

# CERN

## COURIER

No. 4 Vol. 8 April 1968

European Organization for Nuclear Research



CERN, the European Organization for Nuclear Research, was established in 1954 to '...provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, theoretical and experimental, in the field of sub-nuclear physics. This branch of science is concerned with the fundamental questions of the basic laws governing the structure of matter. CERN is one of the world's leading Laboratories in this field.

The experimental programme is based on the use of two proton accelerators — a 600 MeV synchro-cyclotron (SC) and a 28 GeV synchrotron (PS). At the latter machine, large intersecting storage rings (ISR), for experiments with colliding proton beams, are under construction. Scientists from many European Universities, as well as from CERN itself, take part in the experiments and it is estimated that some 700 physicists outside CERN are provided with their research material in this way.

The Laboratory is situated at Meyrin near Geneva in Switzerland. The site covers approximately 80 hectares equally divided on either side of the frontier between France and Switzerland. The staff totals about 2350 people and, in addition, there are over 400 Fellows and Visiting Scientists.

Thirteen European countries participate in the work of CERN, contributing to the cost of the basic programme, 197.5 million Swiss francs in 1968, in proportion to their net national income. Supplementary programmes cover the construction of the ISR and studies for a proposed 300 GeV proton synchrotron.

CERN COURIER is published monthly in English and French editions. It is distributed free to CERN employees and others interested in sub-nuclear physics.

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Editor : Brian Southworth

Advertisements : Micheline Falciola

Photographs : Gérard Berlin

Public Information Office

CERN, 1211 Geneva 23, Switzerland

Tel. (022) 41 9811 Telex 2 25 48

Printed by: Ed. Cherix et Filanosa S.A.

1260 Nyon, Switzerland

# Comment

The main article in this issue runs through the list of experiments in the present programme of the 28 GeV proton synchrotron. The majority of the experiments are concerned with the accumulation of information on the properties of the newly discovered particle resonances or of the more familiar elementary particles — this work has been called the new spectroscopy. Other experiments are attacking fundamental problems about how Nature behaves — such as the questions of symmetry or the limits of application of quantum electrodynamics.

Each experiment is likely to slot just a few more pieces of information into the complex jig-saw puzzle that is our present knowledge of matter on the sub-nuclear scale. Each piece by itself can tell us little, but in its correct position, with others around it, the pattern in at least one area of the puzzle may become clear — we may begin to understand that aspect of particle behaviour.

It is difficult to appreciate which are vital pieces for the solution of the whole puzzle (if, in fact, there is a final solution that we could understand). In the meantime,

the methodical work of particle spectroscopy goes on in an analogous way to the atomic spectroscopy earlier this century. Then, vast books were compiled giving the measured atomic spectral lines, testimony to years of painstaking effort though in themselves just collections of data. Nevertheless, the emergence of quantum mechanics stemmed from the need to interpret this data and had a great bank of information to show that its interpretation of the atom was correct.

We can expect that particle spectroscopy will prove equally valuable in helping to formulate and to confirm a theory of elementary particles.

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Cover photograph: A view of the East Hall looking towards the proton synchrotron. One significant difference in this photograph compared with the same view appearing on the cover of CERN COURIER a year ago, is the rash of wooden huts. These house the small computers being used on-line to electronics experiments. They are clustered around experiments using the slow ejected beam. About ten on-line computers are now in use at the synchrotron. (CERN/PI 84.2.68)

# Experimental programme at the proton synchrotron

Exactly one year ago CERN COURIER included a review of the experiments under way at the 28 GeV proton synchrotron. This article is a similar review of the current programme prior to the annual shut-down of the synchrotron which takes place from 25 May.

## Available beams

The two figures overleaf are simplified representations of the layout of beam-lines and experiments in the three experimental halls.

In the South Hall, a variety of secondary particle beams (along the b, d, m and q beam-lines) are drawn from an internal target station situated in straight section 1. b15 is a neutral beam at  $2.8^\circ$  to the direction of the proton beam at the target; for the present experiment, neutrons of energy above 6 GeV/c are selected. d27, and its extension d27a, provides negative pions in the momentum range 4 to 15 GeV/c. The m beam-line is divided into two branches; m4e is a separated beam which can give low momentum (below 2.5 GeV/c) pions, kaons and protons, m4b can give the same particles up to a momentum of about 2 GeV/c. The q beam-lines can provide unseparated beams of pions and protons; q5 gives momenta up to 3 GeV/c and q4 momenta up to 1.2 GeV/c.

In addition to this profusion of beams drawn from the same internal target station is h3, a fast ejected proton beam of momentum 12 GeV/c which feeds the muon storage ring. This arrangement in the South Hall is substantially the same as a year ago with the addition of the neutral beam b15.

The North Hall has the single beam-line, k7 from an internal target in straight section 6, feeding the small hydrogen bubble chamber. It is an electrostatically separated beam which delivers positive and negative kaons and anti-protons in a momentum range around 1 GeV/c.

The East Hall is the area which has seen the biggest changes in the course of the year. The slow ejected proton beam, e3 from straight section 62, has come into full use as a source of particles for counter experiments. Five such experiments are now in progress and commissioning of this beam has had a great influence on the number and range of counter experiments which can be incorporated into the experimental programme.

A special septum magnet is used to split the ejected beam so that it can feed three target stations at the same time.

One of these yields secondary particles for b13, a neutral beam which is at present being used for investigating neutral kaons, one feeds p2, an unseparated beam which can give pions, kaons and protons in the broad momentum range 4 to 16 GeV/c, and one feeds two beam-lines — p1 which is virtually identical to p2 in the particles and momenta it can provide, and b14 which is another neutral beam currently being used as a source of neutral kaons. Further back along e3 before it reaches the septum magnet, targets can be inserted to produce protons, pions and kaons down the beam-line s4.

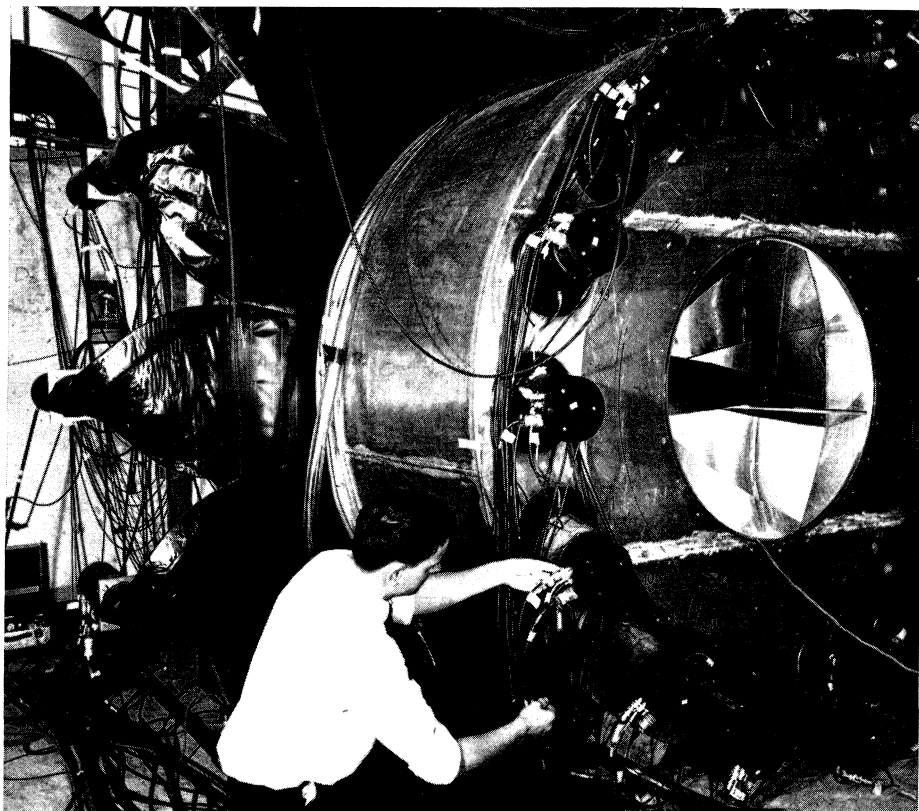
In the top half of the East Hall, another ejected beam e4 (fast ejected from straight section 58), is used as a source of three beams for the 2 m hydrogen bubble chamber. Moving from low to high momenta — k8 uses electrostatic separators and gives kaons in the momentum range 1.2-2 GeV/c, m6 also uses electrostatic separators and gives kaons in the range 2 to 4 GeV/c, and u3 which has radio-frequency separators (see CERN

The photograph below shows part of the detection equipment for the Xi hyperon beta decay experiment, S 50. The large cylinder is a gas Cherenkov counter to distinguish between electrons and pions. Inside the cylinder can be seen the mirrors focusing the Cherenkov light onto the photomultipliers in the black top hats. Behind is a great wheel of scintillation counters to detect the decay products of the Xi.

