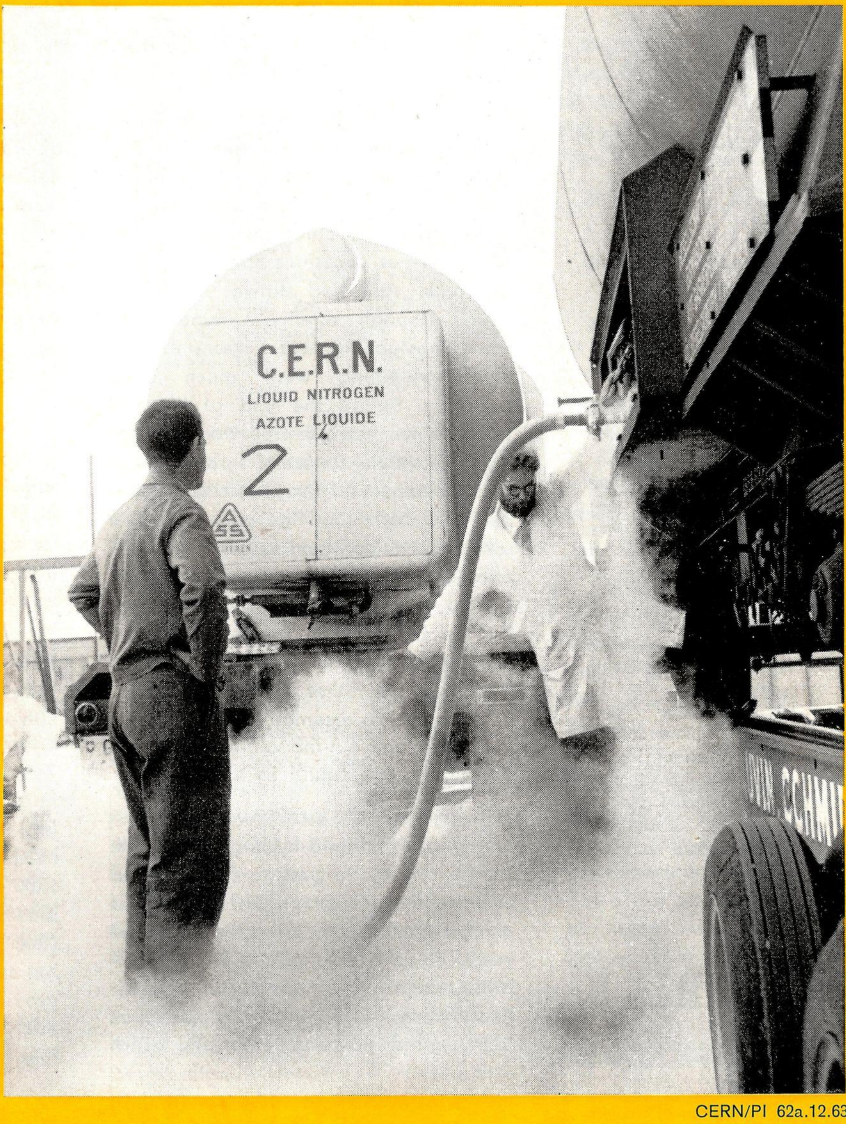
CERN COURIER



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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

The European Organization for Nuclear Research (CERN) came into being in 1954 as a co-operative enterprise among European governments in order to regain a first-rank position in nuclear science. At present it is supported by 13 Member States, with contributions according to their national revenues : Austria (1.96%), Belgium (3.85), Denmark (2.09), Federal Republic of Germany (22.86), France (18.66), Greece (0.60), Italy (10.83), Netherlands (3.94), Norway (1.48), Spain (1.68), Sweden (4.25), Switzerland (3.20), United Kingdom (24.60).
Contributions for 1964 total 107.2 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.'

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The cover photograph shows one way to keep cool during the summer hot weather (though it was in fact taken last winter !). Outside the East bubble-chamber building of the proton synchrotron, liquid nitrogen is being pumped from the large railway tanker in which it is delivered to one of the containers in which it is stored at CERN. These, constructed like giant thermos flasks, hold some 9000 litres of the liquid, which is at a temperature of −196° C. A cloud is formed by the condensation of water from the air, cooled by the liquid flowing through the pipe. Among other uses, liquid nitrogen plays an important part in the operation of liquid-hydrogen bubble chambers, where it provides cooling for heat shields placed between the very cold chamber and the vacuum tank, which is at room temperature. It is also used as a cooling medium in the hydrogen refrigerator.

CERN COURIER

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Last month at CERN

In the second half of June, the **British National Hydrogen Bubble Chamber** successfully came into operation in the East bubble-chamber building of the CERN proton synchrotron. Although on two previous occasions the preliminary 'technical' runs had shown up defects which (though relatively minor) had meant postponing actual operation, this time everything went much more smoothly. Before the end of the first week, which had been allotted only for tests, several thousand photographs were accumulated for physicists in Durham and Turin, and the chamber's first scheduled experiment began the week after. Some reward could at last be seen for the many months of hard work, both by the British team in charge of the chamber and by those in CERN's Track Chambers and other Divisions who had co-operated to assemble the equipment here and carry out the various modifications that were found to be necessary.

This new liquid-hydrogen bubble chamber is the largest so far operated in Europe. By convention, its size is given by reference to the length of the actual liquid-hydrogen container, which is aligned with the direction of the incident beam. Although usually known in CERN as the 150-cm chamber, the British chamber in fact has a length of 60 inches, equivalent to 152.4 cm (that is, at room temperature ; about 0.6 cm less at the operating temperature of -246° C).

The chamber was built by the collaborative efforts of three British universities (Birmingham, Liverpool and London), the Rutherford High Energy Laboratory and the Department of Scientific and Industrial Research, at a cost of about £ 1 million (12 million Swiss francs). This cost also covers the development of automatic film-analysis equipment, of the Hough-Powell type, for seven British universities.

Earlier in the month, the final machine runs were made for the second phase of the **neutrino experiment** at the CERN proton synchrotron. One of the decisions taken by the Nuclear Physics Research Committee at its meeting on 10 June was to cancel the two weeks' run provisionally scheduled for next August (see *CERN COURIER*, vol. 4, p. 60, May 1964) and in fact not to schedule any further runs during 1964.

