

50th Session of CERN Council

The Council met on 20,21 June under the Presidency of Professor W. Gentner

Some physics from the CERN machines

The Director General of CERN Laboratory I, Professor W.K. Jentschke, reported on some of the highlights in the physics programme at the CERN accelerators.

The Intersecting Storage Rings, with the very high energy particle collisions which they make possible, continue to provide completely new, fascinating information on particle behaviour. Results published since the last Council meeting include the measurements on the total cross-section for the proton-proton interaction (see March issue, page 67) which, against general expectation, revealed that the interaction probability at high energies grows with increasing energy. The region of influence of the proton grows as its energy increases and this is a new insight into the nature of the strong force governing the proton behaviour.

A second surprising result, which has been reported to Council before (see January issue, page 3), concerned the number of particles which bounce out at very wide angles from the near head-on collisions in the ISR. About one in a hundred million collisions results in particles emerging with high transverse momentum (over 4 GeV/c). This is about ten thousand times higher than was expected from what had been seen at lower energies. It implies that, whereas a proton colliding with a proton normally results in the two particles brushing through one another with comparatively modest effects, occasionally something hard runs into something hard and particles can then fly off in any direction. Doing the sums reveals that the phenomena observed are probing the structure of the proton at the level of less than 5×10^{-15} cm.

A popular interpretation is that such collisions are occurring between mas-

sive, point-like 'partons' — hypothetical constituents of the proton. If this is so, a high transverse momentum particle emerging on one side of the colliding beams should usually be associated with another jet of particles, further produce of the collision, emerging in the opposite direction. The latest results are qualitatively in agreement with this picture. High transverse momentum particles do have these other particles in association with them. The more massive kaons and nucleons are more common than usual in ratio to pions and both jets are predominantly positive in total charge — these properties are predicted by the parton-parton collision model.

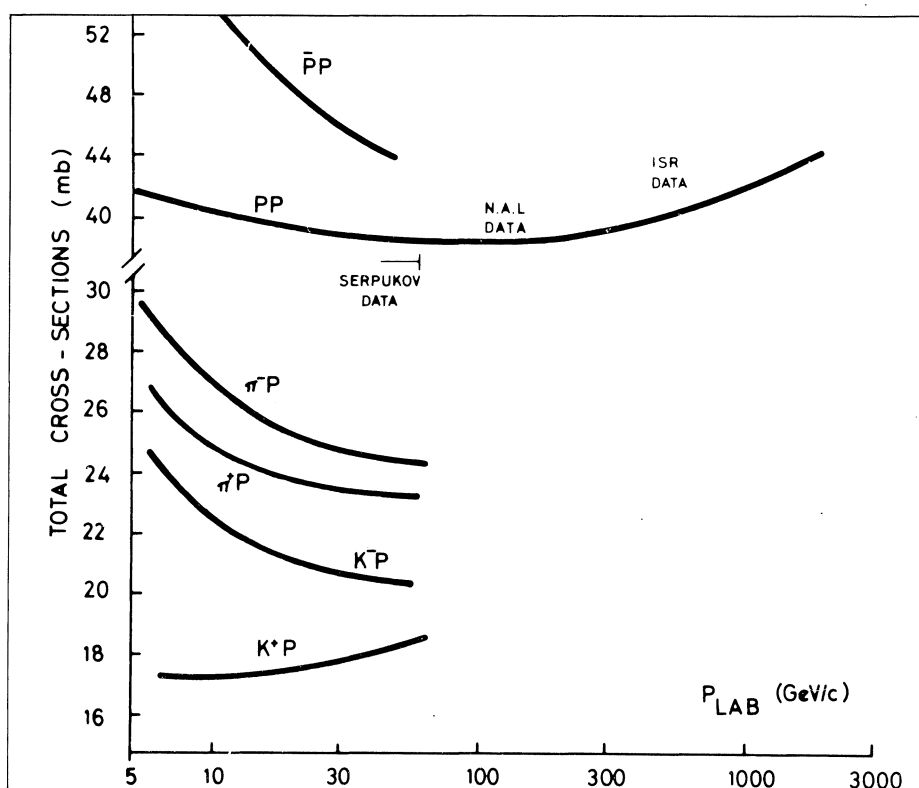
Another recent result is the observation of very massive resonances. At lower energies resonances up to about two proton masses are well known; the resonance subsequently decays into a nucleon and a few pions. It was

expected that similar phenomena would be seen at the ISR but not out to as far as a resonance of twelve proton masses such as has now been seen. The production and decay of this massive particle will obviously be studied further.