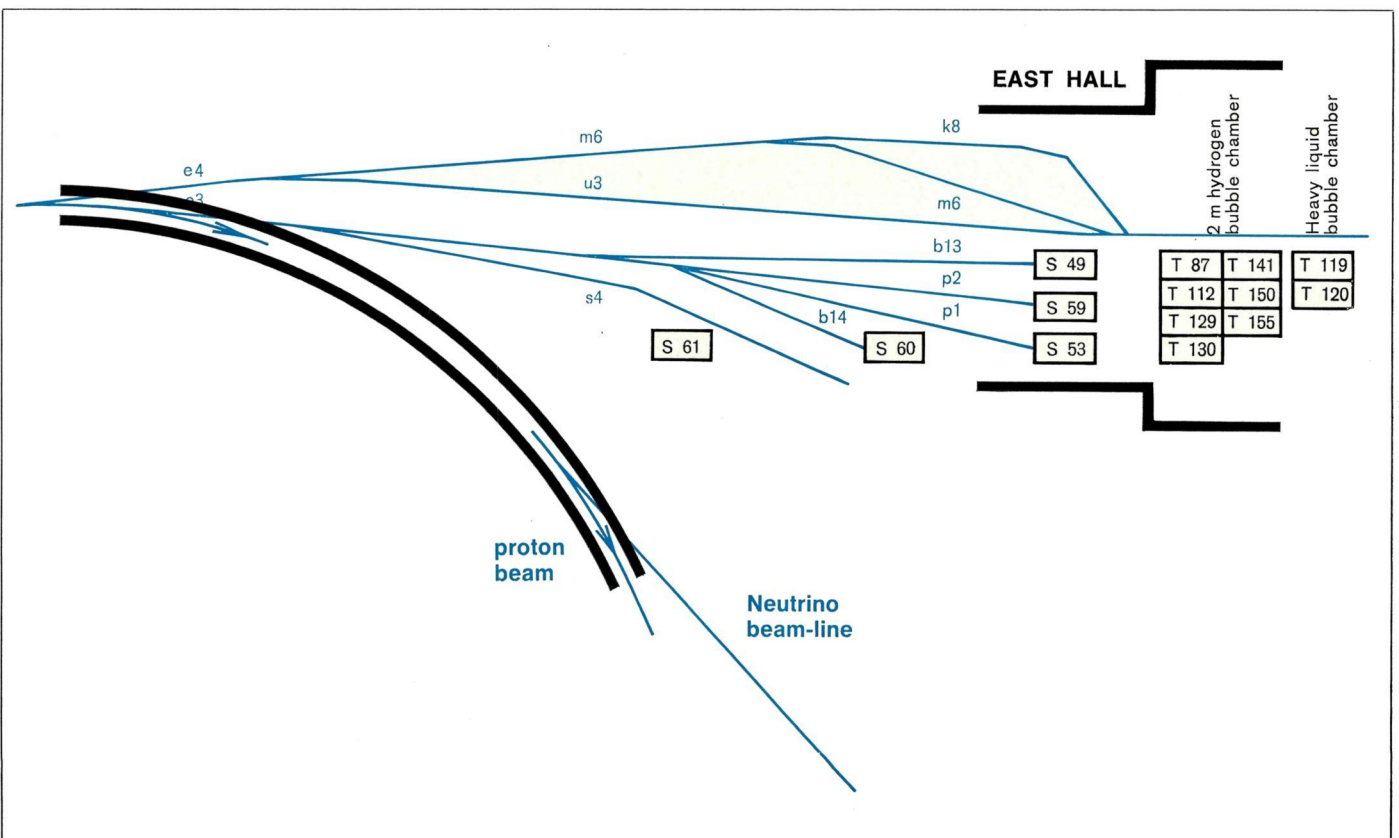
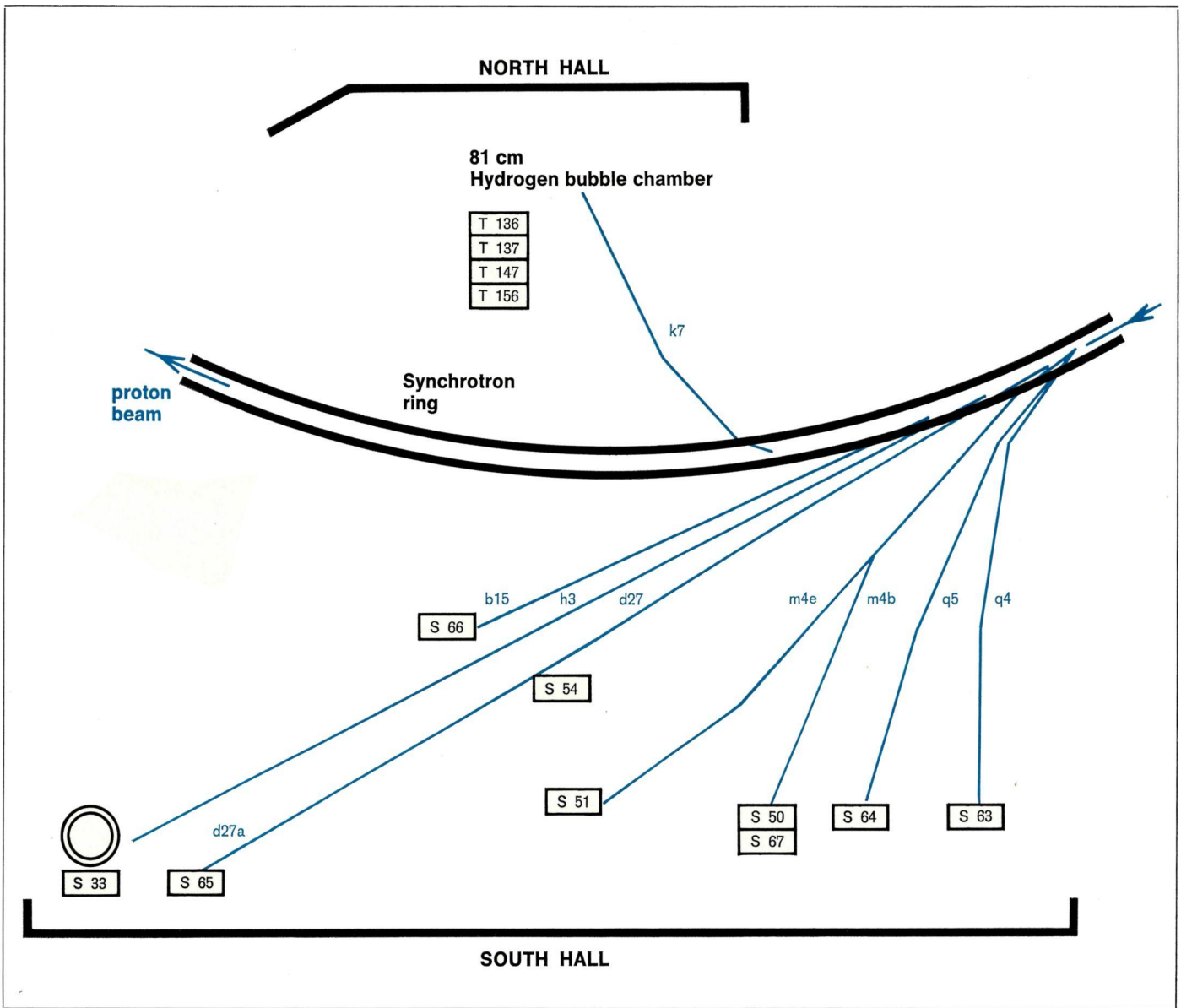
COURIER vol. 7, page 252) and gives pions, kaons and protons with momenta up to 20 GeV/c. The high energy beams can also be used after having passed through the hydrogen chamber, an extension called u3a, to feed the heavy liquid bubble chamber.