Several thousand new photographs of neutrino interactions have been collected in the recent runs, both with the bubble chamber and the spark chambers, and it will take some time yet to analyse the findings satisfactorily. In addition, it had already been planned to **enlarge the CERN heavy-liquid bubble chamber,** and work on the actual rebuilding can now go ahead. The chamber was removed from its concrete enclosure in the South hall on 7 July and transported to the newly finished extension of the NPA building (no. 162) for dismantling. The new chamber body will have a volume of 1200 litres, more than twice that of the present chamber, and a fiducial volume (that part within which an interaction has to occur in order to be certain of providing sufficient information for analysis) nearly three times greater than previously. This will be especially valuable for experiments with antineutrinos. The greater volume entails also the lengthening of the magnet by 21 cm, with the mounting of three additional coils. Work is also progressing on various modifications to the illumination system, the expansion equipment and the temperature-control circuits.

During the last neutrino run, a successful pilot experiment **combining spark chambers with nuclear emulsions** (expt. E49) was carried out in the neutrino beam. The idea of this is to use the high resolution of the emulsion technique, to obtain greater accuracy of measurement, while retaining the discrimination against background afforded by an array of spark chambers triggered by electronic counters. Each set of tracks arising from a neutrino interaction in the emulsion stack must be associated with particular tracks on one of the spark-chamber photographs, and it was to test the feasibility of finding such correlations that the pilot experiment was carried out, using a 10-litre stack of emulsion. Its success points to other interesting applications, for example the study of cascade particles produced by negative kaons, in which the interaction producing the cascade particle would be found by tracing back into the emulsion the track of the associated positive kaon appearing in the spark chamber as a result of selection by the triggering system.

At the same time as the 152-cm chamber was going into operation, the **81-cm Saclay/École Polytechnique liquid-hydrogen bubble chamber** began a new series of runs in the k_4 beam in the North experimental hall of the proton synchrotron. This beam is of separated kaons, of momentum variable between 0.6 and 1.2 GeV/c, or of separated anti-protons between 0.6 and 1.4 GeV/c. The chamber will be operated either with liquid hydrogen, in which case all the target nucleons are protons, or with liquid deuterium (heavy hydrogen), which provides equal numbers of protons and neutrons.

Six counter experiments and two emulsion experiments were also in progress during the month, apart from the usual exposures for nuclear-chemistry experiments and various calibration measurements.

Prof. V. F. Weisskopf, CERN's Director General, was one of the members of the Scientific Council of the **International Centre of Theoretical Physics** at Trieste who met for the Council's first session in Vienna on 28 May. The other members are Robert Oppenheimer, Professor of Physics and Director of the Institute for Advanced Study, Princeton, U. S. A., Manuel Sandoval Vallarta, Professor of Physics and Member of the Nuclear Energy Commission of Mexico, and Abdus Salam, Professor of Theoretical Physics, Imperial College, London, and Director of the Centre.

The main purpose of the Centre, established by the International Atomic Energy Agency in June 1963, is to foster, through training and research, the advancement of theoretical physics, with special regard to the needs of developing countries. Its range of interest will be broader than that of the Theoretical Studies Division at CERN, embracing solid-state physics and low-energy physics, among other things, as well as high-energy and elementary-particle physics. The Centre will be inaugurated by a Seminar on Plasma Physics, which will be held from 5 October to 15 November.

In addition to having its Director General as a member of the Council, CERN will collaborate with the Trieste Centre by a periodic exchange of scientists and by encouraging its experimental physicists to accept invitations to lecture in Trieste on their work.

Also in Vienna, Prof. Weisskopf and Mr. G. H. Hampton, Directorate Member for Administration, were among the many participants in the **Second Scientific and Parliamentary Conference** held there from 23 to 27 May. This conference, a successor to the one held in London in 1961, brought together members of parliament and scientists from 20 different countries and many international organizations to discuss the complex problems that arise between those who are responsible for scientific progress and those who, in large measure, are responsible for paying for it and using its results.

At about the same time it was announced that **Prof. Weisskopf** had been elected as Foreign Corresponding Member of the Austrian Academy of Sciences. In Geneva, on 5 June, at a ceremony in the hall of the University, he was awarded the degree of Doctor honoris causa, a recognition not only of Prof. Weisskopf's high position in the world of science but also of the close ties that bind the University of Geneva to CERN. In recent months Prof. Weisskopf has also received honorary degrees from the University of Uppsala (Sweden) and Yale University (U. S. A.).

TERAPROTONS AT THE PS

On 29 July the intensity of the circulating beam in the CERN proton synchrotron reached, for the first time, 10^{12} (a million million) protons per pulse. Adopting the next prefix in the series kilo-, mega-, giga-, etc., engineers at the PS are now talking of their intensity in terms of the 'teraproton'. This intensity is a hundred times greater than the design figure.

At its 184th annual meeting on 13 May, in Boston, the American Academy of Arts and Sciences elected among its Foreign Honorary Members, Prof. **Léon Van Hove**, leader of the CERN Theoretical Studies Division.

At the CERN Council meeting on 19 June, Dr. **Giorgio Brianti** was appointed Leader of the Synchro-cyclotron Machine Division, in succession to Dr. Pierre Lapostolle who, as announced previously (*CERN COURIER*, vol. 4, p. 47, April 1964), is now in charge of a group in the Accelerator Research Division.

Dr. **G. Ross Macleod** was appointed acting Leader of the Data Handling Division, confirming, in effect, the position he had occupied since last September, when the Division leader, Dr. **Lew Kowarski**, went to Purdue University (U. S. A.) as a Visiting Professor. Dr. Kowarski (who, incidentally, was made 'Officier de la Légion d'honneur' by the French Government earlier this year) came back to CERN after the termination of the academic year at Purdue, but will return there for another nine-month period starting in September next.

For the election of this year's Chairman of the CERN Staff Association Committee, many nomination forms were received but they all carried the same name, that of last year's Chairman, **Guy Vanderhaeghe.** Since no other name was put forward, Dr. Vanderhaeghe, who is Head of the Training and Education Section (see *CERN COURIER* vol. 3, p. 155, December 1963) was declared elected.

