

Distribution: limited

SC-85/CONF.811/5
PARIS, 14 November 1985
English only

UNITED NATIONS EDUCATIONAL,
SCIENTIFIC AND CULTURAL ORGANIZATION

Round-table in commemoration of Niels Bohr Centenary

Niels Bohr - A survey of some of his contributions
to science and international co-operation

Unesco House, Room VIII, 28-29 November 1985

NIELS BOHR AND THE EARLY HISTORY OF CERN

by

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(The views expressed by the author do not necessarily
reflect the standpoint of Unesco)

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My contribution is based only in part on my memory and personal diary of those years. I have also used the remarkable work carried out by the group of young historians⁽¹⁾ led by Armin Hermann, professor of History of Science and Technology at the University of Stuttgart. Until now, this work has been circulated in the form of "preliminary reports" as a preparation of a detailed history of CERN - from the beginning to 1965 - in two volumes of about 600 pages each, that will be published by North Holland. The first volume will appear in 1986, the other about one year later. From this extensive presentation, John Krige, one of the members of Hermann's group, keeping in contact with his colleagues, will extract a more concise history, contained in a single volume of 300 pages and addressed to a wider public.

I had also the privilege of consulting the record on magnetic tape of the speech that Leon van Hove, who has been Director General of CERN from January 1976 to December 1980, pronounced on May 6, 1985, at CERN on occasion of the celebration of Niels Bohr centenary⁽²⁾.

For time reasons I can not summarize here the succession of events that, starting from the late 1940s brought to the creation of CERN on September 29, 1954. At that date the provisional Organization, established on February 1952, came to an end, passing to the permanent Organization the task of pursuing and developing the work of planning, designing and constructing the European laboratory and its two accelerators.

I should only recall that already at the end of the 1940s in many European and overseas places, scientists were becoming aware of the continuously increasing gap between the means available in Europe in the field of nuclear physics and elementary particles and the means available in the United States, where a few high-energy accelerators had started to produce results, while others had already reached advanced stages of construction or design.

It was becoming more and more evident to many physicists, in Europe and Overseas, that such a situation could be changed only by a considerable effort made in common by many European countries.

These views of the scientists were also in harmony with those of many politicians.

In those years in many European countries, in particular in France, Italy, West Germany and Belgium, the idea of moving towards some form of economic and/or political unification of at least a considerable part of the old continent, was considered of primary importance by many authoritative politicians, who adopted it as a guiding principle of their immediate and long range program of action.

I remember that in the years 1948-1950 the various problems arising in connection with the construction of a large accelerator by an international organization were examined in Rome in frequent discussions between Bruno Ferretti, professor of theoretical physics, and myself, and in letters exchanged with Gilberto Bernardini, who, in those years, was at Columbia University, where he had been invited by I.I.Rabi.

I remember that I became aware that similar problems were discussed in other European countries, in particular in France, when I heard of the European Cultural Conference held in Lausanne in December 1949. At the meeting a message

from Louis de Broglie was read by Raoul Dautry, Administrator of the French Commissariat à l'Energie Atomique. In the message the proposal was made to create in Europe an international research institution without mentioning, however, nuclear physics or fundamental particles. To the message of de Broglie Dautry added the proposal that the Conference study the ways of strengthening collaboration in two fields, in astronomy and astrophysics by building powerful telescopes and all necessary auxiliary material, and in the field of atomic energy, by setting up a centre with all the required modern apparatus.

As we see from this example, at that time the opinions were still rather vague about the type of research to be tackled by the new organization and even more about the nature of the collaboration to be established.

In June 1950 the General Assembly of UNESCO was held in Florence and Isidor I. Rabi, who was a member of the delegation from the United States, made a very important speech about "the urgency of creating regional centres and laboratories in order to increase and make more fruitful the international collaboration of scientists in fields where the effort of any one country in the region was insufficient for the task". In the official statement, approved unanimously by the General Assembly along the same lines, neither Europe nor high-energy physics were mentioned. But this specific case was clearly intended by many people, in particular by Rabi himself and by Pierre Auger, who was Director of the Department of Natural Sciences of UNESCO.

