always the problem of so many hours, so many square feet, and you just cannot do everything. I suspect that we are going to have to expand to meet the needs already foreseen in our own country. We should of course try of accommodate people from Europe, if the worst came to the worst, but we should regard this as a pretty desperate circumstance.

Do you consider that, should the 300 GeV project go ahead, the machine would come up very quickly to full utilization?

Professor Amaldi (Chairman of the European Committee for Future Accelerators):

In part, the speed of utilization depends on the amount of money that is available before the machine is ready for the preparation of experiments. In part too, it depends on the enthusiam of the people who want to use the machine. This I would expect to be considerable. I am convinced that the young physicists will be extremely interested in using the machine and there will be a considerable number of them in a position to use the machine. Some have already been working at CERN on the existing accelerators, others will have been working with the Intersecting Storage Rings, experienced in very high-energy techniques, and then there will be people from the other European Laboratories. From the point of view of desire and capability, I see no problem, but it does depend on how much money they will have to prepare the experiments. It may be that in the beginning because of the cost of the experiments, the programme will start slowly.

Professor Jentschke (Director of DESY Laboratory, Guest Professor at CERN):

There has never been any difficulty in Europe in using machines efficiently if we have the money. For example, there are about 130 scientists working at DESY of whom perhaps only 20 or 30 are from the Centre itself, about 30 come from outside Germany and the rest are from the other Universities in Germany. I think it is very important that all the national centres should have an international flavour. We have found it of considerable value to the level of scientific research in DESY to have French physicists, a team from America, visitors from the United Kingdom and so on. I don't think there is any danger of facilities not being fully used if they are available.

What would be the role of these national accelerators if a big new international Laboratory came into being?

Professor Gregory (Director General of CERN):

One very fundamental point in our field is that, at a given point in time, we need to have the most modern equipment that is possible. If at the same time, there is a set of less modern machines as a complement to the big machine, we are in a very healthy situation. If however we do not have in Europe one of the best machines in the world, then activity in this field will slowly decay. I believe that some people will be invited to work on the USA machine and will indeed participate in the work there, but in terms of the overall status of physics research in Europe, essentially, this field will decay. Certainly, for some time, people will continue to work on the old accelerators, but they will not be able, for example, to participate fully in conferences such as the one that is taking place at Vienna. We should be in the position of having second-rate equipment producing second-rate results. Moreover, we should lose our best people to other fields and to other countries and there will be little opportunity in the future of regaining the situation.

The 300 GeV machine is a piece of equipment that will be modern for a very long time and will preserve our potential in Europe with respect to the United States. To what extent we should be able to utilize the secondary machines will depend on the money that is available, but I have no hesitation in saying that in ten years from now the best possible use will be made of the big machine and it will be that one which will attract the best people.

Dr. Stafford (Deputy Director of the Rutherford Laboratory):

The problem is rather more complex than we have so far discussed. Not only are there these aspects of the relationship between the big machines and small machines (and I believe that during the past five years it has been possible to do quite important physics at lower energies) and the impossibility of seeing a future if there is no big machine, we have also to remember that it is not just a matter of seeking new information. It is equally important to feed this information back to the Universities and then throughout the scientific community of Europe. If all the experimental work is concentrated in the United States, it is very hard to see how to get the full benefit of advances in thinking. When CERN started, for example, and when the Rutherford Laboratory came into operation, the environment of physics changed appreciably in England. The quality of the students that were coming along changed because the people who were teaching them had got themselves into a new way of thinking and into the way of doing advanced physics. One has to be aware of this general environment of doing advanced work.

Do you expect that it would be University students who participate in the research on the 200 GeV machine in the United States?

Professor Wilson:

The whole emphasis is in that direction. We are deliberately not emphasizing the Laboratory groups and indeed we do not expect to have any pure Laboratory group doing research at the National Accelerator Laboratory. We are thinking in terms of having say one of our members working and collaborating with a University team and when we talk about things, it is always about University teams including students as well as the professors.

Professor Gregory:

This is, of course, how things work at CERN at the present time. I recall at the conference one of the significant results in the weak interaction field was presented by a young physicist from a German University. The group that performed the experiment included two Senior Professors who certainly were also major participants in the experiment. But I remember that when the original proposal was being considered, it was made clear that it would be a student that made the proposal and it was on this presentation that the decision was taken. The account was given during the Vienna conference by the same student. This is one way in which the University professors are bringing forward and developing the level of work in the Universities.

Professor Ekspong (Stockholm University):

This is the most important counter to the suggestion that the European machine is made unnecessary by the one in the United States. Wilson has said that they could try to accommodate some Europeans but I think what would happen would be that the best men from Europe could be accepted there, but the students would be divorced from their research professors and from then on there would be no growth.

If these are the principal arguments for the project, how does one interpret the position of the UK?

Dr. Stafford:

All one can say here is that the body of high-energy physicists in Britain are unanimous in supporting the 300 GeV project. If the government has in fact disagreed, this is something else. All the scientific bodies who were set up to give advice on the project came down in support of it.

Professor Amaldi:

I am sure that if we go on with the project Britain will come in. I have absolutely no doubt in my own mind about this; there is even historical support for it. If we go on and we do well, as we shall do, then they will join and they will become one of the top members of the new Laboratory. I am quite sure that the important thing is to keep going and Britain will be with us later.

Dr. Stafford:

It is certainly the declared policy of the nuclear physicists to continue to press our government to join.

Professor Gregory:

It cannot be overstressed that Britain remains a member of the Organization at CERN. The new Convention will provide for two Laboratories and the countries who are members of the Organization can elect to join one or both of the Laboratories. The UK has in no way indicated that it wishes to withdraw from the Organization and I suspect that this has not been fully understood everywhere.

What more does Sweden, for example, need to know before it can come to a decision on its position?

Professor Ekspong:

The advisory bodies of the Swedish government and the Norwegian and Danish governments have all submitted their views. The Swedish Minister of Education has sought comment from a wide range of advisory bodies including the Universities and industrial organizations. Some were very strongly in favour of the project, some mildly in favour, and some against. The government has it now in hand and I know that the project is being intensely studied in government circles. There have also been discussions between Sweden, Norway and Denmark, but I cannot anticipate the results.