At the 28 GeV proton synchrotron the days of the 'exploratory' experiment are largely over and have been succeeded by the days of the 'high statistics' experiment studying already known phenomena in great detail. One such experiment has now assembled a welter of detail on interactions between pions.

The role of the pion is fundamental in strong interactions; it is by the

The general trend of cross-sections for different interactions between particles as the energy increases. The probability of the proton-proton interaction taking place (as studied at the high energies available with the Intersecting Storage Rings) increases as the energy goes higher, contrary to expectation.



The 'candidate' for antineutrino-electron scattering recorded on film from the Gargamelle heavy liquid bubble chamber. An antineutrino entering the chamber from the left scatters an electron producing the track apparently starting by itself and travelling across the photograph.

exchange of pions that the strong force is transmitted from one place to another. But sorting out how pions interact among themselves is a difficult task. With their short lifetime (around 2×10^{-8} s) they cannot readily be isolated and brought into interaction in the clean way of the proton-proton collisions in the ISR. Nevertheless, it is possible to produce a beam of pions from a target hit by high energy protons and these pions can be directed onto another target.

Careful analysis of what happens in this second target can distinguish the effect of the interaction between an incoming pion and a 'virtual' pion associated with a nucleon in the target. For example a negative pion brushing against a proton can be thought of as brushing against a neutron linked with a positive pion. The two pions can emerge together leaving the neutron.

Studying this at the PS has yielded

new information on the pion exchange process and on the pion-pion interaction in the energy range 600 to 1900 MeV. In particular it adds fresh evidence for the existence of the rho prime meson (of mass 1600 MeV) which has already been spotted in a four pion decay mode at electron machines (see March issue page 78).

The hot topic in the PS programme is the search for signs of electron-neutrino scattering in the heavy liquid bubble chamber Gargamelle. Such events are predicted by theories which could unify the interpretation of weak and electromagnetic interactions and thus be of very great importance in bringing together aspects of our understanding of Nature which up to now have been kept in separate compartments.

Since the December Council meeting one candidate for such an event has been picked out from the 800 000 photographs taken last year. The

search is being continued in further experiments with Gargamelle.