I knew Rabi very well since 1936, and on occasion of his trip to Florence, I had with him a thorough conversation about the future European laboratory.

A further endorsement of this idea came from the International Union of Pure and Applied Physics (IUPAP), which was at that time under the presidency of H.A. Kramers from the Netherlands. I was one of the vice-presidents and

asked Kramers, at the beginning of the summer 1950, to include the discussion of Rabi's proposal, with specific reference to Europe and high-energy physics, in the agenda of the meeting of the Executive Committee of IUPAP that was to take place at the beginning of September of the same year at M.I.T. in Cambridge, Mass. As a conclusion of a rather long discussion I was asked by the Executive Committee of IUPAP to get in contact with Rabi and with physicists from various European countries in order to clarify the aims and structure of the new organization and to help in the co-ordination of the different efforts. My first step was to write to Auger who in the meantime had presented the problem to the Conference on nuclear physics held in Oxford during the month of September where, according to reports of Auger and Ferretti (also present in Oxford), in the discussion that followed Auger speech, Niels Bohr proposed "to begin by building a big apparatus to accelerate particles" where by "big accelerator" was meant a machine providing about 1 GeV.

After the UNESCO Conference in Florence Auger had the authority to act but there was no money appropriated on the scale required for a detailed expert study of such a project.

Exchanges of views between Auger and Denis de Rougemont, director of the European Cultural Centre (ECC), founded at the already mentioned Lausanne meeting of 1949, brought Denis de Rougemont to convene in Geneva on December 12, 1950 a committee for scientific co-operation for discussing Rabi proposal at the UNESCO conference in Florence. The meeting was announced very late and many people could not participate because of other commitments they had taken for the same days. For example, I had already accepted to participate in a conference on elementary particles, taking place in India and therefore asked to be replaced by my colleague and friend B. Ferretti. The participants in the December 1950 meeting in Geneva were (in addition to a few

people of ECC): P.Auger, P.Capron (B), B.Ferretti (I), H.A.Kramers (NL), P.Preiswerk (CH), G.Randers (N), M.Rollier (I), and .Verhaege (B).

The Commission concluded its works with a series of recommendations, the most important of which was "the creation of an international laboratory centred on the construction of an accelerator capable of producing particles of an energy superior to that foreseen for any other accelerator already under construction", i.e. the cosmotron of Brookhaven (3 GeV) and the Bevatron of Berkeley (6 GeV).

The Commission also discussed and endorsed the estimates brought by Ferretti of the cost of such a machine obtained by comparison with the cost of the two American machines mentioned above.

Immediately after this meeting G.Colonnetti, President of the Consiglio Nazionale delle Ricerche of Italy, R.Dautry, Administrator of the French Commissariat à l'Energie Atomique and J.Willelms, Director of the Fond National de la Recherche Scientifique in Belgium made available to Auger some funds which, all together, amounted to about \$ 10 000. This sum, although very modest, was sufficient for Auger to initiate the first steps for arriving at the planning and construction of a large particle accelerator.

At the beginning of 1951 Auger established a small office at UNESCO and invited me to Paris, at the end of April, to discuss the constitution and composition of a Working Group of European physicists interested in the problem.

The first meeting of this "Board of Consultants" was held at UNESCO, in Paris, from 23 to 25 of May 1951. The members of the Board were: E.Amaldi (I), P.Capron (B), O.Dahl (N), F.Goward (UK), F.A.Heyn (NL), L.Kowarski and

F.Perrin (F), P.Preiswerk (CH) and Alfvén (SW) was also present in place of I.Waller.

Two goals were considered: a long-range, very ambitious, project of an accelerator second to none in the world, and in addition the construction of a less powerful and more standard machine which could allow at an earlier date experimentation in high-energy physics by European teams. For various reasons in the paper summarizing the conclusions reached by the consultants only the large machine was explicitly mentioned and underlined.