Professor Gregory:

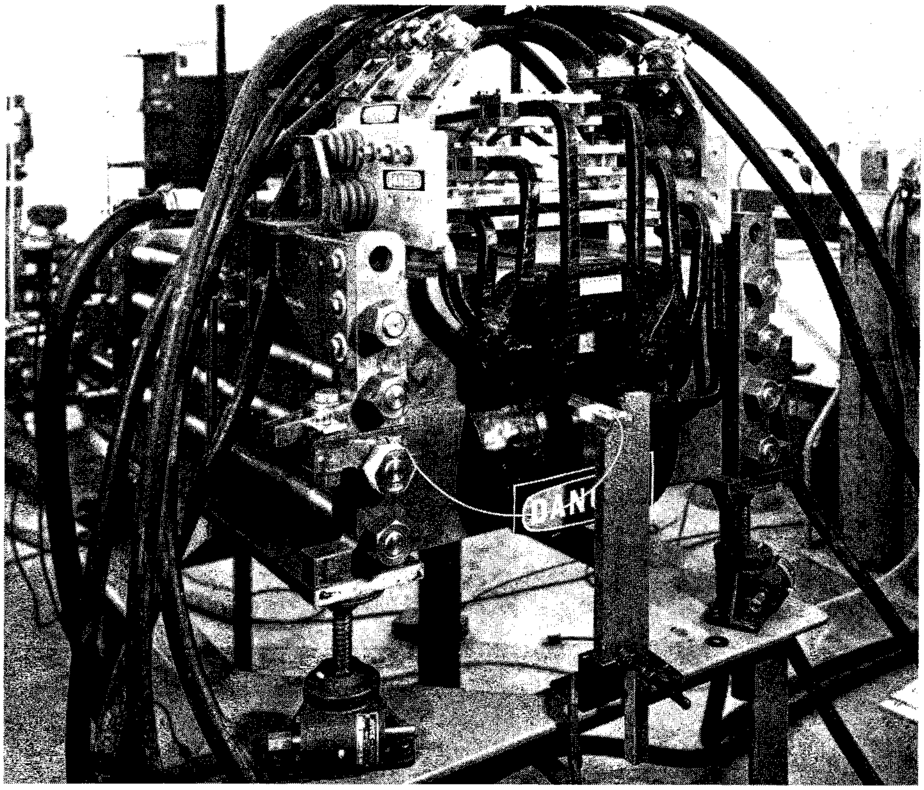
We have five letters of intent and I believe the project will go ahead healthily if we have say two of the smaller countries giving their approval in the near future. I am thinking particularly of Switzerland, Netherlands and Sweden.

The October Council will be an extremely important meeting in establishing the time-scale of the decisions that now have to be taken. I think that we might assume that certain other countries will give a positive answer between October and December and we should work on this basis. This would then provide the necessary number of participants for a major decision to be taken in December. But three months is a very short time and we have to revise the description of what countries are committing themselves to. We have to prepare for the selection of the site and a new Director General and I think it will now be the technical aspects of coming to a decision rather than letters of intent which will determine the time-scale.

So there is a real possibility that the project can move forward as of say March next year?

Professor Amaldi:

It would say definitely 'yes'. If we can get the decision to go ahead at the December meeting and the number of sites reduced to four, then maybe we could have a special meeting of the Council in January, nominate a Director General and sign the description of what the countries engage themselves to. These are technical aspects which involve the new Convention at the same time. We have then four to five months to do this, and it is during these four to five months that we hope to have the answers from a maximum number of countries.



A close-up of the 3 ft bolted magnet model being used to check the magnet parameters for the main ring of the 200 GeV accelerator. Preliminary tests showed a field uniformity across the aperture virtually independent of the field strength up to 18 kG; this field strength would be required for eventual development of the accelerator to an energy of 400 GeV.

200 GeV project

Professor Wilson gave a talk on the progress of the American project during the Vienna Conference. Some of the points from his talk are picked out here.

With the start of the new financial year in July, the project enters a new phase. The first year was spent almost entirely in design work with no possession of the site, and the team was centred temporarily in a block some miles from the Laboratory site. By the end of this year, it is hoped that the complete staff will move onto the site. Currently, some 200 people are working on the project, of whom 60 are scientists and engineers.

The name Weston, which has so far been associated with the project, is not greatly loved by the design team as it is the name of a housing project that went bankrupt ! The National Accelerator Laboratory will therefore have the postal adress of *Batavia, Illinois.* Batavia is the settlement which takes in the majority of the site (and in the future perhaps all of it) so that, apart from being more euphemistic, and with a better image, it is even geographically more appropriate. Weston itself is now called by the project team 'the Campus' compromising as it does some 100 houses each of about 100 m² which are proving useful laboratory and office units.

Experiments have been conducted on the value of using inflatable buildings and although the experiments might be considered a success, the buildings were definitely not. Professor Wilson said that the buildings had been initially inflated by conducting a theoretical physics seminar in them !

One of the basic design criteria is the assumption that 99% or better extraction efficiency can be achieved leading to the use, predominently, of extracted beams. This philosophy has now gone further with the decision to eliminate internal target areas completely, at least in the early phase. A Summer Study in Aspen, Colorado attended by 75 top experimentalists indicated that there are no experiments using an internal target that could not been done equally well from an extracted proton beam. The same study group had also thought about the requirements for large bubble chambers, and there are two possibilities involving current projects at other Laboratories which it might be possible to move to NAL — (1) the 12 ft Argonne chamber, (2) the 14 ft Brookhaven project, after certain modifications. (The BNL chamber has not yet been authorized.) A large bubble chamber is considered essential for neutrino physics and neutrino physics generated a lot of enthusiasm during the Summer Study.

In the lay-out of experimental facilities it has always been envisaged to have an extracted beam with various switch points and this is being taken to its logical conclusion by shifting targets also from the main transport line into the switch areas. Consideration has also been given to the possibility of preparing focusing/separator sections in areas remote from the experimental area and then wheeling complete sections in a very large vacuum chamber as a single unit.

A lot of entertainment came from the propositions for the main building on the site. The design finally chosen is for a building of annular section, slightly conical in vertical form with a centre court covered with a plastic dome to keep out the winter weather. The building will probably be about 150 ft high.

In the current fiscal year, work will start on the buildings connected with the injection system which are of crucial importance in order to meet the target date for the first beam of July 1972.

The CERN Library

Any advanced research centre needs a good Library. It can be regarded as a piece of equipment as vital as any machine. At the present time, the CERN Library is undergoing a number of modifications to adjust it to the changing scale of CERN's activities and to the ever increasing flood of information. This article, by A.G. Hester, former Editor of CERN COURIER who now works in the Scientific Information Service, describes the purposes, methods and future of the CERN Library.

