

CERN News



On 1 February Professor H.F. Schopper took over the leadership of the Nuclear Physics Division in succession to Professor Preiswerk, one of CERN's pioneers, who had occupied the position for the previous ten years. Professor Preiswerk will remain at CERN helping Professor Schopper to settle into his new post and turning again to research — in his own words 'hoping to provide some competition for the young physicists'.

Herwig Franz Schopper was born on 28 February 1924 in Landskron. He read physics at the University of Hamburg. Since 1949 he has occupied successive posts at the Universities of Erlangen, Mainz and Karlsruhe. In 1961 he was appointed Director of the Institute of Experimental Nuclear Physics at the Karlsruhe Nuclear Research Centre, and from 1967 to 1969, he was President of the Scientific Council of the Centre.

His contacts with the international scientific world have been numerous. He spent six months in 1950 at the University of Stockholm, a year (1956-1957) at the Cavendish Laboratory at Cambridge working with Professors O. R. Frisch and D. H. Wilkinson on parity violation in beta decay, and several months (1960-1961) at Cornell University working with Professor R. R. Wilson on electron scattering. He is well known at CERN having worked here in 1967 and 1968 as a Visiting Scientist.

On computers

A further step (an 'interim solution') to keep the installed computing capacity at CERN in line with demand was completed in January. The CDC 6400, which together with the CDC 6600 provide the central computing service, has been converted to a 6500 with the addition of a second processor, an additional 64 K of core store and some peripheral equipment. In this way the capacity of the existing system is extended to cope with the foreseeable demand for about the next two years.

The amount of computing done at CERN doubled annually from 1962 to 1967 and a succession of ever more powerful computers had to be acquired. Since 1967 the growth rate has decreased somewhat to a doubling every two years and extensions to the CDC central computers have kept pace, and will keep pace through to about the end of 1971.

Study groups have looked at the computing requirements for the coming years, taking into account such predictable items as the number of bubble chamber pictures to be taken, the number of events from electronics experiments, the number of physicists at CERN needing access to computing, etc. Their studies have shown that a computer with several times the capacity of a CDC 6600 will need to be in operation from the beginning of 1972. Beyond that date the requirements are less clear but the coming into service of the various items of the improvement programme at the 28 GeV proton synchrotron and of the Intersecting Storage Rings suggests that by about 1975 the installed computing capacity will need to be about ten times that of a CDC 6600.

Preliminary approaches to computer manufacturers in this context began in 1967 and at the end of 1968 the first requests for tender were sent out. No single machine then being developed seemed likely by itself to meet CERN's long-term needs and a solution in a series of steps had to be devised. Step 1 has been the extension of the existing system completed in January. The proposed step 2 will be the acquisition for 1972 of a new computer, having about four times the capacity of a CDC 6600, while keeping the existing system in operation. Computer firms have

recently been invited to tender for the new computer, the tenders to be at CERN by the end of February. It is hoped to put the proposed solution before the CERN Council at its June meeting. Step 3 cannot be defined very precisely at the moment but may involve the acquisition of another new computer about 1974-1975 while phasing out the existing system (CDC 6600 and 6500).

These developments will obviously have a big impact on the costs and manpower involved in the computing service. At present the service involves about 70 people and an expenditure of about 10 million Swiss francs per annum. By 1975 this could rise to 140 people and an expenditure of 20 million Swiss francs per annum. Costs would thus roughly double while the computing capacity would increase about fivefold. Figures of this order have been fed into the long-term financial planning for CERN Meyrin which has extended to 1975.

Fellowships in computer research

CERN has recently extended its Fellowship programme to take in areas of applied physics in addition to the long established Fellowship programme in particle physics. Initially, the new programme is on a modest scale in terms of numbers of Fellowships offered but it does provide new opportunities to scientists and engineers from the Member States to participate in aspects of CERN's work where the facilities and expertise are among the most highly developed in Europe. The field of computers is a predominant example and a limited number of scientists can now come to CERN to take up Fellowships for up to two years to do computer research.