These conclusions were made immediately known, but were received by various people in completely different ways⁽³⁾. This became very clear on occasion of the colloquium, sponsored by IUPAP, on "Problems of Quantum Physics" that was organized by Niels Bohr and Stephan Rozental and took place in Copenhagen from 6 to 10 July, 1951. This colloquium was followed by the 7th General Assembly of IUPAP, that also was held in Copenhagen, from 11 to 13 of the same month. During these two meetings a number of discussions took place in the lecture rooms as well as in the corridors and during the meals or the entertainments, about the programme worked out by the group of UNESCO consultants.

Bohr and Kramers that, as I said before, was president of IUPAP, started to be afraid of the consequences, especially of the financial consequence, of this programme that appeared too ambitious to them. They doubted the wisdom of starting immediately the construction of a large machine. It was better, they thought, to procede by steps, for example by constructing first a small machine, an idea that had been stressed by Perrin and Verhaege at the meeting of the Board of Consultants and had been proposed also by other people (for example, Wideroe, in Switzerland).

In discussions parallel to the IUPAP meeting the agreement was reached of recommending to procede in three phases: the first phase should be devoted to the study of

two accelerators, one big, the other rather small, and also to the creation of an institute for advanced studies. The second phase should be centered on the construction of the small machine, while the construction of the large machine should be tackled only in the third phase, starting, perhaps around 1955 or later.

This agreement was clearly a compromise and did not satisfy neither the people that favoured the programme proposed by the UNESCO Board of Consultants, nor those that shared the views of Bohr and Kramers. During summer 1951 James Chadwick from U.K. who was an old friend of Bohr, by correspondence with him and on occasion of a long visit he paid to Copenhagen, became a supporter of the idea of starting with an international coordination around the Copenhagen Institute and an international use of the large facilities that could become available: in Liverpool a 400 MeV Synchrocyclotron and in Uppsala a 200 MeV Synchrocyclotron.

The possible construction of a large machine could be examined in a later stage.

The people of UNESCO and of the Board of Consultants proceeded in their work and made attempts for taking into account the line of thought of Bohr, Kramers and Chadwick. There was no difference in principle as it is shown, for example, in a letter of October 1951 of Bohr to Auger and where Bohr refers to "the great European effort with which, in principle, everybody so deeply sympathizes". The question was what to do and in which order.

The Board of Consultants held two other meetings one in October, the other in November, but did not succeed in appeasing the worries of the other side. These worries became particularly clear when the 28 and 29 November, 1951, all the leading scientists from the Netherlands and Norway gathered in Kjeller, Norway, for the inauguration of the research reactor that had been constructed together by the Dutch and the Norwegian.

During this same period Auger was preparing an official "meeting of government representatives", in order to take the first important intergovernmental step towards CERN. He was very worried to see that the difficulties had remained and called another meeting of the consultants on December, 14, 1951.

Three days later, on December 17, 1951 started, in Paris, the "Conference on the Organization of studies relating to the establishment of a European Nuclear Physics Laboratory" that had been prepared by Auger and his staff but, formally, was called by the Director General of UNESCO.

Shortly after the opening of the meeting the Dutch delegation introduced a compromise solution trying to combine the two approaches. This compromise resolution was the central topic of discussions but the delegates were not able to reach an agreement. Everybody felt, however, that a remarkable progress had been made towards a solution agreeable to all participants, and that a re-consideration of the whole matter was desirable. Under these circumstances the meeting decided, on December 20, to interrupt its work and to resume the discussions in a second session to be held in February in Geneva.

The second session of the UNESCO meeting took place in Geneva on February 12 to 15, 1952 (Fig.1). An agreement was easily reached. This was embodied by a formal inter-governmental document which was signed the February 15, by the Representatives of eleven European States, but not by the Representative of United Kingdom, that, at that stage, desired to keep the position of "Observer". The title of this important document was:

"Agreement constituting a Council of Representatives of European States for planning an International Laboratory and organizing other forms of co-operation in Nuclear Research".