A. G. Hester

The CERN Library is part of the Scientific Information Service (SIS), under Dr. A. Günther, which in turn is part of the Data Handling Division. The other sections of the Service are concerned with document reproduction and publications exchange, the latter being closely connected with the Library. Often in what follows, the term 'Library' should really be replaced by 'Scientific Information Service', but the distinction is not usually noticeable to the Library user.

The purpose of the Library is to provide anyone at CERN — staff member and visitor alike — with all the documentation necessary for his work. The most intensive use of the service is, of course, made in the fields of major interest, notably high-energy physics (theoretical and experimental) and accelerator technology. Here the Library aim is clear: to collect everything available. In more marginal fields (for example medium- and low-energy nuclear physics, electronics, computers, etc.), the proportion of literature actually collected is smaller, depending on the subject, and in some areas the emphasis is more on bibliographies, abstract bulletins and the like, from which the existence of publications in a particular field can be ascertained. In administrative, and similar 'support' fields, hardly anything is collected without an individual request from the person interested.

From this it is clear that, although the number of different subjects to be found in the catalogue is very large, the Library does not aim at a comprehensive collection of literature in all possible fields of interest. Instead, the work involved in obtaining, registering and indexing any document is considered to be justified only if there is a reasonable chance that it will be of direct use for someone's work.

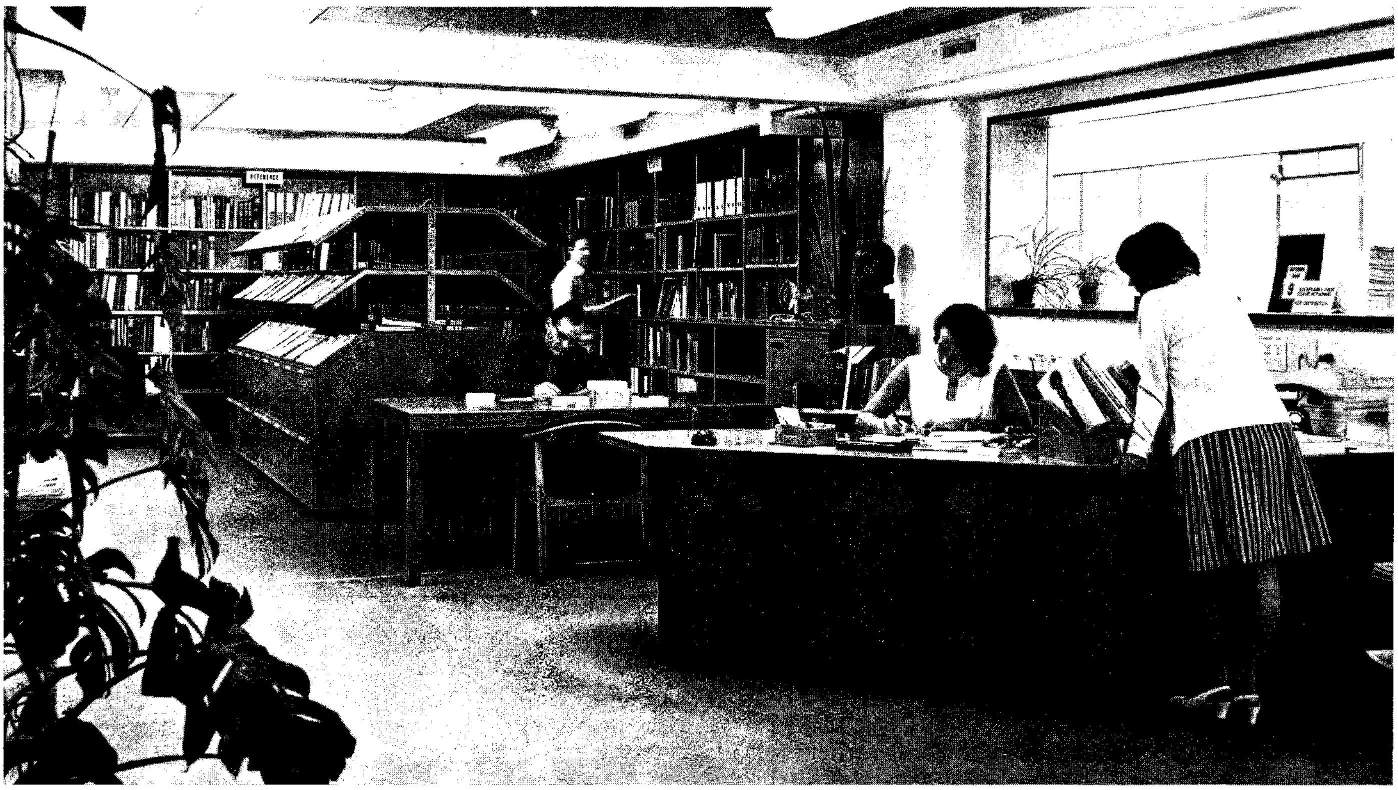
Following the same line of reasoning, anything especially asked for by someone is considered to be worth cataloguing so that it becomes potentially available to all. Any book, periodical, or other document that needs to be purchased by CERN must therefore be ordered through the Library, and becomes part of the Library stock, even if on long-term loan to a particular user.

Overall Library policy, and particularly subscriptions to periodicals, is in the hands of a Library Committee, appointed by the Director General, on which all Departments of CERN, as well as the Library, are represented. The present chairman of this Committee, which normally meets several times a year, is Dr. L. Kowarski. •

Library holdings and services

Most people associate libraries with books, and the CERN Library contains rather more than 20 000. However, in a scientific library, other types of material have an equal or greater importance.

Thus over 500 different periodicals are received regularly, mostly on subscription though some come as a result of exchange agreements for CERN publications and others (essentially industrial 'House Journals') as gifts. For the more important periodicals one copy of each issue is not enough, and a total of 160 duplicate sets are therefore taken in addition.



The reading room of the Central Library showing the desk, with some of the reference collection and the preprint racks behind.

CERN/PI 74.9.68

Two photographs taken in the PS Library, the 'satellite library' located in the Proton Synchrotron Division building. On the left, the racks of periodicals ; on the right, the book collection and card catalogue drawers.

Another important part of the Library collection consists of scientific and technical reports issued by numerous laboratories and organizations throughout the world. Last year some 800 such reports were catalogued. Then there are progress reports, annual reports, etc, from various institutions, a varied collection of pamphlets, brochures, reprints and similar material, and special collections of CERN reports and certain high-energy physics and accelerator conference proceedings. Of particular importance is the steady input of 'preprints' and other unpublished material requiring quick notification to the CERN physicists, who rely on this kind of material to keep up to date with the latest results in their field.