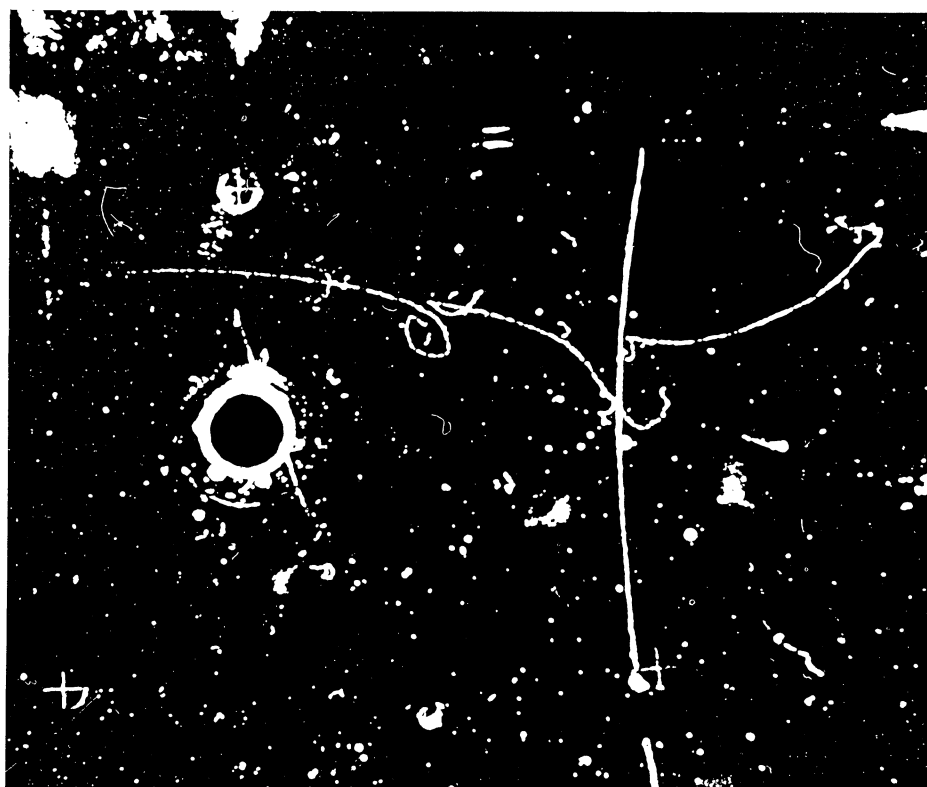
The 600 MeV synchro-cyclotron finished operation on a high note prior to its long shutdown for implementation of the improvement programme. A fiendishly difficult experiment has started to try to measure transitions in a muonic helium atom (where a negative muon has come under the influence of the positive nucleus). Just before the shutdown it looked as if transitions were being seen and that the adventurous experiment would bear fruit after all.

The aim is to carry out yet another very refined test of the laws of quantum electrodynamics which have so far held good over an enormous range of study. They predict very small corrections to the classical Coulomb force. In particular electron-positron pairs appearing and annihilating in the vicinity of a charge causes what is known as 'vacuum polarization' and slightly alters the energy levels in an atom. With a muonic atom the muon lives much closer to the nucleus in a region of more intense electric field and the effect on the energy levels is more pronounced. It looks as if transitions between levels can be measured and QED put under the microscope again.

Budget problems in Laboratory I

In December of last year, the Council voted on budgets for coming years in accordance with what is known as the Bannier procedure. This involved approving the budget for 1973, a firm estimate for 1974 and a provisional determination for 1975. Normally a provisional determination for 1976 would also have been approved but it was postponed until the June 1973 session to give time for a further look at the long term implications of voting the proposed figure.

To understand where difficulties have arisen it is necessary to go back



The mole appears again. The head of the Robbins boring machine, which set off from straight section 1 of the SPS in February, emerged 1.2 km round the ring at the gallery of straight section 2 on 14 June within 3 cm of its scheduled position — to the joy of the machine builders who can now be more confident that they are not building a separated orbit cyclotron.

a few years to the time when the SPS project in Laboratory II was authorized. Laboratory I became part of the package deal in giving the go-ahead to build the new machine alongside the existing Laboratory. The budgets which had been discussed for the years when all the improved facilities would be in action at Laboratory I were cut back to reduce the extra expenditure falling on the Member States with the construction of the SPS.

At the same time there was concern to ensure sufficient exploitation of the improved facilities to justify the considerable investment they had involved. Therefore a series of budget figures for Laboratory I during the construction years of the PS were drawn up and agreed in discussions with the Council (though each annual budget is not definitive until formally voted by the Council the preceding December). This is often referred to as the 'gentlemen's agreement'.

