

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

The experimental programme is based on the use of two proton accelerators—a 600 MeV synchro-cyclotron (SC) and a 26 GeV synchrotron (PS). At the latter machine large intersecting storage rings (ISR), for experiments with colliding proton beams, are under construction. Scientists from many European Universities, as well as from CERN itself, take part in the experiments and it is estimated that some 1200 physicists draw their research material from CERN.

The Laboratory is situated at Meyrin near Geneva in Switzerland. The site covers approximately 30 hectares, equally divided on either side of the frontier between France and Switzerland. The staff totals about 2600 people and, in addition, there are over 400 Fellows and Visiting Scientists.

Thirteen European countries participate in the work of CERN, contributing to the cost of the basic programme, 235.2 million Swiss francs in 1969, in proportion to their net national income. Supplementary programmes cover the construction of the ISR and studies for a proposed 300 GeV proton synchrotron.

CERN COURIER is published monthly in English and French editions. It is distributed free to CERN employees and others interested in sub-nuclear physics.

The text of any article may be reprinted if credit is given to CERN COURIER. Copies of most illustrations are available to editors without charge.

Advertisements are published on the sole responsibility of the advertisers.

Editor: Brian Southworth
Assistant Editor: Philippe d'Agraves
Advertisements: Micheline Faluola
Photographs: Gérard Berlin

Public Information Office
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 41 96 11 Telex 2 36 98

Printed by: Ed. Chertel et Filippa S.A.
1290 Nyon, Switzerland

41st Session of CERN Council

The Council met on 19-20 June under the Chairmanship of Dr. G.W. Funke.

Progress Report

The Director-General, Professor B. Gregory, selected a few topics from the activities at CERN over the past six months.

The performance of the accelerators has been very reliable and some major improvements have been made to the basic operation of both machines.

At the 600 MeV synchro-cyclotron, breakdowns have absorbed less than 3% of the available operating time. Further developments in beam sharing techniques (new ability to run both the extracted proton beam and an internal target simultaneously) have almost doubled the effective beam time available for physics. The extracted beam has reached a record intensity of 5.6×10^{11} protons per second. At the 28 GeV proton synchrotron, reliability has been improved to reduce breakdown time to about 5% and here also record intensities have been achieved with weeks of operation at an average intensity of 1.7×10^{12} protons per pulse. A new method of taking the beam through 'transition energy' (the energy at which the beam behaviour in the machine changes) has been successfully tested. This is an important development in view of the

much higher intensities where high particle loss could have occurred at the transition energy. Physics results from both machines are to be reported at the Lund Conference (25 June - 1 July).

Collaboration with Soviet scientists on the 76 GeV machine at Serpukhov has yielded its first published results (see CERN COURIER vol. 9, page 99). These were on negative particle production at high energies and the first stage of total cross-section measurements has recently been completed. A search for high mass (4 to 8 GeV) negative bosons using the missing mass technique has been accepted for the coming experimental programme at Serpukhov, and members of the team who have carried out the very successful experiments at CERN using this technique will be participating.

Construction of the ISR is continuing well to schedule. Practically all components are now on order. About half the magnet cores and coils are now at CERN and many are installed. All major components of the r.f. system have also arrived. In preparation for the experimental programme, the general purpose magnet system for one of the interaction regions has been selected and detailed design work has started. An Intersecting

Contents

41st Session of the CERN Council	162
A report of the June Council session where further steps towards the 300 GeV Laboratory were taken, and where the future of CERN Meyrin during the construction period of the new Laboratory was discussed	
Computers in control	166
A review of the growing number of uses of computers in the control of particle accelerators throughout the world	
Around the Laboratories	171
FRASCATI : Colliding beam operation of ADONE ; TRIUMF : Annual meeting ; RUTHERFORD : Development of a new method of magnet construction ; BATAVIA : Preparation for the experimental programme	
Development of Multiwire Proportional Chambers	174
An article by G. Charpak describing this new type of particle detector and its distinctive properties	
CERN News	177
Visit of astronaut R.L. Schweickart ; Discussion on international education ; New neutrino shielding ; Development of radiation resistant materials for accelerator magnet construction.	