There is also an extensive collection of reports in the form of 'microfiches', photographic negatives 148 × 105 mm², each recording up to 72 printed pages. New microfiches are received regularly, through the U.S. Atomic Energy Commission, and many of the reports not otherwise collected by CERN are available in this form. They can be read using a high-quality reader in the Central Library or a portable reader which can be borrowed at the same time as the microfiche.

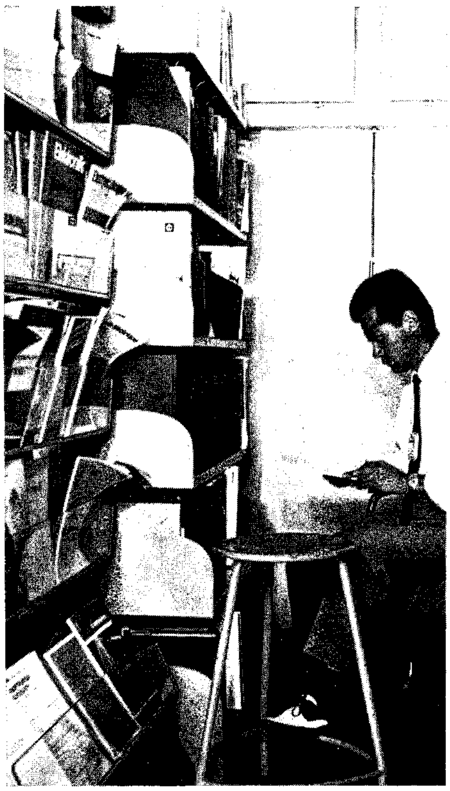
The Library staff are available to help readers find information or particular publications. So far as resources allow, they can also help with the compilation of bibliographies on special subjects or on the publications of particular authors. If a wanted publication is not in the collection, it can often be quickly obtained on loan from another library, since CERN is affiliated with an efficient inter-library loan system. Reports issued by institutions with which CERN has publications exchange agreements can in most cases be obtained on request, if they are not already in the Library, and of course many reports, but more especially books, are purchased to satisfy particular requests from readers.

Most items in the library are available for loan. The principal exceptions are abstract bulletins and bibliographies, which, together with a selection (mostly duplicate copies) of important periodicals, major text books, conference proceedings, handbooks, tables, dictionaries, etc., form the Reference collection. The most recent issue of any periodical is also not allowed out of the Library. There are other books which are hardly ever in the Library, although fully catalogued and available to anyone when required. These, on long-term loan to certain readers, may be on special subjects, of interest only to small groups of people (Customs regulations, medical handbooks, books on education...) or extra copies of certain books needed very often in day-to-day work (the typical example here being the many French-English dictionaries in offices all over CERN).

Bibliographical lists

Documents are not just collected and catalogued; their availability has to be made known to users. This notification is by means of various lists issued by the Scientific Information Service, some directly concerning the library holdings, others of more general interest:

Select accessions — issued fortnightly; lists new books, reports and pamphlets received in the Library.



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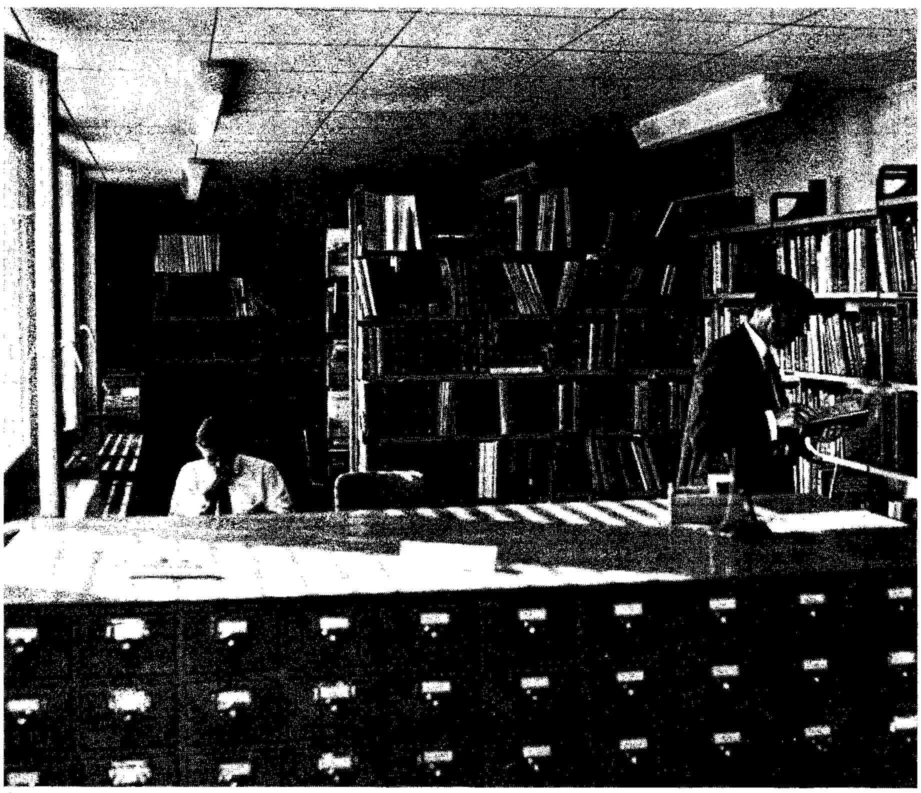

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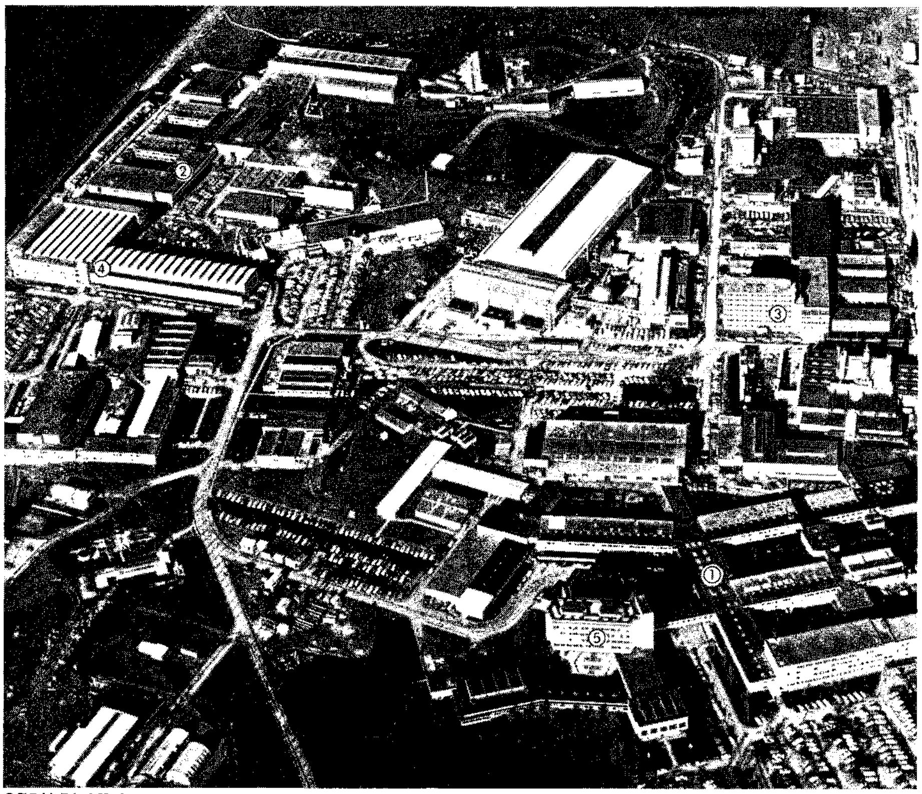