This title shows the spirit of compromise pervading the document. This feature is further stressed by Article 1, which reads:

"A Council of Representatives of European States is hereby constituted for planning an International Laboratory and organizing other forms of co-operation in Nuclear Research".

At the second session in Geneva the proposal was introduced by the Danish delegates to have a large scientific conference in June 1952, in Copenhagen, in order to discuss in depth the scientific aims and the basic scientific equipment of the new laboratory.

The word "Council" used in the Agreement of February 1952, still appears today in the acronym CERN:

Centre Européen pour la Recherche Nucléaire.

The Agreement had to be ratified by the parliaments of the Member States, since the financial contributions were fixed in its Annex. Enough ratifications were obtained rather rapidly so that on May 2, 1952 the Agreement came into force and the Council could start its work.

The first decision of the provisional Council was the creation of four groups and the nomination of the officers in charge of them.

Two groups had the task of designing and starting the construction of the two machines, a third group that of taking care of the laboratory and the subsidiary equipment⁽⁴⁾. The fourth Working Group, that could start immediately to operate, was the Group for Theoretical Studies, "to be based in Copenhagen, and Niels Bohr accepted of becoming its leader, what was not so light for a man of his stature, already at the age of about 67. He also became a regular participant of the Council Meetings of the

provisional Organization. In the same meeting I was nominated Secretary General, with the task of coordinating all the activities of the new Organization, in particular the work of the four groups.

The Executive Group, composed of the leaders of the four groups and the Secretary General, who chaired it, had regular meetings where the most important decisions were taken about all problems arising in a rapidly growing organization. Niels Bohr took part if not in all, certainly in many of these meetings and with his wide vision of all cultural and general problems, his kindness and wisdom, gave a great help in points of substance as well as of style.

The large Copenhagen scientific Conference, proposed in February by the Danish Delegation, took place, as foreseen, in June 1952. On purely scientific reasons the conclusion was reached by a overwhelming majority of the physicists participating in the Conference, that "Europe should try to construct a proton-synchrotron for energies between 10 and 15 GeV".

Immediately after the Copenhagen Conference, the June 20-21, the provisional Council held its 2nd session in Copenhagen. The conclusions reached by the scientific Conference were presented to the Council by Werner Heisenberg. The Council accepted them and approved also another Danish proposal that fitted into the notion of other forms of co-operation in nuclear research. Namely another international co-operation in the field of cosmic rays.

The result was that one year later, in 1953, a very large expedition of balloon flights was organized in Sardinia with the participation of many European universities. It gave data for studying the properties of the new particles produced in nuclear emulsion by high altitude cosmic rays.

The 3rd session of the provisional Council was held in Amsterdam on October 1952 and took three important decisions that I should mention here:

- 1) They decided where the European Laboratory should be. They decided unanimously for the Geneva site.
- 2) They decided that the big machine should be a proton synchrotron of about 30 GeV. The change of energy was due to the rediscovery, in August 1952, by Courant, Livingston and Snyder of the "strong focusing" principle⁽⁵⁾ which allowed a remarkable reduction of the amount of iron and copper necessary for constructing a large magnet for a fixed value of the magnetic field and, therefore, permitted to reach a higher energy of the accelerated particles for the same total cost of the machine.
- 3) The Council created a committee on other forms of co-operation⁽⁶⁾ and Niels Bohr accepted to chair it.

I should add that after the adoption of the strong focussing principle in the construction of the proton-synchrotron, Niels Bohr became much more favourable to this machine which, by involving the application of a new principle, was loosing the unpleasant feature of a scaled up version of already existing accelerators.