Cover photograph : Russell Schweickart, astronaut of Apollo 9, splashed down at CERN on 4 June. Story page 167.
(CERN/PI 125.6.69)

Storage Rings Committee has been set up under the Chairmanship of Professor W. Jentschke and is tackling the difficult job of selecting from the flood of requests to do colliding-beam experiments to fix the initial experimental programme.

300 GeV

The main topics of the Council session concerned the final preparatory steps for the decisions on the 300 GeV accelerator to be taken in October. J.B. Adams, Director of the 300 GeV programme, presented a paper which summarized much of the wealth of information concerning the project which has been produced since 1963.

In particular he confronted questions centring on whether the design is making full use of developments in accelerator technology and whether it might not even be better to wait a few years to see whether recent ideas result in a cheaper machine.

The design prepared in 1964 absorbed many of the technological advances which had emerged up to that time — such things as a new method of r.f. acceleration in the main ring, and the use of a vacuum vessel fitting snugly round the beam requiring highly refined beam control. Later developments do not indicate that the design has erred on the side of conservatism. However, many of the assumptions may well be challenged in order to achieve economies in the final design.

The 1968 design of the 200-400 GeV accelerator, now under construction at the National Accelerator Laboratory at Batavia, USA, has received a lot of attention. The NAL magnet lattice makes later extension to higher energy easier but involves a problem of selecting the best energy at which to optimize costs (where 'optimize' means taking into consideration construction costs and subsequent operating costs). The very compact magnet design at NAL has coils installed on the medium plane which has an element of risk due to the radiation flux in this plane. The smaller circumference at NAL is achieved at the sacrifice of 'free' space between magnet sections. The CERN design may prove too generous in this respect but with existing accelerators 'free' space has always become usefully occupied. All these points will be examined again and the final design of the 300 GeV machine and Laboratory will take into account the cost saving ideas of NAL.

The costs of the two accelerators are virtually the same but the construction time-scale is very much faster in the USA — 5 years compared with a scheduled 8 years in Europe. It involves an annual rate of spend during the peak construction years about twice as high as

in Europe, a fact which is unlikely to commend itself to European Finance Ministers.

Radically new principles or new technologies for particle acceleration such as the collective ion method (Electron Ring Accelerators, see CERN COURIER vol. 8, page 28) or the use of high field superconducting magnets (see CERN COURIER vol. 8, page 186) may hold out, in the long term, the possibility of very high energy accelerators at comparatively low cost. However, it will take many years before questions as to feasibility, let alone cost, can be answered. Europe, which is now several years behind the USA and the USSR, would be unwise to wait when the hopes held out by the new ideas may not be realized and may, in any case, prove just as expensive to implement.

The possibility of European groups working at the USA 200 GeV accelerator, perhaps in an exchange arrangement for access of USA groups to the CERN ISR, could only go a very small way towards meeting Europe's needs. The demand for machine time at Batavia from American groups is likely to be overwhelming, and though NAL would probably go out of their way to help European participation, the available machine time would almost certainly be very small. Operating with groups across the Atlantic would be more expensive per unit of achievement than building a new European Laboratory. There is also the fear that CERN would thus be organizing emigration to the USA, which is contrary to one of the reasons for which CERN came into being.

If the decision to go ahead is taken in October with, initially, a limited number of participating countries, the new Laboratory will begin to implement a 'Stage 1' programme based on a 200 GeV accelerator which, with simple additions, will become the full 300 GeV programme when more countries are able to join. Even if no further resources become available, the Stage 1 programme will provide powerful facilities in Europe for particle physics research into the 1980s.

Programme Definition

The Council accepted the text of The Programme for Construction and Bringing into Operation of the CERN 300 GeV Laboratory'. This is the document which defines the scope of the Laboratory and the commitments of Member States who join it. Since it is the crucial document within the terms of which the Laboratory must operate and which lays down what governments are signing their name to in joining the project, we reproduce it here in full :
I. Preamble

1. Article II, 3 (c) of the Convention provides for the construction and operation of a Laboratory to include a proton

accelerator for energies of about 300 gigaelectronvolts (3×10^{11} eV). A study for such a Laboratory and its facilities was reported in documents CERN/563, CERN/700 and CERN/702, which together have formed the background to the present decision of Council. The cost of the Programme described in these documents was estimated to be 1776 million Swiss francs at 1967 costs and constant prices.

