

31st Session of CERN Council



The Council met at CERN on 15 and 16 December 1965. Major decisions on the improvement programme for the existing installations and on the intersecting storage ring project were reported briefly in the January issue of the *COURIER*. This article amplifies the information concerning these decisions and in addition covers a review by Professor Weisskopf of the contribution of CERN to high energy physics during his five years as Director General.

Professor Weisskopf, making his last appearance before the Council as Director General of CERN, presented a review of the contribution of CERN and its collaborating Laboratories throughout Europe, to the progress of high energy physics. The following paragraphs are a condensed version of this review.

"About the beginning of 1960 a new wave of discoveries was breaking loose in high energy physics. It was realized that the elementary particles exist in many quantum states or 'resonances'. The existence of these quantum states has dominated high energy physics ever since and their systematic study has started a new discipline — the spectroscopy of elementary particles. We are by now aware of some underlying mechanism of which the detailed structure remains to be discovered and explored.

In addition to the field of 'strong interactions', which was opened up by the new spectroscopy, there are the 'weak interactions' and the 'electromagnetic interactions'. In 1960, the field of weak interactions was still absorbing the discovery of the violation of parity in 1957. This discovery has enabled the mechanism of the interaction to be formulated in a more systematic way and yielded relevant questions which may clarify the basis of these mysterious interactions. At the same time, the field of electrodynamics had an excellent theory of the interaction of charged particles with the radiation field. But the theory still faced fundamental problems such as the existence of two types of electron (the light and the heavy electron or muon), and the electromagnetic properties of the strongly interacting particles.

CERN contribution

I would like to present to you the contribution of CERN to the attack on these problems. The tables include some of the important research results from CERN or its European collaborators in the period from 1960-65. The results underlined were either obtained for the first time in Europe or more thoroughly investigated here than elsewhere.

1. 'New particles'

a) Baryons

Antistates:

$\bar{\Xi}, \bar{N}^*, \bar{Y}^*$

Excited states:

$\underline{Y^*(1,5/2)} \quad \underline{Y^*(0,5/2)}$

$\underline{\Xi^*(1/2,?)}$ $\underline{\Xi^*(?,?)}$

b) Mesons

$f(0,2), \underline{K^*(1/2,2)}$

$\underline{E(0,?)}, \underline{D(0,1)}$

$\underline{A_1(1,1)}, \underline{A_2(1,2)}$

$\underline{C(??)}, \underline{(K^+K^+)(?,?)}$

properties of mesons

The experiments were of varied character, results coming largely from bubble chamber research but with important contributions from counter and spark chamber experiments. The importance of Europe's contribution to the discovery and classification of baryon and meson states can be roughly gauged from the number of papers published on the subject (although this says nothing about the quality of the papers). From 1960 to 1965 about 30 % were written by European groups even though CERN has really only been fully operative for the last two or three years.

In the last few years the study of the new spectroscopy of particles has led to some conclusions about certain symmetries (SU_3 , SU_6 or U_{12}) to which the unknown underlying structure is subjected. The Theoretical Studies Division at CERN, which is in some ways the European nerve centre of theoretical studies in elementary particle physics, has participated actively in the classification of ideas regarding these new symmetries.

2. Strong interactions

a) Theory

Regge poles

Diffraction scattering

Pomeranchuk theorem

Peripheral model

(meson exchange)

General field theory

b) Experiment

Shrinking of diffraction

peak

Quasi-elastic scattering

Total cross-sections

Peripheral processes

Charge exchange collisions

All the collision processes which lead to the production of the excited quantum states are strong interaction processes. It was always the tendency among the physicists connected with CERN, to study these processes and their mechanism and not only the products.

Much pioneering work in this direction was done at CERN and in Europe.

3. Weak interactions

a) Theory	b) Experiment
<u>Cabibbo angle</u>	Neutrino $\nu_e \mp \nu_\mu$ <u>lepton conservation</u> <u>$M_W > 2 \text{ GeV}$</u> <u>form factors</u>
Symmetries	
CP violation	
<u>(5th force)</u>	
	Σ decay <u>$(\Sigma - \Lambda)$ parity</u> <u>e/μ ratio</u> $\Delta S / \Delta Q = 1$
	K^0 decay $\Delta S / \Delta I = 1$
	Λ decay C_V / C_A
	Ξ decay $(\Delta I = 1/2)$
	π^+ decay <u>$(\pi^+ \rightarrow \pi^0)$</u>
	K_S^0 decay <u>(energy dependence)</u>
	μ capture in H
	μ decay (electron polarization)
	Precise measurement of universal weak charge.