After the decision of the provisional Council to place the European laboratory in the vicinity of Geneva, many Scandinavian physicists felt necessary to take steps concerning the future, in the long run, of the Copenhagen Institute, where Niels Bohr for about three decades had created and lead the most extraordinary institute of theoretical physics ever seen. The February 17, 1953 a meeting took place in Göteborg in Sweden of Danish, Norwegian and Swedish physicists, where they elaborated the plan to establish, with the other Scandinavian countries Finland and Iceland, a Nordic Institute for theoretical atomic physics to be based in Copenhagen. This is the

institute that became Nordita. They also realized that Geneva will become the centre of high energy experimental physics and inavoidably will attrach also the corresponding theory, but that, in spite of that, there was room for something else for maintaining the long tradition of international collaboration that had prevailed over decades in Copenhagen under the leadership of Niels Bohr.

The Nordita became one of the leading institutes in theoretical low energy nuclear research, it achieved two Nobel Prizes in 1975, Aage Bohr and Ben Mottelson, and pioneered the collaboration with the East, with the Soviet Union and the countries of the Soviet block and, more recently, with China.

Returning to the early history of CERN I should recall that in parallel with the activities mentioned above the layers prepared the "Convention for the Establishment of the European Organization for Nuclear Research".

This Convention was signed in Paris on July 1, 1953 and entered into force when a prescribed point in the ratification procedure was reached on September 29, 1954.

The Council of the permanent Organization held its first session in Geneva on October 7-8, 1954 and among many other important decisions appointed Felix Bloch Director General of the (permanent) Organization and created the Scientific Policy Committee (SPC).

The first chairman of the SPC was Werner Heisenberg, and Niels Bohr accepted to be a member.

Bohr continued to be the leader of the theoretical group in Copenhagen until the September 1, 1954, when he was replaced by his pupil and collaborator Christian Møller. This group continued its activity until the end of 1956. At its 6th Session the Council decided the December 14, 1956, the termination of the CERN Theoretical Group in Copenhagen

and the end of the activity of C.Møller as its leader. About one month later the Council, at its 7th session, created the Theory Division in Geneva, with Bruno Ferretti as leader.

Niels Bohr did not participate in all meetings of the SPC but whenever he went to Geneva for such a meeting he took an active part. For example in one of these meetings, in November 1955, Bohr intervened in the discussion of the future programme of research to be carried out with the synchrocyclotron, not too far from completion, pointing out that not all countries would be able to send a complete research team, and that one had to foresee the formation of teams composed of individuals from various countries.

In another SPC meeting of November 1956, in a discussion about bubble chamber pictures, Bohr stressed the importance of automatic scanning and measuring methods and suggested that the pictures after the first analysis at CERN, could be rescanned in other laboratories, perhaps, for other types of events.

At the same meeting the SPC accepted the proposal of terminating the existence of the theoretical group in Copenhagen on October 1, 1957. Bohr gave an account of the activities carried out in Copenhagen and pointed out that the Theory Division at CERN had now two tasks:

- 1) To carry out theoretical studies and provide guidance in direct connection with the experimental work made with the accelerators;
- 2) To provide the advanced education of the young physicists, which until then had been taken care of by the Copenhagen group.

In another meeting of the SPC, held in April 1959, an important discussion took place about the experimental research programme of the PS which was expected to be put in

operation in a few months. Actually a full energy beam circulated in the PS on December 25 of the same year. Bohr intervened in the discussion for supporting the concept of "mixed teams" proposed by Massey of London, i.e. teams including, in addition to outside scientists, also a few CERN staff which would facilitate the utilization of the technical services of the Meyrin Laboratory by the outside scientists and technicians.

The last meeting of the SPC attended by Niels Bohr was the 22nd meeting, held in Geneva on November 25, 1961 (I recall that N.Bohr died on November 18, 1962). In November 1961 UK had financial difficulties and had requested a reduction of CERN budget. Some people had proposed the closing down of the synchrocyclotron but Niels Bohr said to be so strongly against such a decision "that the possibility of doing so should not even be mentioned". He stressed that this machine is "an integral part of CERN which produced remarkably good results".

As I said before the protonsynchrotron entered into operation on November 25, 1959. A ceremony of inauguration of this machine took place at CERN on February 6, 1960. This occasion was a great feast for all the people that had conceived or contributed to plan and construct CERN and its machines.