II. Approval of the Programme

In accordance with Article II, 4 of the Convention, the Council hereby approves the Programme defined in this document for the construction and bringing into operation of the new Laboratory and its facilities. The Programme can at any time be amended in accordance with the provisions of the Convention.

III. Description of the Programme

1. The aim of the Programme is to provide in Europe a Laboratory and facilities which will enable nuclear particle physics research to be carried out at incident proton energies of about 300 GeV. The principal facility of the Laboratory will be a 300 GeV high-intensity, high-utilization proton accelerator. The cost of this Programme, estimated to be 1776 million Swiss francs at 1967 costs and constant prices, would be 1902 million Swiss francs at 1969 costs and constant prices.

2. The Programme shall be executed in consecutive stages according to the financial provisions made available by the Member States participating in the Programme.

3. The first stage of the Programme shall comprise a Laboratory containing a machine capable of accelerating an intense beam of protons up to an energy of at least 200 GeV, together with all necessary buildings, supplies and experimental equipment sufficient to enable nuclear particle physics research to be carried out up to that energy level.

4. The design of the Laboratory and the accelerator shall be so arranged that, by economical extensions to the first stage of the Programme, a proton energy of about 300 GeV and an internal beam intensity of at least 10^{12} protons/second can be reached.

5. A Laboratory which would meet the requirements of paragraphs 1, 3 and 4 of this Section is described in document CERN/869.

6. The site of the Laboratory shall be at...

IV. Financial Provisions for the Programme

1. In accordance with Article III, 4 of the Convention, the Council determines that there shall be for the Programme a minimum initial period of participation which shall end on the date of the bringing into operation of the Laboratory referred to in paragraph 3 of Section III, or eight years after the commencement of the

execution of the Programme defined in paragraph 1 of Section V, whichever is the sooner. During this period, expenditure shall not exceed 1431 million Swiss francs at 1969 costs and constant prices.

2. The estimated annual costs of the Programme, within the financial ceiling of 1431 million Swiss francs at 1969 costs and constant prices mentioned in paragraph 1 of this Section, are as follows :

Financial year after the date of commencement of the execution of the Programme

(million Swiss francs at 1969 costs and constant prices)

1	2	3	4	5	6	7	8	Total
16	50	140	220	235	250	260	260	1431

3. The annual budgets for the Programme shall not exceed by more than 15% the estimated annual costs set out in paragraph 2 of this Section adjusted for any cost variation which may be determined by the Council.

4. The Council shall determine in accordance with the Financial Rules and the Internal Financial Regulations of the Organization the circumstances in which money uncommitted in any one year may be carried over into the following year. Any such money shall not be taken into account in applying the terms of paragraph 3 of this Section.

5. The scale of contributions of the Member States participating in the Programme, calculated in accordance with Article VII, 1 (b) of the Convention and taking into account paragraph 6 of this Section, shall be decided by the Council for the period up to 31 December 1971 and for subsequent periods of three years.

6. In accordance with Article VII, 1 (b) (i) of the Convention, the Council determines that, as long as the Member States participating in the Programme are confined to those listed in the table of contributions first decided under the terms of paragraph 5 of this Section, no Member State shall be called upon to contribute a percentage of the annual costs of the Programme greater than 38.5%. If additional Member States join the Programme, the maximum annual percentage contribution shall be 38.5% multiplied by the ratio of the sum of the average net national incomes at factor cost used in calculating the scale of contributions then current to that to be used in calculating the scale of contributions after adherence of the Member States concerned, or 25 %, whichever is the greater.

7. For the purpose of Article VII, 4 of the Convention, all expenditure incurred in respect of the Programme during the minimum initial period of participation as defined in paragraph 1 of this Section shall be deemed to be capital expenditure.