On 22 June, CERN was visited by Prof. **D. Gjaerevoll**, Norwegian Minister for Social Affairs. With him were Mrs. R. Sewiriin (a Member of the Norwegian Parliament), Mr. B. Skall, Mr. S. Chr. Sommerfelt (Norwegian Delegate to CERN Council) and Mr. T. Ibsen (Adviser to the Norwegian Delegates) ●

Two open letters *Weisskopf ⟷ Weinberg*

Although the amount of money spent on scientific research, and particularly on fundamental research such as high-energy physics, is still only a small fraction of the total wealth available in the world, it is nevertheless larger in total than it was even a few years ago and the demand to spend more is increasing on all sides.

Those responsible for using the money invariably maintain that it is well spent and that an expanding economy could well afford to devote a much greater fraction of its resources to this 'investment in the future', but at the same time they recognize that such an increase in relative expenditure could not go on indefinitely. However, it also seems true that in many branches of science there is a certain minimum level of support below which progress becomes insignificant. If any particular country wishes to conduct research in a certain field it must therefore provide at least this minimum amount of money for its contribution to have any value. To take a more specific example, there would be little use in contemplating an experiment that would take six months' running time on an accelerator if a more powerful (and necessarily more expensive) machine somewhere else could, after the same preparation time, produce the results in a few days.

It seems clear that the time will come when responsible decisions will have to be made by each country, or group of countries, as to which particular lines of research will be fully supported and which deliberately neglected. A necessary corollary is that attempts will have to be made to assess the relative importance of each of the many possible branches of scientific research, not only for any particular country but perhaps (in the case of very expensive fields) for mankind as a whole.

Problems like these are in fact already being discussed, in private and in public. One of the forums for written contributions is the quarterly journal Minerva *(London, C. S. F. Publications Ltd.) which, in its issue of winter 1963 (vol. I, no. 2), carried an article by Dr. Alvin M. Weinberg, entitled* Criteria for scientific choice. *More recently,* Physics Today, *one of the publications of the American Institute of Physics, has printed a revised version of this article (vol. 17, no. 3, March 1964). In the course of his argument Dr. Weinberg felt impelled to rate high-energy physics rather low in his order of priorities, a conclusion which drew a strong protest from Prof. V. F. Weisskopf. The latter's defence of high-energy physics, as well as Dr. Weinberg's comments, together formed the subjects of two 'open letters' published in the June issue of* Physics Today.

We are pleased to be able to reproduce these 'open letters' here, to give an idea of the questions involved and perhaps to stimulate others to delve further into the discussion.

Dear Al :

Your article in *Physics Today* on 'Scientific Choice' touches some of the most important questions which we will face in the immediate future. You presented the situation in the clearest possible way and you pointed out the terrible difficulties which are inherent in any form of scientific planning. I agree with most of what you are saying and I like the way in which you said it. There is one important point, however, in which I cannot follow you. I accept your three 'external criteria' for scientific choice: technological merit, scientific merit, and social merit. I would even go along with your sharper definition of scientific merit, when you propose that '... other things being equal, that field has the most scientific merit, which contributes most heavily to and illuminates most brightly its neighbouring scientific disciplines'. But I cannot follow your arguments when you apply your criteria to the field of high-energy physics.

You argue that, by the criteria which you have set forth, high-energy physics rates poorly. In particular, you argue that the world of subnuclear phenomena, which are discovered by this branch of physics, seems to be remote from the rest of the physical sciences. Here I cannot agree with you at all.

High-energy physics has shown that there is a structure in the proton and the neutron, that the nucleon is not as elementary as it seemed. This structure, and the internal dynamics of the nucleons, exhibit unexpected and completely novel features that show few parallels in the structure of previously known entities such as nuclei and atoms.

The nucleon is the basis of all matter and therefore of all science. Aren't you interpreting your own criteria in a rather superficial way if you consider subjects such as the structure of the nucleon as remote ? Questions concerning the stability of nucleons, the reasons for the mass difference of neutron and proton on which the existence of matter is based, the question of the possibility of more basic units of which the nucleon is a compound system, the problem of why there is one and only one electric charge unit, are these and similar questions to be considered as unimportant and remote from the rest of science ? It seems that they aim at the centre of all scientific interest.

It is true that many scientific disciplines can be pursued without knowing the answers to these problems. For most of terrestrial physics and chemistry, the nucleus may be considered as a charged massive point. But should we therefore have discouraged science from penetrating the nuclear structure ? It is also true that the theory of relativity is not very relevant for most scientific investigations outside high-energy physics. Still, you will agree that the deeper insight which relativity gave us into the structure of space and time would have justified even more efforts than we are now spending on high-energy physics. It is this kind of insight which high-energy physics is aiming at and I have no doubt that it will also lead to it, after more intensive study.

I am sure that you agree in some way with this point of view, which is deeply ingrained in the thinking of every physicist. You are a physicist like all of us, and a better one in many respects. Indeed, you pay respect in your article to this point of view when you admit that the discovery of the violation of parity conservation 'bears strongly on the rest of science'. In fact, this statement would not hold from the point of view which you adopt when you call high-energy physics remote from the rest of physics. The violation of parity has not much practical importance in any other discipline, except that it helps here and there in the determination of nuclear-level properties. It implies, however, a thorough change of our views on the role of symmetry in nature, and this is what determines its relevance for the rest of science. It is most likely that the study of the subnuclear world will lead to changes in our view of matter and space, compared to which parity violation will appear trivial.

But even on the somewhat superficial basis of direct connection with other sciences, the balance sheet of high-energy physics is not so negative as you have indicated. You mention in your article that ' the strongest and most exciting motivation for measuring the neutron cross-section of the elements lies in the elucidation of the cosmic origin of the elements'. I quote this statement because it puts emphasis on the understanding of a problem which has 'philosophic' interest in itself. Now, let me draw your attention to the recent discoveries of violent events in the centers of galaxies. Here it seems that energy is produced in amounts and in rates that surpass by far everything that can be expected from ordinary nuclear or chemical processes. The order of magnitude alone of these energies makes it most likely that hyperons, mesons, and the whole subnuclear world play a role in these cataclysms. Here we have a clear connexion with other sciences, such as radio-astronomy and cosmology. The results of high-energy physics could be very relevant for questions regarding the creation of matter, the expansion of the universe, etc. ; does this not represent an important contribution to the scientific merit of high-energy physics ?

