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'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.'

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The cover photograph shows a minor result of a successful series of experiments with a new piece of equipment. At the end of the day on 27 July, one end of the East bubble-chamber building was cleared of construction equipment, the bottles and glasses were laid out, and people from many parts of CERN as well as the 'visitors' from England gathered to toast the successful completion of the first run by the British National Hydrogen Bubble Chamber. For further information about the run, see under 'Last month at CERN' on this page.

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.

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Published by the
European Organization for
Nuclear Research (CERN)

PUBLIC INFORMATION
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Printed in Switzerland

Last month at CERN

'HBC 152' finishes first run

On 27 July the group operating the British 152-cm hydrogen bubble chamber, and those who had been associated with its installation and use at CERN, celebrated the successful completion of its first run, with over a quarter of a million photographs to their credit. Because of the hydrogen safety regulations still in force in the 'British' end of the East bubble-chamber building, the party was held in the 'CERN' end, in the shadow of the big 200-cm chamber still under construction.

As mentioned in *CERN COURIER* last month, the first week's 'technical' run of the 152-cm chamber also produced 10 000 pictures of positive-pion interactions. In the first two weeks of full operation for physics experiments (25 June to 5 July), 100 000 pictures were obtained showing interactions of negative kaons of momentum 5.08 GeV/c. This (experiment T 49) was for the 'K' collaboration' linking physicists in Birmingham, Glasgow, London (Imperial College) and Oxford Universities as well as groups at the Rutherford High Energy Laboratory and the Max-Planck Institute in Munich. The kaons were obtained by means of the o_2 beam line, the 180-metre long arrangement of magnets, collimators and electrostatic separators specially designed by British physicists for use with the new chamber. An average of 15 kaons per pulse was obtained in the bubble chamber, with a 'contamination' of 7 pions or muons.

In the third week (9-14 July) a further 40 000 pictures with K^- at 5.08 GeV/c were obtained and the beam line was then readjusted to give positive kaons at 5 GeV/c for the T 55 experiment, in which groups at Cambridge (U.K.) and Brussels (Belgium) as well as at CERN are collaborating. On the evening before the visit of the British Press, a highly satisfied group of physicists celebrated a collection of 60 000 pictures, each showing about 15 kaons — 10 000 pictures more than

they had asked for and including about twice as many interactions as they had expected. After a ten-hours rest to allow some emulsion and nuclear chemistry exposures in the o_2 beam, the run ended (15-19 July) with another 66 000 pictures for the T 49 experiment, this time using negative kaons at 6 GeV/c. At this energy the performance of the beam line surpassed all expectations and about 60 kaons were obtained at each accelerator pulse, with only a small contamination of other particles, (nearly all muons). This intensity would have given far too many tracks on the bubble-chamber photographs, even with the final magnet in the beam line to distribute the incoming particles across the whole field of view of the cameras. Hence the collimator apertures had to be closed down to reduce the flux again to about 15 kaons per pulse, with a spread in momentum about the mean value of only $\pm 0.3\%$.

Visit of British Press

On 15 July CERN was host to some two dozen journalists representing newspapers and technical publications in the United Kingdom. The main purpose of the visit, which was arranged by the Department of Scientific and Industrial Research and the CERN Public Information Office was to see the British 152-cm bubble chamber in operation, but advantage of the occasion was taken to obtain a more general view of the work that is done at CERN and the plans for the future.

After Prof. Preiswerk, Leader of CERN's Nuclear Physics Division, had welcomed the visitors in the Council Chamber, Prof. C.C. Butler gave an introductory talk on 'What is CERN and where does the BNBC fit into its work?'