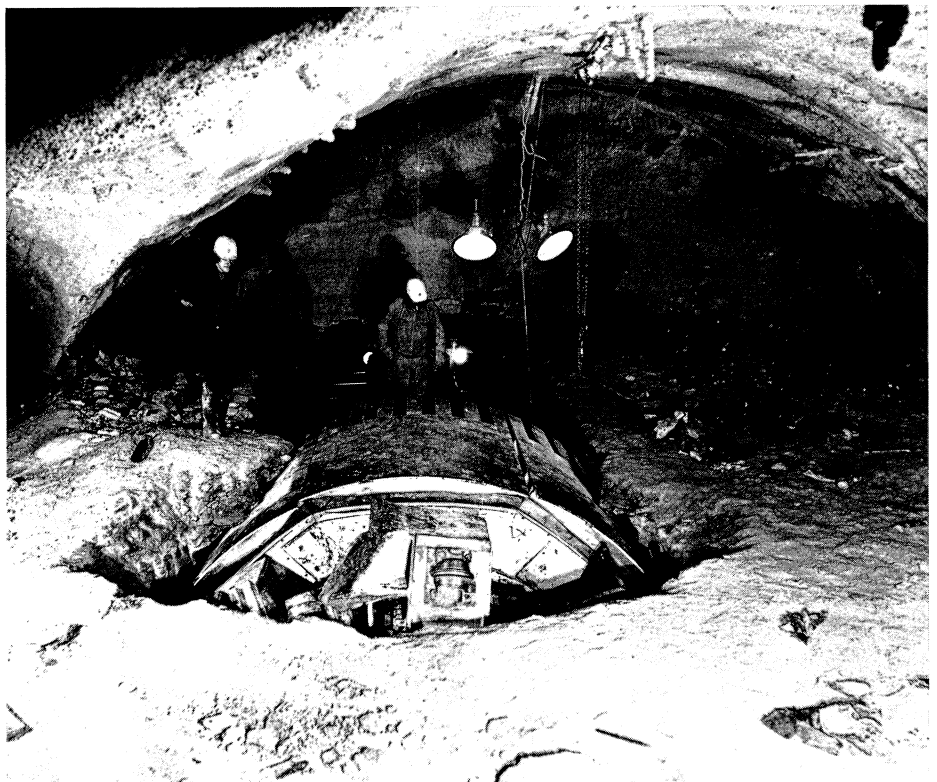
Without losing their claim to be gentlemen, several delegations have had to call for reductions in the anticipated figures. Soaring inflation in Europe has had its inevitable effect on the CERN expenditure (which moves each year with a 'cost variation index') and the figures now look much higher. When national science budgets do not move so fast, the size of the contribution to CERN can have complicated internal repercussions.

CERN has carried out a long and detailed programme and budget review and the latest information on this was presented at the Council meeting. In addition to the cuts mentioned above, Laboratory I has to find a substantial amount of money to prepare for physics at the SPS (the equipping of beam-lines and experimental areas), so much so that a deficit of about 70 million Swiss francs appeared in the sums for the four years 1974 to 1977.