I agree with your negative estimation of the technological merit of high-energy physics, although we must be prudent not to dismiss completely the possibility of a technological application of subnuclear phenomena by future generations. After all, we are today creating in our reactors here on earth conditions prevalent in the centres of stars, and that must have appeared equally preposterous to scientists several decades ago.

In view of my present position at CERN, you will not be surprised if I wholeheartedly support your assertion of the great social merit of high-energy physics as a field of international collaboration. Here the possibility and the efficiency of common efforts among different nations was impressively demonstrated. Let me point out, however, that this value stems mainly from the fact that this field is basic and relevant for all sciences and therefore touches questions which all thinking human beings

Dr. Weinberg is Director of the Oak Ridge National Laboratory (Tennessee) of the U.S. Atomic Energy Commission. Born in 1915 in Chicago, he studied physics at the University of Chicago and is a specialist in the applications of nuclear physics to practical use. He received both the Atoms for Peace award and the Lawrence Memorial award in 1960 and served on the President's Scientific Advisory Committee in 1960-1962.

Prof. Weisskopf is Professor of Physics at the Massachusetts Institute of Technology and, since 1961, Director General of CERN. He was born in 1908 in Vienna, where he began his studies in physics, and afterwards moved extensively around Europe before settling in the U.S.A. in 1937. He was awarded the Max Planck medal in 1956.

are deeply interested in. This, and of course the high cost of that research, are the reasons why it is a most proper object to be tackled by a collaboration of all nations. If we are not convinced of the intrinsic value of this research, if we consider its scientific merits marginal, if we consider national efforts as wasted when devoted to it, it will never serve as it should, as a worthy object for a common effort of all humanity.

Sincerely yours,

Victor F. Weisskopf

Dear Viki :

I am grateful to you for your generous and thoughtful letter. That we agree on as much as we do, I find satisfying even though we disagree on some aspects of the assessment of high-energy physics.

To some extent, our disagreement hangs around the word ' remote '. My belief is simple: that high-energy physics is remote in the same sense that cosmology is remote — not that it is lacking in the highest order of intellectual excitement and stimulation. What we are trying to decide, basically, is *how fast* high-energy physics should be pushed relative to competing branches of science. I submit that most discoveries in high-energy physics, intrinsically exciting and interesting as they may be, will probably not make very much difference as far as *what is done* to elucidate the rest of the physical universe. So to speak, there are few parts of science (aside possibly from cosmology itself) that are waiting breathlessly for insights from high-energy physics and without which they cannot progress.

You draw the analogy with relativity. Here I have two points: first, that relativity was a cheap discovery (and I have no argument at all about cheap discoveries); and second, that even relativity bears widely on our understanding of things around us, like atomic fine structure.

But I think the force of my argument would have been clearer had you compared high-energy physics with quantum mechanics. Before quantum mechanics the world around us, the feelable and touchable world of solids and chemicals, was mysterious; quantum mechanics illuminated the vast stretches of science dealing with these things in a way that I cannot visualize high-energy physics doing.

Quantum mechanics not only deepened our conceptual insights into the world about us; it enabled scientists concerned with many diverse fields to progress at a rate impossible without quantum mechanics. Lack of a theory of the atom, in 1926, was holding up progress in all of physical science, particularly the parts dealing with the tangible and accessible world around us. I would therefore, admittedly in retrospect, see great urgency in getting on with the exploitation of Schroedinger's and Heisenberg's insights. Though I am impressed with the possibility, even probability, that high-energy physics may yield the key to understanding gravity and cosmology, I just cannot visualize high energy as having the all-pervading influence on physical science that quantum mechanics has had. I believe in this sense I am justified in characterizing high-energy physics as ' rather remote ' from the rest of science and in disagreeing with your implied assumption as to the urgency with which it is to be pursued.

As a physicist, I am enchanted and astonished by the wonderful new symmetry principles, and their violations, and I am convinced that a clearer understanding of where the elementary charge comes from, or the reason the nuclear force saturates, would be

Continued on p. 95

27th Session of CERN Council

Report on the past; discussion of the future

This year's summer Session of the Council was held in the Council Chamber at the Meyrin Laboratory on 18 and 19 June. Delegates from the Member States and the three 'Observer' countries attended, under the presidency of Mr. J. H. Bannier (Netherlands).

PROGRESS REPORT, NOVEMBER 1963 - MAY 1964

An important item on the agenda was the presentation by the Director General, Prof. V. F. Weisskopf, of the progress report* for the six months ending May 1964. Speaking first of the technical side of the laboratory's activities, he noted the very satisfactory operation of the 28-GeV proton synchrotron : its low breakdown rate, its ability to provide beams for the neutrino experiment and a bubble chamber simultaneously — a unique feature —, and the addition of two more beam lines, bringing the total to ten (not including the installations of the external proton beam or calibration beams). The machine had provided high-energy particles for eighteen experiments during this period, and at one time nine experiments were in progress simultaneously in the three experimental halls. There had been progress in the field of data evaluation, and here it was becoming more and more clear that the work required at least as much ingenuity as that on accelerators. The change-over to the more-powerful CDC 6600 computer would also entail much preparatory work for the Data Handling Division. In Prof. Weisskopf's opinion, the automatic analysis of bubble-chamber and spark-chamber pictures would become an essential feature of high-energy physics experiments, and he was proud to announce the successful completion of an analysis involving the evaluation of over 200 000 spark-chamber pictures, carried out entirely automatically by the Hough-Powell device developed at CERN. The Director General was also able to announce the success of the first tests on CERN's microwave particle separator, mentioned in last month's *CERN COURIER*. However, he also pointed out that CERN did not lead over the whole field ; there were also some areas in which we were definitely behind progress in the U.S.A., for example.