It will have been obvious from the discussion above that the computing requirements of the Laboratory are often at, or beyond, the limit of the ability of commercially available equipment and systems. This has led to CERN carrying out considerable research in developing new computing techniques and in applying them to physical, mathematical or engineering problems. In recent years these developments have included — multiprogramming operating systems for the CDC 6000 computers, new compiling techniques (especially with reference to optimization

for parallel processor units), permanent storage facilities, remote access computing facilities and file manipulation. Research is being made into quantitative performance analysis of these large systems with a long-term aim of performance prediction, an area which is becoming increasingly important.

The development of interactive graphical computing is another area where research is in progress, both from the point of view of systems and of applications. In this work CERN is exploring new ways of handling mathematical functions in a graphical form, processing visual data (such as photographically recorded experimental data), carrying out engineering design, etc. A CDC 3200 computer equipped with a large interactive graphical display unit will shortly be available for this work, and there will be an interactive display unit on the CDC 6600.

Closely related to this is research on pattern recognition, at present specifically aimed at the automatic processing of spark chamber and bubble chamber film. This, however, has many aspects in common with other applications, for example, medical data processing, character recognition, and it could easily be extended in these directions.

In the near future, it is planned to undertake research in the area of programming languages and of compilers (at present Fortran is used almost exclusively, for essentially historical reasons). This is becoming increasingly important in making machines accessible in the widest sense. Such research would complement that on interactive computing methods that is already under way.

In applied mathematics, original research has been done over the past few years on the theory of Romberg integration, the theory of approximations by Chebyshev series, Monte Carlo methods, multi-variant minimization, computation of Coulomb wave functions and polynomials.

Looking ahead, CERN is concerned with overall computer system design, and work is at present in progress on studying the problems associated with communication networks, multi-processor systems, large-volume permanent storage systems and multi-access systems. There is consider-

able scope for original contribution to the theoretical analysis or description of these problems, as well as to the practical work of making detailed system specifications and evaluations.

It is on some of these topics that the research Fellows will work.

Computing school

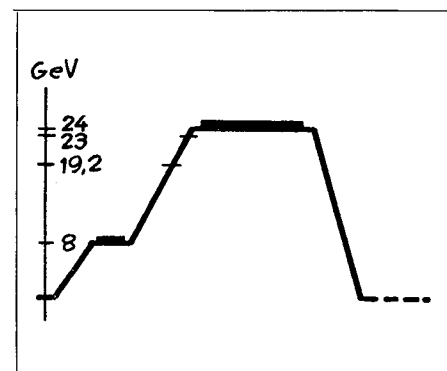
This year, for the first time, CERN is organizing a 'Computing and Data Processing School'. It will be held at Varenna in Italy from 30 August to 12 September and is open to about 70 young computer scientists and high energy physicists coming principally from the CERN Member States.

The initiation of this school, which may well become an annual event, is a recognition of the emergence of computer science during the past two decades as a subject in its own right. On the other hand, physicists usually have recourse to computing in an ad hoc way looking for the solution to particular problems—mainly in the recording and analysis of increasingly large volumes of data. It is felt that considerable benefit will come, in both directions, from bringing together computer scientists and computer users. Computer scientists will appreciate more fully the problems of the experimental physicist and may see more clearly the lines of research which could ease the problems. Experimental physicists will appreciate more fully the possibilities and limitations of computers by seeing the current state-of-the-art in computer science presented in a broad framework.

There is an Advisory Committee for the school with the following members, in addition to members of CERN staff: L. Bolliet (Grenoble), M. Cresti (Padua), A. Donnachie (Manchester), D. Harting (Amsterdam), F. Hertweck (Garching/Munich), P. Kirstein (London), B. Levrat (Geneva), C. Strachey (Oxford) and B. Zacharov (Daresbury).