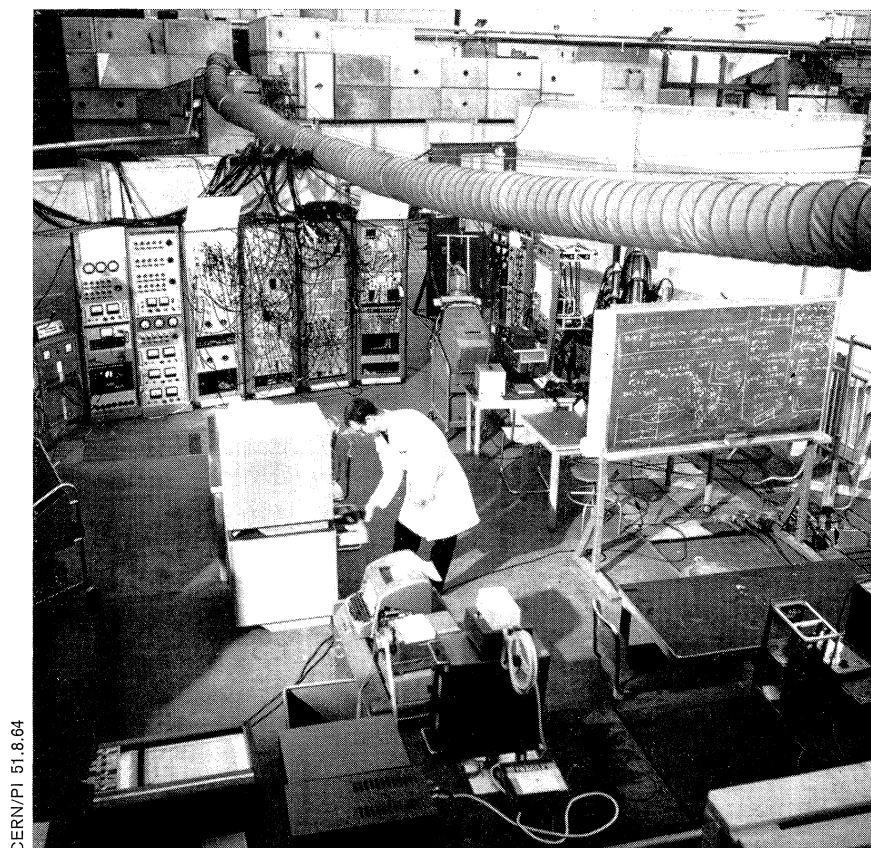
Prof. Butler, who is Head of the Physics Department at Imperial College, London University, began by saying that his audience might find it a little strange to be told about CERN by some-

one who was also a visitor, but that this was in fact an example of the principle of CERN, as an organization which belonged to all the physicists engaged in high-energy physics research in its Member States. The United Kingdom contributed nearly a quarter of CERN's financial resources, and British physicists could very proudly feel that they owned a quarter of the Laboratory. They could use the facilities of CERN, paid for out of its normal budget, and they could also bring to CERN equipment wholly financed from their own resources. This was the case with the British bubble chamber which the journalists had come to Geneva to see. During their visit they would also see the 81-cm French bubble chamber, which had been at CERN for some years and which had been used not only by the French physicists in charge of it but also for the well-being of European physics as a whole. At Imperial College, for instance, the physicists had analysed very many pictures that had come from the French chamber, just as in return they would send pictures from the British chamber to France and other countries.

Prof. Butler went on to describe the 28-GeV proton synchrotron and its operation, and the purpose of 'fundamental-particle' or 'high-energy' research, before describing the way in which the use of bubble chambers has developed in Europe. He then explained the way in which a bubble chamber works, with particular reference to the design of the British chamber. Finally he talked about the O_2 beam line — 'the most sophisticated of its kind in the world' — which conveys particles of the right kind, at the right energy and in the required numbers from the accelerator to the bubble chamber.

After the traditional view of CERN and its surroundings from the roof of the Administration building, the visitors were taken to the East bubble-chamber building. There, as well as being given an explanation of the British chamber and its various controls, they were able actually to look into the liquid hydrogen to see the spray of tracks formed every two seconds as the accelerator was pulsed and the chamber expanded. Then, in the Data Handling laboratories, they were shown some of the photographs being inspected on the new scanning table developed for use with the CERN 2-metre bubble chamber and how the tracks were measured on a 'IEP'.