The weak interactions have always been in the centre of interest at CERN. One of the first decisive experiments on the 600 MeV synchro-cyclotron in 1957 established the decay of the pion into electrons. The neutrino experiments have been very fruitful and currently, after the discovery of CP violation at Brookhaven, intensive research is underway on this problem.

4. Electromagnetic interactions

a) Pure interactions	b) Electric hadron properties
<u>(g-2) experiment</u>	Λ magnetic moment
(muon magnetic moment)	<u>π^0 lifetime</u>
γ -ray absorption	$\pi^0 \rightarrow 3\gamma$
e^+ annihilation	<u>Time-like form factor of</u>
μ -e scattering	<u>proton</u>
Theoretical calculations	

CERN is pioneering and is ahead of other Laboratories in the investigation of the riddle of the heavy and light electrons. We have also recently made an important contribution to knowledge of the electromagnetic structure of protons and mesons. The 'electric heart-beat', as it were, of the particle was measured and surprisingly proved a thousand times weaker than expected.

5. Nuclear structure

Double hypernuclei
Muonic X-rays (quadrupole moments)
He₄ excited states
 Pion double-charge exchange
 Muon capture rates
 Theoretical studies

This research started late but is now in full swing, mainly on the synchro-cyclotron. Europe was always advanced in this field, both in theory and experiment, and at CERN we have a unique opportunity to apply high energy beams to these questions.

Four reasons

This review shows that CERN and the other European Laboratories are today in the forefront of nuclear and

elementary particle physics. The results could have been more impressive; some of the recent sensational discoveries were made elsewhere. Nevertheless the work done in Europe is now on a level with that at other similar research centres.

There are, in my view, four reasons for this satisfactory state of affairs. The first is the quality of the people working at CERN. We have a devoted and enthusiastic group of collaborators, who cover a wide spectrum of abilities.

The second reason is the quality of our equipment and research facilities. The two accelerators are in excellent condition with an unusually high reliability of performance. Many new facilities have been brought into use as a result of a long-range development programme. Today we have well-functioning systems for fast and slow ejection allowing a much better exploitation of the beam. We have developed a very reliable set of electrostatic separators and recently put into use a radio-frequency separator, which was the first in the world to be exploited for experiments. CERN has constructed a heavy liquid bubble chamber which is at present the largest in the world, and a 2 m hydrogen chamber which was put into use a year ago and has worked faultlessly. For our data handling facilities, we acquired last year a new computer — the CDC 6600 — which should provide us with the most advanced computing devices for all our needs. Automatic scanning machines for track chamber pictures, the Hough-Powell Device and the Luciole Device, were conceived and developed at CERN. The HPD is now in use all over the world.

The third contributing factor to our work is the excellent support which we have received from the Member States: from the scientific community and from the governments, via the Council. The governments have looked at CERN as a centre of fundamental science in Europe, which must be kept going and blossoming, because Europe was the cradle of modern science and should remain in the forefront of it. We feel that CERN had always been a pet child of the governments; I am sure the reason for this sympathy and support is the fact that CERN is a symbol of European unity, and of successful international collaboration.

The fourth reason is perhaps the most important one: we were able here at CERN to develop an atmosphere favourable for research, a spirit of openness, of discussion between groups, a spirit which appreciated good ideas, a good experiment, a good result.

Because of these four reasons, CERN will go on producing excellent results. In fact, I am convinced that the real golden age of CERN lies ahead. CERN is now a mature institution; we have much more experience in doing things, in thinking about things, in acting together. Five years is a short time in the life of an institution and this development is bound to go on. I am convinced, therefore, that the scientific achievements of CERN and Europe will be more impressive in the future. This is why I am looking forward to Professor Gregory's report in 1970, and to the corresponding report of the Director General in 1975, when the storage rings and the new improvement programme will have been put into use. I am sure that they will be far more impressive than what I could tell you today."

Basic Programme

Council approved a budget of 149.67 million Swiss francs for the basic programme of CERN in the year 1966. The basic programme concerns the exploitation and development of the existing CERN installations. The considerable increase in the budget over that of 1965 marks the approval of the Council for the start of an improvement programme on the 28 GeV proton synchrotron. 6 million Swiss francs are allocated to this work in 1966.