Finally, we should mention yet another fast ejected proton beam, drawn from straight section 74, which, directed onto a target, produces the pions and kaons which decay to provide the neutrinos of the neutrino beam-line. This beam-line, having served for a very successful series of neutrino experiments which finished collecting data towards the end of last year, is not currently in use but will come back into action for further experiments next year.

We now move to the experiments currently using the machine. In the space available this can be little more than a list of experiments. More extended descriptions of some of them have been, or will be, given in CERN COURIER at appropriate



CERN/PI 249.1.68



times. When an experiment has already been covered in some detail the volume and page number is given.

## Electronics experiments

### S33

To measure the 'g-2' value of the muon to an order of magnitude better than before. This experiment by a CERN group uses the muon storage ring in the South Hall fed by an ejected proton beam. Pions produced when the proton beam hits a target, decay into muons which are held in orbit in the magnet of the storage ring. By observing the way the spin of the muon changes direction as the muons circle the ring, the 'g-2' value is measured. It is of importance because it could indicate the limit to which the very successful theory of quantum electrodynamics is applicable or throw some light on the relationship between the muon and the electron. (See vol. 6, page 152; vol. 7 page 233.)

The main measurements on negative muons were completed a year ago but some more statistics on negatives are now being collected; the polarity of the magnet was then reversed and measurements on positive muons reached a value for g-2 of the same accuracy. The experiment will be completed by the May shutdown.

### S 49

To examine the interference of the long-lived and short-lived neutral kaons in their decays to two charged pions. This experiment in the East Hall involves a team from Aachen, CERN and Turin. The interference is examined close to the target where the neutral kaons are produced and the phase of the decay amplitudes has been measured without use of a regenerator (vol. 6, page 43).

This experiment and a related one, S 60, is serving to collect still more data on which to base an explanation of the violation of charge-parity symmetry in the decay of the long-lived kaon (vol. 8, page 11). A measurement of the mass difference between the long-lived and short-lived kaons will be made using a

wire spark chamber and an on-line computer.

### S 50

To examine the beta decay of the Xi hyperon. The experiment is being done by a CERN, Heidelberg team. A negative kaon beam of momentum 1.65 GeV/c is directed onto a polyethylene target to produce the negative Xi hyperons.

The decay of the Xi is observed in an optical spark chamber. A large gas Cherenkov counter distinguishes between electrons and pions from the Xi decay. The aim is to measure the branching ratio of the decay into an electron plus a lambda compared with the decay into a pion plus a lambda. At present this ratio is estimated from four events observed in bubble chambers to be about  $10^{-3}$ . The team hopes to see about 20 beta decays and thus improve the accuracy of this measurement.

### S 51

To search for electromagnetic decays of rho, omega and phi mesons. It involves a Bologna, CERN team using a negative pion beam on a hydrogen target to produce the neutral mesons identified by time of flight measurements on the neutron produced at the same time. An array of heavy-plate spark chambers is set up to catch the decays of the mesons into electron-positron pairs.

The experiment can give information on the interaction of the electromagnetic field with matter. It will also measure the omega/phi 'mixing angle'. The physically observed omega and phi mesons do not slot straight into their appropriate octet predicted by SU3 theory and some theoretical juggling has been necessary to reconcile the observations with the expectations. It involved interpreting the observations as mixtures of the true omega and phi (treated as waves) in a similar way to the explanation of the long-lived neutral kaon as a mixture of the true neutral kaon and its anti-particle.

### S 53

To examine elastic scattering of pions and kaons on protons at large angles (up to  $180^\circ$ ). A CERN team are carrying out a survey of pion-proton and kaon-proton

scattering for both positive and negative particles over a wide range of incident energies.

This experiment is being conducted in a secondary beam, p1, produced from a target in the slow ejected proton beam in the East Hall. The system consists of scintillation counters, Cherenkov counters, analyzing magnets, counter hodoscopes and twenty eight wire spark chamber planes on-line to an IBM 1800 computer. This computer records the raw data on tape, monitors the equipment and makes some on-line checks of the data. The final analysis is done by the large central computers.

The direction and momentum of the incident particle are determined before the liquid hydrogen target; the direction of the scattered particle is measured as are the direction and momentum of the forward going recoil proton. In the set of measurements now being completed, the scattering of 5 and 7 GeV/c pions and kaons has been studied in the backward direction from  $u = 0$  to 1.2 (GeV/c) $^2$  and in the forward direction from  $t = 0.2$  to 1.1 (GeV/c) $^2$ .

### S 54

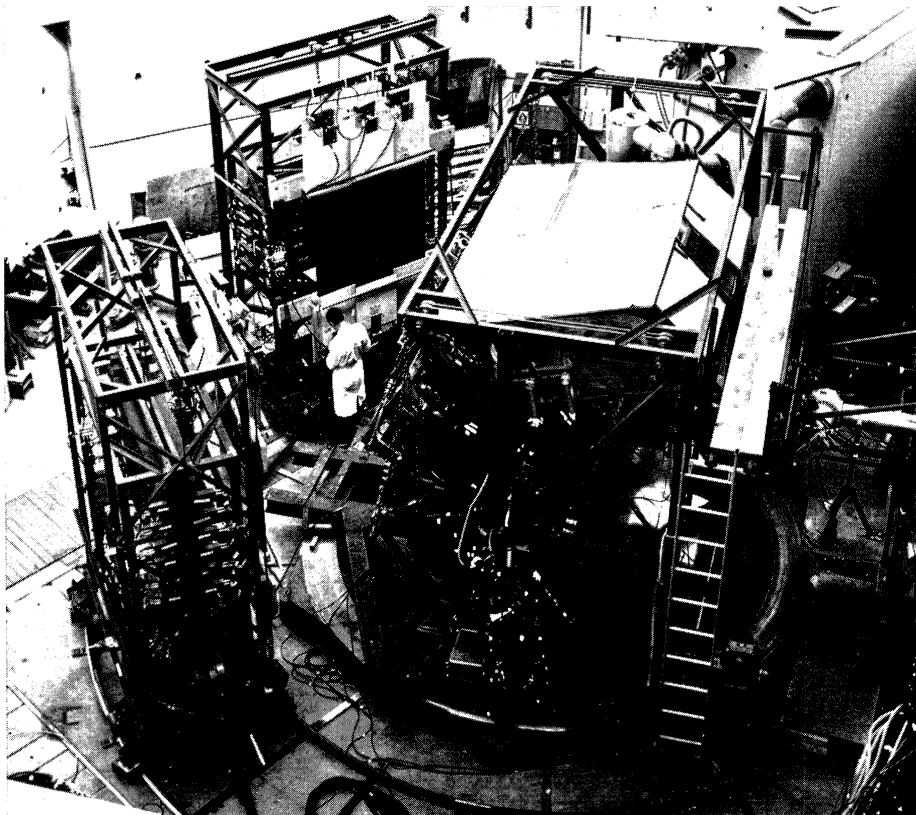
Measurements of polarization parameters in pion-proton scattering. This experiment is being carried out by a team from Saclay and uses a polarized proton target; Saclay is one of the leading centres of research on and with polarized targets.

They will examine elastic scattering of positive and negative pions over the momentum range 5 to 18 GeV/c. The aim is to determine the 'Wolfstein parameters', A and B, in the spin rotation.

### S 59

To measure the polarization parameter,  $P_0$ , over a range of scattering interactions using a transversally polarized proton target. A team from CERN, Orsay, Louvain and Pisa is involved in this experiment which uses a variety of incident beams, of higher intensity than those previously available, drawn from a target in the slow ejected beam in the East Hall. Positive and negative pions, positive and negative kaons, protons and anti-protons will be used in the survey.

The formidable array of detectors used in experiment S 51 looking for electromagnetic decays of mesons. The beam passes along the tube coming in from the right of the picture. Close to the target are heavy-plate spark chambers to observe electrons and, further out, on rails so that they can be easily moved to different angles, are two racks of scintillation counters for time of flight measurements on neutrons.