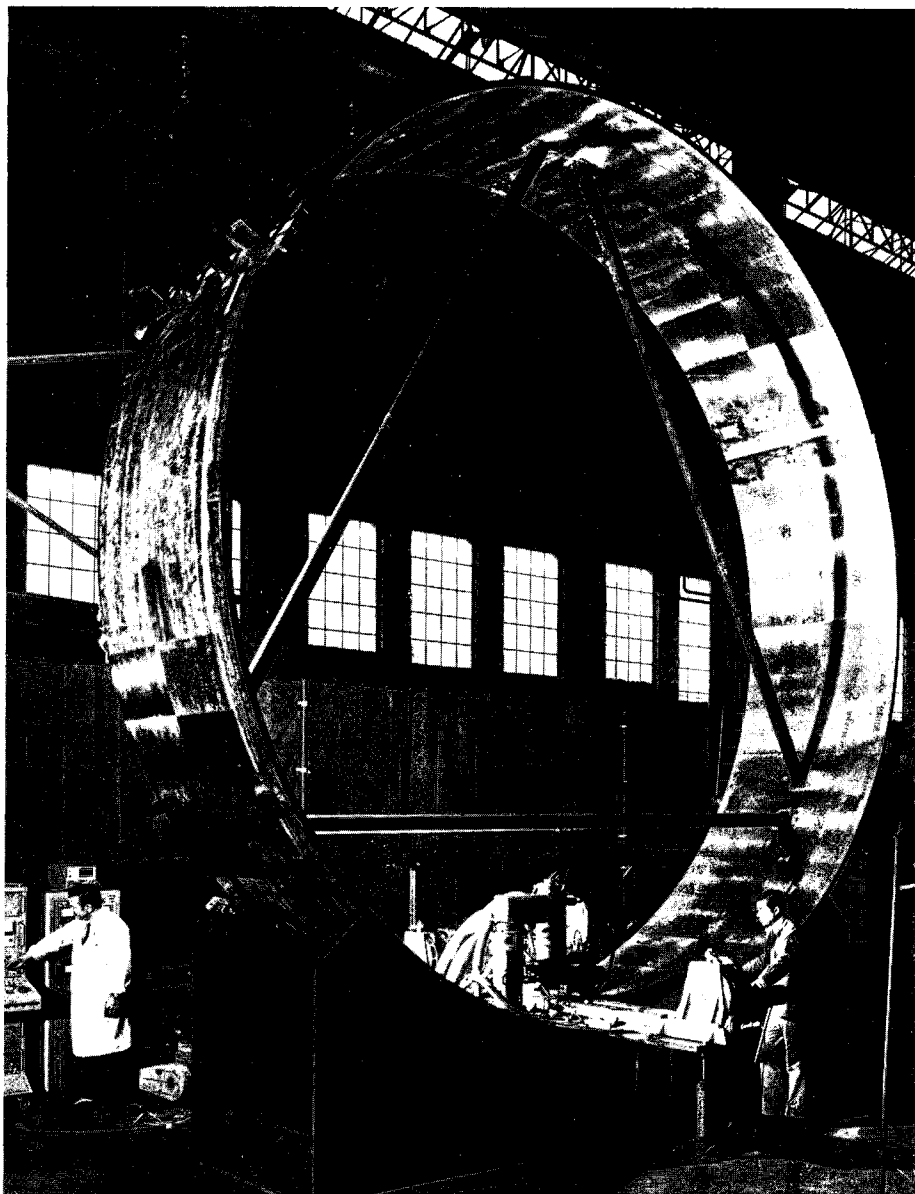
The courses at the school will cover — Programming languages (J.J. Duby, IBM/Grenoble), Computer systems design (W. Miller, Stanford), Data processing in electronics experiments (B. Levrat, Geneva), Data processing in bubble chamber experiments (P. Villemoes, CERN), Simulation

in high energy physics (F. James, CERN), Simulation in computer design (D.M. Gibson, IBM/Poughkeepsie), Algebraic manipulation (M. Engeli, FUF/Zurich), and Computer graphics (B. Zacharov, Daresbury). Evening lectures are being arranged on Artificial intelligence (D. Michie, Edinburgh), Impact of computers on nuclear science (L. Kowarski, CERN) and Computers in space research (a NASA official).



