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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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 (1.90%), Belgium (4.07), Denmark (1.95), Federal Republic of Germany (19.15), France (20.81), Greece (0.60), Italy (9.90), Netherlands (3.77), Norway (1.58), Spain (4.21), Sweden (4.15), Switzerland (3.23), United Kingdom (24.68).
The budget for 1962 is 78 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

After the intense activity of the month before, August was a relatively quiet month at CERN, and many people were on holiday. For those that remained, work went on as usual, but with little of special note to report.

Contents

The cover photograph illustrates the main theme of this issue, the International conference on instrumentation for high-energy physics, held at CERN in July, and shows the concentration of the participants as they listen to Prof. Jentschke's closing talk in the main auditorium. The television camera and monitor screen for the 'overflow' rooms can be seen on the right-hand side of the picture.

Photo credits : all photos by CERN/PIO.

CERN COURIER

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Among the experiments reported at the High-energy Conference in July were those on the decay of positive pions into neutral pions, the scattering of muons by carbon, the capture of muons by protons, the anomalous magnetic moment of the muon, and the lifetime of the positive muon. These interesting and important measurements were all made with the CERN **600-MeV synchro-cyclotron,** which then, so it seemed, chose the very week of the Conference to break down. This was not too inconvenient since the 'proton room' was in any case being used for the Conference. After necessary repairs to the vacuum system had been carried out, the programme of experiments planned for this summer was continued, with further measurements on the muon lifetime and a study of the formation of hydrogen molecules incorporating a muon.

From 21 August to 3 September, the accelerator was shut down, mainly to effect a transfer of the radiofrequency system to a new equipment room. A general improvement of the r.f. system was also undertaken, including an increase in the range of the frequency sweep, which permits the use of a higher magnetic field at the centre of the machine. The resulting increase in field gradient and hence in vertical focusing of the beam is expected to result in better yields of secondary particles from internal targets.

During the last week of August, the **proton synchrotron** was also shut down, beginning a two-month period during which major alterations are being carried out, directed mainly towards the opening up of the East experimental area, the extraction of the primary proton beam, and new investigations into the nature of neutrinos.

Before the shut-down the machine ran well, and although several pieces of equipment suffered breakdowns the amount of time lost was comparatively small. In the last two weeks, over 300 000 pulses of accelerated protons were delivered, covering some 168 hours altogether, at energies ranging from 11 to 24 GeV. The intensity was remarkably high, averaging over 5×10^{11} protons per pulse during this period.

Among the experimental teams working with the accelerator up to the shut-down was the group from **Argonne National Laboratory,** led by **Dr. A. Roberts,** which has now completed its experiments at CERN. The members of the group, with their successful spark chamber and other equipment, are now returning to the U.S.A.

On 7 August a visit was paid to the Laboratory by Mr. **Joseph Godber,** Minister of State for Foreign Affairs of the United Kingdom, who took advantage of his presence in Geneva for the 18-nation Disarmament Conference of the United Nations to take a look at our Organization, where the barriers of nationality are much less noticeable. He was accompanied by Lady Wright and Mr. N. Wright, wife and son of the Deputy U. K. Delegate to the Disarmament Conference, by General E. L. M. Burns, Deputy Leader of the Canadian Delegation, and by Mr. M. Cavaletti, Italian Ambassador and Delegate to the Conference ●

The 1962 International Conference on Instrumentation for High-Energy Physics at CERN

GENEVA July 16 - July 18, 1962

Only a few days after the Conference on high-energy physics (reported in the August issue of CERN COURIER), the lecture rooms of CERN were crowded again for the 1962 International conference on instrumentation for high-energy physics. This conference also takes place now every two years, under the auspices of the International Union for Pure and Applied Physics, and it has become the practice to hold the two more or less consecutively, to assist the many physicists who wish to attend both. Normally they are held in different places, but special circumstances this year made it easier to have them both at CERN, although this created more work for the Conference Secretariat and a greater disruption of the Laboratory's normal life.

Nearly 300 participants from 24 different countries joined those working at CERN to consider and discuss the apparatus (not counting the accelerators themselves) required to carry out the kind of experiments whose results had been reported the week previously. More specifically, they were interested in the development of the equipment to make possible the next advances in experimental high-energy physics.

Programme

Although agan divided into 'parallel' and 'plenary' sessions, the programme was arranged somewhat differently to that for the high-energy conference preceding it. As almost all the papers were received in advance it was possible to hold plenary sessions in the morning, at which the general development was surveyed in a series of talks by invited speakers, followed by parallel sessions in the afternoons, at which individual papers of about ten minutes duration filled in the details. Many of the instruments or methods discussed showed themselves as highly complex examples of physics and engineering, although others were yet more remarkable for their simplicity. Here, we can give only a brief and incomplete account of this interesting Conference; the whole story must be obtained from the 'Proceedings', which will be published as a special issue of *Nuclear Instruments and Methods.*

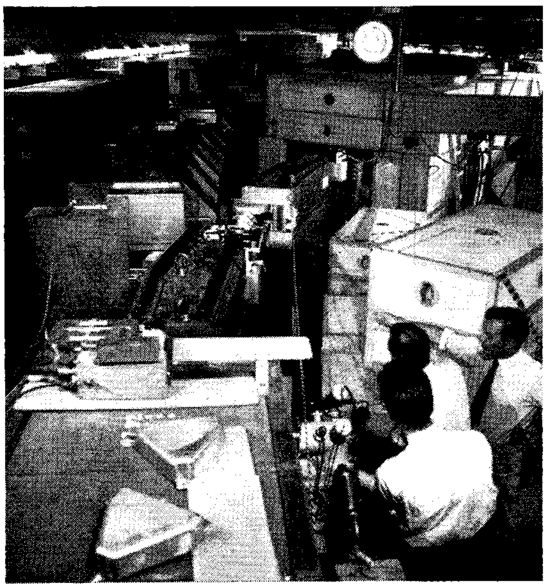
NEW EXPERIMENTAL TECHNIQUES FOR USE AT ULTRA-HIGH ENERGIES AND ACCELERATOR DEVELOPMENT AND IMPROVEMENTS

During the last year or so there has been much discussion and a certain amount of planning of new particle accelerators to produce much higher energies than the 30 GeV at present possible. Values of 300 GeV have been considered, and even 1000 GeV. At the first session of the Conference, **J. Sandweiss (Yale)** reviewed the very pertinent question of the other apparatus required to carry out experiments with such high-energy beams. The conclusion is that present-day techniques will certainly need considerable modification and some will be completely useless. For example, a commonly used method of identifying particles is to time them over a fixed distance — for different particles of the same momentum, the greater the mass the slower the speed and hence the longer the time taken. But with a timing accuracy of 10^{-9} second (a thousandth of a millionth of a second) a distance of nearly 7 km would be required to distinguish between a pion and a kaon at 1000 GeV! The gas Cherenkov counter will still be useful, but would need to be tens, or even hundreds of metres long to distinguish between particles of different mass.

