

Cross-section of seminiferous tubules in mouse testicle (enlarged 1 000 times): on the left is the sample, on the right the result after irradiation by 5 rad of stopped negative pions. The arrow (R.P.S.) indicates a type of germinative cell (spermatocytes in preleptotene stage). Cell survival may be determined by counting the number of spermatocytes missing in the animals irradiated. These experiments are being performed by the CERN Health Physics Group.

voluntarily to the national social security system;

Italy: A first exchange of views has taken place between representatives of CERN and the Ministry of Labour and Social Security and the National Social Security Institute. Italian nationals may make voluntary contributions to the system if they follow the administrative procedure. Detailed discussions will begin again during the summer;

Netherlands: By and large, the group sees no need for a special agreement except for one problem with respect to Dutch nationals over the age of 59 which is still being examined;

Norway: The group sees no need for a special agreement;

Sweden: The Government is to be approached to open discussions on certain problems;

Switzerland: The problem relates to the methods of integration into the 'AVS' system and membership of

health insurance schemes after leaving CERN and contact has been made with the Federal authorities;

United Kingdom: On the whole, very few difficulties arise apart from the problem of the purchase of years of membership — a letter on this subject has been sent to the British Government.

Of Mice and Men

At the end of March, sixty mice were irradiated at the synchro-cyclotron in the course of an experimental programme studying radiation effects on mice and plants (*Vicia faba* bean roots) being carried out by the CERN Health Physics Group.

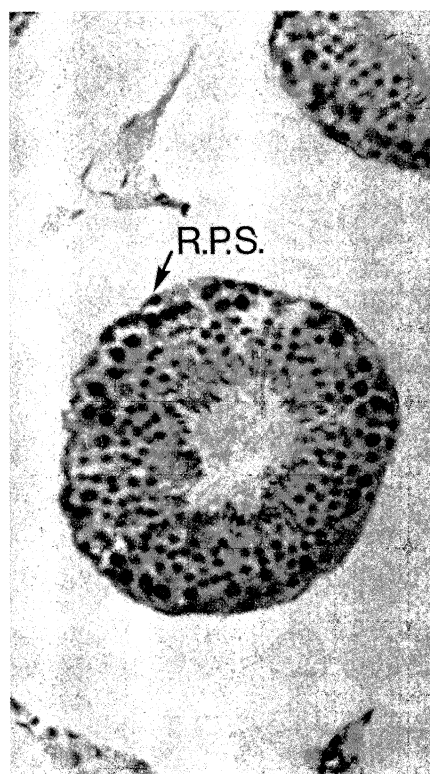
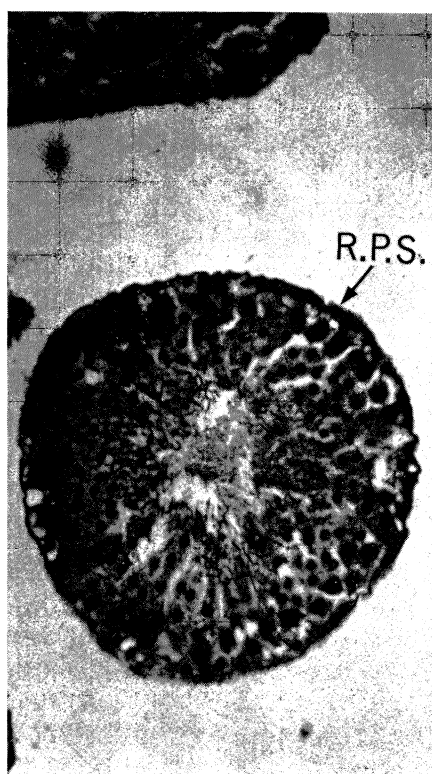
Radiation protection experts are interested in the biological effects of high energy radiation. It is known that the energy lost through ionization as radiation passes through matter

remains virtually constant at high energies but special phenomena, produced by spallation, appear beyond a certain radiation energy threshold. These phenomena, which can be observed at high energy accelerators, may cause very large amounts of energy to be deposited in an abnormal way in small volumes of living tissue.

About twenty years ago all data concerning the biological effects of high energy particles were virtually extrapolations of what had been observed at lower energies. It has therefore been necessary to carry out a programme of experiments to check the data and thus to confirm that the proposed radiation protection measures are adequate. These experiments are being carried out in collaboration with other European institutes of radiobiology.

The experiments are being carried out at the SC and not at a more powerful accelerator, such as the proton synchrotron, because the energy of the protons and even of the secondary beams (of pions for example) at the SC is sufficient to initiate the phenomena of interest. The period of irradiation and observation varies considerably: to study the formation of a cataract in a mouse's eye due to irradiation requires following the case over a few years until natural death occurs, on the other hand, to study variations induced in the growth of bean roots requires only ten to twenty days of observation. The phenomena induced in the irradiated plants or mice are compared to those occurring naturally in the same species and to those observed after exposure to more common forms of radiation such as X-rays and neutrons.