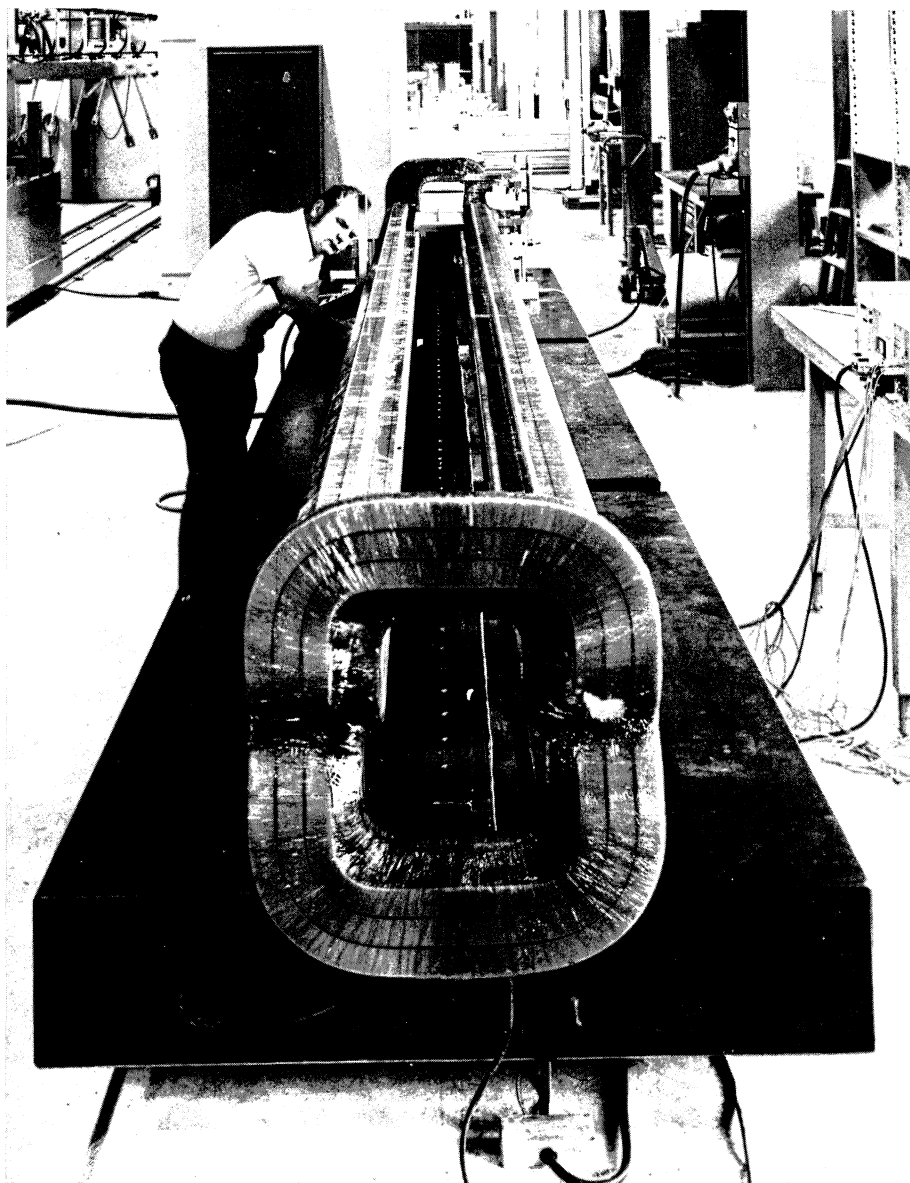
The knife was brought to bear on Laboratory I. Administrative services were reduced severely, staff numbers were held down, technical development (other than in preparation for SPS physics or, to a modest extent, for the ISR) was stopped. The physics programme was cut back by reducing bubble chamber output, running time of the ISR, exploitation of the West experimental area and use of high intensity Booster beams. Doing the sums after these cuts indicates a deficit of 57 MSF over the four years. The financial difficulty is not evenly spread over the years but grows from early years, when effort is mainly on design, towards the end, as the bills for equipment arrive. To avoid a peak appearing in the budgets, money is being set aside in a Special Fund (19 MSF in 1973) to be used for preparations for SPS physics. But there still remains a lot of money to be found.

The programme was then studied again. Several sections were left untouched — preparations for SPS physics (which implies CERN's future research), the ISR physics (which is unique in the world and giving fascinating results) and the synchro-cyclotron (which for comparatively little outlay provides research material for a large number of physicists who, certainly until the start-up of the SIN accelerator at Villigen, have no equivalent machine in Europe).

This leaves the proton synchrotron and the proposed cuts are — to close the North experimental Hall and to close the South Hall, to close down the heavy liquid bubble chamber Gargamelle (though it may have a future at the SPS), to close the South-East Area when the g-2 experiment is complete, to go slower on building up the computer facilities. If this does not prove to be enough, then the SC, ISR and SPS experimental



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Bending magnet coils for the SPS which have arrived at CERN. These first coils are being severely tested before the magnet production and testing chain gets fully underway later this year.

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programmes will have to come under the axe also.

With the realization that the CERN physics programme will inevitably have to be reduced even with the 'gentlemen's agreement' figures, CERN urged the Council to approve the provisional determination for 1976 (379.2 MSF at 1973 prices). However, to allow still more time for discussion the decision was postponed until December.