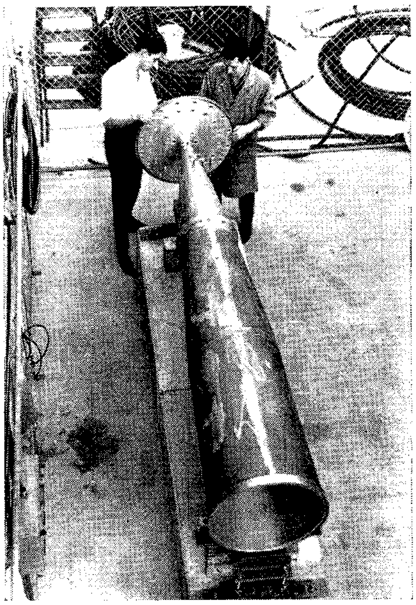
Various novel ways were also discussed of handling the primary proton beam, in order, say, to obtain a very high intensity of neutrinos with the minimum background of other particles. It was obvious from a study of the problem that experiments with such a giant accelerator would need to be performed quite differently from those at present, and that the full potentialities could not be realized without much new development.

H.G. Hereward (CERN) surveyed the development and improvement of existing accelerators, for which the drive is always towards higher intensity, greater flexibility, and greater precision, with reliability as an over-riding criterion.

The 6-GeV Bevatron at Berkeley, U.S.A., is being modified and a new injector installed, in the expectation of raising the intensity towards 10^{13} protons, per pulse. Both the alternating gradient synchrotron (AGS)



Specially shaped magnets with both bending and focusing properties, installed close to the vacuum chamber, enable greater numbers of secondary particles to be obtained. The photograph here shows the two designed for the pion and kaon beam known as a_2, from the CERN PS, mentioned in CERN COURIER in July this year.



Specially designed to increase the flux of neutrinos available at the CERN PS, the 'neutrino horn', of which the body is shown here, produces a shaped magnetic field that concentrates pions (from which the neutrinos are produced) in the same kind of way as the early gramophone horns concentrated sound. It will be used in conjunction with the fast ejection system for the PS proton beam and a system of high-current pulsed magnets and lenses. Its own current, also pulsed in synchronism, will reach a value of 300 000 A.

GLOSSARY

— **GeV** is the abbreviation for giga-electron volt, equivalent to a thousand million electronvolts. The latter is the energy gained by an electron, or any particle with the same amount of electric charge, positive or negative, accelerated in an electric field through a potential difference of 1 volt.

— **Cherenkov counters** depend on the fact that when high-energy particles travel through a transparent gas, liquid, or solid, at a velocity faster than that of light in the same substance, light is emitted at an angle characteristic of the velocity, much the same as a shock wave is produced by a supersonic missile. This light is detected by a 'photomultiplier' which converts it into an electrical signal. Suitable arrangements enable the angle of emission of the light and hence the velocity of the particle to be determined.

— **A scintillation counter** consists of a special solid, liquid or gas that emits a flash of light when traversed by a nuclear particle. The light (proportional to the energy of the particle) is directed on to the sensitive face of a photomultiplier, which produces a proportional alectric pulse.

— **An ionization chamber** is a device for collecting and measuring the electrically charged ions produced by nuclear radiations.

— **A spark chamber** consists essentially of an array of parallel plates, in which alternate ones are connected together, something like the plates of a radio tuning condenser. The interspace is filled with a gas like argon. Application of a high-voltage pulse between the two sets of plates causes sparks to be produced along any track of ions left by a nuclear particle. The sparks are then photographed, or otherwise detected.

— **Bubble chambers** utilize the fact that a liquid can be kept at a temperature ~~just~~ above its boiling point, but prevented from boiling by increasing the pressure to which it is subjected. If the pressure is released immediately before ~~after~~ ionizing particles have passed through, bubbles of gas form along the tracks and can be photographed.

— **Superconductivity** is the property that some metals have of losing their entire electrical resistance suddenly when cooled below a certain temperature, so that a current once induced requires no power supply to keep it flowing. The resistance is restored again by too high a current or by a magnetic field above some critical value, or letting the system heat up again.

at Brookhaven and the proton synchrotron (PS) at CERN are now producing internal beams of 0.5×10^{12} protons per pulse, and it seems clear that before long this figure will be raised to 10^{12}. However, there is a space-charge limit at 2 or 3×10^{12} (mutual repulsion of the charged particles preventing further enhancement of the beam), to overcome which would require modifications such as a new injector.

Experimental areas are being enlarged at several accelerators, and systems for extracting proton beams are being planned for the Bevatron, Saturne (Saclay), the AGS and the PS. At the PS, a resulting increase by as much as a factor of 1000 is expected for the intensity of some secondary beams, obtained when the primary protons strike a target. Such things as improvements in target positioning, the shielding of the internal beam from the ring magnet, and special extraction magnets fitting close to the ring vacuum tube, all contribute to larger numbers of secondary particles. Techniques for sharing beams between two or more experiments are also likely to improve.

Greater precision is becoming necessary in the positioning of targets and the primary beam itself, as well as in beam size, owing to the more stringent requirements of separated particle beams and the interest in neutral particles, for which a knowledge of the precise point of origin is required.

RECENT ADVANCES IN COUNTER TECHNIQUES

V.L. Fitch (Princeton) reviewed the field of electronic counters, dealing with particle detectors of the Cherenkov, scintillation, and solid-state types.

Focusing Cherenkov counters, in which the emitted light is focused on to photomultipliers that produce an electrical signal proportional to the amount of light, have been widely developed in the last year or two. Since the light is emitted only by particles travelling faster than some threshold value, particles of the same momentum but different mass can be distinguished. Out of several examples, one developed at CERN is essentially a tube of hydrogen at a pressure variable between 0.5 and 3 kg/cm², 10 metres long and 15 cm in diameter. Electrons can be differentiated from a background of pions and muons ten to a hundred thousand times more intense, at a particle momentum of 8 GeV/c. Other Cherenkov counters, using liquid or solid radiators rather than gas, have been combined with 'light multipliers' or closed-circuit television systems to give greater sensitivity, and new developments in some laboratories enable both the direction and the velocity of a particle in the counter to be determined.

Scintillation counters are now a well-established, versatile form of particle detection, and there was nothing fundamentally new to report. The main advances have been in the use of large arrays of counters, and of counters in conjunction with slabs of absorber to provide energy measurements up to higher values. An allied device now being developed is the **scintillation chamber,** where an image of the actual track is obtained with the aid of highly sensitive image intensifiers.

Also fairly new is the **'solid-state' detector,** effectively a solid ionization chamber, which can be very useful when small size or the ability to work in high magnetic fields is essential.

PRESENT STATUS OF SPARK CHAMBERS

The second day opened with a survey by **J. Cronin (Princeton)** of what he termed the 'phenomenal' development of spark chambers in the past two years. They are now in use by some 60 different individuals or groups all over the world, and several important discoveries have been made as a result, the most recent being the proof of the existence of two neutrinos.

Spark chambers have two important properties : the inherent track persists long enough for the chamber to be triggered after the particle has gone through, and yet this 'memory' time is nevertheless short (about half a microsecond). Thus it is possible to have up to a million particles per second traversing the chamber and still obtain photographs showing only particles with specified characteristics, as selected by means of scintillation or other counters which cause the high-voltage pulse to be applied to the chamber. Moreover, about 10 milliseconds after the pulse the chamber is ready for use again, so that up to ten photos are possible for each burst of an accelerator like the PS.