That day, in front of a large audience composed of authorities of Member States, staff of CERN and scientists from many laboratories and Universities in Europe, Niels Bohr pressed the button putting the PS into operation (Fig.3).

I like to stress today, about 25 years later, that Niels Bohr was the right person to do that for many reasons, a few of which should be mentioned here as a conclusion of my speech.

The first point is that the Institute of Theoretical Physics of the University of Copenhagen, created and led by Niels Bohr for a few decades starting from the early 20s, has been always a quite exceptional centre of investigation and thinking about the more fundamental laws of nature, based on the collaboration between scientists coming from any part of the world.

When after the Second World War a number of people started to think, here and there, about the possibility of creating an European Centre of research of completely new dimensions, all of them had in mind, consciously or unconsciously, this unique example, unique not only for the scientific results achieved there, but also for the close and effective collaboration between people coming from different countries that Niels Bohr had promoted and developed.

The fact that Niels Bohr adhered from the beginning to the general idea of an European venture in the field of high energy physics, has been also of paramount importance. His authority, not only as a scientist, but also as an upholder of all basic human values, was so high to give an extraordinary strength to the endeavour to create CERN.

His participation in the life of CERN during its first years of existence, as the leader of the Theoretical Group in Copenhagen, and as a Member of the SPC, has provided an unvaluable guarantee in front of the Governments of the Member States and a reassuring sign of the continuity between the great atomic and nuclear physics tradition of the 20s and 30s, with the set of problems that the physicists and engineers of younger generations entering in this new adventure, were facing.

All these people, and I belong to them, recall Niels Bohr with profound admiration, lasting gratitude and great affection.

- N O T E S -

- (1) In addition to Armin Hermann, from the Federal Republic of Germany, the group is composed of: John Krige from South Africa, Dominique Pestre from France, Ulrike Mersits from Austria, all full time, and Lamberto Belloni from Italy, part time.
- (2) In the afternoon of May 6, 1985, CERN celebrated the centenary of Niels Bohr with two speeches:
Abraham Pais: "Niels Bohr as a scientist";
Leon van Hove: "Niels Bohr and the creation of CERN".
- (3) Studies in CERN History: D.Pestre: CHS-2, June, 1983; CHS-3, March, 1984; CHS-9, May, 1984.
- (4) The leaders of these three groups were: C.J.Bakker (NL) for the SC, O.Dahl (N) with F.Goward (UK) as deputy for the PS, and L.Kowarski (F) with P.Preiswerk (CH) as deputy for the Lab. group.
- (5) E.D.Courant, M.S.Livingston, H.S.Snyder: "The Strong Focusing Synchrotron. A New High Energy Accelerator", Phys.Rev. 88 (1952) 1190-1196. I have used the word "rediscovered" because the same principle had been found by the Greek engineer Christophilos in 1950. In the same year he applied for a U.S.A. patent, but his application was not noticed by the experts in the field and therefore remained ignored.
- (6) The other members of this committee were: E.Amaldi, Secretary General, M.S.Dedijer (Y), W.Heisenberg (F.R.G.) and F.Perrin (F). The Committee's task was of making proposals concerning other forms of co-operation and particularly the selection of candidates wishing to work with the existing facilities put at disposal of the Council.

- CAPTION OF FIGURES -

Fig.1 Niels Bohr greets Paul Scherrer, chairman of the UNESCO meeting, at the opening of its second session in Geneva, on February 12, 1952. The third gentleman appearing in the photograph is Messieur Picot, Chairman of the Department of Education of the Canton of Geneva, who represented Switzerland and the Republic of Geneva in offering to CERN the Meyrin site.

Fig.2 A photograph of Niels Bohr, taken at CERN, in April 1953, while he is trying to light a pipe.

Fig.3 Photograph of Niels Bohr pressing the botton to put the protonsynchrotron into operation on occasion of the inauguration of this machine on February 6, 1960.