Progress in the construction of the SPS

The Director General of CERN Laboratory II, Dr. J.B. Adams, reviewed events in the construction of the new accelerator. The most obvious developments are still in the domain of civil engineering but machine components are beginning to arrive on the site and the emphasis will shift in the next few months.

The huge assembly hall has been

made ready to receive components, about half of it being given over to assembly and testing areas for the hundreds of magnets. One of the office and laboratory blocks is fully occupied and a second block is almost ready. (The move of the Laboratory staff to their permanent quarters was completed in July.) A third block, which contains services such as a bank, post-office, etc..., is scheduled for completion later this year.

Meanwhile, deep underground, the mole has been seen again. The large boring machine broke through into the gallery from access shaft 2 on 14 June. The length of tunnel bored out from shaft 1 was 1.2 km and it was very gratifying to see that the survey and alignment techniques were working so well that the mole emerged within 3 cm of its scheduled position.

The boring of the tunnel is behind schedule (though not out of line with the overall machine construction pro-

gramme). Operation of the mole and its tunnel lining and spoil removal train has been re-scheduled and other measures taken for excavating the long straight sections so as to speed the completion of the tunnel. Boring is going faster now and a maximum rate of 30 m a day has been achieved.

Prototype half-cores for the main magnets have arrived from the manufacturers. The first coils for the two types of bending magnet have also been manufactured and are being submitted to rigorous tests involving thousands of thermal cycles and high voltage tests after immersion in water. The first production magnet has been assembled and the measurement routines using computer control have been checked out. The first of the quadrupole magnets will follow soon.

Two cell's worth of the travelling wave structure to be used in the r.f. accelerating cavities have comfortably exceeded their design requirements in the laboratory. Tests are also under way on units for the injection and ejection systems. The ejection systems in particular involve some of the trickiest components of the machine. Development work on electrostatic septum magnets has gone well and construction techniques for producing a long wire septum are now fixed. A full length prototype (3 m long) is being made.

The first three of the 24 computers which will be used in the machine control system have arrived at CERN and are performing well in their first tests. The planning of the experimental areas is well advanced and has of course been greatly influenced by the various discussions involving the high energy physicists who will be using the accelerator.

Decisions affecting the SPS

When the plans to construct the SPS were laid before Council for decision

several years ago, they had several options built into them which could be taken up according to how technical developments and construction progress evolved. In particular there was the possibility of incorporating superconducting magnets in the main ring of the machine. The stage has now been reached where the decisions concerning these options have to be taken.

The first magnet contracts for the SPS were placed for conventional magnets but only half-a-ring's worth were ordered. These would have been distributed around the ring according to the 'missing magnet' scheme (see vol. 10, page 109) and would have held a beam accelerated to 200 GeV. Meanwhile the GESSS collaboration (involving Karlsruhe, Saclay and Rutherford) attacked the problems associated with pulsed superconducting magnets. Had these problems all been resolved, superconducting magnets could have been fed into the empty spaces of the ring to cater for a beam accelerated as high as 500 GeV.

The situation with regard to pulsed superconducting magnets was summarized in the April issue, page 117. Essentially, they have been shown to be technically feasible but there has not yet been time to check how reproducibly magnets can be manufactured and how reliable they are in long-term operation (see later in this issue for news of Brookhaven's work on these problems). Also costs and timescales are tentative because industry has not yet been able to get its teeth into mass producing such magnets. As an example of the cost estimates — a magnet of 8 cm aperture could be about 62 000 Swiss francs per metre (magnet about 48 000, plus refrigerator 14 000). The timescale through to commissioning a superconducting accelerator is estimated as 10 years from now. These figures are clearly outside the limits of the '300 GeV programme' approved by the Council.

Incorporation of superconducting magnets in the missing magnet lattice was also seen as a route to considerably higher energies at a later stage. A subsequent substitution of the half ring's worth of conventional magnets by superconducting magnets would give a machine of 1000 GeV potential. However the GESSS committee also looked at this possibility and concluded that if the physics interest and the financial climate ever opened the door to 1000 GeV, the missing magnet lattice was not the best, or cheapest, route. (This also was detailed in the April issue.)