After lunch the programme began with a visit to the main control room of



CERN/PI 51.8.64

Part of the equipment enclosure for the missing-mass spectrometer experiment in the South experimental hall of the proton synchrotron at CERN. In the foreground can be seen the paper-tape punch and electronic typewriter which are operated from the Mercury computer in the Data Handling laboratories; to their left is an automatic graph plotter also operated by the computer. This equipment allows the physicists to keep a constant watch on the progress of the experiment. The long flexible tube provides ventilation in the area of the hydrogen target and the target can be watched by means of the television receiver seen on the table behind the blackboard.

the proton synchrotron and the visitors' platform in the South hall, followed by a look at the 81-cm bubble-chamber, also in operation, in the North hall. Then came a climb to the upper gallery of the East experimental hall, to view the entire length of the O_2 beam line. The visit ended in the laboratories of the Accelerator Research Division, where the electron storage-ring model was presented and explained, and refreshments proved very welcome at the end of a day in which the weather had been more suited to sunbathing than to inspecting a scientific laboratory.

Experiments at the PS

As mentioned above, during the first fortnight of synchrotron operation the **British and French bubble chambers** were in use together. **Emulsion** exposures were made in the a_8 beam for trials of the E11a experiment on the magnetic moment of the positive sigma hyperon, and whilst the 152-cm chamber was out of action for some hours during the early part of its run the opportunity was taken to expose two emulsion stacks to about 2 million anti-protons, for the benefit of several

French laboratories. (This was in addition to an exposure to kaons which took place later in the run.)

The complex system of spark chambers in the d_{15} beam line was removed during the month, following completion of the experiment on the peripheral production of gamma rays. The beam line was then modified to d_{17} for the experiment designed to carry out a systematic investigation of the unstable mesons (or meson 'resonances'), using the '**missing-mass spectrometer**'. This apparatus, which, incidentally, is of particular interest from the point of view of the development of experimental techniques at CERN, had been moved from the synchro-cyclotron to the South hall of the PS during May. It uses a hydrogen target, together with a collection of sonic spark chambers and scintillation counters to detect the incoming and outgoing particles. The electrical signals from the detection system are registered by electronic scalars, which translate them into numbers, ready for recording (in an electrically coded form) on magnetic tape. The numerical data is also transmitted over a cable, 1.2 km long, to the 'Mercury' computer, which carries out various calculations and transmits the

results back to the physicists at the PS. This allows a constant check to be kept on the functioning of the apparatus and, more particularly, on the results being obtained. The progress of the experiment is in fact determined by the kind of results that it gives. This is the first time that an experiment has been carried out at the PS 'on-line' to a computer.

The d_{17} beam line itself is also of note, since its first element is a new 'thin' magnetic lens of the 'split-pole' type*, specially developed for use in regions of the target area where space is limited. This type of lens, evolved after extensive investigations using 'model' techniques, employs a novel combination of a split pole having sections of different heights with three separate excitation windings, to achieve the required accuracy and value of field gradient. It is only 50 cm wide, compared to 117 cm for the standard quadrupole with the same aperture (20 cm) and similar performance, and 1.5 metres long.

In the second fortnight of synchrotron operation, six different **counter experiments** were in various stages of operation round the machine. These included the missing-mass spectrometer, as well as the well-established **PAPLEP** and **proton-proton scattering** experiments, which are continuing to gather data.

In the South hall, considerable progress was made with the assembly of the apparatus for the experiment (S 30) to determine the **rate of decay of the rho meson into a pion and a gamma ray**, relative to its decay into two pions. The apparatus to detect the decay products includes a number of spark chambers arranged around the liquid-hydrogen target, and an optical system to enable the sparks to be photographed. Looked at from one side, the plates of all the spark chambers are perpendicular to the plane of a large vertically placed lens. The action of the lens is such that objects viewed through it from the focal point appear to be in line with each other if they are in fact on a line parallel to the lens axis. The camera placed at the focal point thus 'sees' straight along each spark-chamber gap. On either side of the spark chambers, two vertical glass plates have been set up. These have identical grids of fiducial mark engraved on them, and the plates are accurately aligned so that the marks define a set of imaginary lines parallel to the axis of the lens. Thus, with the camera

accurately positioned, the two sets of fiducial marks appear superimposed on the photographs and provide a reference grid against which the position and direction of each set of sparks can be measured. Mounted immediately above the lens is an identical one which forms part of a similar optical system, with the addition of a large plane mirror mounted, at 45° to the horizontal, above the spark chambers. This allows the chambers to be photographed from a vertical viewpoint. A three-dimensional reconstruction of the path of each decay particle is then obtained by combining the measurements from the two photographs of each interaction.

