CERN

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

By C. J. Bakker

THE Council meeting of the European Organization held in Geneva on October 7 and 8, 1954, was a great occasion. In his opening address R. Valeur of France, retiring President of the interim Council, notified the Council of the entering into force of the Convention for the establishment of a European Organization for Nuclear Research, as a sufficient number of instruments of ratification had been deposited by then.*

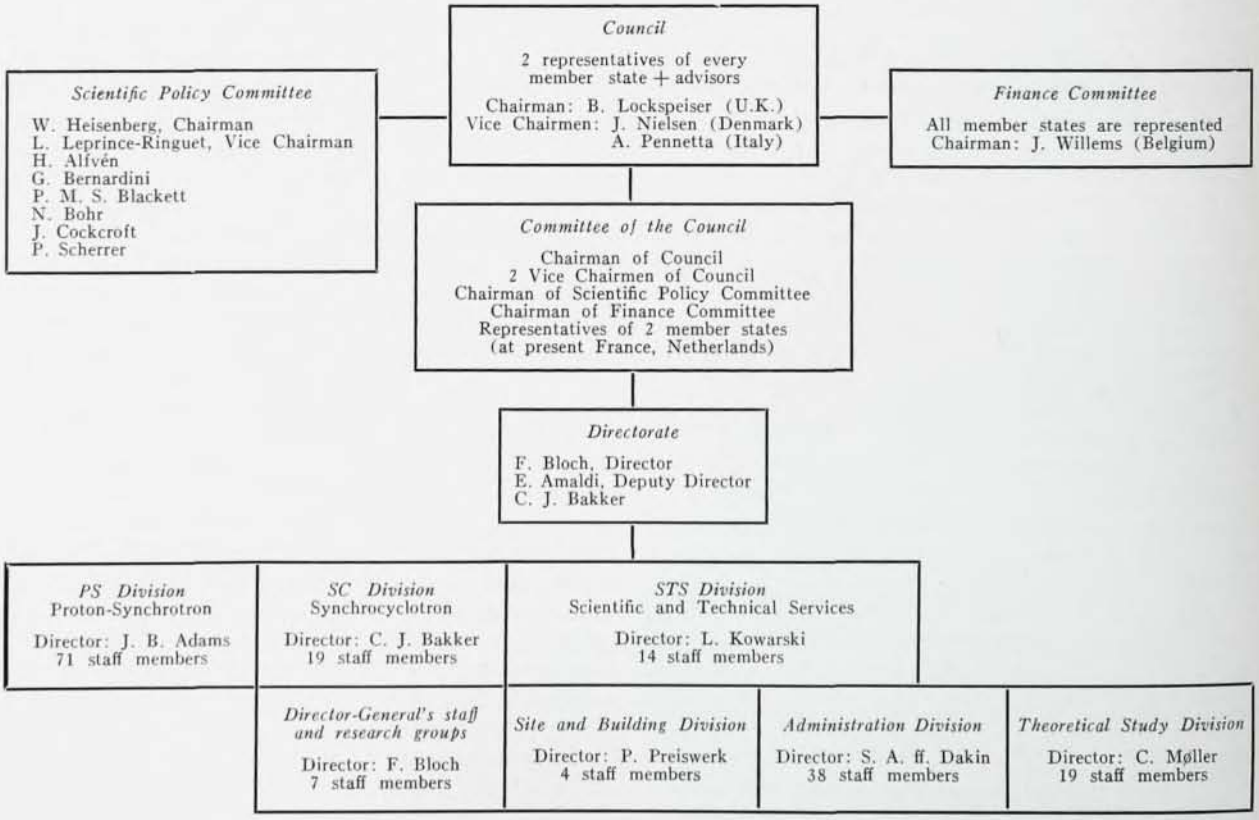
At the October 1954 Council meeting some distinguished guests were present who had played an important part in the events leading up to the foundation of the Organization. Among them was Professor I. I. Rabi of Columbia University, who in 1950 in Florence during the General Assembly of Unesco, as a U. S. A. delegate, presented a proposal which gave rise to a resolution of a general character aiming to encourage the formation of regional research centers and laboratories.

I may remind you that CERN was created because after the war it was felt in various European scientific circles and in particular among the physicists of several European universities and research institutions that, in order to regain a first-rank position in nuclear science, it was necessary to make a common effort.

