

The European Organization for Nuclear Research (CERN) came into being in 1954 as a co-operative enterprise among European governments in order to regain a first-rank position in nuclear science. At present it is supported by 13 Member States, with contributions according to their national revenues: Austria (1.92 %), Belgium (3.78), Denmark (2.05), Federal Republic of Germany (22.47), France (18.34), Greece (0.60), Italy (10.65), Netherlands (3.87), Norway (1.46), Spain (3.36), Sweden (4.18), Switzerland (3.15), United Kingdom (24.17). Contributions for 1963 total 92.5 million Swiss francs.

The character and aims of the Organization are defined in its Convention as follows:

'The Organization shall provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto. The Organization shall have no concern with work for military requirements and the results of its experimental and theoretical work shall be published or otherwise made generally available.'

Last month at CERN

During the first half of November the **proton synchrotron** was shut down for routine maintenance and modifications as well as changes to the external beams. One of the major jobs was the installation of new main cooling-water

pipes between the cooling room and the South experimental hall, increasing the capacity available for the cooling of beam-transport magnets by about 20 per cent. In fact the limitation is now provided by the pumps rather than by the pipes and eventual replacement of these by more powerful ones will provide for an even greater flow.

replaced, except on two magnets which were inaccessible because of part of the neutrino beam. The new tubing is expected to last about 4 years in most parts of the ring, but it may have to be renewed more often in the target areas, where the radiation intensity is much higher.

Contents

Last month at CERN	152
Lectures on bubble-chamber analysis programmes	153
Development of supplementary training	154
Guy Vanderhaeghe	155
Puzzle photos	156
Books	158

The cover photograph shows that the main auditorium at CERN has more than one use, and that a young audience can be even more attentive than the physicists and engineers who more often occupy the seats. The occasion was the performance of a play called 'Capucines', presented by the drama group of the international organizations, 'Harlequin and Co.', during the first of this year's two Christmas parties bringing together the children of CERN staff and some of those from neighbouring communities. Also on the programme were a film and a conjurer, as well as refreshments and the visit of Father Christmas.

CERN COURIER

is published monthly in English and in French. It is distributed free of charge to CERN employees, and others interested in the construction and use of particle accelerators or in the progress of nuclear physics in general.

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.

Published by the
European Organization for
Nuclear Research (CERN)

PUBLIC INFORMATION

Roger Anthoine

Editor:
Alec G. Hester

CERN, Geneva 23, Switzerland
Tel. 34 20 50

Printed in Switzerland

Among the work carried out at the linac in this period were a rearrangement and realignment of all the apparatus concerned with transporting the proton beam from the end of the linac to the entry to the synchrotron, and a modification of one of the triplet magnetic lenses between the pre-injector and the linac. Further equipment for carrying out measurements on the beam was also put into place. One result of these efforts appears to have been a further increase in the current accelerated through the linac when operation was resumed.

In the ring, the radiofrequency accelerating unit in section no. 51 was removed, and the vacuum box for the 'rapid beam deflector' inserted in its place. At the same time the r.f. system was modified to allow for voltages of 3.05, 3.2 and 3.6 kV, instead of 2.85, 3.2 and 3.6 kV. The new lowest value corresponds to normal acceleration with the 15 accelerating cavities that remain. Among other work, the controls were finished and all the cabling installed for the rapid beam deflector, which will be used to provoke a relatively short burst of protons on an internal target.

The radiation produced around the accelerator during operation has caused the rubber tubing carrying the cooling water to and from the ring magnets to lose its elasticity and strength, and during this shut-down all the tubing was

In the East experimental hall, a new beam, o_3 , was constructed to serve the **École Polytechnique heavy-liquid bubble chamber**, now modified to contain a liquid-hydrogen target. By using a new type of jointed vacuum chamber between the poles of the bending magnets, it has been possible to make part of this beam common with the o_2 beam already in existence. Work was also begun on another beam, known as c_8 , which is the latest in the family of 'c' beams to provide protons scattered out of the synchrotron at approximately full accelerated energy. In the South hall, more work on beam modifications prepared the long d_{15} beam for use in the calibration of spark chambers from the neutrino experiment, and changes for a similar purpose were made to the a_5 beam in the North hall.

The spark-chamber calibration runs were carried out when operation of the machine was started again on 21 November, and a number of counter and spark-chamber experiments were continued.

At the **synchro-cyclotron**, the main experiments, as for the past few months, were concerned with aspects of the 'polarization' of positrons (that is, the degree of alignment of the axis of spin with the direction of flight). Among results still being evaluated were those for the 'ABC experiment', the first part of which was carried out at the SC during September and October. The

The editor of CERN COURIER and the staff of the Public Information Office take this opportunity to send to all readers their best wishes for 1964.