The lenses are made of 'plexiglas', with a diameter of 1.4 metres and a focal length of 10.5 metres. The special tools to shape and polish them, as well as the lenses themselves, were produced in CERN. Each of the four reference plates is about 235 cm wide and 200 cm high, with a thickness of 1.6 cm, and the fiducial marks (engraved at CERN also) form a square grid with 100-mm spacing, each point being positioned to about 0.01 mm. The mirror is in two parts, each 1 m x 2.5 m x 25 mm thick, aluminized on the front surface. To ensure accurate results, all these heavy components had to be aligned with a high degree of precision. The whole apparatus is enclosed in a light-proof wooden structure some 14 m long, 3 m wide and 4 m high, and all that can be seen (apart from the usual impressive array of electronic equipment along the side) is the q_3 beam line entering at one end and the two cameras projecting at the other.

In the East hall, the d_{16} beam was used by the group from Saclay investigating 'charge-exchange' reactions of pions, while the monitor beam for the o_2 beam was used for a novel, short experiment to check the **second postulate of relativity theory** — that the velocity of electromagnetic waves is independent of the velocity of the source emitting them.

On - line computer

Previously, another step towards automatic processing of experimental data was made on 19 June, when the Nuclear Physics Division took delivery of the major components of its **SDS 920 computer**. Compared to the CDC 6600 now on order for CERN, or even its present IBM 7090, this is a small machine, but it is also intended to serve a completely different purpose. The whole computer, with its auxiliary equipment, will be set

up as a self-contained unit inside a small mobile hut, so that it can be transported to any of the experimental halls and 'built-in' to any desired set of electronic detection equipment.

Its first use is expected to be in conjunction with the sonic spark chambers of the proton-proton scattering experiment in the East hall of the proton synchrotron. Here, individual protons are tracked to and from the target by means of the spark-chamber array. In each chamber the noise from the spark takes different times to reach each of the four microphones placed around its edge and, as with the missing-mass spectrometer, these times are given numerical form by scalars in conjunction with an oscillator, each scalar counting the number of oscillations between the high-voltage pulsing of the chamber and the arrival of the sound at its particular microphone. After each proton has passed through the apparatus the readings of all the scalars, together with other relevant data in numerical form, will be fed automatically into the computer, the programming of which will cause suitable checks for consistency to be carried out. Between accelerator bursts the accepted information will be transferred from the computer on to magnetic tape and the tapes will afterwards be taken to the large central computer for complete analysis. Because the computer can accept information much faster than it can be stored on magnetic tape, it will be possible to record the behaviour of about ten protons in each accelerator burst, instead of that of a single one, which is all that can be done at present.

This computer indicates clearly the rapid development that has taken place in computer techniques (both design and use) in the past few years. The central computing unit occupies a cabinet some 165 cm high x 125 cm wide x 64 cm deep, and weighs 600 kg, making it easily transportable. Yet in computing speed and scope it is comparable to CERN's 'Mercury' computer, only six years old, whose racks line the wall of a large room (as seen on the left-hand side of the photo on p. 76 of the June issue of *CERN COURIER*), and which was sufficient for the whole laboratory for some years after its installation. The SDS 920 was manufactured by Scientific Data Services Inc., of Santa Monica, California, and supplied through the French firm 'Compagnie Européenne de Calculateurs Industriels et Scientifiques'. Its cost, with peripheral equipment, was about 600 000 Swiss francs ●

* Report CERN 64-5.