I shall not mention here all preparatory work performed during the interim period of CERN, but rather tell you in some detail about the present situation.

* When the Council of CERN met at its second session on February 24, 1955, all member states had completed the process of ratification.

TABLE 1. European Organization for Nuclear Research (CERN) Structure Chart
(as of January 1, 1955)



Present Situation of CERN

Table 1 shows a structure chart of the Organization as it is now. In the Council each member state is represented by two delegates with a single vote and as many experts as they deem necessary. Among the delegates there are such physicists as Prof. N. Bohr for Denmark, Prof. W. Heisenberg for Germany, Sir John Cockcroft for the United Kingdom, Prof. F. Perrin for France, Prof. P. Scherrer for Switzerland, Prof. I. Waller and Prof. T. Gustafson for Sweden, and Prof. S. R. de Groot for the Netherlands. Besides these physicists there are representatives of leading national organizations in their own countries such as Sir Ben Lockspeiser, Secretary of the Department of Scientific and Industrial Research in London; J. Willems, President of the Institut Universitaire des Sciences Nucléaires at Brussels; J. H. Bannier, Director of the Netherlands' Organization for Pure Scientific Research (ZWO). There are also jurists and diplomats particularly interested in the organization of international and cultural relations such as Dr. A. Pennetta, legal consultant of the Italian Foreign Office, and J. de Bourbon-Busset of the French Ministry of Foreign Affairs.

At the October 1954 meeting of the Council Sir Ben Lockspeiser of the United Kingdom was unanimously appointed President, as a successor of R. Valeur of France, who is now with the French Embassy in Washington, D. C. Prof. J. Nielsen of Denmark and Dr. A. Pennetta of Italy are Vice Chairmen.

As the Council will meet only once or twice a year, a smaller body called the Committee of Council was set up which will meet more often and deal with current problems. Moreover, the Council is assisted by a Finance Committee and a Scientific Policy Committee. In the Finance Committee all member states are represented. The most important work of the Committee is to prepare the budgets for the Organization, which have then to be approved by the Council. The Scientific Policy Committee advises the Council on scientific matters. Distinguished scientists are members of the Committee. They are Prof. W. Heisenberg (Germany) Chairman; Prof. L. Leprince-Ringuet (France) Vice Chairman; Prof. N. Bohr (Denmark), Prof. H. Alfvén (Sweden), Prof. G. Bernardini (Italy), Prof. P. M. S. Blackett and Sir John Cockcroft (United Kingdom), and Prof. P. Scherrer (Switzerland).

The rest of the table shows the organization of the staff now at work in Geneva. At the October 1954 Council meeting Prof. F. Bloch from Stanford University was unanimously appointed Director General. In the Directorate he is assisted by Prof. E. Amaldi (Italy) as Deputy Director General and by Prof. C. J. Bakker (Netherlands).

C. J. Bakker, Director of the Dutch Institute of Nuclear Physics and Professor of Physics and Head of the University of Amsterdam's Zeeman Laboratory, presented this paper as an invited address at the New York meeting of the American Physical Society on January 29, 1955. It has since been announced that Professor Bakker is to succeed Felix Bloch as Director General of CERN this year when Professor Bloch's resignation becomes effective. Professor Bloch is returning to Stanford University in September.

On January 1, 1955, the total staff of CERN amounted to 172, divided among seven divisions.

I can now say a few words on the work of these divisions. As is well known, CERN is designing and building two big accelerators. One is an alternating gradient proton synchrotron for 25 Bev protons, the other a 600 Mev synchrocyclotron.

The Proton Synchrotron Division

During the interim period of CERN the PS division was under the directorship of Dr. O. Dahl (Norway). Since last October J. B. Adams (United Kingdom) has taken over.

The division has made an extensive study of the theoretical implications of the alternating gradient focusing principle. The effect of nonlinearities on resonance stopbands and stabilities of the particle motion has been studied. Although this study is still in progress there is a growing conviction that a 25 Bev machine can be realized. The engineering design of the magnet units, the radiofrequency accelerating system, the injection linac, the building, etc., is progressing.

In Table 2 is given a list of the parameters of the machine as they are envisioned at the moment.