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An aerial view of the CERN site, picking out the location of

1 : The Central Library
2 : The PS Library
3 : The TC reference collection
4 : The NPA reference collection
5 : Salle Pauli

Preprints — issued weekly; lists papers and reports received and known, or assumed, to have been submitted for publication in scientific periodicals. A cumulative author index is issued every three months, with a cumulative supplement each week for the Library.

Forthcoming conferences — issued every two months; lists relevent conferences to be held within the following twelve months.

CERN scientific reports — issued every six months; lists all CERN 'Yellow' reports.

Reprints of CERN publications — issued every six months; lists reprints of papers by CERN authors published in scientific periodicals.

CERN publications — issued every few years; gives essentially a cumulation of the above two lists, with author index.

Whilst the last three lists are made generally available, the others are intended primarily for people at CERN and are hence of little interest outside.

Reading rooms

The major part of the library collection is housed in the Central Library, close to the complex containing the Main Auditorium, Council Chamber, Restaurant, Bank, and other amenities (see photograph on this page). Recently extended, and somewhat rearranged to separate more distinctly the loan section, the reference section and the bibliography section, the total area available is some 450 m², with 275 m of shelving for books, 525 m for periodicals and bibliographies, 256 drawers and 110 m of suspended files for reports and pamphlets.

A subsidiary collection, consisting mostly of duplicates of material in the Central Library, but also containing many other documents on accelerator design and use, is housed in the PS library, near the proton synchrotron. This has a surface area of 58 m².

Both reading rooms contain a full set of catalogue cards, so that the availability of any publication can be ascertained in either of them. A member of the Library staff is normally on duty in each room during the day to assist readers with any queries and to book out loans, but both rooms are open permanently and books and reports are thus available at any time of the day or night, week-ends included, for consultation or even for loan.

Since 1965, a small reference collection of important periodicals, conference proceedings and handbooks has been housed in the Track Chambers Division.

Of particular historical interest is the Salle Pauli, near the Council Chamber. This houses the private library of the late Professor Wolfgang Pauli, presented to CERN in 1960. It contains over 700 books, more than half of them on physics and mathematics, and a few periodicals, but the major part of the collection is made up of some 10 500 reprints of papers on physics and mathematics, particularly quantum theory, published during the period 1920-1959. This reading room is open every working day from 2 p.m. to 4 p.m. and the documents can be consulted at other times by special arrangement. A catalogue of the reprints is shortly to be published.

Looking to the future

In a growing organization like CERN, scientific information services must obviously expand and evolve to meet new needs as they arise (although it is a well-known rule of big institutions that increases in services do not keep in step with increases in direct activities!) The early establishment of the PS library and extension of the Central Library reading room were in line with this development.

Less noticeable, but undoubtedly more important in the long run, are the changes 'behind the scenes'.

An early example was the introduction of an automatic typewriter system, operating with punched cards, to prepare entries for the six-monthly lists of CERN reports and reprints. This facilitated publication of a cumulated *List of Scientific Publications, 1955-1964 (CERN Bibl. 7)* including an author index produced automatically by computer.

Preprints are another example. At first these were catalogued like any other document, but very soon their growing number and the over-riding need for speedy notification led to their simple announcement on the weekly preprint list — initially typed in one go, later prepared from separate entry slips typed as the preprints were received. Since 1966 the usefulness of each list has been enhanced by the simultaneous preparation of an updated author index, made possible by the additional use of punched cards. For some years also, a simplified loan procedure has been used for the circulation of preprints. The growth in demand shows up very clearly in Table I, which summarizes the stock and activities of the Library up to the end of 1967.

Early in 1967, the general need to plan ahead for the expansion of CERN on to the ISR site gave rise to the question whether more fundamental changes might not be needed in the Library, in place of the previous rather mild adaptation to circumstances.

The Library Committee accordingly set up a 'Working Party on Scientific Information', representative of both the Library

Part of the Library book collection in the Central Library.

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users and the Library staff, under the chairmanship of Dr. L. Kowarski, to study the future scope and techniques of the Scientific Information Service.

Library scope and location

A questionnaire on the use of the Library facilities was compiled and distributed to all actual and potential users in June 1967. Nearly 50 % of the forms were returned and only a few of these were from people who said they never used the Library at all. It could thus be confidently assumed that the replies represented the habits of a high proportion of users. The questionnaire was also of great help in showing definite patterns of activities which the Working Party could reliably take into account, along with other criteria, in formulating its recommendations.

Concerning the scope and location of the Library, these recommendations were, briefly, as follows:

- The existence of one Central Library for the whole of CERN should be preserved.
- The present Central Library reading room should be enlarged but adequate space should be foreseen for a new location in a few years' time, in the region of the new 'centre' planned for the enlarged site.
- The Library should continue to concentrate on CERN's main interests, with an improved coverage of some peripheral subjects and an enlarged Reference collection.
- The present PS Library should be preserved and a similar 'satellite library' might later be established on the far side of the French site. A limited number of new reference collections, like that in TC Division, could be envisaged.
- The Library catalogues should be made available in all new auxiliary libraries ('satellite' and 'reference'), and possibly elsewhere. Compilation and distribution of the bibliographical lists should be maintained and improved.

Development of the Library facilities is now proceeding along these lines, a recent decision being to establish an auxiliary reference collection serving physicists in the Nuclear Physics Apparatus Division.