CERN/PI 54.9.67

#### S 60

To examine the interference of the long-lived and short-lived neutral kaons in their decays to two neutral pions. Like S 49 above, this experiment will yield some more information for the solution of the charge-parity violation problem.

In vol. 7, page 31 the first observation by a CERN, Rutherford, Aachen group of the CP violating decay of the long-lived kaon into two neutral pions was reported. That experiment measured the ratio of the amplitude of the decay of the long-lived kaon into two neutral pions compared with the amplitude of the decay of the short-lived kaon into two neutral pions. The present experiment is a follow-up of this result to determine the phase of this ratio. Data-taking is now finishing and a quarter of a million pictures have been taken for analysis.

#### S 61

To examine particle production at high energies in proton-proton and proton-nuclear interactions. A CERN team are carrying out this survey of the production

of secondary particles using the slow ejected proton beam in the East hall incident on a variety of targets — hydrogen, beryllium, copper, aluminium, lead, boron carbide and carbon. They look at the emerging pions, kaons and protons of both sign with a magnetic spectrometer, scintillation counters, threshold Cherenkov counters and a DISC counter.

The detailed data from the experiment will help towards an understanding of the production mechanism of secondary particles. By giving more information on secondary particle yields at high energy from different targets, it will also help in planning the beams for the experimental programmes of the next generation of accelerators.

A continuation of these studies at the higher energies available from the 70 GeV machine at Serpukhov has been agreed, and will be carried out by a joint CERN, Serpukhov team later this year.

#### S 63

To examine the elastic scattering of pions on deuterium. This experiment is being

carried out by a CERN, Trieste Group. They are using at present a low momentum (900 MeV/c) negative pion beam in the South Hall incident on a deuterium target and have a detection system of wire spark chambers to pick up the elastically scattered particles. The experiment will be continued on a higher momentum beam after the shut-down.

The investigation will check a theoretical model of pion-deuteron elastic scattering and will provide phase measurements at momentum transfer different from zero.

#### S 64

To explore the boson spectrum over the mass range up to 5 GeV. This experiment by a Berne, CERN, Geneva team is a variation and extension of the missing-mass spectrometer experiment (vol. 7, page 31) which identified seven particles for the first time. The present set-up is a new type of mass spectrometer using wide-gap wire spark chambers (vol. 7, page 219) and a large magnet to analyse the recoil protons.

This new method is initially being applied in a low momentum beam in the South Hall to check the method and the equipment. It has repeated the previous search and has confirmed the findings. The experiment will eventually extend the investigation to higher momenta.

#### S 65

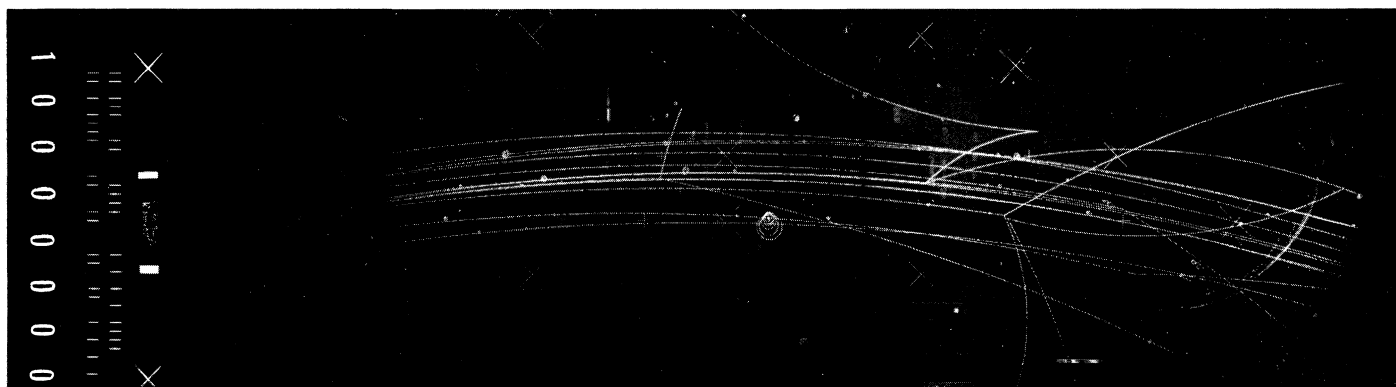
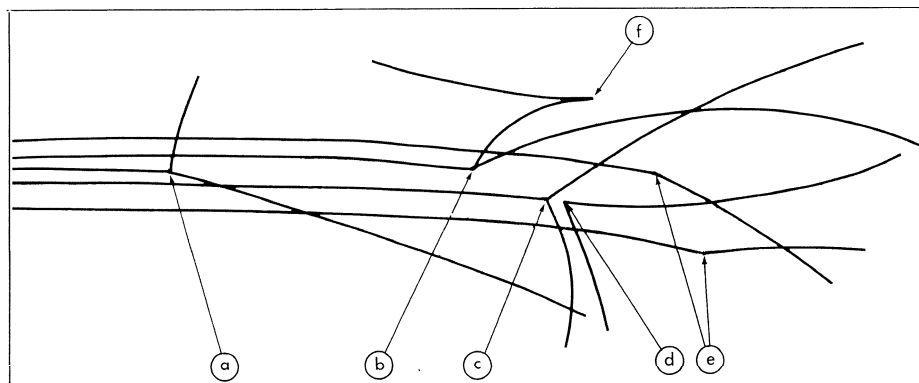
To examine neutral final states in the pion-proton interaction. This CERN, ETH experiment uses optical spark chambers set-up in a magnetic field to look at the negative pion interaction on a hydrogen target producing a neutral kaon and a lambda. Pion beams of momenta 5, 7 and 12 GeV/c are available from the d27a extension in the South Hall.

They have found that the lambdas are essentially 100% polarized, an observation which has not been made in any other high energy interaction.

#### S 66

To examine neutron-proton scattering above 6 GeV/c. A Karlsruhe team are using the new neutral beam in the South Hall obtaining about 30 000 neutrons per pulse.

The ten millionth photograph taken with the 81 cm hydrogen bubble chamber. This chamber has been at CERN since 1961 initially on loan from the Saclay Laboratory where it was built (together with several others of the same size). It became the responsibility of CERN in 1966 and has continued to prove very reliable. Positive kaons with a momentum of 0.98 GeV/c enter the chamber from the left. Two of them decay (e), while three others interact with protons in the chamber. At (a) an elastic scattering takes place; at (b) the interaction gives a positive pion, a positive kaon (which decays at [f]) and neutral particles; at (c) the interaction gives a positive pion, a proton and a neutral kaon which decays into two charged pions at (d).



They will look at the elastic scattering of neutrons on protons (in a hydrogen target) carrying these measurements to higher momenta (up to about 16 GeV/c) than previously done. The spark chamber detection system can look at small neutron angles and can examine the behaviour of the diffraction peak.

In addition to this first experiment the investigation will extend to total cross-section measurements using hydrogen, deuterium and lithium targets.

S 67

Measurement of a kaon-proton cross-section. A Caen, CERN team has tested an experimental set up on a low momentum beam in the South Hall. The aim is to measure the cross-section of the interaction negative kaon plus proton goes to neutral kaon plus neutron in the momentum range about 1.5 to 3 GeV/c. This could reveal possible  $Y^*$  resonances which have not yet been found and will provide further information on those already known.

## Bubble chamber experiments

The three bubble chambers in operation at CERN have worked very reliably over the past year. The total number of pictures in 1967, for example, was 2 100 000 for the 2m hydrogen chamber (including 523 000 in deuterium — the chamber was filled with deuterium for a series of experiments beginning in November 1967), 1 700 000 for the 81 cm hydrogen chamber which has recently taken its ten millionth picture (see photograph), and over 1 125 000 in the heavy liquid bubble chamber during the neutrino experiments.

The bubble chamber programme is now characterized by some experiments collecting information at higher energies than previously used (taking beams from the radio-frequency separated beam-line, u3) and by other experiments building up very large numbers of photographs, to achieve very high statistics, at lower energies. This later characteristic is a direct result of the advances towards automatic film measurement and the

increase in computing capacity which make it possible to cope with the analysis of much higher numbers of photographs.