TABLE 2. Parameters, CERN-PS (January 10, 1955)

maximum energy	25 Bev
maximum field at equilibrium orbit	12 kGauss
radius of curvature in guiding field, r_0	70.08 m
mean radius of machine, r_m	100 m
field index n	282
total transition energy	5.9 Bev
phase shift per magnet period μ	$\pi/4$
betatron wavelengths per circumference, Q	6.25
magnet units, each 1/2 foc., 1/2 defoc.	100
magnet periods (2 magnet units)	50
superperiods, 5 magnet periods each	10
length of magnet unit	4.4 m
normal field free sections, each 1.6 m	80
long field free sections, each 3.0 m (evenly spaced, containing rf stations, apparatus for injection and ejection)	20
pairs of linear (4-pole) lenses	10
pairs of nonlinear lenses	10
rf accelerating stations (2 gaps)	16
rf harmonic	30
rf range	4.3–14.3 Mc/s
energy gain per turn, at 1 sec acceleration time (repetition 5 sec)	50 kev
rf volts across gap, at 60° stable phase angle	2.8 kv rms
rf power per gap	$\simeq$ 5 kw peak
injection energy	50 ± 0.1 Mev
injection time	6 μsec
injection by Linac—Alvarez type, 3 tanks, total length 30 m	
rf power 5 Mw for 200 μsec every 5 sec	
magnet weight (including coils)	3500 tons
peak magnet kva	28×10^6 kva
mean magnet power	1.5×10^6 watts
magnet gap at equilibrium orbit	10 cm
vacuum chamber, stainless steel 1.5 mm wall	8 × 12 cm
magnet alignment tolerances	0.3 mm vertically
(including field errors) total rms	0.6 mm horizontally
effective tolerance on n after correction by lenses and pole face windings	± 1.5%
effective differential tolerance in n between + and — sectors after correction	± 0.3%
estimated area reached by particles under unlucky alignment circumstances	6 × 9 cm

I may mention here that there is a close and fruitful cooperation with the Brookhaven staff, working on the design of a similar machine. The CERN machine may be in operation about six years from now.

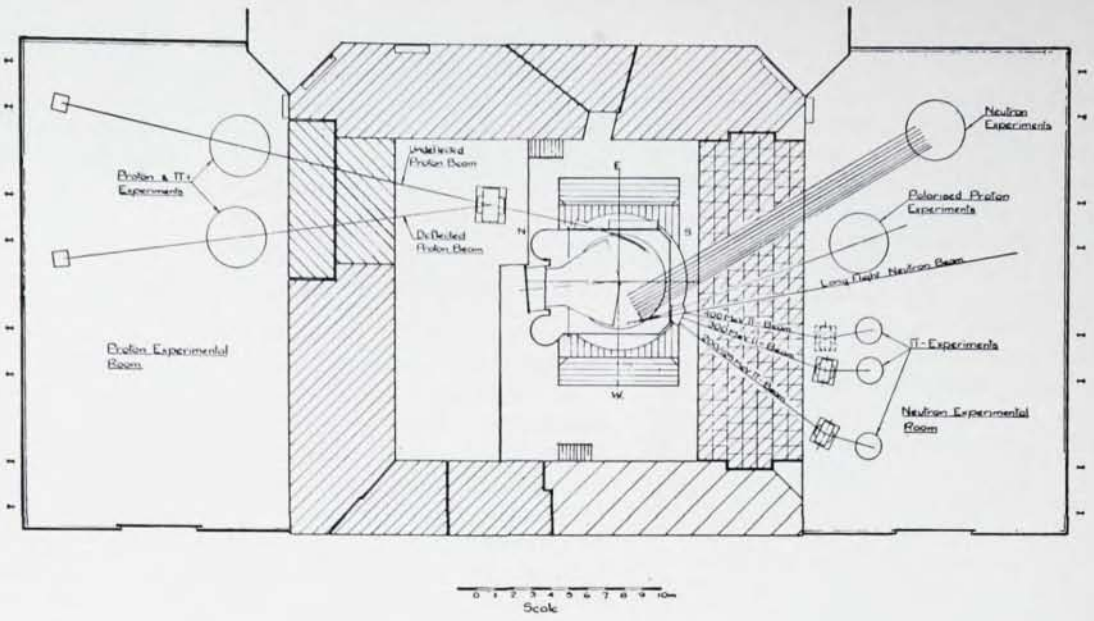


Fig. 1. Plan view o synchrocyclotron.