V. Execution of the Programme

1. The execution of the Programme shall commence on the date when the Council

has appointed a Director-General for the new Laboratory or a person to act in his stead and voted a budget for the Programme.

2. Within one year from the commencement of the execution of the Programme, the Director-General shall present to the Council for approval :

- a master plan showing the proposed layout of the Laboratory and its equipment on the site ;
- detailed specifications and estimated costs of the proton accelerator, its buildings and supplies ;
- approximate specifications of the experimental equipment, its buildings and supplies which will initially be constructed at the Laboratory, together with the financial provisions to be allocated for these facilities ;
- an estimate of the running costs of the Laboratory which will enable research to be carried out with the facilities provided by the first stage of the programme.

3. The specifications for the first stage of the Programme as required by paragraph 2 of this Section shall be consistent with the aim of the Programme as described in Section III, and the cost estimates and financial provisions referred to in sub-paragraphs (b) and (c) of paragraph 2 of this Section shall enable the first stage of the Programme to be carried out within the duration and financial ceiling as set out in paragraph 1 of Section IV. The cost of the research phase mentioned in sub-paragraph (d) of paragraph 2 of this Section is not included in the financial ceiling set out in paragraph 1 of Section IV.

4. The Director-General shall, together with the Director-General of the CERN-Meyrin Laboratory, ensure close collaboration between the two Laboratories in the implementation of their respective programmes of activities.

5. The Director-General of the new Laboratory and the Director-General of the CERN-Meyrin Laboratory shall jointly present as soon as possible to the Council for approval co-ordinated Financial, Staff and other Rules and Regulations for the two Laboratories, including social security arrangements for the staff. Meanwhile, those in force at the CERN-Meyrin Laboratory shall apply also to the new Laboratory.

6. The Director-General of the new Laboratory, in consultation with the Director-General of the CERN-Meyrin Laboratory and with the Scientific Policy Committee, shall propose to the Council in due course the establishment of consultative machinery to ensure that scientists in the participating Member States take part in the planning of the Programme, including bringing the new Laboratory into operation.

7. The Director-General of the new Laboratory shall report periodically to the Council the value and distribution of the contracts arising from the Programme. In view of the fact that those contracts concerning advanced technological goods and services have an important effect on the industries of the Member States, such contracts shall be awarded in conformity with the Financial Rules of the Organization in force at the time whilst being reasonably well distributed amongst the Member States participating in the Programme.

Staffing and Tendering Policy

Section V5 of the Programme Definition requires the Directors General of the two Laboratories to present co-ordinated staff rules and regulations to Council. In the meantime, the present arrangements in force at CERN-Meyrin will apply to both Laboratories. The appointment policy that is currently applied at CERN-Meyrin is to be adopted throughout the construction period of the 300 GeV.

The policy for the placing of tenders is referred to in V7 of the Programme Definition. This clause gave rise to serious misgivings on the part of several Member States. It implies that tenders for the purchase of plant, equipment, supplies and services for the 300 GeV will normally be limited to manufacturers and contractors located in participating Member States, unless it is not reasonable technically and, or economically to do so. This ensures that the countries financing the new Laboratory gain from the advanced technologies which will be required.

Several delegations pointed out that this clause abandoned the 'free-tendering' principle which had been of great benefit to CERN in the past. They felt that, long-term, this could lead to the difficulties which have beset other European organizations where contracts have to be distributed in approximate proportion to contributions, and could be a hindrance to other States joining the project at a later stage. This last point was, however, contested by other States who have declared their intention to participate.

Procedures for the final decisions

It is hoped that at the October Council session the final decisions on the 300 GeV project can be taken and the procedures for these decisions were agreed as follows :

- 1) States affirm their intent to participate.
- 2) The short list of sites for the Laboratory is established. (Since the host country must participate in the project, the short list at present stands at Doberdo (Italy), Drensteinfurt (Federal Republic of Germany), Focant



(Belgium), Göpfritz (Austria), Le Luc (France).