Mechanization of cataloguing procedures

The present Library catalogue exists in the form of two identical collections of cards (one kept in the Central Library, the other in the PS Library), each composed of two distinct and separate files: the Alphabetic Catalogue and the Subject Catalogue.

Each catalogued document (book, report, reprint, etc.) appears in principle at least once in each of these two files. However, a CERN report, for example, will be listed first under CERN (subdivided by Division), then under the name of each author, and again under the number of the report; if the report is the Proceedings of a conference, a further entry is made under the town where the conference was held. Books are entered under author and title, and so on. The Subject Catalogue is based on the Universal Decimal Classification (UDC) and if the subject matter of a document needs two or more UDC numbers, a separate card is required in the catalogue under each one. Thus, instead of the minimum of two cards per document, the catalogue usually contains many more. There is one reprint of a paper on the CERN search for the intermediate boson which required 37 cards (authors' names) in the Alphabetic file and 1 in the Subject file; 76 cards altogether (Central and PS Libraries). This may be exceptional but it is not unique.

Although much of the work in the cataloguing procedure is routine copying and sorting, the necessity for strict accuracy means that it has to be checked, if not also carried out, by people with full library training. With the continued growth in the number of documents to be handled, a growing proportion of their time is wasted in this way, and the prospect of a third card catalogue in some future satellite library (114 cards for the intermediate boson report!) is daunting indeed.

Copying and sorting, however, are ideal tasks for a computer. A logical answer to the problem was thus seen to be the use for the Library catalogue of CERN's administrative computer (IBM 360/30), and this solution was endorsed by the Library Committee Working Party.

Briefly, the idea is to put the basic bibliographical information for all documents into a standard computer-readable form. After some time, no further additions will be made to the card catalogues, which will be retained only to locate the older documents. Future catalogues will be in book form, enabling copies to be made available in as many places as desired; location of an entry in the catalogue will be by means of various indexes (subject, author, report number, etc.) automatically produced from the master entries stored in the computer memory and updated as required. Once the error-free main entries are stored in the computer, lists, indexes, etc, can be produced in various formats automatically, with little or no further checking.

The first use of this system will be for the joint cataloguing of reports and preprints in a single list, to be issued weekly like the present preprint list. Already, reports bearing the date of issue 1968 have

Library Statistics 1954 · 1967

1. Since 1967 only : previously counted under 'loans issued'.
2. Since July 1964 only : previously counted under 'loans issued'.
3. Since 1962 only : not counted before.

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
BOOKS														
accessioned	533	1239	1181	1248	1544	1425	1178	1380	1087	1272	1506	1797	2220	2170
in stock		1772	2953	4201	5745	7170	8348	9728	10815	12087	13593	15390	17610	19780
PERIODICALS														
titles		166	195	257	296	334	356	348	369	395	448	479	494	518
additional sets		—	36	42	101	105	112	117	130	135	139	155	151	160
bound volumes		307	497	763	1203	1592	1937	2161	2431	2758	3118	3549	4314	4915
LOANS (issued)		1788	2157	3923	5292	6041	6531	10546	12754	14361	16618	14236	14218	11389
NEW BOOK CIRCULATION [1]														5119
PREPRINT REQUESTS[2]											8732	20740	29503	34916
INTERLIBRARY LOANS														
borrowed		502	421	461	446	725	550	491	561	663	781	559	673	812
lent[3]									161	151	186	220	194	202

been catalogued in the new way and announced by means of special supplements to the preprint list. The author index to the preprint list already includes reference to these reports, and report-number and subject indexes will follow in due course.

For subject indexing, the contents of each document will be described by means of a limited number of 'descriptors', taken from a controlled vocabulary. For any chosen descriptor, the subject index will show all the reports to which it was assigned, together with all the other descriptors given to each report. It is expected that this method will prove more suitable than the more rigid UDC framework, particularly for CERN's research interests. A slight initial disadvantage, is that all the descriptors will be in English, whereas the UDC number presently used for a subject can be found from either the English or the French term. It is planned to continue using the UDC for books.

At a later stage, books, reprints, etc. will also be catalogued using the new procedure, and some of the routine Library operations, such as ordering new books and controlling periodicals, may also be incorporated.

Beyond that, it is not safe to predict, but one of the most attractive and challenging aspects of a computerized cataloguing system is the opportunity that it offers for future development, not only within CERN itself but also in a wider field. All over the world, experiments are being carried out on the storage, sorting and rapid retrieval of information in various forms. The exchange between libraries of catalogue files on magnetic tape is already quite common. The printing of many scientific periodicals by computer could lead to the automatic provision of standardized catalogue entries on magnetic tape. Easier methods of 'communicating' with computers are being actively developed.

Compatibility of systems and needs, the proportion of relevant information in borrowed or bought computer tapes, speed, and cost, will be among the factors determining whether such advances could be usefully adopted by a comparatively small, narrow-based library like that at CERN. One point should be made, however, particularly as this article has said almost nothing about the people who provide the Library service. However much computers may be employed to carry out the routine tasks, the Library will always have need of the special knowledge, interests, and abilities of human beings. The work of the Library staff may change, but Library users may rest assured that the aim is for better service, not robot librarians.

Instrumentation at Versailles

A brief account of the 'International Symposium on Nuclear Electronics' held from 10-14 September at Versailles.

The presence of such well-known scientists as Professors Otto Frisch and Francis Perrin together with 700 of their younger colleagues at the Versailles symposium, shows how important the topic has become in less than a generation. Since the first meeting in Paris in 1958, Belgrade, Paris again, and then Bombay have been the forum for international meetings on nuclear electronics. This year, the Palais des Congrès at Versailles welcomed the 'International Symposium on Nuclear Electronics' from 10-13 September.

The symposium was organized by the Société Française des Electroniciens et Radio-électriciens (SFER) with the participation of the International Union of Pure and Applied Physics (IUPAP). CERN was a sponsor of the meeting together with other international and French organizations, professional associations and instrument manufacturers. The symposium followed immediately after the 14th International Conference on High-Energy Physics, held at Vienna, and the Nuclear Electronics meeting absorbed the 'Instrumentation' Conference which traditionally follows the 'High-Energy Physics' Conference. A few of the scientists seen at the Austrian Imperial City the previous week were therefore to be found at the French Royal City at Versailles. Altogether some 200 papers were presented by participants from 32 countries.

The technology associated with high-energy physics can be arbitrarily divided into three large classes of instruments: accelerators, detectors, and data handling equipment.

The Versailles symposium did not cover accelerators, and detectors came in only if they used electronic techniques. Thus the bubble chamber was not mentioned, though automatic measuring systems for photographs were discussed, whatever type of detector was used to obtain them.