New particles

Reporting on the physics achieved with the machines, Prof. Weisskopf dealt first with the bubble-chamber experiments, in the latest series of which some 2 million photographs had been taken. The 81-cm liquid-hydrogen chamber from Saclay had again proved its usefulness and versatility early this year, by 'deputizing' at short notice for the 150-cm British chamber, which had not after all come into use until recently. Among the results now available from previous runs of the 81-cm chamber were the discovery or confirmation of several new 'resonances' — or 'particles', to give them a more impressive name (the C^0 has already been mentioned in *CERN COURIER*). Two experiments at CERN had helped to eliminate some confusion over two of these resonances, the f^0 and the B, and had proved that they were two distinct particles with the same mass but different values of isospin. A new examination of films showing the annihilation of antiprotons in flight, this time to study the decay into two kaons and a number of pions, showed strong asymmetries in the angular distributions of the various particles and also confirmed the previous discovery at CERN of a $KK\pi$ resonance, a short-lived 'particle' with a mass of 1430 MeV/c^2. Recalling the excitement over the hypothetical particles called 'quarks' or 'aces' (*CERN COURIER*, vol. 4, p. 26, March 1964), Prof. Weisskopf told how several experiments at CERN, particularly the special exposure of the 81-cm bubble chamber in the o_2 beam last March, had proved either that these particles do not exist or that their mass is greater than 2.3 times that of the proton, so that the energy made available by present accelerators is insufficient to produce them.

Study of rare processes

Turning to electronics experiments, Prof. Weisskopf mentioned that these should really be called spark-chamber experiments, since there were now very few in this category that did not exploit the newer technique. One of the more important results had come from the study of the very rare decay of the lambda particle into a proton with the emission of an electron and a neutrino. This process had been shown to obey the same laws as the well-known radioactive beta decay, in which it is a neutron that changes into a proton. The study of another very rare process had produced some examples of the annihilation of an antiproton-proton pair into a pair of muons, supplementing the previous results on the annihilation into electron pairs.

News on the progress of the neutrino experiment was also given by Prof. Weisskopf. Records of between 5000 and 6000 neutrino interactions were now 'in stock', but analysis was still proving difficult and time-consuming, mainly because of the unexpected complexity and variety of the events. Another unexpected result had been the difficulty of obtaining conclusive proof for the existence of the 'intermediate boson', the W-particle. Indeed there was now a growing feeling that the particle cannot be produced at the energies presently available.

* CERN/544. The account given here includes other information taken from the report as well as that specifically mentioned by the Director General.

Early in the Session, the President read a message of greeting from Mr. François de Rose who has had to give up his close association with CERN following his appointment as Ambassador of France to Portugal. Mr. de Rose was one of the small group of scientists and diplomats who first conceived the idea of a European research organization, round about 1948, and was one of the French signatories to the Agreement setting up the original 'Conseil Européen pour la Recherche Nucléaire' in 1952. He was a member of the CERN Council continuously from 1956 until his resignation, being Vice-President in 1957, President in 1958, 1959 and 1960, and Vice-President again this year.

Mr. J. Willems (Belgium), last year's President of the Council has agreed to take Mr. de Rose's place as Vice-President for the rest of 1964.

Among important developments concerning CERN's smaller accelerator, the 600-MeV synchro-cyclotron, Prof. Weisskopf mentioned its growing use for experiments that fit more correctly into the field of 'nuclear' physics rather than that of 'high-energy' or 'particle' physics. These concern the study of the 'structure' of the atomic nucleus (see, for example, *CERN COURIER*, vol. 3. p. 35, March 1963). The new nuclides boron-6, boron-7 and carbon-9 have been produced for the first time in one of these experiments. An experiment in 'particle' physics had given good evidence for the non-existence of the so-called ABC particle (*CERN COURIER*, vol. 3, p. 152, December 1963), a hitherto suspected resonant state of two pions with a mass of 330 MeV/c^2.

More visiting theorists

Another aspect of CERN's work emphasized by the Director General was the close association between experimental and theoretical physicists. During the period under review the theorists had given especial help in the analysis of the results of particle-scattering experiments and the neutrino experiment. More fundamentally, the various aspects of the new SU_3 symmetry theory had been the subject of many discussions and papers in the Theoretical Study Division. Greater office accomodation enabled the number of Visiting Scientists in the Division to be increased to 23, in addition to 21 Fellows and Research Associates from Member States and 8 from elsewhere. The number of staff scientists remained at 11, with one computer programmer.

CERN'S FUTURE PROGRAMME

The major part of the Session was devoted to a discussion of the principles that should govern CERN's future programme. No proposals were formulated and nothing that was said implied any commitment for the Member States, so that opinions could be freely expressed.

Opening the discussion, the Director General suggested that it should be divided into three main areas :

1. the importance of high-energy physics research, and its place in European science and culture ;
2. the proposed programme for development and use of high-energy facilities over the next ten years ;
3. the financial implications of such development.

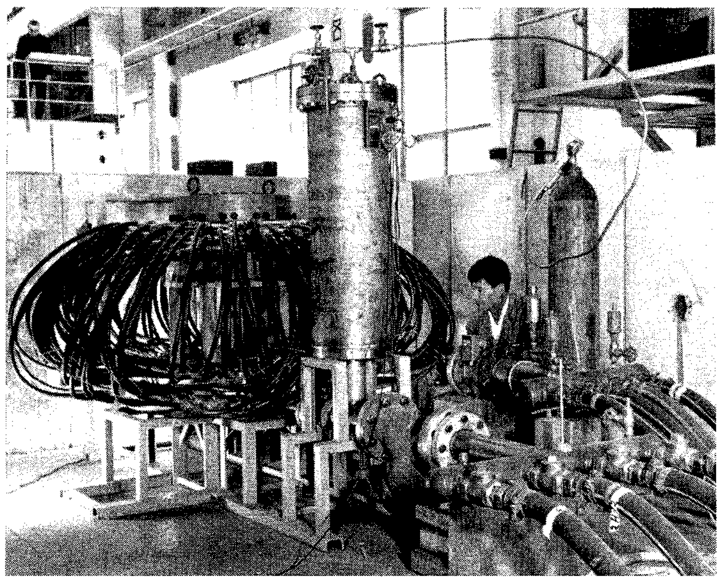
The first question was " why ? " : what is the point of high-energy research ? Why is it the basis of all science, necessary for the healthy development not only of science but also of education in Europe ? Then, what is the proper balance between the different sciences and what criteria should we evolve to define the different allocations of money and manpower ?

The second question concerned the actual programme proposed. In order of increasing cost, the major projects were :

(i) the maintenance and improvement of the present CERN, as a scientific institute in the forefront of high-energy physics ;
(ii) the construction of intersecting storage rings for the CERN PS ;
(iii) the construction of a 300-GeV proton accelerator.