- 3) The site is selected. (Each Member State will name one site and a double two-thirds majority is needed — two-thirds of all Member States and two-thirds of participating States.)
- 4) The selected site is inserted in 1116 of the Programme Definition.
- 5) The Definition is then approved.
- 6) Formal letters of participation are presented.
- 7) The scale of contributions is established.
- 8) A Director-General is appointed.
- 9) A budget is voted.

Another requirement in order that the 300 GeV may go ahead is that the amendments to the CERN Convention (see CERN COURIER vol. 8, page 56) are approved by all Member States. Delegates were able to announce that the administrative measures to bring this about are under way or complete in all Member States. If all ratifications are not through in time, an interim arrangement bridging several months may be necessary.

Future of CERN Meyrin

CERN was asked to make forecasts on the development of the existing Laboratory so that Member States will have a clear idea of budgets during the construction period of the 300 GeV. Dr. M.G.N. Hine led a detailed analysis of the future through to 1975, taking into account the available facilities and choosing levels of exploitation to define a 'nominal' programme from which to estimate costs. The programme

recognizes that sacrifices will be necessary and that all that would be ideal cannot be realized. The analysis also took into account the role of CERN Meyrin in the overall context of European resources in coming years.

The nominal programme leads to a budget in the region of 350 million Swiss francs (at 1969 prices) for the year 1975. After that date; there could be some gradual reduction but it is considered too soon to attempt to predict for the years beyond 1975 since many important factors (such as the degree of success of the ISR project, the financial development «n Europe, etc..») are not known.

The Council praised the analysis, accepted the lines of development used in drawing up the nominal programme, and considered that budgets for 1975 in the range 330 to 350 million Swiss francs will be acceptable. The precise annual budgets will be worked out as usual following the Bannier procedure.

Withdrawal of Spain

The Council received with great regret the confirmation of the decision of Spain to withdraw from CERN with effect from 31 December 1968. Spain first announced in August of last year that it was considering withdrawing, but great efforts have been made, right through to the beginning of June this year, on both sides, to explore all the possibilities which might allow Spain to remain a Member State. No solution could however be found.

Spain's withdrawal is due solely to economic and financial reasons. Despite the decision of the Council to reduce the contribution of Spain by 50% for the

years 1969-71, the Spanish government felt unable to meet its contributions for the coming years. The government stated that it views, without the least reserve, the usefulness and efficiency of CERN and is fully convinced that CERN is an organization of the greatest value, to which it wishes every success in the noble task to which it is devoted.

Ambassador E. Pérez-Hernández, Permanent Delegate of Spain in Geneva, in confirming the decision of his government, thanked CERN for the kind consideration Spain has been accorded and conveyed the great appreciation of the scientific community in Spain for all that it has gained by participating in CERN. Ambassador Hernandez concluded with the hope that one day in the future his country will again be able to take part in the work of CERN.

In his reply the Director-General recalled that when Spain joined the Organization in 1961 it was largely an act of faith, for the country had hardly any scientists active in high energy physics. One of CERN's essential tasks is to help university professors and students to develop expertise by providing facilities for first-class research. This task has certainly been fulfilled in the case of Spain where, by now, many excellent groups of experimental and theoretical physicists have come into being. It is because of this excellent potential that CERN has tried in every way to solve the present problems. The Director-General concluded with a particular tribute to Professor J. Otero Navascués without whose drive and enthusiasm all that has been achieved in collaboration with Spain would not have been possible.

Computers in control

A review of some of the tasks assigned to computers in accelerator operation at Laboratories throughout the world. It brings out just how far the use of computers in accelerator control has come in a very few years.

The review does not aim to be complete. In particular, developments covered in recent issues of CERN COURIER will be mentioned rather than repeated.

At the Washington Accelerator Conference in March, M.Q. Barton of Brookhaven presented a paper on 'Computers in accelerator control rooms — a personal appraisal'. The following extracts make an appropriate introduction to this review.

'Some view the computer as something that is to take over complete operation of the machine. We can then discharge all of the operators, etc., except for one person who punches the cards to tell the computer the desired parameters for a given accelerator run. Others view the computer as an intermediary between human operators and the accelerator. Here the computer in no sense controls the accelerator but merely centralizes, miniaturizes, and conveniently formats the instruments and controls for the human operator who still exercises the conventional operator's role. Still others view the computer as a diagnostic tool. Finally, a sizable number of people still view the computer as an infernal nuisance; an infinite sink of money and effort which accomplishes nothing that couldn't be done more economically without using a computer.