The first stage of the PS improvement programme will run up to the end of 1968 and will include an increase in the repetition rate by a factor of 2 or 3 (involving a new magnet power supply); improved experimental facilities (such as a more intense neutrino beam, an on-line data handling installation, a large spark chamber, a long pulse r.f. separator); the heavy liquid bubble chamber 'Gargamelle', which will be constructed by France; and an extension of the experimental areas. The improvements will enable more complex experiments to be done and, in particular, using Gargamelle and the more intense beam of neutrinos, neutrino physics will be on a quantitative basis for the first time.

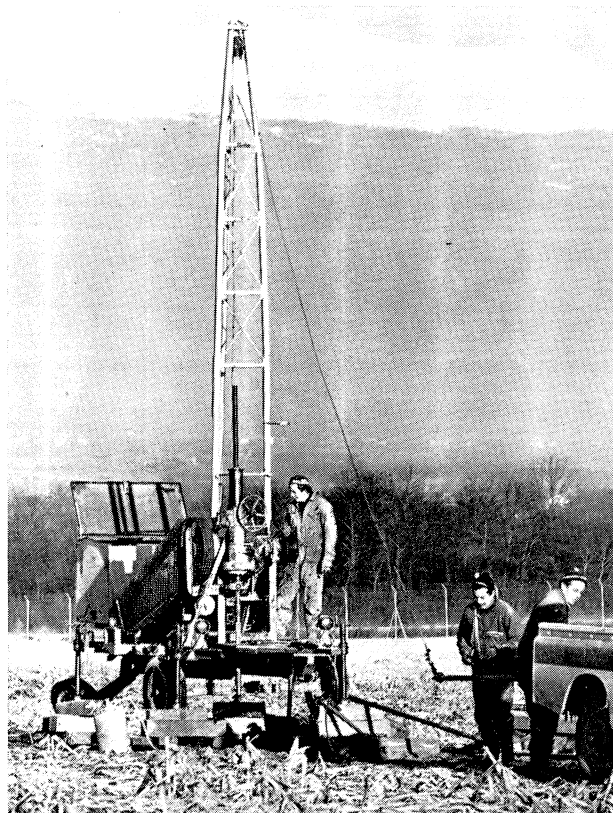
The second stage of the programme, planned for completion in 1970 and 1971, includes a very large hydrogen bubble chamber (volume of 25 m³); a new 200 MeV injector (giving a 4 or 5 fold increase in intensity per pulse); and more advanced experimental facilities. This stage represents a further increase in quantity and quality for the PS and its surrounding facilities.

ISR Project

In addition to the basic programme, which comes under the terms of the original CERN Convention, there are two supplementary programmes. The first of these is the intersecting storage ring project. At the Council Session in June 1965 the project was approved in principle and in December all the Member States with the exception of Greece were able to announce that they were willing to participate. A budget of 21.7 million Swiss francs was voted for 1966.

The estimated cost for the full project, over the six years 1966-71, is 332 million Swiss francs. It covers the building of two intersecting storage rings which will be supplied with protons from the 28 GeV PS; two colliding beam halls; one 25 GeV experimental hall and all the necessary buildings, laboratories, workshops and other services (power and water supplies, cooling and control equipment, roads, etc.).

Professor Leprince-Ringuet spoke as Chairman of the Scientific Policy Committee urging the ISR project as 'sound and highly recommendable', providing the greatest degree of flexibility which it can be hoped to obtain with this kind of machine. The SPC advised that during the first months of the project, before large sums of money were committed, any possibility of improving the collision structures be pursued, so as to make the final version of the ISR the best conceivable within the limits of the site and the financial provisions.



A fourth boring being taken at the beginning of January' on the French half of the CERN site, as part of the geological survey for the ISR project.

At present, preliminary work is underway on the newly acquired French site. The area has been fenced off. Drainage works between the PS South Hall and the centre of the ISR, and the first section of the service tunnel on the French site, connecting the main sub-station with the ISR, are under construction. Early in the summer of this year the major construction work will begin.

The intersecting storage rings will be a unique facility. It is the only project of its type, producing head-on collisions in two high energy proton beams, which is going ahead anywhere in the world. Its uniqueness leads to new and challenging technical problems (beam stacking in the ISR, very stringent vacuum conditions, improved detection methods) and will eventually allow the investigation of extremely high energy proton interactions which could reveal a new range of phenomena. Authorization for this new development at the CERN site contributes considerably towards ensuring the vitality of CERN in the coming years.