It is proposed therefore to shy away from the incorporation of superconducting magnets in the SPS main ring and to complete the machine with conventional magnets. Within the provisions of the programme authorized by the Council, it is possible to purchase and install enough magnets to fill the ring. This gives the machine the capability of reaching 400 GeV.

Finally, it is proposed to follow what is known as 'Schedule C' in constructing and commissioning the machine. In line with the various options and energy stages, several schedules have been on the table. Schedule C involves installation of all the magnets before commissioning so that the machine will have 400 GeV potential from first operation. Accelerated proton beams will be fed to the West experimental areas by the end of 1976 and the North experimental area by early 1978.

These proposals were approved by the Council.

Schooling of CERN children

The progress of the consultations between the French authorities and CERN concerning the schooling of children of CERN personnel was reported to Council. As described in the May issue (page 146) a Collo-

quium was held at Sèvres to discuss the pedagogical structure of a schooling system adapted to the needs of both the French families of the region and the CERN community.

The outcome of the Colloquium was considered to be very satisfactory by the Council and several delegations declared the intention of their educational authorities to participate in the schools. Some countries, however, have formal difficulties in finding a mechanism whereby teachers could be sent to the schools and administrative measures to get around these difficulties remain to be found. Many other administrative aspects of the schools are not yet clear.

The French government was asked to make known its programme for implementing the system. At the same time CERN was asked to provide information on the numbers of children likely to frequent the schools. A survey of all parents with children of school age has been conducted within CERN and has revealed virtually unanimous support for the type of schooling system which is proposed. The results of this survey will be used to provide the French authorities with numbers for the children who may go to the schools from September of this year or in later years when the system is really on its feet.

The Council expressed its strong support for the work which is being done to try to find a good solution for the schooling of children of CERN personnel.

Staff Rules and Regulations

The Council approved a variety of changes to the Staff Rules and Regulations which, in effect, spell out the conditions under which people work at CERN. Most of them are of purely internal relevance but some themes have been incorporated which merit wider attention.

The Council relaxed on the evening of 20 June and celebrated the twentieth Anniversary of the founding of CERN. The Convention establishing CERN was signed in Paris on 1 July 1953.

1. Sir Ben Lockspeiser, the first President of the CERN Council, came to CERN for the occasion and is seen here speaking at the dinner with two of his successors, Professor W. Gentner (the present President) and Professor E. Amaldi, on his left.

The opportunity was also taken to pay tribute to three distinguished Council members who from now on will not be so intimately involved in the affairs of CERN:

2. Professor J.K. Boggild of Denmark (with another former Council President, G.W. Funke on his right);

3. Professor F. Perrin of France (with the Director General of CERN Laboratory II, Dr. J.B. Adams, on his left);

4. Sir Brian Flowers of the United Kingdom (with Professor Boggild on his right).

There is more equality in the treatment of all members of the personnel irrespective of their grade within CERN or sex. Thus all grades are now accorded the same annual leave. Married men and women have equal right to various allowances and grants. Certain welfare provisions have been improved — such as increased contributions to schooling expenses, longer maternity leave, help for handicapped personnel. There are also new provisions concerning occupational training, health and safety.

Most of the revised Staff Rules and Regulations came into force on 1 July. They are the outcome of a lot of careful thought and effort by a Working Group, set up by the Finance Committee, which consisted of representatives of the Member States of the CERN Administration and of the Staff Association.

New appointments

A. Bohr and G.H. Stafford have been elected as members of the Scientific Policy Committee for three years. The Council appointed D. Amati as Leader of the Theory Division for three years as from 1 July succeeding B. Zumino. Also to take effect from 1 July for three years are three reappointments — G.R. Macleod as Leader of the Data Handling Division, C. Tièche as Leader of the Finance Division and G. Ullmann as Leader of the Personnel Division.



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