The chamber is very versatile, the area, thickness, shape, spacing, number, and material of the plates can all be chosen to suit the experiment. Arrays of different chambers can be used together. Chambers have been made by stretching thin aluminium foil on lucite frames ; by contrast, the 10 chambers used in the Brookhaven neutrino experiment used aluminium plates 25 mm thick and each weighed 1 ton ; one Russian chamber has a plate spacing of 250 mm. A recent CERN experiment used nine chambers spaced 1 metre apart, with a series of 32 mirrors to project all nine pairs of images on to one frame of 35 mm film ; the displacement of a track between chambers gave its angle of flight.

A growing development is the use of spark chambers in magnetic fields, thus producing curved tracks from which values of momentum can be obtained. Rather surprisingly, the magnet has little effect on the operation of the chamber. Knowledge tends to be empirical, and as with many other electrical discharge devices, spark chambers are used to a great extent without any detailed understanding of their precise mode of operation. Some studies have, however, been carried out particularly in Russia on the requirements to be satisfied before a spark follows the ionization track in each gap rather than occurring perpendicular to the plates.

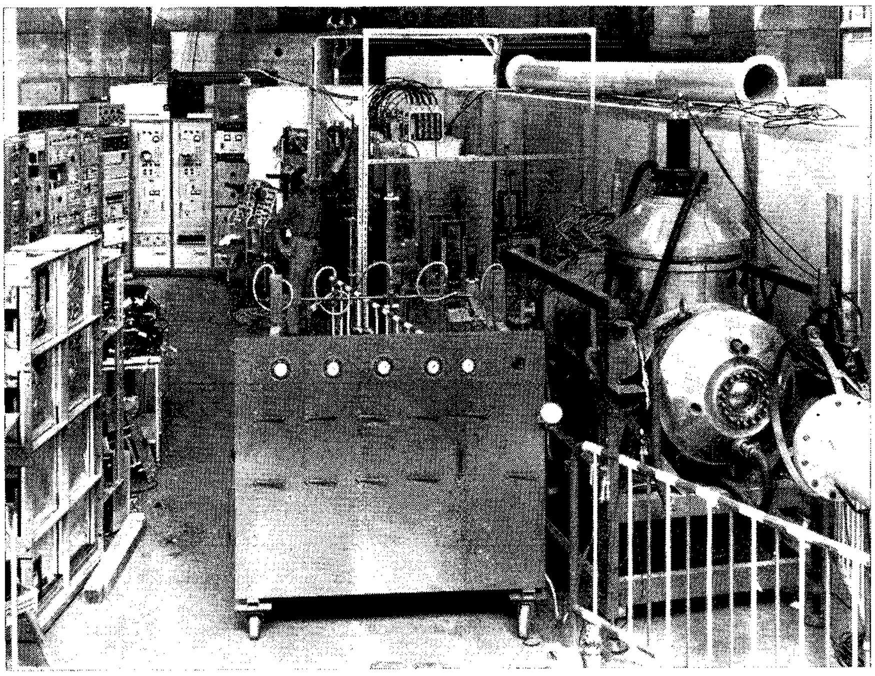
New types of chamber

Even greater usefulness is promised by a number of new ideas now being developed. Instead of photographing the 'lightning' (of a spark) it is possible to 'listen to the thunder', and to measure the transmission time of the ultrasonic sound waves from the spark to derive its position. One idea being developed at CERN is to replace the plates by sets of fine parallel wires, oriented and connected in such a way as to record the position of the particle by means of the electrical pulses created by the spark. Another is to construct the plate in the form of a delay line, the time between the application of the voltage pulse and the appearance of the signal being a measure of the position of the spark. All these methods allow the possibility of connecting the spark chambers directly to a computer, for processing and analysing the results.

A more radical departure, also originating at CERN, promises to be the basis of a new type of counter altogether. It utilizes a transparent insulating liquid contained in a 'box', the bottom of which is of porous ceramic. Gas is forced through the ceramic and keeps the liquid continuously filled with small bubbles. If a charged particle passes through and a high-voltage pulse is subsequently applied, sparks occur only in the bubbles along the track and can be photographed. Like the conventional spark chamber, this can be made to operate only on selected particles ; it thus combines some of the advantages of the spark chamber with those of the bubble chamber.

RECENT ADVANCES IN BUBBLE-CHAMBER TECHNIQUES

R.P. Shutt (Brookhaven) reminded his audience that it is just ten years since the first bubble chamber was constructed in a small glass tube. Two years later, liquid hydrogen was first used in a chamber and the use of large metal chambers was



Several kinds of particle detectors can be seen in this picture of equipment being assembled for tests at CERN. In the right foreground is a gas Cherenkov counter of the focusing type, used to ensure that the spark chamber behind is triggered only by electrons. In between, some plastic scintillators can be seen, mounted vertically on top of their photomultipliers. On the extreme left a large liquid scintillation counter is awaiting positioning. In the centre foreground is the filling apparatus for the Cherenkov counters, while racks of control and counting equipment can be seen in the background.

proved possible. At the 1960 Conference in Berkeley many versions were described, but since then new technical developments have been rare and the emphasis has been on actual use, or on the engineering completion of the large chambers then planned. In the past two years over 100 important papers have been written describing results obtained with bubble chambers, and some 20 million photographs of particle tracks have been obtained. The 72-inch (183-cm) liquid-hydrogen chamber at Berkeley, which operates at a temperature of —245°C, recently ran for 9 months without being allowed to warm up.

The liquid-hydrogen chamber now under construction at CERN, with a length in the beam direction of 2 metres, will be one of the two largest ever made ; a similar one is being built at Brookhaven. A 2-m liquid-propane chamber is also being made, at Dubna.

DEVELOPMENT OF DATA-ANALYSIS SYSTEMS FOR BUBBLE CHAMBERS FOR SPARK CHAMBERS AND FOR COUNTER EXPERIMENTS

G.R. Macleod (CERN) began his talk on the last morning by explaining that in the field of data analysis 24 papers had been submitted for the meeting and another 18 for the informal sessions arranged for the following day. This meant that not everything could be considered fully at the meetings, but it was an indication of intense activity.

The standard method of evaluating bubble-chamber pictures can be divided into five steps :

1. scanning - events of interest are selected from the complete length of film ;
2. measurement - the co-ordinates of points on two or more stereoscopic views of the event are obtained in a form suitable for input to a computer ;
3. geometrical reconstruction - the curvature and direction in space of the tracks and the positions of interaction vertices are computed ;
4. kinematic analysis - the computer compares the results of various hypotheses against the actual event and determines quantities describing the kinematics of the event ;
5. experimental analysis - the particular events needed for the results of a chosen experiment are selected, and histograms or other appropriate graphs plotted from the results.