300 GeV accelerator

The second supplementary programme concerns the preparatory studies for a future very large accelerator which would be built elsewhere in Europe. A budget of 5.2 million Swiss francs was requested to enable this work to continue. Some Member States however considered that this figure was too high and that the proposed build up during 1966 implied a too early freezing of the design and too large commitments for 1967.

Professor Leprince-Ringuet said that the Scientific Policy Committee considered that it would be catastrophic for the future of CERN if the preparatory studies for the 300 GeV project were stopped. The working group would be broken up; it would be difficult to set up again and the breaking up would give the impression that the project was being abandoned for a fairly long time. This would have irreversible effects in many countries, which would revise the balance between national and international expenditure. The SPC was firmly of the opinion that the preparatory studies should continue.

It was agreed to continue the work for three months on the basis of a budget for 1966 of 4 million Swiss francs while the problem is being reconsidered by the Finance Committee.

Nine Member States offered a total of twenty-two sites for consideration as the location of the 300 GeV project. This has now been reduced to thirteen; Germany and Italy are putting forward more than one site and discussions will be started shortly with the authorities concerned to determine the order of preference. Site studies are now in progress. They include investigation of the site itself — geological, geotechnical and hydrogeological — and also investigation of local industrial potential, manpower availability, housing, etc. Council has requested an interim report on the site proposals at the June 1966 meeting and complete dossiers on the 8 or 10 remaining sites by June 1967. The President reminded the Delegates that a method for selecting the site remains to be established.

In addition to the site studies, preparatory work concerning the machine itself is underway on a small scale. It includes basic design studies for the accelerator. The European Committee on Future Accelerators, which under the Chairmanship of Professor Amaldi recommended the 300 GeV machine in its report of 1963, has been reconvened to discuss the technical and scientific problems connected with the project and to give guidance on the work to be done during preparatory studies.

And then there were thirteen —

The sites remaining under active consideration for the proposed 300 GeV machine are as follows:

Austria	Göpfritz
Belgium	Focant
Federal Republic of Germany	Drensteinfurt
	Ebersberg
	Reimsbach
	Sarrlouis
France	Le Luc
Italy	Doberdo
	Nardo
Norway	Kongsvinger
Spain	El Escorial
Sweden	Uppsala
United Kingdom	Mundford

There are also general layout studies and feasibility studies for accelerator components — linear accelerator improvements, magnet construction problems (experience is being gained from the models for the ISR), r.f. accelerating systems, induced activity and shielding problems, new control methods and survey techniques.

Serpukhov collaboration

Professor Weisskopf reminded the Council that the USSR would soon be completing their 70 GeV accelerator at Serpukhov, which would be for several years the highest energy accelerator in the world. The possibility of CERN collaboration at this research centre was being discussed and proposals as to the way in which co-operation could be achieved have been put forward to the USSR. The Council supported Professor Weisskopf's initiative.

The Session closed, as reported in the January issue of the COURIER (p. 3), with a farewell speech by the President to Professor Weisskopf after five years in office as Director General, and a welcome and an assurance of continued support for Professor Gregory, the new Director General.

CERN News

PS Breakdown

On the night of 8 February, a mechanical accident occurred on the main magnet power supply of the proton-synchrotron. The PS is shut down and the Experimental Planning Group is working out proposals for a new programme to compensate as far as possible for the loss of the experimental time which had been scheduled up to Easter.

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As the protons are accelerated in the synchrotron, they are held in their orbits of constant radius by a rising

magnetic field in the hundred magnets of the synchrotron ring. This rising field is achieved by providing a pulse of power (which can be as high as 34 560 kW) to the magnets. To take such large surges of power direct from the Geneva electricity grid would produce fluctuations in the grid voltage at the repetition frequency of the machine and affect other users on the grid.

A power supply is therefore introduced between the grid and the magnets to smooth out the effect of the machine pulses. It does this by storing mechanical energy, in its rotating components, some of which is converted into electrical energy once every few seconds to pulse the magnets and the loss in energy is made up more gradually from the grid. The

rotor of the power supply motor in fact weighs 5180 kg and revolves at about 3000 rev/min.

The accident occurred when a clamping band, which holds the rotor coils in position, fractured, possibly because of direct mechanical failure or because of a short circuit which caused sufficient local heating to melt the band. Due to the centrifugal force, the ends of the windings splayed out and hit the stator windings. Both sets of windings suffered extensive damage but no harm appears to have been caused to either the rotor or the stator laminations. Complete spare sets of the windings exist and the motor was immediately taken to the manufacturers to be rewound. It is estimated that the repairs will take three months and will cost about 90 000 Swiss francs.