When the world's first high energy accelerators came into action, thorough precautions were not taken to combat the dangers presented by the emerging beams and by the gradual accumulation of induced radioactivity.



On 20 May the 'mole' had burrowed its way 650 m around the SPS tunnel. The photograph shows the spoil being pulled out by train; twelve wagons carry 60 tons at a time. The pipes on the right of the tunnel wall take air and water to the working face. Metal hoops are installed temporarily to hold the walls at this point in the tunnel since it is one of the sections which will be later enlarged from 4 to 6 m.

This tank is being built to dry out vacuum components for the SPS — along the walls are the supports for the heating elements. The components will be chemically cleaned and rinsed with demineralized water. Within the tank they will be heated to 150°C while under a vacuum of 1 torr. After this they will be sealed off and be ready for installation. The tank, constructed in the Main Workshop, is 7 m long and 1.5 m in diameter and is scheduled to be brought into use at the end of June.

Shielding of the machine itself was thought to be enough. To ensure that the appropriate measures were taken, when CERN's first accelerator (the SC) operated in 1957, a small radiation protection group was formed and attached to the Scientific and Technical Services Division, the predecessor of the present Data Handling Division. In 1961, as people became aware of the considerable problems in the field of radiation protection, the group was reorganized and attached to the Directorate. It now has about forty staff including visiting scientists and a few Fellows.

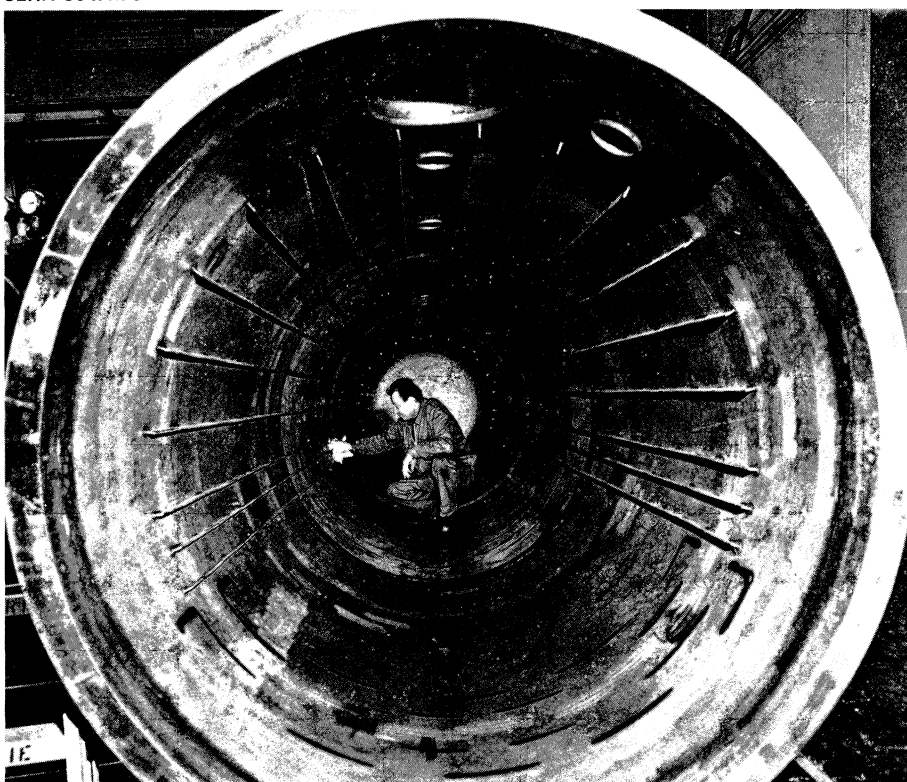
The main aim of the Health Physics Group is to locate radiation hazards to assess them correctly, to take necessary precautions or impose necessary restrictions and to pass on information efficiently. The group must also check that personnel radiation exposures remain within acceptable limits.

The hazards vary according to whether machines are running or shut down. In the latter case the danger comes from conventional (mainly gamma) radiation due to activation of the accelerator components by high energy particles and the radioactivity may reach very high levels locally. In this case, monitoring and personnel dosimetry do not present any basic problems though the hazards due to high intensities and unusual spectra have to be taken into account. At present 90 % of the total radiation dose received by CERN personnel is of this type.

When the machines are running the main hazards are due to high energy particles and their secondaries. This may affect not only the experimental areas but also their immediate surroundings and even the whole site. In contrast to 'conventional' radiation, the hazard is much more difficult to evaluate as no single instrument can provide a complete picture of the radiation.



CERN 304.4.73



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Completion of the winding of half the coil for the d.c. superconducting bending magnet now installed in the beam-line to the European bubble chamber, BEBC. Inset is a microphotograph of a cross-section of the superconductor used in constructing the magnet. The conductor is rectangular, $1.5 \times 3 \text{ mm}^2$; inside a copper matrix are 367 thin filaments of niobium-titanium $65 \mu\text{m}$ in diameter.