The Synchrocyclotron Division

The construction of the 600 Mev synchrocyclotron is now well under way. The 3000-ton magnet with a pole diameter of 5 meters has been ordered. The iron frame will be manufactured by Schneider-Creusot in France. A magnetic quality of 2.03 Weber per m^2 at 300 Ampere turns per cm has been guaranteed. The coils with aluminum windings are being manufactured by the firm ACEC in Belgium. Erection of the magnet at the site in Geneva will start in October 1955. The installation of the remaining parts of the machine will continue through 1956 and 1957. The parameters are given in Table 3.

TABLE 3. Parameters of CERN Synchrocyclotron

maximum energy, protons	600 Mev
pole diameter	5 m
exit radius ($n = 0.2$)	2.27 m
exit flux density	17.9 kGauss
center flux density	18.8 kGauss
frequency range	28.7 to 16.6 Mc/s
repetition rate	53 pulses/s
expected internal beam current, average	1 μA
total Ampere turns required	1.2×10^6 At
magnet weight (steel only)	2500 tons
magnet power	750 kw
installed high-frequency power	100 kw
total power installed in SC building	2.5 MvA
vacuum chamber volume	23 m^3
operating pressure	6×10^{-6} mm Hg
diffusion pump diameter (two)	80 cm
total pumping speed at 10^{-4} mm Hg	24 m^3/s

The main difference between the CERN synchrocyclotron and existing machines of this type is the high-frequency system in which a vibrating reed instead of a rotating condenser will be used. The system is similar to that adopted in the enlarged synchrocyclotron in Berkeley.

Figures 1 and 2 show a plan view and vertical section of the CERN synchrocyclotron.

Figure 3 shows a model of the aluminum tuning fork to be used for the modulation of the high frequency. Experiments with scale models have shown satisfactory results and a full-scale tuning fork has now been ordered to be tested in the high-frequency system.

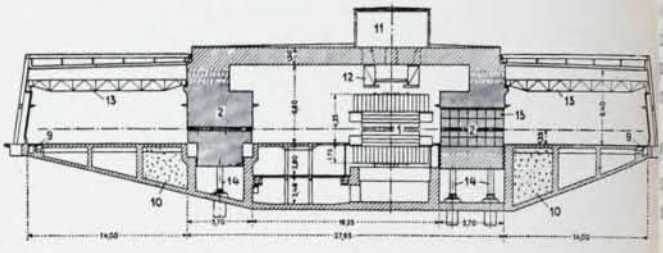


Fig. 2. Vertical section of synchrocyclotron:
1. magnet
2. moving walls
9. cable ducts
10. gravel filling
11. ventilation room
12. crane (70 tons)
13. crane (20 tons)
14. lifting devices
15. baryta blocks

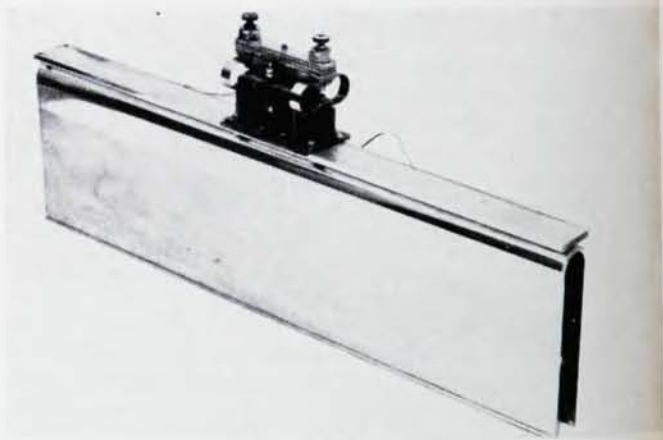


Fig. 3. Aluminum tuning fork (¼ scale model of dimensions 50 x 13.5 x 3.5 cm).

Scientific and Technical Services

The Division of Scientific and Technical Services, under the direction of Dr. L. Kowarski, undertakes various scientific and technical activities which are considered to be of interest to the establishment as a whole, rather than closely and exclusively connected with one or the other of the great accelerators. By attending to some of these parallel aspects at a time when the greatest effort of CERN is directed towards the machine-building activities proper, the Division helps to avoid delay in the development of a many-sided scientific life around the machine.

In the *Instrumentation* section development activities are well under way aiming at the creation, at the Geneva center, of a nucleus of scientists and designers capable of quickly producing up-to-date types of detecting and measuring devices well adapted to local needs. Advanced prototypes and facilities for their limited duplication are aimed at, rather than mass production; electronics and cloud chamber techniques are the main fields envisaged at present with due attention to the novel ionization sensitive devices such as bubble chambers. There is a close connection with, and participation in, the cosmic-ray research at present sponsored or undertaken by CERN.