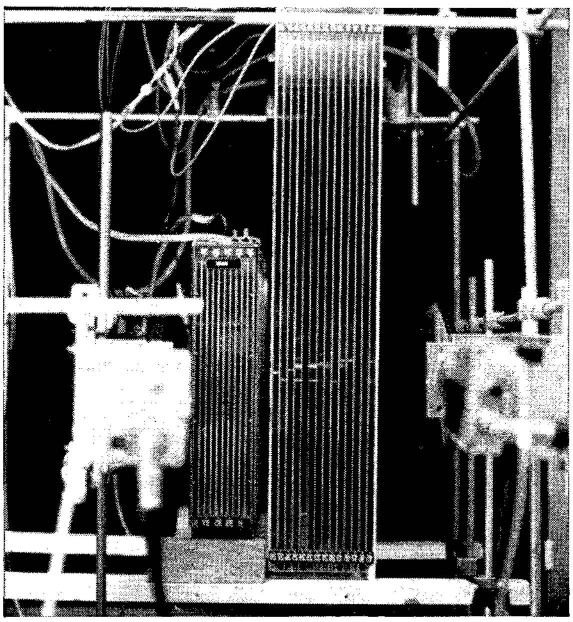
Various computer programmes have been or are being developed to deal with the last three stages, but effective ways of incorporating the high proportion of events at present rejected by the programme are still needed. Also, because of the many thousands of photos that may be accumulated in any one study, reliable methods of 'book-keeping' are becoming more and more necessary. Usually the computer is used for this too, a complete record being kept on tape in such a form that the data for any event can be quickly extracted again.

Automatic scanning

The need for faster working to deal with the rapidly growing number of photographs has resulted in attempts to speed up the second stage, the slowest in the chain, and the first step was proposed by Hough and Powell at the 1960 Conference. The system has since been developed by a collaboration of Berkeley, Brookhaven, CERN, and the Rutherford Laboratory, and three instruments are now about ready to process experimental data. In operation, the tracks of interest are first measured rapidly, in a similar way to that used at present, by an operator who moves a marker along each track, thus causing a small number of approximate co-ordinates to be punched on to cards. A **flying spot digitizer (FSD)**, using a scanning device similar to that of the original television system, then automatically measures the accurate co-ordinates of every track bubble and feeds them straight into the computer memory. From this the computer programme, instructed by the card input, can select the events to analyse and substitute the accurate co-ordinates for the rough ones ; the remaining three stages are then similar to those currently in use.

A rather different method has been developed by the Alvarez group at Berkeley. In their **scanning-measuring-projector (SMP)** the films are searched by an operator in the usual way, but when an interesting event is found the movement of a small aperture along each track causes a series of accurate co-ordinates to be fed directly into the computer memory. When the whole event has been measured, the data are processed in a similar way to that in the Hough-Powell system.

In both systems the flexibility of the computer enables it to be used to the full, so that with the SMP, for example, a geometry or kinetics calculation for a previous event would be interrupted only momentarily for the feeding in of co-ordinates from a new one. Each event takes about 15 seconds to process completely, and assuming one interesting event is found every 4 minutes on each SMP, fifteen of them connected to one 7090 computer could deal with a total of some 4 events each minute. In this way, with only single-shift working (8 hours per day, 6 days per week, 50 weeks per year), either system can measure 5×10^5 events per year — more than five times the present rate of processing and comparable with the yearly output of a large bubble chamber.



End-on view of two of the Argonne Group's early spark chambers during tests at CERN. Tracks caused by charged particles from a synchrotron target can be seen in the right-hand chamber ; the left one was not connected. On either side of the chambers are scintillation counters for triggering. The numbers identifying the gaps are printed in reverse, since the photographs would normally be obtained, during experiments, with the aid of a mirror system.

The concentrated programme made it difficult to collect people for this group photograph, and many participants are missing.

Progress is also being made towards the elimination of the operator in the first stage of processing (the selection of wanted events from the whole film). It is generally agreed that three operations are necessary : reduction of the track images on the film to a set of 'track elements', sections short enought to be considered straight ; association of track elements into tracks ; selection of tracks making up an interaction. On this basis the approach varies from adaptations of the flying-spot digitizer used in the Hough-Powell system to the design of special computers incorporating pattern recognition devices.

Spark-chamber photographs are at present processed in a similar way to those from bubble chambers, but the development of fully automatic methods has become imperative owing to the rate at which the photographs can be produced — the Argonne group at CERN, for example, recently took 100 000 pictures in one week, 15 000 of which contained specific tracks of primary interest. The generally lower precision required in the measurements and the almost total absence of background make the task easier than in the case of bubble-chambers, but the probable need to deal with chambers of complicated shapes and the effects of operation in magnetic fields can make it more difficult. Cathode-ray-tube scanning systems of various types are currently being developed ; one at CERN is designed to scan only between the plates, giving a position measurement for each spark it encounters.

Some workers aim to use television cameras that will record directly the positions of the sparks in digital form on magnetic tape, without the use of film at all. More radically, the new types of spark chamber reported at the Conference may eliminate altogether the detection of light and subsequent digitizing of the track.

Counters

The main development of data-processing methods for counter techniques since 1960 has been in the use of digital data-handling devices and of 'on-line' computers. In the first, the signals obtained by arrays of counters are fed immediately into a storage system, and then between accelerator bursts the data is extracted on to punched paper tape, cards, or magnetic tape, as appropriate, ready for processing by a computer. In the second the information is extracted between bursts from the store straight into the computer, which can be programmed to give a continual check on the progress of the experiment. For example a special low-cost computer has been designed at M.I.T. to perform partial processing of the data in this way and also to monitor periodically such items as beam intensity, magnet currents, and the operation of each counter. Developments in electronic techniques, circuitry, and equipment, have contributed largely to this kind of progress.

HIGH MAGNETIC FIELDS

The last plenary session of the conference was devoted to a review by **T.H. Fields (Northwestern University, U.S.A.)** of progress in the use of more powerful magnetic fields. Not only will these be more and more necessary at higher particle energies, but their use in many experiments today can lead to savings in cost, or to greater accuracy in measurement.

Pulsed magnets, employing more or less conventional materials but with very high electric currents flowing for a very short time, are useful for fields of 50 000 to 300 000 gauss. The greatest problem in obtaining higher values is to obtain sufficient mechanical strength of the coil, and particularly of the insulation.

'Cryogenic' coils, operating at very low temperatures, have many advantages when the strength of the fields required and the scale of the application is large enough to warrant the complexity of refrigeration systems, etc. Sodium and aluminium seem to be the best conductors, and the sort of power saving that can be achieved is 90 % of that required by an equivalent magnet with copper coils.

Superconducting coils allow even further power savings, but introduce their own special problems. Very high current densities can be obtained, but generally the superconducting property is destroyed by the magnetic field produced. By using very thin films of conductor, however, it seems that this defect might be overcome to a large extent. More hopefully, a number of alloys have now been produced which seem to have different properties to those of pure metals, in particular a higher critical field, but the materials are very brittle and difficult to use.

CONCLUSIONS

The closing talk was given by **Prof. W. Jentschke,** head of the DESY (Deutsches Elektronen-Synchrotron) project at Hamburg. He began with a brief historical review, and recalled that only ten years ago the largest particle accelerator was the Cosmotron, which had just accelerated protons to 3 GeV. The principle of strong focusing (basic to machines like the CERN PS and designs now being considered) was first being explored for steering particle beams. There were no man-made antiprotons, no K-mesons, and more than half our present-day list of 'particles' (not counting the new 'resonances') were unknown, most of them not even dreamed of. The first bubble chamber had recently been demonstrated, with about 2 cm^3 of liquid in a glass bulb, Cherenkov counters were just being developed, and spark chambers were unknown. Transistors had not yet replaced thermionic valves to any extent, and the times that could be resolved in single-particle detection were some ten times longer than the 10^{-9} second that is commonplace today.