At CERN a set of detectors is used to measure the total radiation dose: neutrons from the thermal range up to approximately 15 MeV are measured with an RIC (rem ionization chamber), particles above 20 MeV (from nuclear interactions) are measured by carbon activation, and gammas and charged particle ionization are measured by differentiation between two chambers. It is thus possible to obtain a quick plot of the radiation fields in the experimental halls, evaluate the hazards facing those working there and advise on the necessary precautions.

The Health Physics Group has established a network of monitors covering each experimental hall and the site as a whole. The monitors are of two types:

- equipment for monitoring the radiation areas, which consists of portable instruments for measuring the total dose equivalent at specific points and of a network of instruments providing readings which are continuously relayed to the Group and, if necessary, to the control rooms;
- fixed monitoring stations which continuously measure and record the radiation levels on the site. These stations can be read remotely. In addition, a denser network of integrating systems provides total dose readings which are distributed at quarterly or yearly intervals. As this network extends to the far corners of the site, the radiation level just outside the Laboratory is also evaluated.

The instrumentation also includes monitors installed at critical points on the site to check gas and liquid waste. Experience has shown that the hazards due to radioactivity in gas and liquid waste are negligible but a constant watch is still kept on them. The Group also handles all the personnel dosimeters distributed to the staff (more than 5 000 per month).

On average only a few incidents

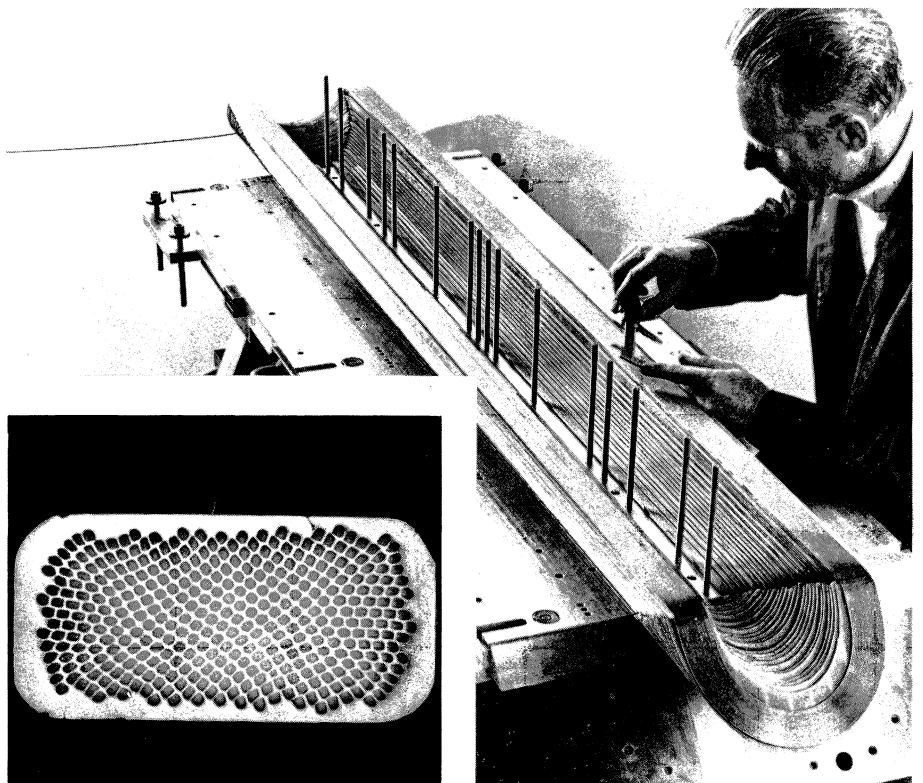
which require thorough investigation are recorded each year. Cases of over-exposure are few in number and, until now, low in value. During the past ten years, doses resulting from accidents have not exceeded five or six times the maximum permissible annual dose.

Superconducting bending magnet

A superconducting bending magnet has been developed for the beam-line to the large European bubble chamber, BEBC. It is now installed in its final position in beam u7, some 50 m from BEBC in the West Hall where it provides a deflection of 8° .

The project has already been discussed in vol. 10, page 228. Initially, there were plans for two identical magnets enclosed in a common cryo-

stat, and the technical features were described by G. Kessler, P. Lazeyras and F. Schmeissner at the Conference on Magnet Technology held in Hamburg in May 1970. Since then, there have been some changes. First of all, to give scope for possible modifications to the beam and especially to take into account the advent of the SPS, greater flexibility has been obtained by separating the two magnets and having each of them in its own cryostat. Secondly, it turned out that the bending power required for the initial operating period of BEBC would be lower than foreseen and that a single magnet would be adequate. For these reasons, only one superconducting magnet fitted in a correspondingly shorter cryostat has been built. In addition small changes in coil configuration and a slight increase in effective length reduced the nominal current and thus the current density and stored energy.



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