The creation of similar sections for *Chemistry, Health Physics,* and possibly *Calibrations* is envisioned in the appropriately near future. Electronic and mechanical *workshop* facilities are being developed as needed.

Information activities (library, documentation, publication of CERN reports, documentary relations with other similar establishments, press relations) require a scientific and technical, rather than a purely administrative, competence and have for this reason been entrusted to the same division.

Site and Buildings Division

The Director of the Site and Buildings Division is Prof. P. Preiswerk.

Before the final Convention of the European Organization for Nuclear Research came into force, some preliminary construction work on the site was started, namely the roads giving access to the future buildings, canalisation work, drainage, and the excavation of the SC building. Electricity, water, and gas were brought to the site.

After the first session of the new Council, construction work really could start and the order could immediately be given for the construction of the whole SC building. Actually a large part of the foundations was finished before the winter season slowed down the work. Baryta for the shielding walls is regularly arriving from the South of France. The building should be ready next autumn to receive the first parts of the magnet.

The general layout of the PS building is now fixed and detailed plans are in preparation. For the PS building numerous soundings are being made. The soil consists of hard molasse covered by a moraine layer. The magnet foundations are foreseen to be independent of the ring building's foundations and will be erected on molasse ground.

The excavation work for one part of the PS building, namely experimental halls and annex laboratories, has been ordered and work started at the end of January 1955.

Plans for the power house (main transformer station and central heating), the main workshop, and the laboratories of the central building complex are ready. It is expected that the construction of these buildings will be started in the first half of this year.

Figure 4 shows the site at Meyrin where the laboratory is being constructed with respect to the city of Geneva. Figure 5 shows a model of the site with the buildings. A model of the building of the synchrocyclotron is shown in Figure 6. Finally, Figure 7 shows how the work on the foundation of the SC building is progressing.

Theoretical Study Division

The Theoretical Group set up in Copenhagen by Professor Bohr, and directed by him during the interim period of CERN, is now still stationed in Copenhagen. Professor C. Møller has taken over the directorship. The division performs research work on fundamental problems of nuclear physics. Moreover, it provides advanced training for junior theoretical physicists from the participating countries and offers them the opportunity to perform research work under the guidance of senior theoretical physicists. In addition, this division takes care of the liaison aspects of the scientific work carried out by CERN members in European laboratories which have put their facilities at the disposal of CERN. Both in Liverpool and Uppsala CERN members are engaged in work with the synchrocyclotrons.

The Theoretical Study Division will later move to Geneva where, in the meantime, a small group is engaged in related work.

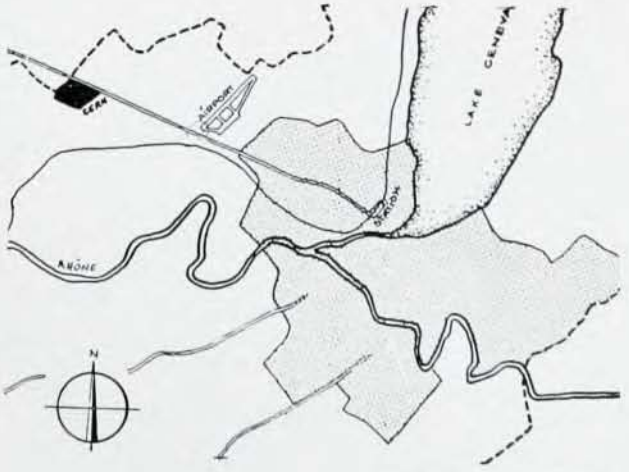


Fig. 4. Site at Meyrin.

Other Activities

CERN also sponsors cooperative European research endeavors, such as the two international expeditions for launching balloons for cosmic-ray investigations from Sardinia (Italy) in 1952 and 1953.

In this respect I may mention that CERN has now taken over from the Manchester group the operation of the cloud chambers installed on the Jungfraujoch in Switzerland. Some members of the Manchester group joined CERN. Besides the physical results to be obtained with this installation, it is thought that the experimental techniques used in cosmic-ray research can later be useful for the experiments with the machines. Professor Amaldi takes a special interest in the cosmic-ray research.