These advances have been made at research centres throughout Europe and at CERN itself.

The European Universities involved in the bubble chamber programme are legion; they are listed in brackets for each experiment.

Using the 81 cm bubble chamber and the k7 beam in the North Hall :

T 136, T 137

To investigate the nature of the structures seen in the positive kaon-nucleon total cross-sections (Bologna, Glasgow, Rome, Trieste). These experiments, using kaon beams up to a momentum of 1.4 GeV/c, will take about 100 000 pictures both with hydrogen and then with deuterium in the bubble chamber.

7 147

To study low energy interactions of anti-protons on nucléons (Bologna, Padua, Pisa, Turin). For this experiment the

chamber is filled with deuterium and fed with an anti-proton beam; 100,00 photographs are scheduled. They will be looking at events producing many pions — this type of investigation has already been carried out for anti-proton - nucléon interactions at rest and has become a speciality of the smaller hydrogen chamber. The experiment will study in particular the structure seen in the anti-proton - nucléon total cross-section at a momentum of 1.3 GeV/c.

1 156

To study negative kaon-proton interactions at low momentum (CERN, Heidelberg, Saclay). This experiment will be a more detailed study of the momentum region from 1.1 to 1.27 GeV/c and will concentrate on investigating the existence and properties of two  $Y^*$  resonances with masses of 1860 MeV and 1910 MeV. 90 000 pictures have been scheduled.

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*Using the 2 m hydrogen bubble chamber and the k8 beam-line :*

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1 129

To study the quantum numbers of the  $D^0$  meson (CERN, Collège de France, Institut du Radium, Liverpool, Lausanne, Neuchâtel). The  $D^0$  meson is a resonance built up of a kaon an anti-kaon and a pion and the experiment will look at interactions in which incoming anti-protons at 1.2 GeV/c annihilate with the protons in the chamber to produce kaons and pions.

This experiment is an extension of the anti-proton annihilation experiment done with the 81 cm chamber. Observing the interactions in the larger volume of the 2 m chamber will provide more information for the analysis. 200 000 pictures are scheduled. Though the  $D^0$  meson is the centre of interest, anti-proton annihilation is a prolific source of interesting data and the experiment will be able to investigate many other features also.

T130

To examine the mass region around 2040 MeV (CERN, Heidelberg, Saclay). The experiment takes a negative kaon beam of momentum 1.4 to 1.7 GeV/c and uses the negative-kaon — proton interaction to search for fine structure in the region of the  $Y^*$  resonance at 2040 MeV. 100 000

pictures are scheduled. This collaboration has been examining K-p interactions for several years and has reported many results on the discovery of new resonances and the measurement of the quantum numbers of others.

1 155

Studies on kaons (CERN, Saclay). This experiment has been allotted 500 000 photographs. They use a positive kaon beam into the chamber. 300 000 events will be devoted to the production of neutral kaons of well-defined momentum to study the  $AS = AQ$  rule using the leptonic decay of the kaon; to measure the life-time of  $K^0$ , and to investigate secondary interactions of the  $K^0$ . 100 000 events will be used to study the three body reaction where the positive kaon interacts with a proton to give a neutral kaon, a proton and a positive pion. The remaining 100 000 events will be used to study the decay of the positive kaon into charged pions.

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*Using the 2 m chamber and the m6 beam-line :*

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1112

To study resonances and production mechanisms (Amsterdam, Ecole Polytechnique, Nijmegen, Oxford, Saclay, University of California Los Angeles). This experiment is taking a further 400 000 pictures to bring the total number in this investigation to over a million. They use a negative kaon beam in the momentum range 2.8 to 4.5 GeV. The aim is to extend the statistics on the properties of resonances.

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*Using the 2 m chamber and the u3 beam-line :*

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1 37, 1 150

To study resonances and production mechanisms (Durham, Geneva, Hamburg, Milan, Saclay). They use a positive pion beam of momentum 11.7 GeV/c into the chamber and examine the interaction positive pion plus proton giving two, four, six or eight 'final state' particles. A total of 300 000 pictures has been scheduled for this experiment.

1 141

To study kaon-proton interactions (Birmingham, Glasgow, Edinburgh, Oxford). A

positive kaon beam of momentum 10 GeV/c is fed to the chamber and the pictures (200 000 have been scheduled) will be used particularly to confirm the existence of two  $K^*$  resonances (at 1320 MeV and at 1800 MeV), to determine the spin-parity of the  $K^*$  resonance at 1400 MeV, to search for further boson resonances, and to examine the production of anti-hyperons (including possibly the anti-omega).

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*Using the heavy liquid bubble chamber and the u3 beam-line :*

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1119, 1120

This experiment, known as the 'jet experiment' was described in vol. 7, page 249. The participating centres were then listed as Berkeley, Ecole Polytechnique, Milan, Orsay and Saclay. To these should be added Bergen, Madrid, Strasbourg and Valencia. Physicists from Brookhaven will also participate in the experiment and European groups have been offered the possibility of extending this investigation in a later experiment to be performed, with negative kaons of momentum 13 GeV/c and a chamber filled with a hydrogen-neon mixture, at the Brookhaven synchrotron.

The CERN experiment, which is scheduled to take 300 000 pictures, uses positive and negative kaon beams of momentum 10 GeV/c into the heavy liquid bubble chamber, filled with a propane-neon mixture, stationed behind the 2 m hydrogen chamber. Interactions at these high kaon energies tend to produce a forward spray of particles similar to the jets sometimes seen in nuclear emulsions from cosmic rays. Hence the name 'jet experiment'.

The experiment will look at 'coherent' interactions of the high energy kaons on heavy nuclei. The kaon gives the nucleus a slight impulse but leaves it intact while the kaon itself may completely transform under the impulse to a high-mass resonance or a multiple particle state. The experiment can also investigate kaon-proton interactions producing neutral pions, taking advantage of the short distances these pions travel in the heavy liquid before producing observable charged particles.



# Book Reviews

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## High Energy Collisions of Elementary Particles

by R.J. Eden (Cambridge University Press, 1967, 55 s).

The contents of this useful book are less general than the title. It concerns itself in fact with collisions of hadrons, in circumstances where weak and electromagnetic interactions are supposed to be negligible, and mainly with the case of two hadrons going in and two coming out. This of course is a very reasonable topic for a book. It corresponds to a fairly well defined set of experimental situations, and to an even better defined set of theoretical activities.

Although the book is mainly theoretical, there are concise summaries of experimental data up to about the 1966 Berkeley Conference. The author shows confidence in the durability of his work by referring for further information to the proceedings of the 1968 and 1970 Conferences.

Apart from introductory and peripheral material, attention is given mainly to theories in which analyticity of one kind or another is the central notion. Thus there are substantial chapters on Regge poles, and on general consequences of analyticity and unitarity, including asymptotic bounds on cross-sections. Proofs (even where they exist) are in general not given, but enough explanatory material is included to make the quoted results intelligible.

The book can be warmly recommended to theorists not specialized in this field, who wish to get a good idea of what was done in it up to about one year ago, and a rough idea of how it was done.

*J.S. Bell*

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## Science Year

The World Book Science Annual, volume 1967. (Field Enterprises Educational Corporation, Chicago; 435 pages; \$ 6.95).

As in previous years, this third issue of 'Science Year' contains a wealth of top-quality photographs and striking colour plates. The artist's impression of the expansion of the universe, for example, will most certainly capture the imagination of the

amateur physicist. Those who are keen botanists will be fascinated by the pictorial survey of how alpine plants manage to survive. A hologram and its filter have been included as an integral part of the book and those who are interested in finding out about this method of photography can set the hologram up in front of a light source. 'Science Year' thus provides miniature apparatus for demonstrating this exciting technique of three-dimensional photography.

The volume is not, however, a collection of fine pictures interleaved with gadgets. The text is of the same high quality. There is, for example, some very interesting reading on the various applications of holography and on the production of nuclear energy.

To mark the tenth anniversary of the day man first set out on the conquest of space, three of the twenty-four chapters are devoted to space research, the sciences of mankind and of the earth, astrophysics and physics, and the chemistry of medicine.