Electronics experiments

An 'electronics experiment' requires first of all detectors which give electronic signals either relating to the time of arrival or the energy of a particle (scintillators together with photo-multipliers; semi-conductors) or defining the particle trajectory (scintillators; semi-conductors; spark chambers). The signals usually need to be amplified before they can be used. The information obtained is then sometimes handled in analogue form (that is to say the amplitude of the signal is used and possibly its development as a function of time). The final processing is always carried out digitally: the signals are converted to digital form when they can be manipulated by computer techniques. This short description indicates the main topics of the meeting: 'electronic' detectors, nuclear electronics proper and the use of computers.

On detectors, about twenty papers covered the extraordinary improvements in the performance of scintillators and photomultipliers. Rapid progress is also being made with spark chambers and semi-conductor detectors. Semi-conductors are being made of large volume (100 cm^3 at Strasbourg). They are particularly suited for low or medium energies (up to 1 GeV). They have applications in the study of elementary particles, for example in the investigation of pi-mesic and k-mesic X-rays which has been revolutionized by these detectors.

Regular readers of CERN COURIER will have followed the progress of spark chambers since 1960. (See, for example, vol. 7 page 219.) Wire chambers are now coming into use on a very large scale in sub-nuclear physics. At CERN there are wire chamber arrays with up to 50 000 wires and there are proposals here and at Brookhaven for up to 200 000 wire arrays (planes $10 \times 10\ m^2$). These chambers determine the position of the spark discharge in the wake of a particle, using either core read-out or magnetostrictive read-out. Both methods have their adherents and the rapporteur at the session (G. Charpak)) remarked that though there are more chambers in existence using cores (which have the advantage of higher sensitivity, and higher repetition rate — up to 1000 pulses per second) than magnetostriction, the cores will probably give way to magnetostriction which is less troublesome, more suitable for large systems, and easier to operate in magnetic fields. One magnetostrictive wire chamber of original design was reported from Heidelberg — a plane of wires woven in a parallelogram rolled in a cylinder, which detects particles emerging from a hydrogen target at all angles.

Another advance, which is at an early stage but nevertheless exciting considerable attention, is the multiple wire proportional chamber (developed at CERN by a group led by G. Charpak). A plane of independent wires is placed between two plane electrodes and the system immersed in a gas such as an argon-propane mixture. If a particle passes between two wires, the pulse received on each of them is proportional to the energy lost in the sensitive volume around them. Each wire acts as an independent proportional counter down to distances of 0.1 cm between the wires. Resolution times below 0.4 μs are easily obtained; detection efficiency is close to 100 %; any number of simultaneous particles can be detected; using suitable gas mixtures, high amplification is possible so that simple, cheap amplifiers can take the signals from the wires; selection between particles of different ionizing power is possible; the chambers can operate in high magnetic fields. Several of these features represent advances on conventional spark chambers. (A detailed account of their use appeared in 'Nuclear Instruments and Methods' 62/1968.) Such a system has already been used in the setting up of secondary beams at the CERN synchrotron (CERN Internal report 68-33).

An original construction of a wire chamber with core read-out was reported from DESY. It has planes made of printed circuits. Up to 60 planes have been put together in an array now being tested.

A lot of effort is going into the development of streamer chambers. At present, their precision is inferior to that of bubble chambers by a factor of about 2-3; an increase in the density of the gas could improve this situation. (They have of course the great advantage over bubble chambers that they can be trigged to record only the events of interest.) The photographs taken by the DESY streamer chamber (described in CERN COURIER vol. 8, page 190) are remarkably clear and comparable with those from a bubble chamber. The same can be said of the photographs produced with a wide-gap spark chamber from Maryland, where the precision of the measurements (150 to

200 microns) is set by the measuring instrument itself.

The Electronics

The sensible development of the electronics associated with the detectors is hindered by particular problems. The unique character of each experiment usually leads to specially adapted electronics. The output of the electronics then needs some intermediate processing before being passed to a computer. Finally, the recording of hundreds of thousands of events from an experiment cannot proceed without some sample checks of the data as the experiment is in progress to ensure that everything is operating correctly. Electronics are required to solve more and more complex problems. But the improvements in methods and in apparatus are opening up new possibilities, stimulating new experiments.

Efforts to bring about standardization and interchangeability in the electronics will be reported in a forthcoming issue. They are increasing the involvement of electronics manufacturers and in this respect it was interesting to note the presentation at Versailles of numerous papers from European firms (SEN, AEG-Telefunken, CSF, Philips, CFTHHB, CGE, Intertechnique, Siemens, IBM, 20th Century, S.A. Télécommunications, RTC-Compelec, le Matériel Téléphonique).

The problems posed by the need to amplify signals have been completely transformed by the characteristics of semiconductors. The amplitude of pulses delivered by semi-conductors can be a close function of the energy of the particle. As this amplitude can be very low, it is important that the system be as insensitive as possible to background noise. Also, the time interval between two successive pulses may vary greatly from one experiment to another, so the characteristics of the electronics must be adapted to these variations.

These two points have led to many, very advanced studies on amplifiers and associated filtering circuits, which have resulted in considerable improvements in the performance of the electronic systems.

The complexity of experiments providing a very large amount of data simultaneously, has led to the rapid development of digital techniques. The processing of data has been revolutionized in recent years. Faced with the increase in the number and complexity of the experimental installations, attempts have begun to build systems capable of being used whole or in part in quite different experiments.

R.A.

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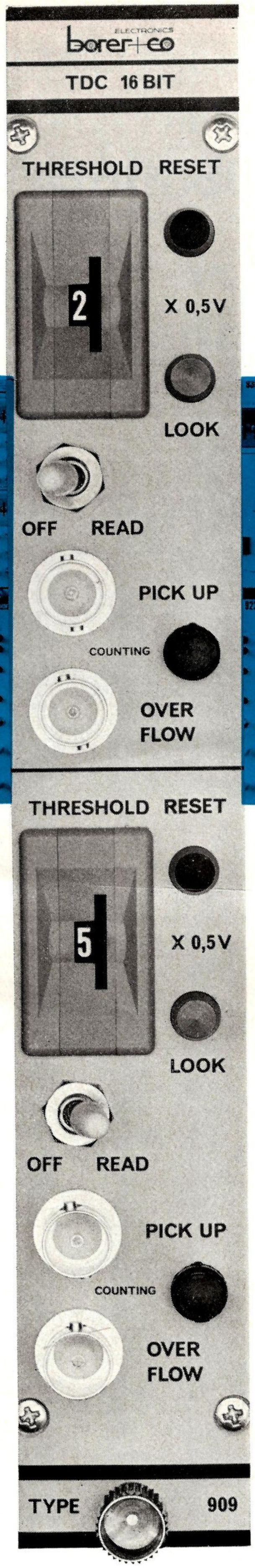