Finally, a research team working in Geneva on nuclear induction directly under Professor Bloch has been established.

Finances

As CERN has just started its real life not much can be said about the finances involved, especially since the cost of the proton synchrotron is still difficult to estimate. For 1955 a budget of 25 million Swiss francs (about 6 million dollars) has been foreseen for CERN. The participating countries share the cost in ratio with their national incomes.

Table 4 shows the scale of contributions of the member states.

TABLE 4. Scale to serve as a basis for the assessment of contributions during the period ending on December 31, 1956. (The table is revised every 3 years.)

	Percentage
Belgium	4.88
Denmark	2.48
France	23.84
German Federal Republic	17.70
Greece	0.97
Italy	10.20
Netherlands	3.68
Norway	1.79
Sweden	4.98
Switzerland	3.71
United Kingdom	23.84
Yugoslavia	1.93
total	100.00

Staff Distribution

As mentioned already, the scientific, technical, and administrative staff of CERN amounts at the moment (January 1, 1955) to about 172 people. Table 5 shows the present distribution of personnel among member states.

TABLE 5. Staff distribution as of January 1, 1955

Belgium	4
Denmark	6
France	34
Germany	12
Greece	3
Italy	15
Netherlands	11
Norway	3
Sweden	6
Switzerland	49
United Kingdom	21
Yugoslavia	2
Others	6
total	172

The high figure for Switzerland is due to the fact that the majority of the lower administrative and technical personnel is recruited locally.

Fig. 5. Model of site with building (*photo by Grünert, Zürich, Switzerland*)

Fig. 6. Model of synchro-cyclotron building (*Grünert photo*)

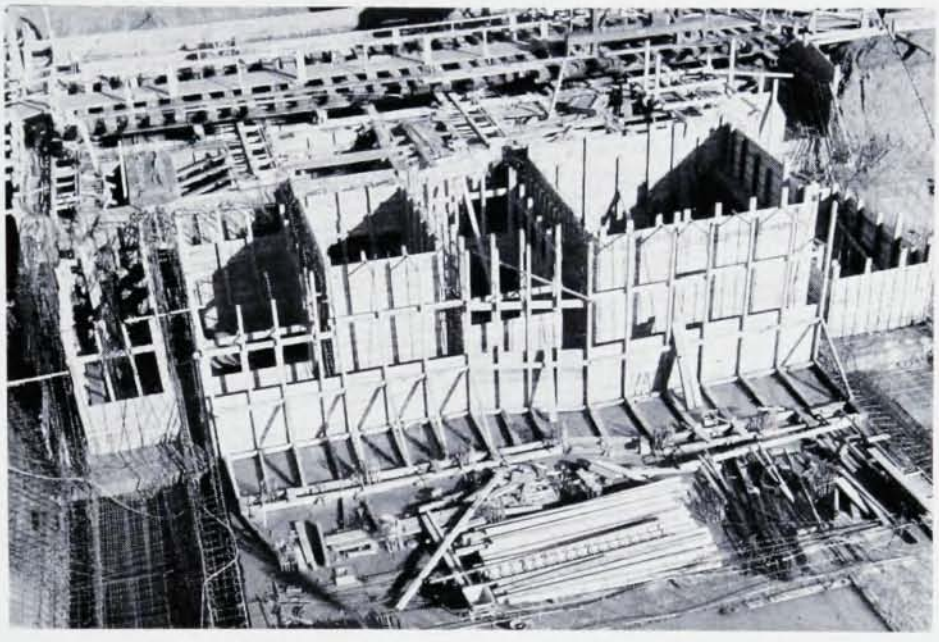


Fig. 7. Building operations at Meyrin (*CERN photo No. 4*)

The Nature and Aim of CERN

Before ending my report I should like to stress a few points which may also be of interest to American scientists and which are essential in order to understand the real nature of CERN.

The first point concerns the organizational structure of the Laboratory, which is determined by the principle expressed in the Minutes of the 7th session of the Council during the interim period of CERN:

> "The new laboratory should resemble in its research characteristics the research laboratory of a university, through which there is a free flow of 'graduates' and therefore most posts should be of a short duration to allow for the flow of scientists through the laboratory so necessary to avoid stagnation. This will also increase the number of scientists who are able to use the unique facilities of the Laboratory."

The second point relates to the purpose of the organization which is established in Article II of the Convention, reading 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 technical work shall be published or otherwise made generally available. . . ."