

high energy radiation in biologically meaningful units are very unusual. The group has kept in very close touch with other accelerator centres by exchanging visits, by correspondence, and by taking part in conferences. As a result CERN has health physics instruments as good as any in the world. The very intimate relationships between the Health Physics Group and the experimenters has meant that the CERN accelerators are surveyed extremely thoroughly: **personal exposures are very low and we have never had a radiation accident.**

Sometimes the group is asked about the protection of people who do not work on the accelerators, and this may be a good opportunity of saying something about the general radiation pattern of CERN.

RADIATION EXPOSURE

Firstly, the accelerators themselves are very well shielded, and only people working very near them can be exposed at all. The Health Physics group makes measurements to ensure that people working in offices cannot receive any significant exposure. Areas where there is any possibility of exposure are barricaded off, and access is very strictly controlled so that no-one can inadvertently walk into a potentially dangerous area. The radiation levels off the site are measured, and are quite negligible. Most of the radiation at CERN is from the accelerators and when they are switched off the radiation stops. There is **no possibility of widespread contamination as the result of an accident.** This is a significant difference from reactors as mechanical damage at CERN would stop the accelerators — and consequently their radiation — whereas with a reactor it may cause the release of radioactive materials which continue to emit radiation after the reactor has stopped working.

INTERNATIONAL STAFF

The Health Physics group is quite international! When this report was written it comprised ten people from seven countries. The deputy group leader, who will run the group until this writer's successor is appointed, is **Pierre Guillot**, who came to CERN in 1959 after preparing a Dr. ès Sc. thesis at the Pasteur Institute in Paris. His main interests are in fast neutron dosimetry and spectrometry of stray radiation fields. These problems are complicated enough in laboratory conditions, but the methods have to be developed to the stage where the apparatus can be transported around the accelerators and results produced quickly and reliably. The senior technician, **Sven Larson**, is a Swede who joined the group at the end of 1957, having previously worked with the Jungfraujoch group in CERN's early days. He is helped in running the instrument services by **Piet Varkamp** a Dutch transistor circuit expert, **Klaus Klein** a skilled mechanic from Germany and **Jean Wiesmann**, a Frenchman, who is in charge of repairs, calibrations and wiring. Ra-

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The PS in 1960

by **Pierre GERMAIN**

**Leader of the „Machine Group“,
Division of the Synchrotron**

We shall soon be celebrating the first anniversary of the commissioning of the machine. On 24 November 1959, the PS reached an energy of 25 GeV. What has happened since then?

The position at the end of last year was as follows. From 2 to 3.10^{10} protons were accelerated during each cycle up to an energy of 25 GeV ⁽¹⁾. The trapping efficiency was 25%, which means that out of four particles injected by the linear accelerator into the synchrotron vacuum chamber, one was actually accelerated.

Generally speaking, the PS worked remarkably well from the start and immediately gave a higher current than had been hoped for a few years before. The PS „Machine Group“ therefore took over a potentially excellent accelerator and this greatly simplified its task because the group could immediately concentrate on developing the equipment and exploiting the accelerator.

The PS „Machine Group“

The „Machine Group“ was created to take charge of the operation, maintenance and development of the machine. It originated in 1959 in a Committee called the Machine Operation Committee headed by C. J. Zilverschoon, who had the difficult task of working out the structure and organization of the present group.

The programme of our group for 1960 is as follows:

- a) Creation of a staff of operators and engineers-in-charge with all the necessary auxiliary organization: setting-up and operating routines, theoretical and practical training, protection of the staff and users, etc.
- b) Rapid development of the minimum facilities which are essential for the exploitation of the machine by physicists.
- c) Completion of the machine installations and ancillary equipment, eliminating temporary installations. Extension of the machine facilities for experimentalists.
- d) Study of the behaviour of the machine, mainly that of the proton beam. This is obviously essential if subsequent performance is to be improved.
- e) Detection and improvement of the inevitable weak points in the equipment

⁽¹⁾ The maximum energy of the PS is about 28 GeV. However, this energy is rarely used because it entails an interval of 5 seconds between two accelerating cycles whereas this interval is only 3 seconds for an energy of 25 GeV.

of a machine as original and complicated as the PS.

The „Machine Group“ has been greatly helped in its work by the advice and assistance of many colleagues who after taking part in the construction and commissioning of the accelerator have now joined other groups. It is extremely gratifying to record that this valuable co-operation is still most effective nearly a year after the commissioning of the machine. Such co-operation is rare enough to deserve special mention. In this connection I should like to thank (hoping not to forget anyone) P. Bramham, M. Geiger, H. G. Hereward, K. Johnsen, P. Lapostolle, B. Montague, C. Schmelzer, W. Schnell, and in fact the whole PS Parameter Committee. I do not mention M. G. N. Hine because, fortunately for us, he joined the group during the year.