In those ten years much has happened, and the instrumentation revealed by this year's Conference, reviewed by Prof. Jentschke and already described in this article, is very different to that known then. The people involved, however, are very much the same, though their problems are changing, and Prof. Jentschke brought the Conference to a close by talking about them :

'There are two kinds of people who build such instruments. There are the ones who are basically interested in physics and suddenly they are stuck, and then they say, "well we have to invent something new". That is for those people the hard way. But fortunately there are also existing some other ones who are more basically interested in the design of instruments, and the physicists are very eager to use then these instruments. I think it is very fortunate that we have both of these types of people. But, nevertheless, the whole development goes in a direction where the number of people employed on such accelerator sites will increase, and the equipment will increase, and so on, and I think that the problems of managing and administration will grow, and will be very difficult, and that much as we learn about the advancement of these accelerators we must also learn that we should be very careful that those people, the physicists and the engineers, who would like to do their technical jobs should be really free to spend their time in the laboratories ; if we succeed in this the progress will be great and the results achieved will increase our knowledge.

So one could have again the old idea that the methods and the means have changed but the adventure to explore our world in physics is still the same as in the times of Galileo and Newton.' **A.G.H.** ●

LATE NIGHT IN BARRACK 10

This picture is indicative of the large amount of work that went on behind the scenes to ensure the success of the two Conferences in July. The whole of each session was tape-recorded, and a team of girls spent every day from 11 o'clock in the morning until an hour or two past midnight, duplicating the discussion ready for checking in the morning by the speakers concerned. CERN scientists were also heavily involved, each session needing at least two scientific secretaries, responsible for the programme, the accuracy and completeness of the record, and the contribution to the 'Proceedings'.

Before the Conferences, the Organizing Committees had to decide on the main subject divisions and review the papers submitted. CERN's Scientific Conference Secretariat, assisted when appropriate by other specialist sections, had the major task of making all the arrangements. Each participant had to be contacted and kept informed of progress, and the bulky Conference folders had to be prepared. Hotel accomodation had to be found (at the height of the tourist season), special transport provided during the Conferences, catering facilities expanded. The SC proton room had to be made ready, television and sound systems installed to link the three lecture rooms.

During the Conferences, every slide used was copied and filed. Afterwards, final versions of all the papers and discussion had to be prepared for the 'Proceedings', including the checking for accuracy of all names and literature references. For the Proceedings of the high-energy Conference, everything had to be marked up for the printer, 'galley' proofs of the text, and then proofs of the pages, with illustrations, all carefully checked — no easy job with so many mathematical formulae and names of every nationality.

In this short space it is quite impossible to do justice to the many people involved, but perhaps these few examples will serve to show that it takes more than just good speakers to make a successful conference ●

Informal Meeting on Track Data Processing, 19 July

The standard instrument used to-day for measuring bubble-chamber and spark-chamber tracks is the 'digitizing projector' (often called IEP in Europe or Franckenstein in America) which enables the operator to determine the co-ordinates of selected tracks and to record them on punched tape. Precision work performed by a human operator is relatively slow and the rate at which the pictures can be processed in this way is felt to be unsatisfactory. In the 'second-generation' machines the operator will have to do only low-precision measurements, and the refined accuracy is introduced by the machine itself, working either in parallel (as in the Hough-Powell system) or in conjunction with the human operation (as in the SMP). Future improvement of these and similar systems may lead to complete elimination of the human operator, thus ensuring a further and considerable increase in speed. Several development projects of this kind are under way in various laboratories ; it is thought that fully automatic processing will be easier to achieve for spark-chamber pictures than for those from bubble chambers.

The processing of the visual information contained in bubble-chamber and spark-chamber photographs is an essential part of these detecting techniques, and the instruments needed for such processing are rapidly growing in importance. This growth presented the organizers of the 1962 Instrumentation Conference with a problem which their immediate predecessors (at Berkeley, in 1960) had already had to face : how to provide an adequate discussion forum for this specialized subject while keeping a balanced view of its place in the instrumentation field as a whole. Following the Berkeley precedent, it was decided to supplement the sessions of the Conference devoted to data handling by an additional day of discussions, which would be open to all those, and only those, specially interested in these techniques.

The meeting was organized, on informal lines, by the Data Handling Division of CERN (Dr. L. Kowarski acting for the Division as a whole, Mr. M. Benot and Mr. B. Elliott as scientific secretaries, and Mrs. G. Andreossi as executive secretary).

Communications and discussions were invited on the three following topics :

1. Present state and prospects of semi-automatic devices for the processing of bubble pictures : the Hough-Powell system (HPD) (CERN, Berkeley, Brookhaven and Harwell), the Scanning and Measuring Projector (SMP) (Berkeley), the Precision Encoding and Pattern Recognition device (PEPR) (M.I.T.), etc.
2. Ideas and reports on similar devices for spark pictures.
3. New developments in programming for the systems currently used (digitizing projector) and for those about to be used.

In the course of the meeting 19 communications were presented and many of them were followed by lively discussions.

In his concluding remarks, Dr. Kowarski summed up the day's proceedings by using a chronological criterion (which Prof. Alvarez had already introduced in his handling of the morning's discussion) to group the different types of instrument discussed. He said : 'We can already speak of a first generation — hardware which, at present, is in actual use ; a second generation, in the state of advanced development ; a third one, almost wholly in the future. There are even one or two intermediates.'

The continuing novelty of the first-generation techniques lies in their programming aspects. Communications on this subject were given by R. Böck (CERN), E. Fett (CERN), A.H. Rosenfeld (Berkeley), J. Zoll (Cambridge), B. Burren (Harwell) and S.Y. Nikitin (Moscow). As Dr. Kowarski commented in his concluding remarks : 'The experience reported was programming experience and it gave a rather terrifying glimpse of the amount of work which goes into straightening out seemingly unimportant details. In fact each of these details is quite essential for the quality of the scientific output ; this means that we shall have to hire more and more programmers.'

Among the devices intermediate between the first and second generations, the most radical innovation is represented by the 'Spiral Reader', whose performance was reported on in a paper presented by L. Alvarez. A somewhat simpler device of the same family was described by G. Brautti (Trieste). An improved digitizing projector, making use of a specific feature of spark-chamber pictures, was described by L.T. Kerth (Berkeley).

The Hough-Powell system (second generation) was presented in some of its secondary aspects. R. Chase (Brookhaven) described a rough-digitizing device based on magnetic induction. P. Hough reported on some programming work, done at Brookhaven, which opens the way towards automatic pattern recognition, to be performed by the computer in conjunction with the standard flying-spot scanner. H. White (Berkeley) presented his views on how the data resulting from the operation of a Hough-Powell or a PEPR system could be stored and summarized for a final examination by the working physicists. J.N. Snyder (Urbana) and R. Hulsizer (Berkeley) reported on the results obtained with the SMP system and the proposed way of using it.

In the 'concluding remarks' the second-generation systems were summarized in the following words : 'Both of them pursue the same aim — to solve the problem of man versus machine, but their ways of approach are diametrically opposed. HPD segregates, SMP combines ; we shall find that they will both be useful in their separate and even slightly diverging ways, HPD holding its own in high-statistics research and SMP being particularly valuable when the events show a more pronounced individuality.'