The American space programme is examined by a historian against its historical background. Contemporary science, he states, involves on the part of the community a sacrifice of much the same character as was required to build the pyramids; this is followed by an argument in favour of the unification of various scientific activities. The second article shows how ten years of space research have yielded not only a mass of information on space but have also had a fundamental influence on our way of life. 'The chief characteristic of the American space commitment is the stress on technology at the expense of basic research.' For the American student, the surprise launching of the first Sputnik very quickly gave rise to such an increase in work that it was sometimes stated to be a 'crime against a generation'! But is this true only for the American student?

Two sections are devoted to the human sciences. One is centred around life in space and describes man's surprising powers of adaptability to this new environment. Reverting to down-to-earth matters, there is a report on the disappearance of hunting tribes and the vital need to record their ancestral customs

before they disappear, contaminated by the influence of a technological civilisation.

In medicine, that vital organ the kidney, is the topic of a fourteen-page article. Two chapters are set aside for astrophysics. One interprets extraplanetary microwaves as a degenerated form of light left over from the original 'fireball' from which the Universe evolved; according to the authors 40 000 million years will elapse before implosion finally occurs. The other chapter examines the nature of the sun and its eruptions, which could endanger the lives of astronauts.

The section on Earth Sciences contains a world plan for weather prediction and seismic research, the main purpose of which is to forecast earthquakes. Twenty-eight pages of absorbing reading are devoted to these two subjects.

Chemistry in the service of mankind is the subject of two chapters written by the editorial team. Five hundred million dollars are spent on steroid hormones each year in the United States; they help cure hundreds of illnesses, increase food production, destroy certain microscopic parasites and, last but not least, provide a measure of control over human fertility. Those who, quite rightly, are concerned at the dangers of plant pollution by aerosols will be gratified to learn about the existence of poisonless pesticides. Air pollution could be virtually wiped out if the technical and economic problems hampering the development of the electric motor-car could be overcome. A report is given on the current situation in the United States and Europe.

Europe is also covered in the Section 'Science File'. Here, the presentation is somewhat different from the rest of the book. Illustrations are few and far between in 130 pages devoted to an alphabetical review of the various achievements, extending from agricultural technology to zoology. Amongst these short summaries appears the term 'high energy astronomy'. Many a sub-nuclear physicist will be intrigued by this paraphrase of X-ray astronomy, as no doubt he will be by the 'chemical accelerator' — a tool which has a future in chemical dynamics.

It is the first time in three years that recognition has been given to certain efforts which Europe has made in the field of science.

# CERN News

ESO received mention (three lines) on account of the 140 inch telescope being built by the European Southern Observatory in Chile. CERN is placed on a similar footing to other accelerator laboratories. The research on CP symmetry and the collaboration at the Soviet Serpukhov accelerator were the topics, but it is a pity that no further details were given; no comparison was made between the USA 200 GeV accelerator and the European 300 GeV project. Despite their significance, the CERN intersecting storage rings likewise failed to find their way into the pages of the Science File.

Two chapters are devoted to scientific personalities: the physicist Abdus Salam, and Helen Taussig a specialist in the treatment of 'blue babies'. A list is given of Science awards and prizes in 1966-67, and the volume closes, in the traditional manner, with an obituary of notable scientists. Here, physics occupies a predominant place with names such as Debye, Frank, Hevesy, Oppenheimer, Van de Graaff and Veksler.

To sum up, 'Science Year' is a book which anyone interested in science should have close at hand; not only as a reference work but also as a source of pleasure. This book is not just a superb collection of illustrations. Although it is a popular edition, it does not fall short of professional standards. The publishers should be given every encouragement to continue to draw their team of writers (the number of European contributors has increased since last year) from all over the world to help produce what is quite a remarkable volume.

R.A.

## G. E. Chikovani

Professor G.E. Chikovani, an outstanding Soviet physicist who had spent most of the past four years at CERN, died from a stroke at his home city of Tbilisi, USSR.

Professor Chikovani was born on 30 June 1928. He was educated in Tbilisi and completed his studies in physics and mathematics under Professor E.L. Andronikashvili. His initial research was in cosmic ray physics and he led several cosmic ray expeditions. In the early 1960s, he was promoted to Department Leader at the Institute of Physics of the Georgian Academy of Science in Tbilisi. His main interest at that time was the development of the newly invented particle detector — the spark chamber.

Much of the pioneering work on spark chambers was taking place in the Soviet Union and Chikovani was among the leaders. He worked initially with small-gap chambers, then with wide-gap chambers following their invention by B.I. Dolgoschein in Moscow. In 1962, he invented the streamer chamber. This may prove to

be his greatest contribution to particle physics for it is probably the most significant advance in particle detection techniques in this decade. The streamer chamber retains the selectivity of the spark chamber while giving the full information of the bubble chamber. It has now been taken up by many laboratories throughout the world.

In 1965, Chikovani came to CERN as a visiting scientist to join the team on the missing mass spectrometer experiment. With him to Geneva came his wife and son, Eugeni, now aged seven. Since then, he has spent most of his time at CERN. His contribution to the experiment was exceptional for he combined a broad knowledge of physics with a flair for work with detectors. From particle physics to welding, from solid-state physics to electronics, from statistics in all its forms to the history of physics — Chikovani was an authority.

Early in 1968, he was proposed for membership of the Georgian Academy of Science, one of the highest honours in science that his country can bestow. But



1.



2.

1. G.E. Chikovani

2. R. Godet

Arrival on 31 March of the base-plate for the magnet of the new heavy liquid bubble chamber, Gargamelle. This is the first (and the heaviest — 140 tons) piece of Gargamelle to arrive for assembly at CERN at the end of the neutrino beam-line.

he did not live to receive this honour. We have lost an excellent physicist and one whose human qualities ensured that he will be remembered with affection by all who knew him.

## R. Godet

René Godet, who joined CERN in 1955 and rose to be head of the Surface Treatment Workshop, died in a car accident at the end of March.

He was born at the nearby French town of Gex in June 1932. He qualified as a fitter at the Ecole de Mécanique of Geneva in 1952 and joined the Proton Synchrotron Workshop as an assistant fitter in July 1955. He was soon entrusted with precision work requiring specialized knowledge.

When the need arose for a 'Surface Treatment Workshop', René Godet quickly applied himself to the intriguing problems of chemistry involved in this type of work. He developed an absorbing interest in his small laboratory, built up from scratch, initially with very limited resources. One of the first things he realized was the difficulty of keeping abreast of the latest developments in this field and to overcome this he organized courses on electroforming with the help of specialists in Geneva. These courses were very well received and developed over the years. They resulted in the formation of the 'Association Romande pour l'Etude des Traitements de Surface (ARETS)' of which Godet became President. The Association's official journal is 'La Revue Polytechnique'.

Eventually, he increased his knowledge to the point where he himself gave courses at the Cours Industriels de Genève, was often called in as an expert and was examiner for trade apprentices final examinations.

At CERN, the originally small workshop was continually improved and in 1965, Godet left the PS Workshop to devote himself entirely to the organization and equipping of a new Surface Treatment Workshop. There he led successful attacks on many technical problems of major importance — these included



CERN/PI 31.4.68

printed circuits, desposits on non-conductors, electrolytic polishing, oxidation of aluminium, etc... The Workshop rapidly became too small and is at present being doubled in size.

His pleasant personality, his enthusiasm and his competence helped René Godet to forge strong links with the industries where surface treatment work is prominent. These links proved fruitful to all those with whom he made contact and resulted in his becoming very well known in this specialized field.

He was a good friend, always with a ready smile, a bon-vivant, and passionately interested in his work. He had often turned away opportunities to better himself financially in order to stay with the Workshop he had created where he considered himself more at home than anywhere else. He unstintingly gave the best part of his life to his work.

Both CERN and René Godet's personal friends have lost a valuable colleague, who was able to impart to his staff a spirit and devotion that it will be difficult to equal.

## Summer Schools

The 1968 CERN School of Physics will be held at El Escorial, Spain, from 26 May to 8 June. This is the seventh in the series of Summer Schools organized by CERN together with local representatives from the country where the school is held — the Chairman of the Organizing Committee is Professor C. Sanchez del Rio from the Junta de Energia Nuclear, Madrid. The purpose of the Schools is to give young experimental physicists the theoretical

background they need for their research. About one hundred students will attend.