The „Machine Group“ is only one of the groups in charge of the development of equipment which the experimentalists need in order to exploit the machine.

Beam transport, the ejection system, and electrostatic separators come under C. A. Ramm's „Propane Chamber Group“. It is F. Grütter's „Engineering Group“ which is responsible for the completion of the generator and cooling system for the beam transport equipment and the bubble chambers and the generator building. Finally the radio-frequency separators are being designed by A. Schoch's „Accelerator Research Group“.

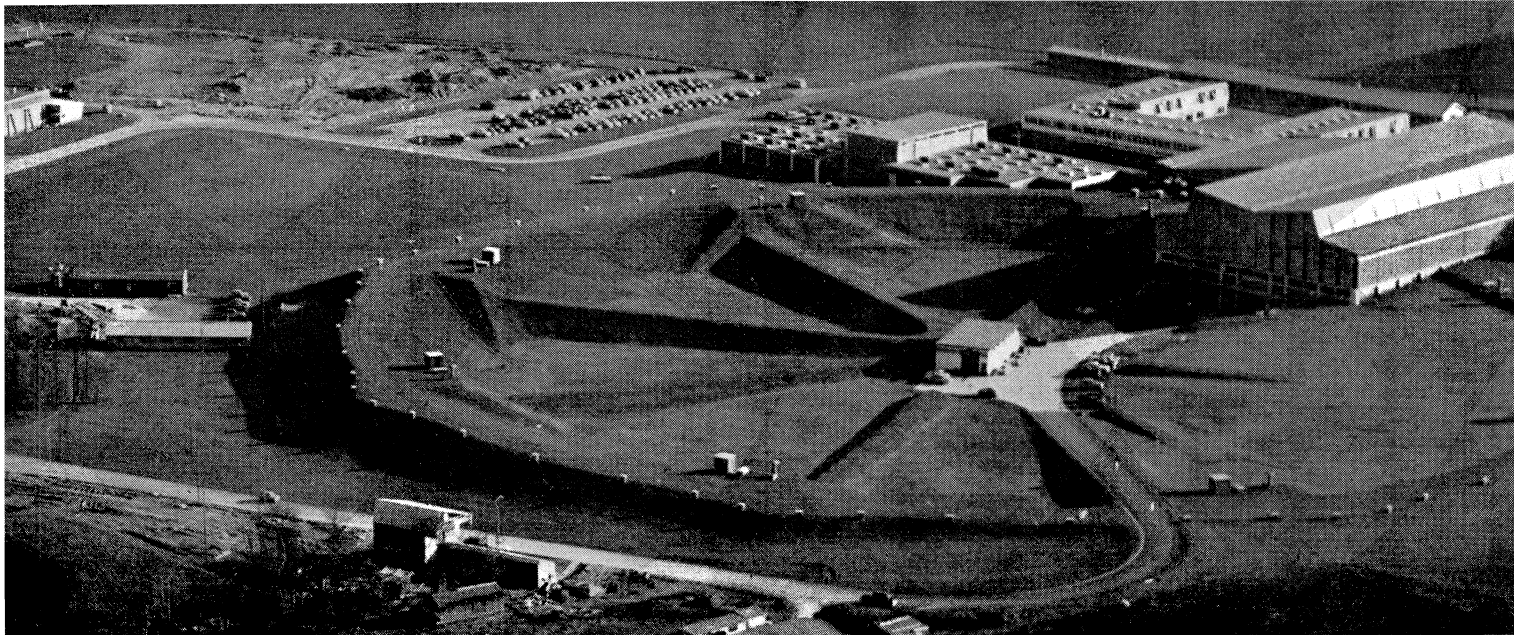
The PS at 1 September 1960

It would be tedious for the reader to have a detailed account of the work done this year on the machine. Those interested can find particulars of these improvements in the quarterly reports issued by the group. Two reports covering the period from January to June 1960 have so far been published ⁽²⁾.

I propose to mention only the most important results directly connected with the exploitation of the machine by the experimentalists. Obviously the other work, although less spectacular, is quite as important.

From the point of view of the research work which it is hoped to do with the accelerator, an important parameter is the current supplied or, in other words, the number of particles the machine accelerates to maximum energy during each cycle. At present this number is regularly between 2 and 3.10^{11} which is more than tenfold what it was at the end of last year. This high intensity means that at present the PS is one of the synchrotrons producing the highest number of particles per second, apart from the fact that its energy is greater than all but one of other accelerators in existence.

⁽²⁾ CERN 60-23 and 60-29: „Quarterly Reports Nos 1 and 2“.