Lectures on bubble-chamber analysis programmes

To convert the measurements of the tracks on two stereoscopic photographs into a complete description of a particle interaction inside a bubble-chamber takes the IBM 7090 computer at CERN about 15 seconds. What is normally neglected in statements of this kind is the fact that to write the 'programme' for such a calculation has probably taken between 10 and 20 man years.

The computer does arithmetic; the programme is a complete set of coded 'instructions' which causes the computer to perform a long series of mathematical operations on the data supplied to it by the input tapes, in order to solve a particular problem. The time taken to prepare the programme is well spent, of course when the same set of calculations has to be carried out on many thousands or hundreds of thousands of sets of data. What takes 15 seconds on an electronic computer might take several days with a hand calculator — and even that requires a programme of a kind.

Over the past few years the Data Handling (DD) Division at CERN has compiled a set of 'standard' programmes (referred to by cryptic names such as REAP, THRESH, and GRIND) for the solution of problems involving bubble-chamber interactions. Each experiment, however, requires specific modifications to the basic programme, which have to be worked out, incorporated and checked. This also takes time, and the experimental programme is now of such a size that the Division's programmes are being left with little opportunity for making fundamental improvements to the existing programmes and for working out new ones. When, earlier this year, the experimentation section of the Division was transferred to the Track Chambers Division, it was decided that the 'upkeep' of these existing programmes should also become the experimental physicists' responsibility after the end of 1963. In this way, the DD Division would be free to concentrate on new developments, such as more complicated programmes for the automatic analysis of bubble-chamber and spark-chamber photographs and the use of counters and spark chambers connected directly to the computer.

This was the background to a series of lectures on bubble-chamber analysis programmes, organized by the Data Handling Division and held recently in the Council chamber at CERN, from 14 October to 7 November. The lecturers were the people who had developed the various programmes, the audience present and possible users of them. The aim of the lectures was to explain the mathematical methods involved in preparation and the detailed contents of each of the programmes. Although envisaged at an earlier stage as an informal discussion with the relatively few CERN

physicists who would take over responsibility for the application of the general programmes to their own experiments, the actual course had about 110 participants, 50 from within CERN and 60 from outside. Most of the visitors were from universities and research institutes in the Member states who take bubble-chamber film from CERN for measuring and send the data back for analysis or else use a similar computer, but quite a number of them came from the U.S.A. This outside interest is not so remarkable, perhaps, when it is remembered that about two-thirds of all the bubble-chamber pictures obtained at CERN are used by other laboratories, often for experiments in which CERN does not otherwise collaborate.

After a general introduction and a talk on the programme REAP, by G. R. Macleod (DD Division), the first week of the course continued with sessions on THRESH, by W. G. Moorhead (DD) and Miss A. M. Cnops (DD), and ended with a discussion of tape-handling routines by R. Lorking (DD). REAP is the input programme which converts the information received on punched paper tape from the measuring projectors (IEPs) into a form suitable for the computer, checking it for consistency at the same time; THRESH, the next stage in the series, is the geometrical reconstruction programme which controls the calculations necessary to convert the measurements made on each of the two stereoscopic photographs into space co-ordinates, the numbers representing the position of each track in three dimensions, inside the bubble-chamber.

The middle two weeks of the course were spent on GRIND, the lecturers being R. Böck (Track Chambers Division) and H. Schneider (also TC). GRIND tests certain kinematic hypotheses to find how closely each one fits the reconstructed event, thus, for example, enabling the physicist to determine the most probable explanation of the interaction. This programme produces a magnetic-tape 'library' for each experiment, containing all the calculated data for each of, perhaps, some 30 000 events.

In the last week the lectures concerned programmes more adapted to the analysis of specific experiments than to the general calculations performed by REAP, THRESH and GRIND. R. Böck, W. A. Cooper, G. Lynch, E. Malamud, (all TC) and F. Beck (DD) spoke on BAKE and SLICE, which both allow the GRIND output tapes to be scanned and additional calculations to be performed on them; SUMX (adapted from a programme written at the Lawrence Radiation Laboratory in Berkeley, U.S.A.), which gives a graphical representation of the results in the form of histograms; and MILLSTONE, a special version of GRIND for certain calculations ●

experiment has been designed to investigate an unexplained result, obtained earlier at Berkeley, that appeared to show a new resonant state of the two-pion system. This is the so-called 'ABC anomaly', named after its discoverers A. Abashian, N. E. Booth and K. M. Crowe. The CERN experiment used a negative pion beam incident on a hydrogen target to produce a neutron

and two pions, and the pion tracks were recorded by spark chambers. As well as scanning the pictures and measuring the tracks in the normal way, the group is trying out a simple automatic system in which the spot of light from the screen of a cathode-ray tube is made to scan automatically along the image of each gap of the spark chamber and to record the position of each

spark. This data is fed into a computer to reconstruct the complete track. The method can only be used, however, with very 'clean' films containing few spurious sparks or other background.

Early in the month the 'temporary' extension to the neutron room, was dismantled and work then began on the permanent structure to replace it ●