The programme this year includes lectures on advanced quantum mechanics and field theory (given by A. Galindo), high-energy phenomenology (L. van Hove), higher symmetries (A. Morales), weak interactions (P. Pascual), resonances (A. Astier and M. Ferro-Luzzi) and CP violation in K-decay (J. Iliopoulos). Two special lectures by Professor D.H. Perkins on neutrino physics and by the Director General, Professor B. Gregory, have been arranged.

The 'Ettore Majorana' International School of Physics will take place at Erice, Sicily, from 13 to 28 July. The School is sponsored by CERN, the Sicilian government, the Italian Ministry of Public Education, NATO and the Weizmann Institute.

The purpose of the school is to give physicists a deeper theoretical understanding of the field in which they are working, with emphasis on the progress made in the past year. Many of the leading figures in the world of high-energy physics will lecture at the school including Professors G. Salvini, T.D. Lee, V.F. Weisskopf, G. Bernardini and E. Amaldi.

## HPD Mark 2

In the review of the experimental programme at the proton synchrotron, mention is made (page 75) of the output of the three bubble chambers at CERN in 1967 — about five million photographs. The frightening job of examining and measuring this vast number of pictures has to be confronted. The big majority of them are dispersed for analysis to Universities and

# Social Service at CERN

M. Blackwell

research centres throughout Europe. Here, we concentrate on the latest stage at CERN itself, of one of the attacks on this problem.

The HPD (Hough Powell Device, named after its inventors P. Hough and B.W. Powell) was described in detail in CERN COURIER vol. 6 page 7. It involves an almost fully automatic method of measuring bubble chamber (and optical spark chamber) photographs using a small spot of light which is made to travel backwards and forwards across each photograph scanning for particle tracks. The tracks recorded on the film, modulate the light signal passing through the film to photomultipliers and information on the track positions is thus available in electronic form to be passed to a computer.

The HPD was first proposed in 1960 and, following a collaborative effort by Berkeley, Brookhaven, Rutherford Laboratory and CERN, a prototype device (HPD Mark 1) came into operation at CERN in mid-1961, initially connected to an IBM 709 computer. Since early 1964, it has been used for measurement of bubble chamber pictures (dealing with about 100 000 for two experiments up to the end of 1967) and, for a larger amount of time, of pictures taken in several experiments using optical spark chambers. All the basic ideas have been shown to work and the measurements have proved slightly more accurate than those done with the conventional hand-measuring machines.

The Laboratories mentioned above have continued to work on the device. The Rutherford Laboratory considered the possibility of having the mechanical parts designed and constructed commercially, to help to standardize the machines and to make them more readily available for other Laboratories and Universities. CERN joined in this effort which resulted in an HPD Mark 2 being delivered to CERN in September 1964. The mechanical, optical and hydraulic parts of the system were supplied by Sogenique (Services) Limited, UK. The electronics are basically the same as for Mark 1 with some improvements to cope with the faster speed of the second version.

By now, Mark 2, connected to the CDC 6600 computer, is in 'production' measur-

ing film produced in two experiments carried out on the 2 m bubble chamber. Its performance is potentially better than Mark 1. The duration of one scan line has been reduced to 2.5 ms compared with 6 ms; it has a smaller spot size and greater light intensity (an improved optical system includes the use of glass fibres as cylindrical lenses). These improvements will enable Mark 2 to carry out measurements faster and more accurately than its predecessor.

The system is not yet fully automatic in so far as some preliminary examination is necessary before feeding the film to HPD. Each picture is examined (on 'Milady' scanning tables) and information is passed to the computer on the number of the frame recording an interesting event, the type of event, and the rough position of each relevant track. (A system known as 'minimum guidance', which would involve telling the computer the position of only the vertex of the event, is being developed.) The HPD with the computer can then do the rest — selecting the right pictures and measuring the appropriate tracks.

Experience with Mark 2 since it arrived at CERN has brought out further improvements which could be made, but it has also carried a little further the solution of what Professor Kowarski has called the problem of 'providing the computer with an eye'.

A detailed description of the HPD Mark 2 and its performance can be found in a recently produced 'yellow report' — CERN 68-4, The HPD 2 Flying-spot digitizer at CERN' by M. Benot, B.W. Evershed, R. Messerli and B.W. Powell.

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## *What is social service ?*

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How does one define 'social service' and what should be its role at CERN? The replies to these questions differ according to the nationality, background and personality of each staff member. Some see it embodied in the lady bountiful social worker in the inevitable wide-brimmed hat; some see it as free schooling and children's services; others as help to the old and the poor. In fact 'social service' is very difficult to define because:

1. It has been used to refer to so many things and so many types of social activity
2. Increased knowledge of psychology and sociology, has resulted in a professionalisation of social work and the traditional role of the visitor from the charitable organization has lost prestige and importance
3. Increased industrialization and urbanization and the necessity of geographical mobility have created new problems, accentuated old ones, and shown that every type of person can benefit from intelligently applied welfare programmes.

Social service simply defined is those services which have as their objective the enhancement of the well-being of the individual.

Social service, in some form or other, has existed throughout the ages but it has been above all in this century that industries and governments have seen it as a moral responsibility. The English historian, Arnold Toynbee, has very perceptively remarked that the 20th century would not be remembered so much for its political conflicts and its technical inventions but as the century in which men dared to fix as their objective the welfare of the human race.

The basic purpose of the CERN Social Service is to work for the well-being of all the Staff. The work itself can be divided into, firstly, services offered to all staff members automatically and, secondly, those offered to families or individuals with particular emotional or physical needs.

The Social Service is one of the units of the Welfare Section of the Personnel Division. The services that it makes available are not widely known among CERN staff and it is the purpose of this article to describe the present aims and activities of the Social Service.

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### The general social services

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#### 1. Staff welcome

The first few days in a foreign country can often be quite bewildering. The Service tries to make this settling-in period as uncomplicated as possible by answering questions and by helping with any emergencies. For example, it has addresses where beds can be hired, children looked after, and for one hundred and one other things. Help is given in drafting official letters and answering important correspondence.

All newly arriving personnel and their wives are welcome to visit the Service at any time to talk over any questions that they may have.

#### 2. Schools advisory service

The Service has up-to-date information on schooling in the region in both the public and the private sectors. Members of the service are happy to talk to both parents and children to explain the educational possibilities and to advise them in their choice. Up-to-date details of nursery schools are also available.

Documentation extends to adult education, especially in connection with language and secretarial courses, and information can also be given on a variety of courses extending from ballet to yoga.

#### 3. Miscellaneous

A list of other areas of information dealt with by the Social Service includes

- baby sitting
- home helps
- local clubs and institutions
- addresses of lawyers and other professional persons
- local social services...

But it would be difficult to compile a complete list. Suffice it to say that after four years of existence and after dealing with several thousand enquiries, the Service is at least able to *find* the answers to most questions.

On a wider scale, the Service tries to support 'welfare' projects in collaboration with other groups and associations. There is close collaboration with the Staff Association on many matters, including contacts with clubs and frequent discussions on social and cultural activities.

For example, the recent survey on welfare was organized jointly by the Service and the Staff Association. Another joint project is the 'Rencontres de Midi'. On the last Monday of every month between October and June, a well-known personality is invited to give a talk on some relevant subject. In 1967, these talks included the leaders of the political parties in Geneva each presenting their case. This year the theme is 'Adolescence' and several lectures have been presented which have proved of special interest to parents of adolescent and pre-adolescent children.

There is also collaboration with the Training Service, especially in connection with language courses which have a social as well as professional significance. Good relationships exist with the Medical Service on topics connected with ill health. Re-adaptation of handicapped workers and many other similar problems are discussed by the two Services. There is also collaboration with the Personnel Service on questions of staff welcome and professional integration.

Outside of CERN good contacts are maintained with the local Social Services and Organizations. There is particularly close collaboration with the Bureau d'Information Sociale and useful contacts with the social workers in the other international Organizations.

The Service works in conjunction with the Ecole des Parents by offering a free subscription to the 'Messages' which are sent each month for a year to parents after the birth of a child. With all these outside contacts, it tries, in whatever way it can, to encourage good relations with the local population and to break down any obstacles which prevent Staff members integrating into the community.