A simplified and less ambitious version of the SMP was proposed by O.R. Frisch (Cambridge). Two other British papers — one by B. Burren (Harwell) on a flying-line scanner and another by A.R. Edmonds (London) on a flying-spot on-line system, put forward, on the contrary, proposals of a rather ambitious kind. This was also the case for the communications presented by J.W. Butler (Argonne), on a fully automatic system for handling spark-chamber pictures, and by B.H. McCormick (Urbana), on a computer specially designed for pattern recognition.

It is intended to publish a CERN Report in which many of the above-mentioned communications, as well as most of the discussion, will be reproduced ● **D.D.**

Historic Television Programme

Telstar shows CERN to two continents

During the evening of 23 July about two hundred million television viewers in Europe and North America had a short glimpse of CERN at work.

Showing our Organization to so many people was a remarkable feat in more ways than one : first, because of the large number of viewers, which clearly shows the power of modern means of communication, and again because of the preparatory work needed for this direct television transmission. Then there was the technical achievement represented by the artificial satellite, relaying electromagnetic waves from Europe to the United States. Finally, it was an historic occasion to which no one could remain indifferent.

— Telstar weighs 76 kg. Its radio receivers detect signals of less than 10^{-9} watt, amplify them without distortion and re-transmit them on a different frequency at a power of 2 watts. Electric power for the 2528 semiconductor components is provided by 3600 solar cells, converting sunlight into electricity. Up to ten television programmes or 10 000 telephone conversations could be transmitted simultaneously.

— The ground stations receive signals with a power of only 10^{-12} watt. Ruby crystal 'masers' are employed in the first stage of the amplifier, which is cooled with liquid helium to reduce the background of electrical 'noise'.

Mondiovision

The transmission in which CERN took part was the first of its kind. Never before had so many television viewers from such a large section of the world simultaneously watched a direct 'live' programme. Naturally it was not possible in Europe to judge the quality of the pictures received in the United States via the Telstar satellite. However, the pictures from America on the small European screens were exceptionally clear, considering the distance, the number of relays, and the frequent switchovers from one system to another between camera and receiver. From 7.58 p.m. onwards on 23 July, the twenty or so people gathered round the monitoring screens placed by the Swiss Television in the PS South generator courtyard clearly felt the historic importance of this moment, while the communications satellite inexorably continued in orbit thousands of kilometres away.

Three hours later it was the turn of the Eurovision network to send its pictures to Telstar to be distributed over the North American continent.

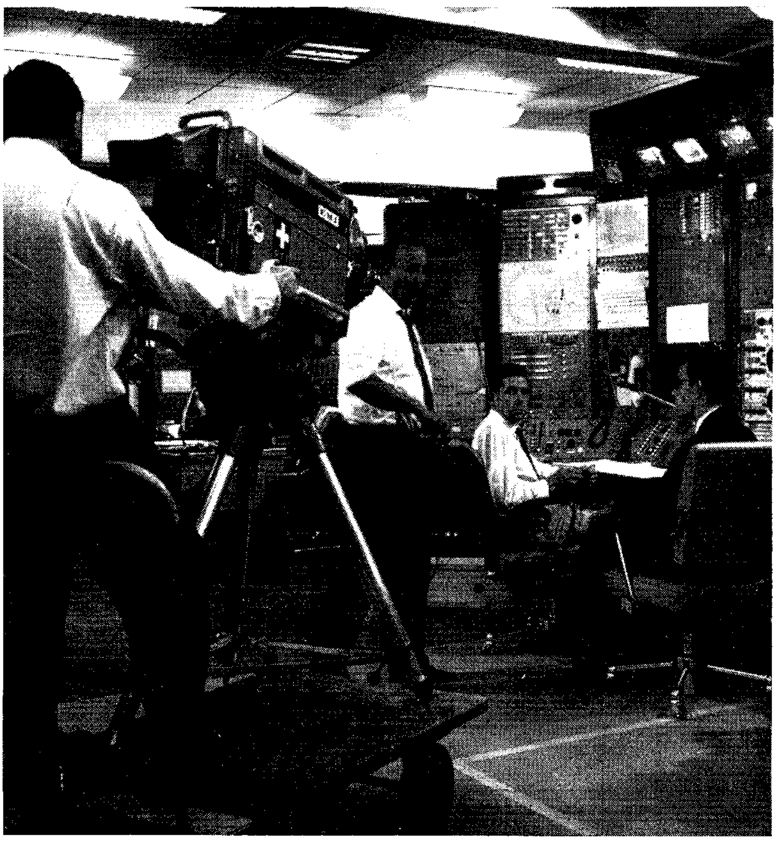
Through the Eurovision network, Austria, Belgium, France, Italy, the Federal Republic of Germany, Sweden, Switzerland, the United Kingdom and Yugoslavia gave the United States a glimpse of life in Europe at that moment.

60 hours of preparation

At Meyrin 60 hours of feverish preparation were resolved in 60 seconds of direct transmission. One minute of programme time had been allotted to Switzerland and similar times to each of the other countries taking part in the Telstar programme. Within the limits of such a short time each country was expected to transmit to American television viewers not so much a page from our continent's commercial catalogue as some evidence of our historic inheritance or cultural background. Moreover, because of the difference in time, it was the night-life of Europe that had to be shown. Although it was 10.58 p.m. in Geneva, it was early evening in New York, and California was still sweltering in the afternoon sun. The third requirement of the programme was for striking and well-lit pictures.

This is why the Swiss producers chose CERN as the subject for their country. Here they found a true symbol of European unity and international co-operation ; a scientific laboratory established for cultural purposes, working day and night ; technical installations which could easily solve the lighting problem ; a place where the difficulties of radio and telephone contact with the European Television Network would not be exceptional, and where there would be room for the necessary monitoring and control installations for co-ordinating with the European programme.

How was the programme itself prepared ? After preliminary negotiations between Walter Plüss, producer of the programme for Swiss Television, and Roger Anthoine,



Decision : before the programme, the producer, Walter Plüss (centre) gives his instructions to the cameraman, H. Schuler, in the PS control room, while L. Blanc and E. Ratcliff (extreme right) await their turn.

Concentration : after CERN's contribution, those who had taken part could join the others round the monitor screen in B. Agoritsas' Laboratory, to see the rest of the programme.

representing CERN, the programme had to be decided upon. In agreement with Peter Standley, Deputy Leader of the PS Machine Division, the PS control room was chosen as the hub of the programme.

This was to take place during the evening of Monday, 23rd. Early on Saturday, 21st, the teams and vans of the Swiss Television and Telegraph and Telephone services had taken over the extension to the control room, the courtyard in front of the South generator building, and the laboratory of B. Agoritsas, rapidly transforming this into a monitoring room in permanent contact with the programme co-ordinating centre in Brussels. When the synchrotron was shut down on Saturday night, rehearsals took place, transmitted directly to Brussels via the parabolic aerial installed on the laboratory roof in direct visual contact with the main Swiss transmitter on 'La Dôle'.

In Brussels, Aubrey Singer, who was in charge of the whole European programme, said that he wished to see not only the synchrotron control room but also the gigantic accelerator itself. This meant feverish activity in the small hours of Sunday morning, and telephone calls to P.H. Standley and a Health Physics representative — L. Haemers — in order to get permission to install a second television camera in the synchrotron ring. A further three rehearsals were held on the Sunday evening and another on Monday, when the countries taking part successively had their transmissions vetted by the Brussels control centre. From the north of Sweden down to Sicily, and from Land's End on the Atlantic coast, to Belgrade, about 10 000 technicians, in touch with each other by the wonder of radio, were thus simultaneously working to prepare this new wonder of intercontinental telecommunications.