The higher current has been obtained partly by increasing the output intensity of the ion source which produces the protons, and partly as a result of the installation of a particle buncher at the input end of the first tank of the linear accelerator—which increases the intensity by a factor of about two—and finally by an improvement of the same order in the trapping efficiency of the synchrotron itself. At the end of last year, out of four particles injected into the synchrotron by the linear accelerator, one was accelerated, but now the figure has improved to about two out of three. The trapping efficiency is, therefore, about 65 % instead of 25 %.

However, the experimentalists do not make direct use of the primary beam circulating in the machine. A target is used which is very frequently no more than a piece of aluminium or beryllium placed, at the end of the cycle, in the path of the primary high energy proton beam circulating in the machine. The interaction of the protons with this target gives the secondary beams.

A small proportion of the protons crossing the target are deflected and leave the machine. They go through the wall of the vacuum chamber and produce in the experimental hall a proton beam of about the same energy as that of the primary beam and of sufficient intensity for the bubble chambers, the photographic emulsions and even for some experiments with counters.

The great majority of the protons hitting the target interact with the nuclei of the target itself, and these interactions give rise to secondary particles (π^+ and π^- mesons, K^+ and K^- mesons, protons and antiprotons, deuterons, etc.) It is the behaviour of these secondary particles which is studied by the experimental teams. By and large, the experimentalists call for two kinds of secondary particle pulses. We are now able to provide these pulses under satisfactory and reliable conditions, which was not the case at the end of last year.

The first type of pulse is a **long pulse of high intensity** used for the counters: the greatest possible number of the primary protons circulating in the machine are made to act on the target and produce secondary particles for a few hundredths of a second, fairly regularly.

The second type of pulse is a **short**

pulse of low intensity: a small fraction of the primary protons act on the target and produce secondary particles for about ten thousandths of a second. This type of short pulse is used for bubble chamber experiments. It is now possible for us to supply the two kinds of pulses during the same accelerating cycle, part of the protons being used to give a short pulse and the rest to give the long pulse. It is obvious that to produce particles at different stages of the cycle and in different parts of the machine is of the greatest advantage. In this case it becomes possible to use the machine simultaneously for several experiments: for instance a bubble chamber and a counter group may use two different targets. In this field we have made enough progress to be able to solve simple problems of simultaneity.

Exploitation of the machine in 1960

It is not intended to list the experimental programmes at present being carried out: this should be done by another writer.

It must, however, be recalled that until now, mainly because the accelerator came into operation more rapidly and possibly more satisfactorily than expected, "beam transport" has been on a small scale. Beam transport refers to the system of electro-magnets, magnetic lenses, power supply generators and electrical connections which produce a given secondary particle beam with specific properties in the experimental hall. In spite of this we are beginning to know something about the nature and intensity of the secondary particles as function of their energy and angle of production. Measurements of the cross-section of these particles have been made in liquid hydrogen. Two bubble chambers, Charles Peyrou's 32 cm liquid hydrogen chamber and A. Lagarrigue's 1 m propane chamber, were placed in secondary beams and took a few tens of thousands of photographs. In addition, nuclear emulsions have been exposed in different beams and at different energies.

From 1 January to 1 September 1960, a period of eight months, the accelerator or parts of it operated for about 1600 hours. About 780 hours of this time were devoted to high energy beam

production and the rest was used for running in and especially for the study of the machine or parts of the machine.

From next year onwards the machine will probably work 100 hours per week.

During the same eight-month period the efficiency of the accelerator, namely the ratio between the actual accelerating time and the planned accelerating time was on an average between 75 and 80 % which is satisfactory efficiency level for such a "new" and complex machine.

To conclude this paragraph on the exploitation of the machine it is proposed to describe briefly the method so far used to fix the programme for exploiting the machine.

A general programme allocating machine time to the various experimentalists is fixed about every three months by the research co-ordinator.

A detailed programme for each week is settled on the Thursday of the previous week at a schedule meeting organized by the "Machine Group". The exact arrangement of the beams, the exact target requirements and the safety measures to be taken are discussed and settled with the experimental groups concerned.

This schedule meeting leads to the publication of the weekly PS programme which is widely distributed in CERN and gives full information about the hours of operation, the users and conditions of access to the machine.

It is impossible to quote the names of all the members of the "Machine Group" who this year have contributed not only to running the PS to the satisfaction of the experimentalists but also to planning the future improvements of its performance.

I would like to take this opportunity of expressing my appreciation for their valuable work, which I know is very often a thankless task. The best way to include them all in this acknowledgement is probably through the Machine Group Committee whose present members are H. von Ballmoos, F. Bonaudi, G. Brianti, A. Decae, H. Fischer, J. Y. Freeman, J. A. Geibel, M. Georgijevic, J. Gervaise, M. G. N. Hine, U. Jacob, G. L. Munday, K. H. Reich, P. H. Standley, C. S. Taylor and B. Vosicki ●