It was essential, Prof. Weisskopf thought, to view this programme as a whole, over a period of time which

CERN/PI 37.4.64



A new air-cored d.c. magnet, for studies of superconductivity at CERN, together with its cooling-water manifolds and safety devices. Designed to be fed from existing electric generators, the coils consist of 11 double pancakes, each with 12 independent parallel cooling circuits (see Report *CERN 64-23* and also *CERN COURIER*, vol. 3, p. 157, December 1963). In the photo, the magnet can be seen on the left, in its steel frame, with the many hoses connecting it to the two water manifolds below. The magnet produces a field of 100 000 gauss in a space 6 cm in diameter, using a current of about 6000 A. The resulting power dissipation is about 0.5 kW per cubic centimetre of coil. For protection, a relay switches off the generators if the flow of cooling water falls below a certain limit ; the tall cylinder in the centre of the picture contains water under pressure, to provide emergency cooling in such a situation while the generators are running down. In the picture also is Mario Grossi, who constructed much of the magnet.

FACTS AND FIGURES FROM THE PROGRESS REPORTS

From November 1963 to May 1964

— The number of CERN staff and supernumeraries increased by about 7 %,
bringing the numbers on 15 May to
1518 staff members,
391 supernumeraries,
69 fellows and research associates,
255 visitors and students,
2233 altogether.

— The total consumption of electricity was
32 620 000 kWh,
with a maximum demand of
18 265 kW.

— The amount of water used for cooling was
1 980 000 m^3.

— The proton synchrotron
operated for 2417 hours,
divided, on average, each fortnight into
222 hours for physics and nuclear chemistry,
34 hours for development,
12 hours for starting up, special tests and breakdowns.
The average beam intensity was
6.8 x 10^{11} protons per pulse.

— The synchro-cyclotron operation included
2018 hours for physics,
369 hours for development,
256 hours for maintenance,
131 hours for faults and repairs.

— The liquefying plants in CERN produced
72 000 litres of liquid hydrogen,
300 litres of liquid helium ;
outside suppliers provided
630 000 litres of liquid nitrogen.

— The Central workshop
worked 56 000 man-hours,
produced equipment valued at 1 045 000 Sw. fr.

— The West workshop
worked 31 000 man-hours,
produced equipment valued at 516 000 Sw. fr.

— The transport service
travelled 225 000 km,
carried 2200 passengers,
moved 104 000 tons of material.

— Work with the 7090 computer
increased from 300 to 500 hours per month.
In May the volume of work had reached
300 jobs per day.

— The Purchasing Office dealt with an average of
1775 orders per month.

— Loans from the library averaged
1335 per month.

— In the main auditorium and Council chamber
470 lectures were given,
1300 slides and films were shown,
73 km of magnetic tape were recorded.

— The volume of translation work
increased by over 30 %.

— Throughout CERN there were
14 'disabling' accidents,
causing 189 lost days of work,
or 7.42 days per 100 000 worked hours.

— The Film Badge Service for personnel radiation control covered
1050 people for regular monthly control,
150 for weekly control,
350 for fast neutron and high-energy radiation.

— The number of visitors to look around CERN was
3000,
mostly in the course of organized Saturday visits.

— Monthly distribution of *CERN COURIER* reached
2642 copies in French,
1811 copies in English.

— Among the responsibilities of the General Safety-Group are
150 cranes.

— The cleaners now maintain on a regular basis
77 000 m^2 of floor area,
50 000 m^2 of windows.

— Three members of the MSC Division presented reports on synchro-cyclotron development at CERN at a Conference on high-energy-cyclotron improvements at Williamsburg, Virginia, U.S.A., in February. They also made contact with members of the future Space Radiation Effects laboratory of NASA, which is constructing a copy of the CERN SC to provide a source of 'artificial cosmic rays'.

— A 'Milady' measuring table for bubble-chamber pictures has been modified, in collaboration with the World Health Organization, to enable measurements to be made on electrocardiographic records.

— A IEP has been successfully operated 'on-line' to the Mercury computer.

— A medium-speed data link now exists between the South and East experimental areas of the proton synchrotron, the experimental rooms of the synchro-cyclotron, and the Mercury computer.

— The prototype of a new scanning table for the viewing of photographs from the CERN 2-m hydrogen bubble chamber has been completed.

— The d.c. magnet constructed for studies in superconductivity has been operated to give a field of 100 kilogauss, with a power dissipation of somewhat below 3 million watts.

— A ring magnet, to 'store' muons for a longer period of time than previously possible, has been designed as part of a new experiment planned to measure the value of 'g-2' for the muon with even greater accuracy than before.

— The study group on new accelerator projects has prepared a detailed report (CERN/542) on the proposed intersecting storage rings (ISR) for the proton synchrotron ●

would include the building and exploitation of the large accelerator — ten to fifteen years. But was it the best programme ? What factors might influence future decisions on it ? For example, science was intimately connected with education and the development of science would naturally be connected with plans for increasing the number and size of universities. The development of high-energy physics in other parts of the world, notably in the U.S.A. and U.S.S.R., must also have some effect, because it was essential that Europe should keep pace.

Then there was the 'national' part of the European programme, to add to the 'international' or 'centralized' part. The two aspects of the overall programme could not be considered in isolation.

Turning to his third point, Prof. Weisskopf said that the financial implications were almost obvious. Sciences like high-energy physics were in a more difficult position than other sciences, for which the total expenses might be equally great but where the individual items were smaller and took less time to build. Because high-energy physics needed large machines, requiring long design and construction periods, long-term plans had to be made and the sums involved appeared correspondingly larger. The responsibility for proposing, accepting or refusing a programme was also greater, and Council delegates should ask themselves again whether the proposed rate of increase of expenditure on high-energy physics (increasing by a factor of three over the next ten years) was reasonable. If it was not, what else could be done ?

Two parts in a thousand ...