Two cameras at CERN

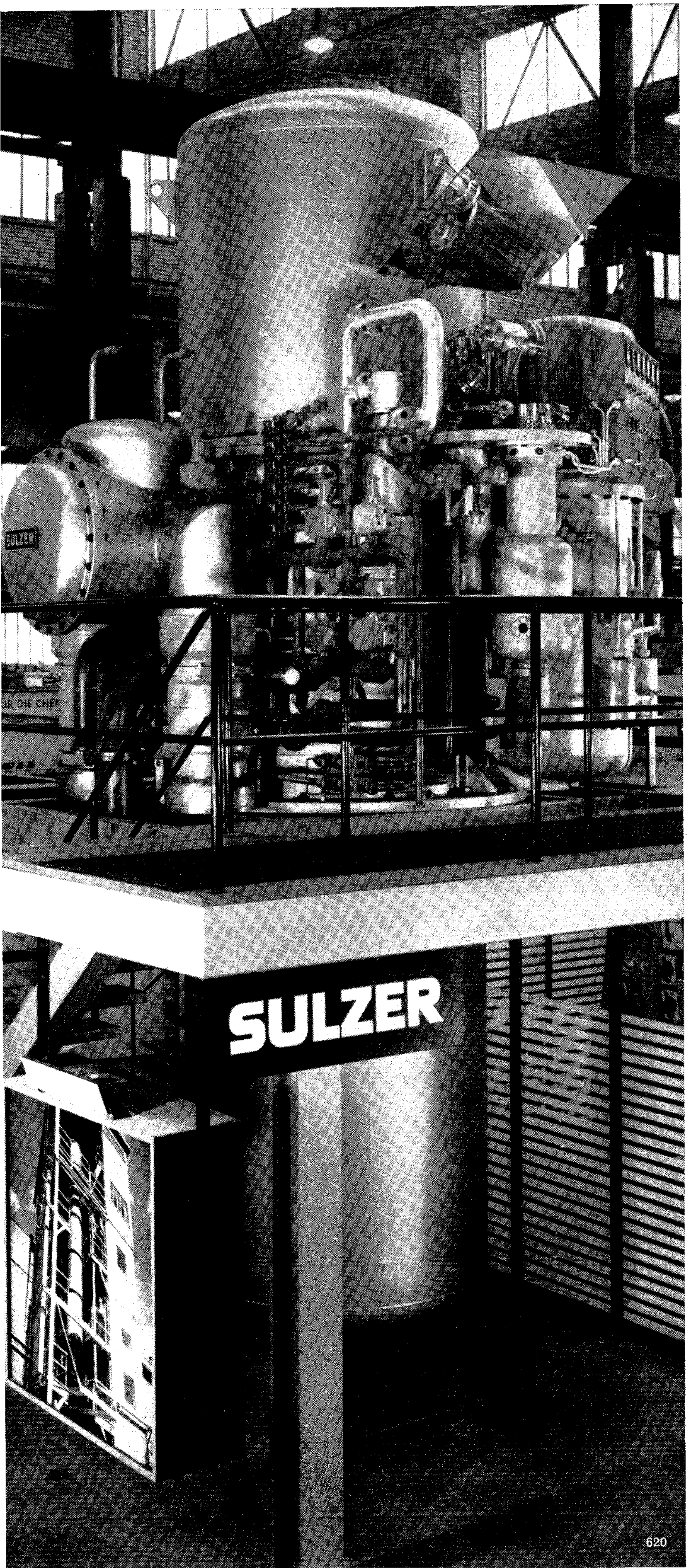
Out of the 55 TV cameras in Europe, two bearing the Swiss colours were operating at CERN. The first had been hoisted on to a narrow platform in the PS ring and, in the hands of R. Kuratchi, was to cover the accelerator tunnel to open the programme. The other, more mobile, was moved round the main control room. There was a technical hitch here a quarter of an hour before the transmission, which nearly upset the whole programme : the No. 2 camera broke down ! It was fortunately repaired at the last moment by replacing a simple coaxial cable in the control van. The pictures taken with this camera by H. Schuler briefly showed the South experimental hall and its cloud chamber, and then the PS control room, where an everyday atmosphere was created with the help and co-operation of the MPS and NP Divisions.

Eight members of the CERN Staff directly helped to create this scene : Ph. Bernard (MPS), H.H. Bingham (NP), L. Blanc (MPS), D. Dekkers (MPS), H. Faissner (NP), R. Pegaitaz (NP), E. Ratcliff (MPS) and Maria Szeptycka (NP).

Other people, though less in the limelight, contributed no less to the success of the programme. These included many members of the MPS and SB Divisions, and special mention should be made of S. Chiarinelli, who was responsible for the electrical connexions for the 15-kW power supply needed for the lighting.

At midnight on 23 July, Telstar's day of glory reached its end. Thanks to the satellite of the American Telegraph and Telephone Company, American TV had broken into European homes, and Europe — including CERN — had been seen all over the North American continent ●

R. A.



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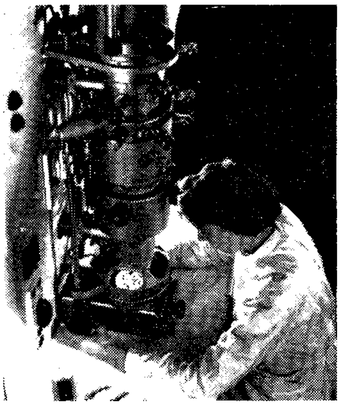

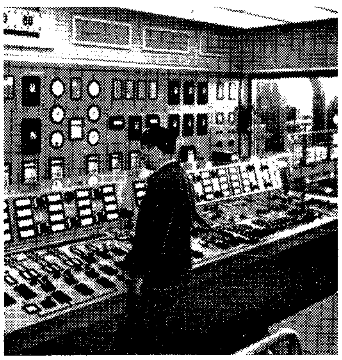

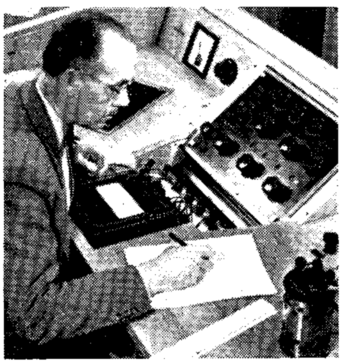

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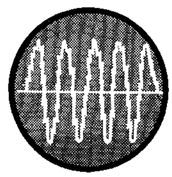

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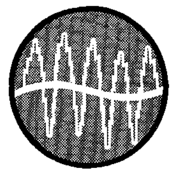

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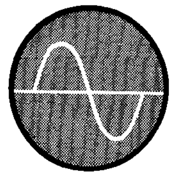