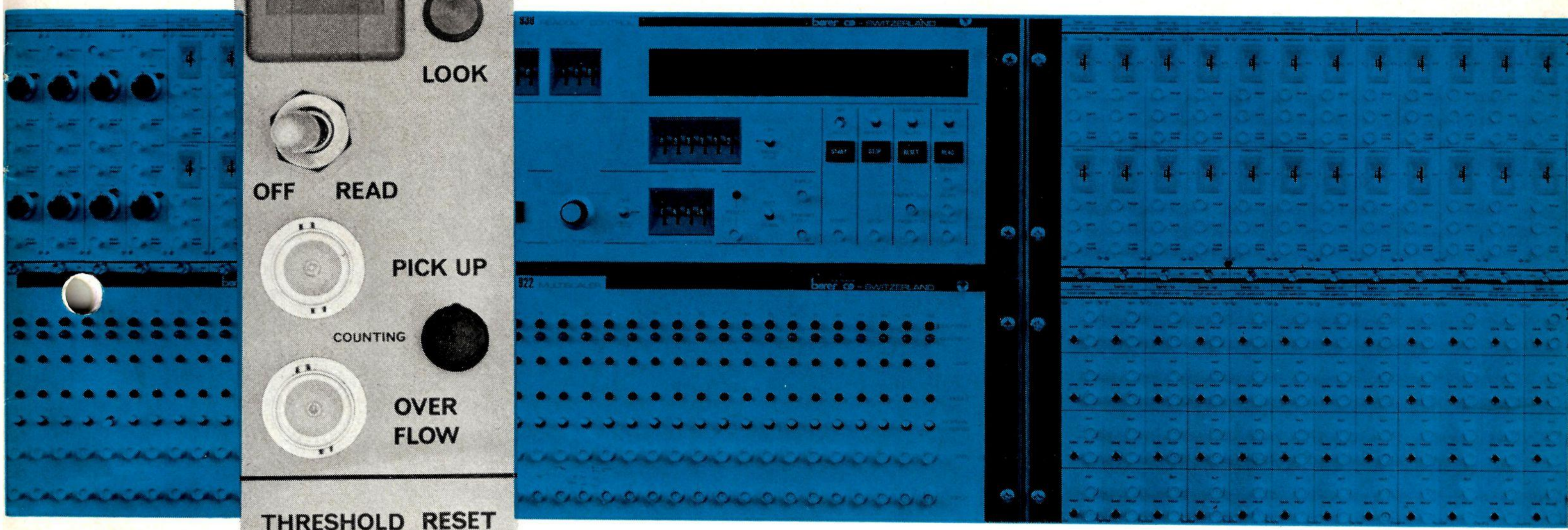

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The TDC 909 consists of two independent channels for digitizing the sonic transit time of spark chambers. It consists of a special discriminator input-circuit giving low jitter triggering of the subsequent 16 bit binary scaler, which counts the pulses from a clock-generator with a maximum speed of 20 MHz. The threshold of the input-discriminator is variable from 0,5 to 4,5 Volt in steps of a 0,5 Volt. For multiple-spark-detection with wire-spark-chambers, a special overflow-output is provided, by passing the second and all the following pick-up signals, which can be used to trigger second or further channels. In this way there is no limit to the multiple-spark-detection by switching TDC's in cascade. The double-spark-resolution is 0,5 μs or 2,5 millimeters for wire-spark-chambers. Using the LOOK-button the contents of this 16 bit binary scaler are displayed on the central control unit in decimal form.

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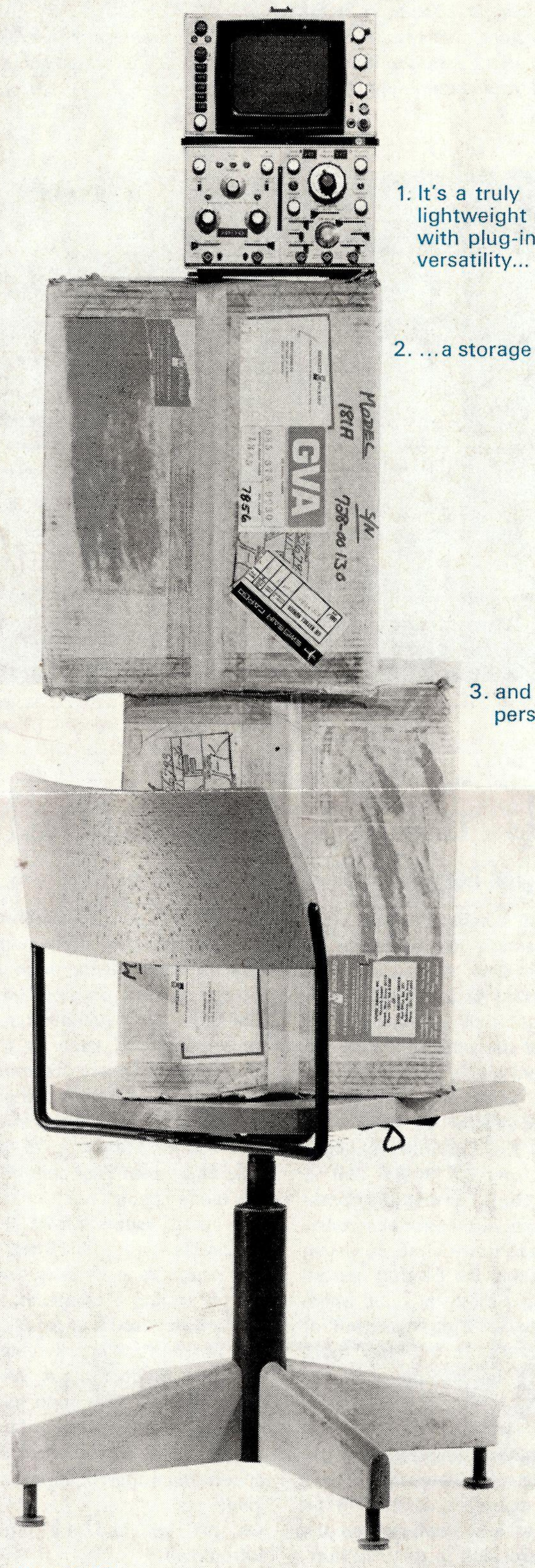

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