Operation of the 28 GeV proton synchrotron is going a long way towards pleasing all of the people all of the time. Mastery of beam sharing techniques is now so highly developed that eight experiments can receive particles from the same machine pulse.

The operating cycle for the first two weeks of February is illustrated schematically in the diagram which shows how the magnetic field in the synchrotron ring changes with time during one machine cycle. The cycle lasts 2.3 seconds. Protons are accelerated to 8 GeV/c and there is then a 'flat-top' of 150 ms duration while the beam (still distributed in 20 bunches) is guided onto an internal target in straight section 1 and provides secondary particles to experiments in the South Hall absorbing from 5 to 10 % of the proton beam. Acceleration is then taken further; at 19.2 GeV/c fast ejection 74 sends two bunches towards the heavy liquid bubble chamber in the neutrino area and at 23 GeV/c fast ejection 58 sends one bunch into the East Hall. Finally at 24 GeV/c the remainder of the proton beam is divided between internal targets in straight sections 1 and 8 providing beams into the South Hall during a flat-top of 520 ms.



Photograph taken in December 1969 in the Neyrpic (Grenoble) division workshops of Alsthom who were awarded the contract for the cryostats to house the superconducting coils of the European bubble chamber. The photograph shows welding, by electron bombardment, of a stainless steel collar 6 m in diameter and 45 mm thick used in the construction of one of the vertical walls of a cryostat.

The technique was developed in collaboration with the CEA (Commissariat à l'Energie atomique). The welding takes place in a local vacuum chamber which encloses the weld joint.

(Photo Neyrpic)

European bubble chamber

Winding of the superconducting magnet coil

The European bubble chamber (described in CERN COURIER vol. 7 page 143) will have a superconducting magnet, which is more than 6 m in diameter, to give a field of 35 kG in the chamber.

When the project was started, enquiries were made with firms likely to be able to undertake the winding of the magnet, and it was found that large sums would have to be spent on winding equipment. In view of the large depreciation factor contained in the price quotations, the prevailing economic situation (which delayed deliveries) and the delicate question of guarantee, CERN finally decided to carry out the winding on the site with equipment specially designed for the job. It was decided to locate the winding shop in a building to be used for exploitation of the chamber, near the West experimental hall.

In May 1968 an engineering contract was

placed with Alsthom (France), to design the work area, the tooling and the various stations of the winding shop. The components were ordered from a large number of suppliers in Europe.

The workshop consists of:

- a winding line consisting of a 6.2 m diameter winding plate, two motorized coil winders 400 mm in diameter, two pneumatic tensioners, degreasing baths, swivelling guides etc., manually operated decoilers for the coil insulating strip, cooling strip and heating strip;
- a welding line consisting of a motorized, coiler, welding bench, straightening rollers, measurement table;
- a production line for the cooling strip (described below);
- a line for insulating the heating strip and for cleaning the cooling strip;
- two assembly platforms for stacking the pancakes and making the connections before the coils are transported to the chamber building.

Coils

Each coil is composed of 10 double pancakes each weighing 10 tons and composed of 176 turns. Each winding consists of 10 elements 1550 m long arranged as shown in Figure 2.

In view of the strong electromagnetic forces, only one side of the conductor strip can be exposed to cooling — the other side presses against a stainless steel strip which takes up the stresses. Between these strips are located the insulating layers and an aluminium heating strip to eliminate, if necessary, stray currents in the superconductor as the field rises.

Superconducting strip

This strip is composed of approximately 200 filaments of NbTi embedded in copper with a cross-section of $61 \times 3 \text{ mm}^2$ and is delivered in 1550 m lengths (see CERN COURIER vol. 9 page 64). By the beginning of February, 9 km of strip had been delivered by Siemens (Federal Republic of Germany). The total length of this order is 66 km, representing a weight of 130 tons.

Reinforcing strip

This strip has a cross-section of $60 \times 2 \text{ mm}^2$ and is delivered in 250 m lengths by CAFL (France). It is made of 316 L stainless steel. There are strict tolerances on dimensions, in particular the longi-