About ten years ago it seemed to me that if one knew enough about the accelerator to program such a computer, one would not need the computer. (I still hold this view towards many proposals for computer 'control' of accelerators.) My subsequent experience was in line with a more general trend of events. In the first place, there has been a major revolution in the availability of computer hardware. The modern computer has expanded enormously in size, speed, and capability and the price has been spiralling downward. On the other end of the connection, the accelerator has developed in directions which make the on-line computer more and more attractive. In the Cosmotron, we had one set of pickup electrodes; in the AGS we have 36 sets and it is probably cheaper now to build a system to analyze 36 such devices around a small computer than without the computer, even if one charges the entire cost of the computer to the project. With future machines involving larger numbers of sets, the computer method is the only really reasonable solution.

Similar arguments apply to other para-

meters such as vacuum gauges and controls, correction winding controls, r.f. parameters, etc., which seem to proliferate in ever larger numbers with each generation of accelerators. The large distances over which large accelerators are spread make it attractive to telemeter information in some coded form. The computer is then desirable to unscramble and process the information.

More and more of the usual instrumentation and control functions around future accelerators will be channeled through computers. Most if not all of the meters, indicator lights, etc., will be replaced by messages on computer-controlled display tubes or other computer-controlled audio and visual presentations. The engineer trying to get a job doing instrumentation or control at future accelerator Laboratories will have to demonstrate a proficiency in computer techniques. Certain well-understood control functions will indeed be taken over by the computer. Some of the more complicated control loops such as, for example, closed orbit control may only be possible with computers.

To balance this glowing advertisement of computer power, I should perhaps point out a couple of the pitfalls. One of the first things one notices when trying to use an on-line computer is that the instruments taking the data used by the computer must measure what they are supposed to and nothing else. Computers are very stupid and can usually not discriminate between a valid signal and complete nonsense. More than one person has found that when the instruments were built well enough to connect to the computer, the computer was no longer necessary.

A second major pitfall is programming. It is a sobering experience to add up the costs of hardware, engineering time, technician time, etc. for some project and then to multiply by about 2V2 to include the programming costs. Fortunately, many instrumentation and control problems are most cheaply solved using computers even if these programming costs are included. There is a tendency to alleviate this problem by using a larger computer than really necessary for the job. Now everyone agrees that larger computers are easier to program than small computers. But there

is a computer version of Parkinson's law which states that a problem which requires five hours to program for a small computer and uses one third of its memory can (and will) be replaced by a more sophisticated problem which requires five hours to program for a large computer and will use one third of its memory. Anyone who denies this law is either not very observant or not being candid.

In conclusion, I do not believe it is possible to form an objective evaluation of the usefulness of the on-line computer to the operation of an accelerator. Other practitioners of this black art probably have personal appraisals quite different from this one. But I am sure that each of you who makes a serious effort to solve some accelerator problem using an on-line computer will soon share with me this one simple conclusion: *the computer is here to stay.*

Argonne

Taking the Laboratories in alphabetical order, Argonne, appropriately in this context, comes first. From the early days of the design and of the Zero Gradient Synchrotron (ZGS), they thought about the use of a control computer and established a position of leadership in the use of on-line computers in accelerator operation.

The monitor and control computer system now performs variety of functions. Data on ZGS operation is gathered and analyzed for presentation to the human operator either as graphs on the computer operated oscilloscope or as line-printer outputs. Pertinent data are also transmitted to the ZGS users. The computer has revised instructions in the programmer memory to alter the operation of the accelerator thus providing on-line feedback control.

A special multi-programming executive program has been developed to meet the requirements for real-time control synchronized to the ZGS cycle. This permits nine control programs to operate simultaneously and one non-control program to operate in the unused time. This last feature has proved very valuable making it possible to develop new control programs in the environment in which they will be used. It also permits many other non-control, but nonetheless accelerator-related