On behalf of the Scientific Policy Committee, Prof. C. F. Powell said he would try to put the whole subject into historical perspective. Remarking that the growth of science, and its infusion into every aspect of our culture, corresponds to an approximate doubling of scientific knowledge every twelve years, he admitted that the share that science demands of our resources could not go on increasing indefinitely. "Nevertheless", he continued, " the present levels, where in advanced countries between 2 % and 3 % of our resources go into research and development, and about 2 parts in 1000 on fundamental research, as compared with 7 % on armaments, would not, I believe, generally be regarded as unduly favourable to fundamental research in a period of human history in which the development of science is the dominant feature of the times ". In research on elementary particles, early economic advantages could not be expected, but this had always been the case with fundamental research. All that could be said was that in the past great advances in natural philosophy had always led to radical changes in our thinking and, eventually, in our practice : " Nobody in the eighteenth century had any intimation of an electrical industry ; or in the nineteenth, of the atomic-energy industry", he added.

Dismissing the possibility that Europe might leave high-energy research to other countries, Prof. Powell stressed the importance of encouraging youth to apply themselves to the most difficult, significant and demanding of the sciences, which at present must include the physics of elementary particles. It was essential to have a balanced development of science, taking into account also all the other claims that exist for the use of men and money, but the attraction of high-energy physics was not an arbitrary fashion. Able minds were drawn to the frontiers of knowledge and they would not be deflected. They would go where the subject was pursued, wherever that might be.

Minimum level of support

In the future, science might be organized on a world scale, but that was far off, and meanwhile Europe must look to its own culture and its own future. The current level of expenditure on fundamental science was not the result of any clear policy, although such a policy seemed to be needed. Prof. Powell suggested that a good principle would be to support science to an extent limited only by the availability of people enthusiastic and competent to do the work. In Europe we had a great wealth of talent still waiting to be developed.

Several other speakers supported the idea that the only limit should be that of the men (or brains) available. It was suggested, moreover, that there was a certain minimum level of support necessary for each branch of research, and that if this could not be provided, it might be better not to do anything at all. However, no one seriously questioned the necessity to continue high-energy physics research in Europe.

Three-point programme

The views of the Scientific Policy Committee on the second group of questions were given by Prof. L. Leprince-Ringuet, who explained the differences between the programme now proposed and that in the Amaldi report last year. The idea had been accepted that the 300-GeV machine might not be constructed as soon as it was technically feasible but that a delay of one year would not be disastrous. On the other hand, developments in the U.S.A., had made improvements to the present facilities at CERN a necessity.

The Scientific Policy Committee considered that the proposed increase in expenditure was reasonable and that anything less would imply postponements that would make it impossible to obtain an acceptable European programme. The programme had to be considered as a whole, but the key was the 300-GeV machine. From 1973/75 it would provide the means of carrying on high-energy physics in Europe ; if it were abandoned all efforts so far made at CERN would have been in vain.

To bridge the gap until the large accelerator came into operation, the intersecting storage rings should be constructed, enabling certain experiments to be carried out at much higher energies than at present possible

As a supplement to this issue of CERN COURIER we are including an artist's impression of the CERN site as it might appear after the construction of the proposed intersecting storage rings.

and also increasing the facilities available with the PS. Finally, these two projects would not make sense unless the available facilities were used to the utmost, by increasing the PS intensity, providing more and better particle detectors, and so on.

Two points of view

Discussion of this programme soon became involved with discussion of the financial aspects, since it became obvious that the two could not be considered in isolation from one another. Broadly speaking, two points of view could be discerned : on the one hand it was proposed that the scientific programme should be adjusted according to the amount of money likely to be made available ; on the other it was believed that the minimum scientific requirements should be determined, as accurately as possible, and that every effort should then be made to persuade governments to provide the money. In relation to the total amount of money available, the sum required would not, in any case, be prohibitively large.

As an example of the first line of thought, it was pointed out that although an increase by a factor three in ten years implied an average of only about 12 % per year, the rate of increase in expenditure needed during the early stages of the programme would be much greater. The rate of increase, it would be possible to obtain, rather than the final level of expenditure, would thus determine the timetable — and even the programme itself, since in most cases there was no sense in starting a project too late.

Not at subsistence level

The alternative, and more strongly held view was that the proposed programme is essential for the viability of high-energy research in Europe, and all that that entails, and that the money must be found. Among the points made in support of this argument was the reminder that in general the population of Europe is not existing at subsistence level and it ought be quite natural to think about the needs of 20-30 years or more ahead. Overall resources were increasing steadily whilst the amount necessary for subsistence increased at a much slower rate ; the amount available for spending otherwise than on necessities, within which expenditure on fundamental research might be included, was thus increasing even faster than the gross national product. In reply to one delegate, the Director General stressed that Europe was lagging behind the U.S.A. in basic research and that the proposed expenditure would still not make much difference to overall ' research and development ' costs. Still less should it affect the amount spent on things such as houses, roads, and hospitals.

On the question of intercontinental collaboration, the general feeling was that this was unlikely for an accelerator of only 300-GeV energy. At this stage Europe had to look after its own destiny. In general, it was agreed that the 300-GeV machine was the most important part of the programme in the long term but, to preserve continuity, improvements to the present CERN were also necessary. The intersecting storage rings had a special importance for European science since they were not being considered anywhere else in the world.

Timetable proposed

In closing the discussion, the President, Mr. Bannier, stressed that the decision on the CERN improvements and the storage rings ought to be taken at the Council session in December 1964. The problem of the 300-GeV machine was not so urgent but it was now hoped that it could be settled by the end of 1966. By that time the decisions on the American plans would be known, the question of intercontinental co-operation would be answered, and the necessary progress with the design and costing should have been made. Meanwhile, the only immediate action to be taken was to invite specific proposals from the Member States of CERN for suitable sites ●

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Prof. C. F. Powell

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Mr. S. Soc **(Yugoslavia)**

* Adviser ** Substitute

Two open letters (continued)

intellectual gems that we who are even a little trained in physics could gain enormous satisfaction from. But there are other gems that I personally also would find at least as satisfying : the elucidation of just what protein in the brain is the memory element ; or what mechanism governs cellular differentiation; or why the universe expands.

If we could afford to support everything at a rate sufficient to satisfy everyone, there would be no problem. As a scientist, I hope that our society will devote an ever-increasing share of its resources to science. As a citizen, I hope that basic science is recognized and appreciated for what it is — a manifestation of man's highest intellectual aspiration — and that it is supported at a level determined in competition with other worthy and intellectually satisfying activities of the society. All of us, scientists and citizens, hope that our society will become much more enlightened and affluent than it now is, and that what this better society decides to spend on science matches what scientists can reasonably use for science.