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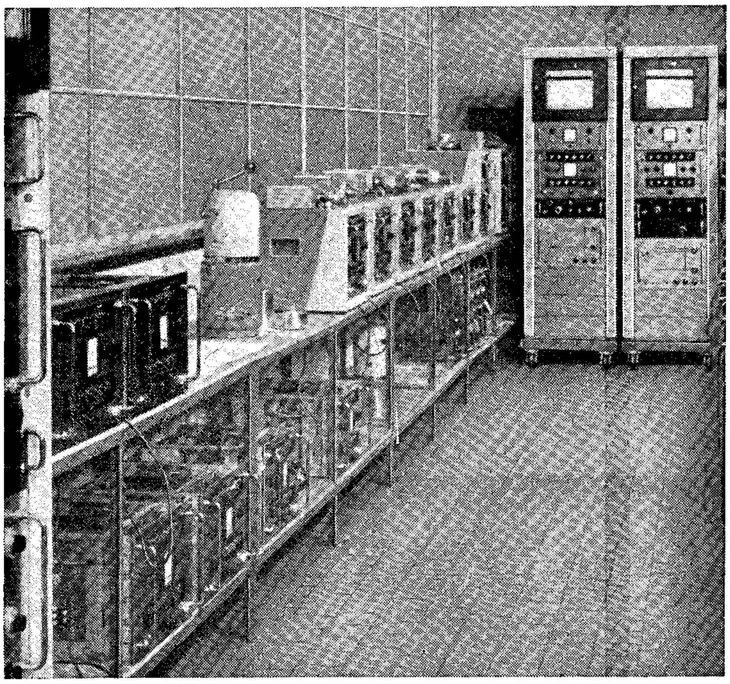

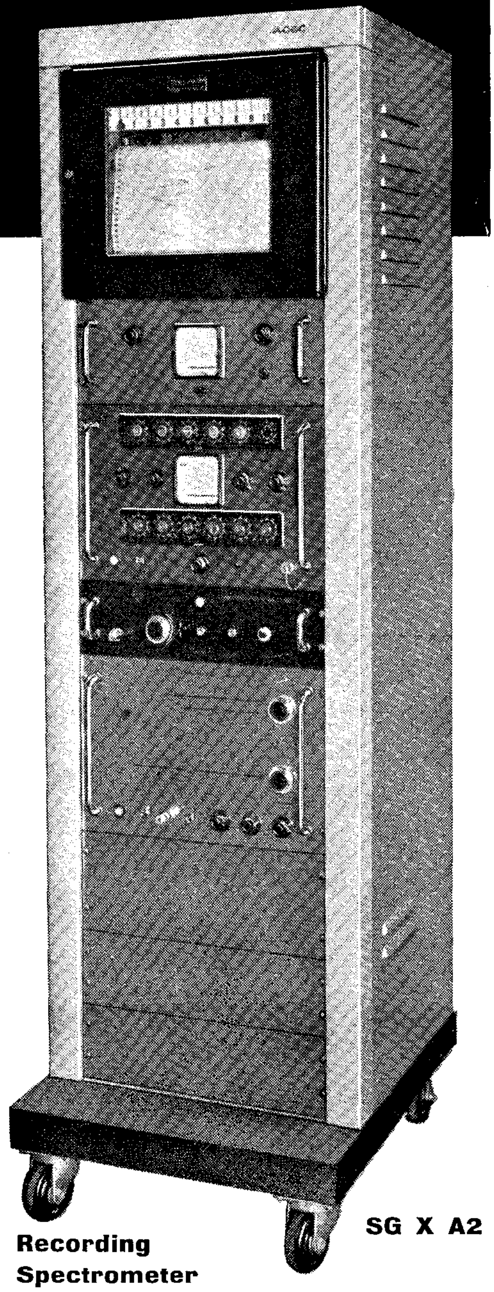

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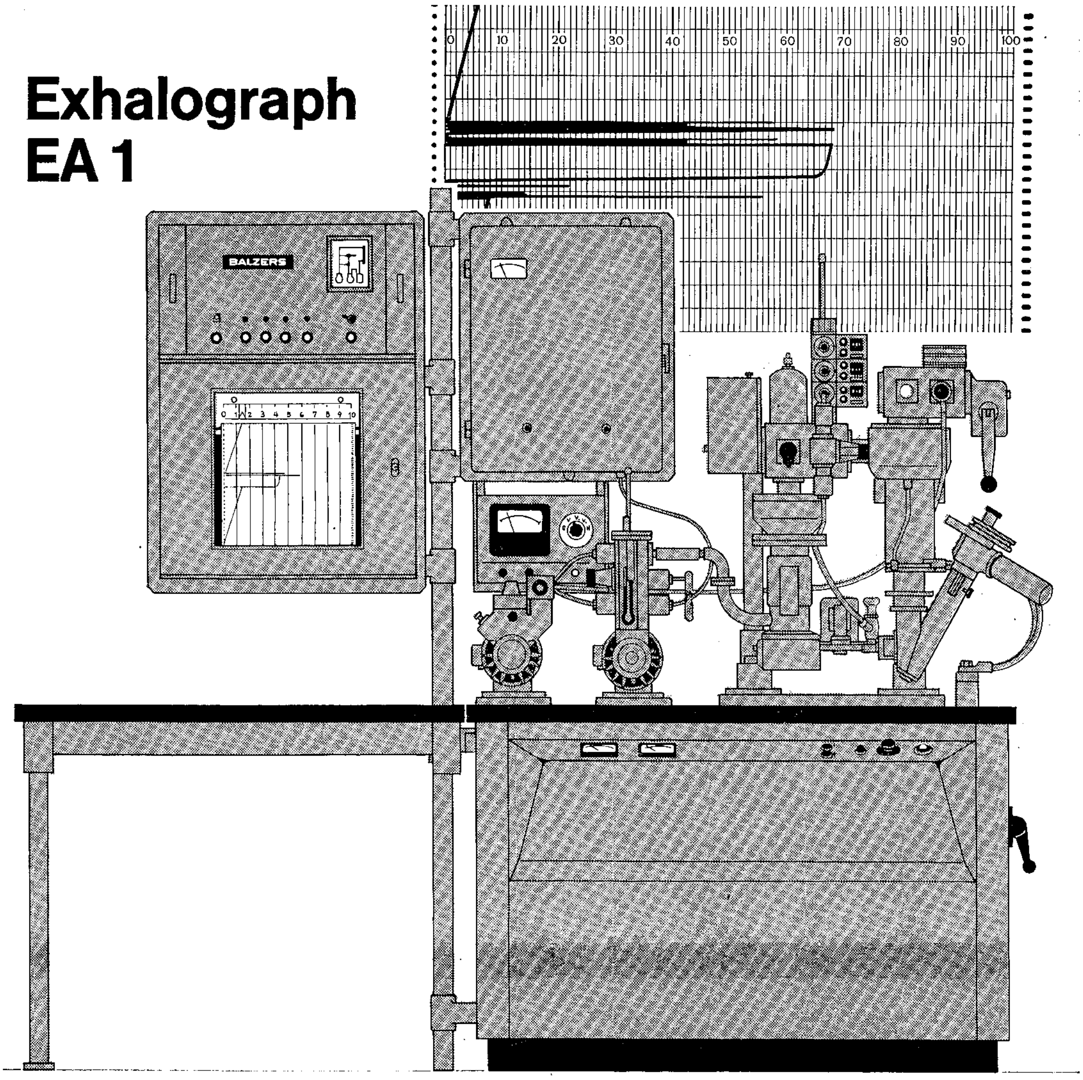

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