Sincerely yours,

Alvin M. Weinberg ●

CERN/PI 25.6.64

Contrary to any conclusions that one might be tempted to draw, the animals in this picture were not destined to turn left after a further 200 metres in order to enter the CERN gates. The scene, photographed recently outside the 'Geneva' entrance to the Organization, shows that in spite of a high-energy research laboratory, a 'cité satellite' and a main road to France, Meyrin still manages to retain much of its former rural character.

The chimney, incidentally does not serve to discharge radioactive gas from the site (there isn't any) ; it is merely part of the central-heating installation and the smoke it occasionally emits is no more harmful than that given off by any other chimney of its kind.

In the background are the Eastern slopes of the Jura mountains.

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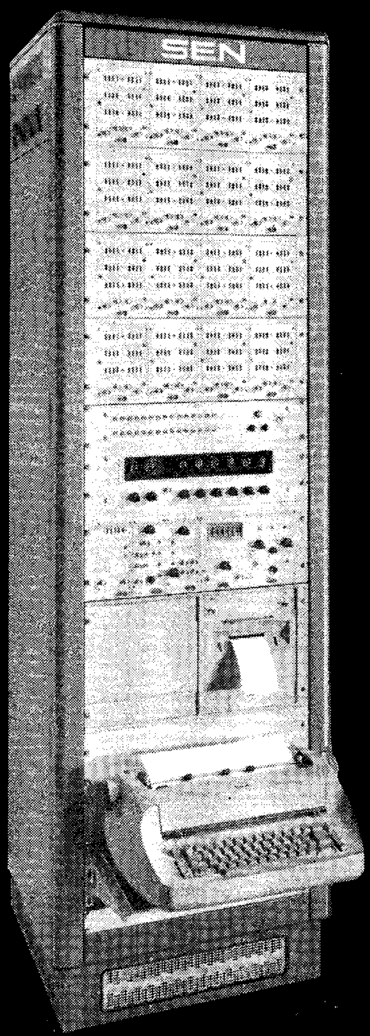

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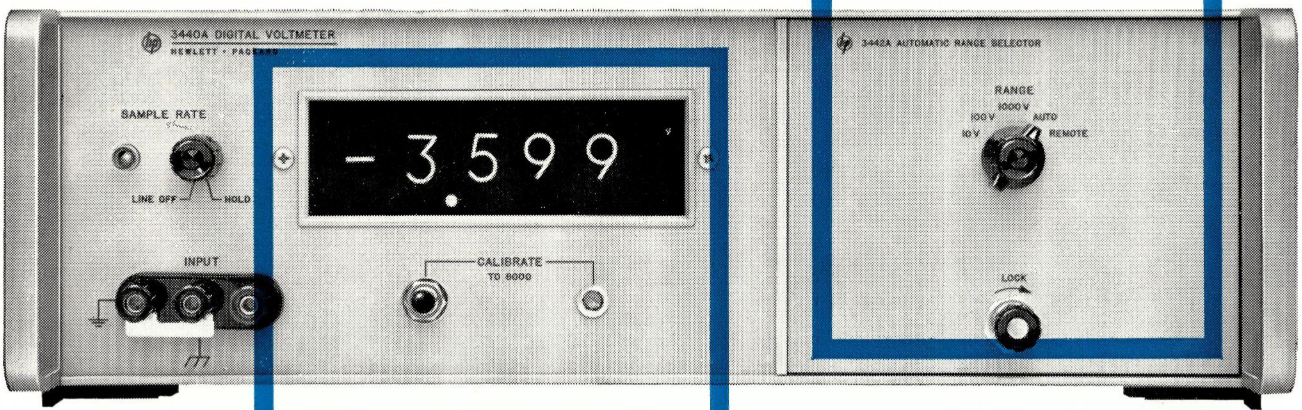

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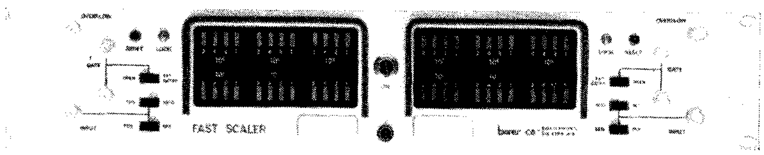

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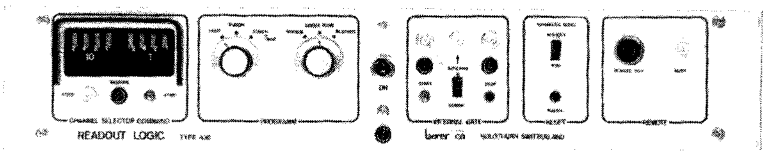

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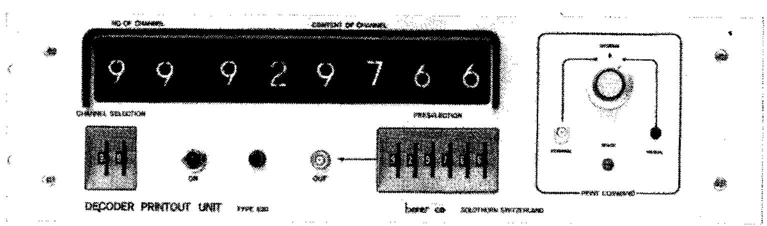

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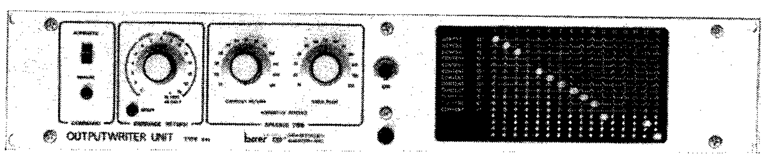

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- Pour la Division "Recherche sur les Accélérateurs".
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Artist's impression of the CERN site in Switzerland and (in green) part of the extension into France, showing on the latter the proposed intersecting storage rings (ISR) for the 28-GeV proton synchrotron.

- Drawn by M. Bron, "Site and Buildings" Division.
- For the "Accelerator Research" Division.
- Distributed by the

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