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### The social services and the individual

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The second, and very important, part of the work of the Social Service consists of offering help to individuals in difficulty or need. The problems fall under many headings. There are those connected with health, where the sickness of a parent may involve boarding-out the children, finding a home help, finding a doctor who speaks the right language, finding a specialist and many other things. There

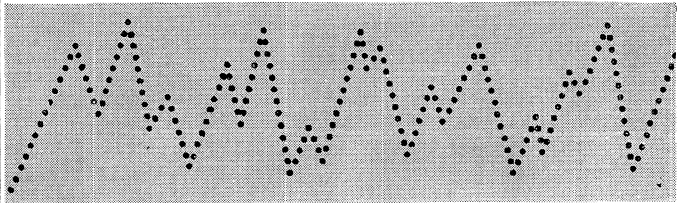
are also problems of a more emotional nature, such as difficulties of integration, professional adaptation, marital difficulties or difficulties with children.

When families do not speak French, or are not familiar with the local Social Services, it sometimes seems difficult to obtain the necessary help. It is for this reason that the Service has two social workers on its staff. One, a medical social worker, and the other a social case-worker.

The CERN Social Service tries as far as possible to provide a good substitute for the services that a person can find in his home country. Because of this, it is very autonomous, the details of all cases are kept strictly confidential and are not transmitted to the Administration. Confidentiality, is of course one of the cardinal principles of social work, but there are others governing the working attitudes of the Service, which can be summarized as follows :

Every person who comes to seek advice is seen not as 'a' human-being, but 'this' human-being. People are not stereotyped or grouped according to nationality of other characteristics. They are accepted as they are and there is no moralizing. The naive doctrine that equates economic hardship or social problems with personal failing is rejected absolutely. Every case is evaluated and not judged. To the Administrator, a person who is guilty of misconduct has done wrong ; but the social worker cannot say this, he can only ask why the person felt the need to act in the way he did. In other words, there is a complete rejection of paternalism, a sincere respect for the value of each individual, and a profound belief in the equal status of all men.

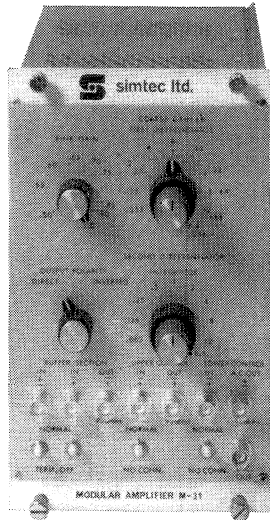
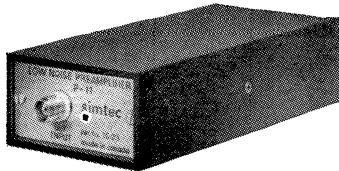
This brief article gives a birds-eye view of the CERN Social Service as it is at present. It must be remembered however, that, by its very nature, the Service is flexible and open to change. The demographic structure of CERN will obviously change as the years go by — the preponderance of young families will decrease and we will begin to see more people approaching retirement age. The social needs will change and the social provision will have to change with them.



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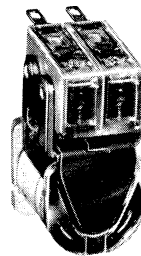
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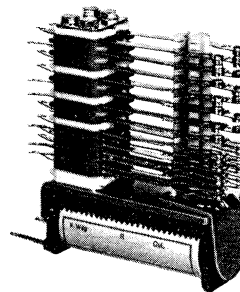
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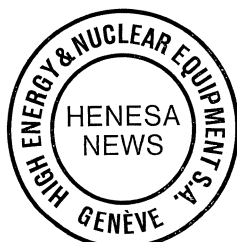
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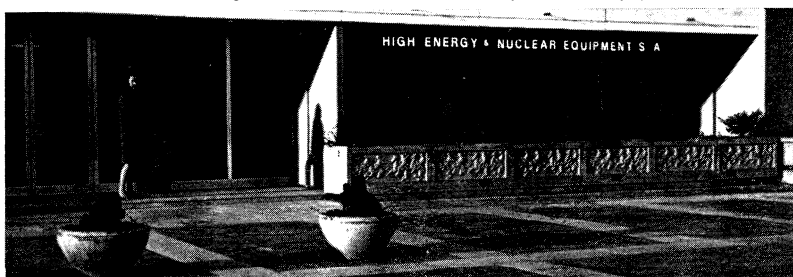
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\* CERN 27-29 May, Conference Exhibition of advanced instrumentation for experimental physicists (COMUS/JANUS), London 13-18 May I.E.A. Exhibition (Olympia) Nuclear Enterprises (stand E609) 20th Century and others will be there.

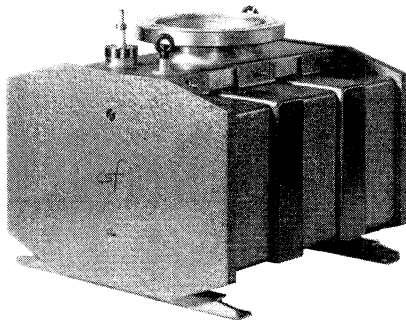
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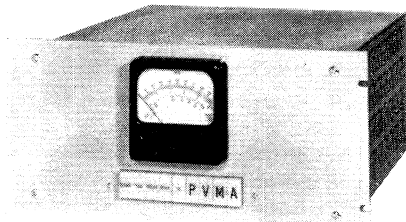
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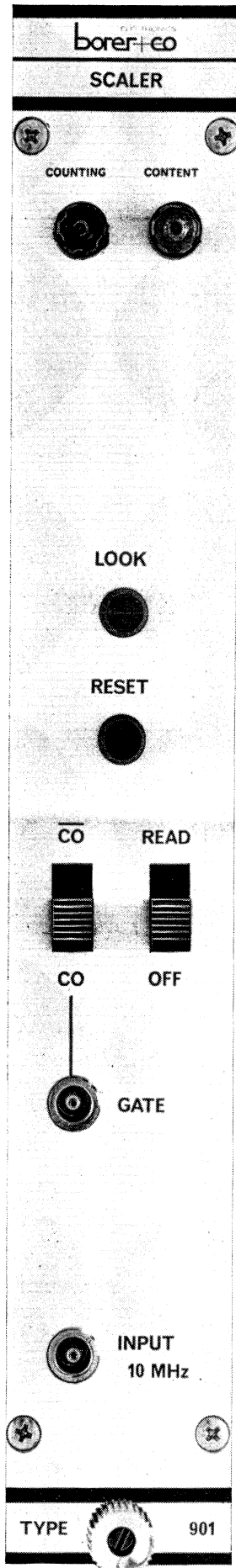
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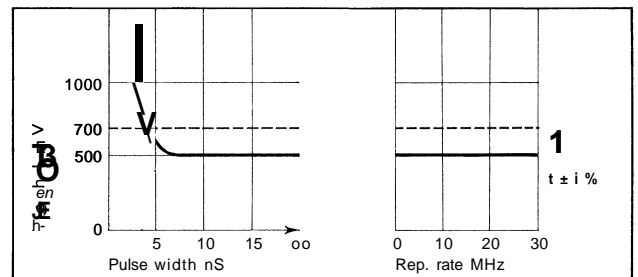


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to be  
certain  
of your  
scaler  
counting  
accuracy  
.....  
read on**



The input-and gate-circuits of the new AEC-NIM-Module Scalers are designed to enable you to forget about pulse conditioning ! A useful two-lamp feature shows actual operation of each scaler. The 'counting' lamp flashes when the scaler accepts a pulse. The 'content' lamp indicates difference from zero. By pressing the 'look' button of any scaler the contents can be seen on a central display unit. A wide range of readout equipment is available. **The scalers can be interfaced to fast on-line computers with a readout speed as high as  $32 \times 10^6$  bits/sec.**

Input characteristics Scaler Type 902



**Many different types are available to meet your specific requirements.**

Counting speed of 10, 30 or 100 MHz with or without input discriminator gating facilities, coincidence or anti-coincidence

Please ask for full technical literature !

**Borer+Co** ELECTRONICS

**Switzerland:** Heidenhubelstrasse 24, Solothurn  
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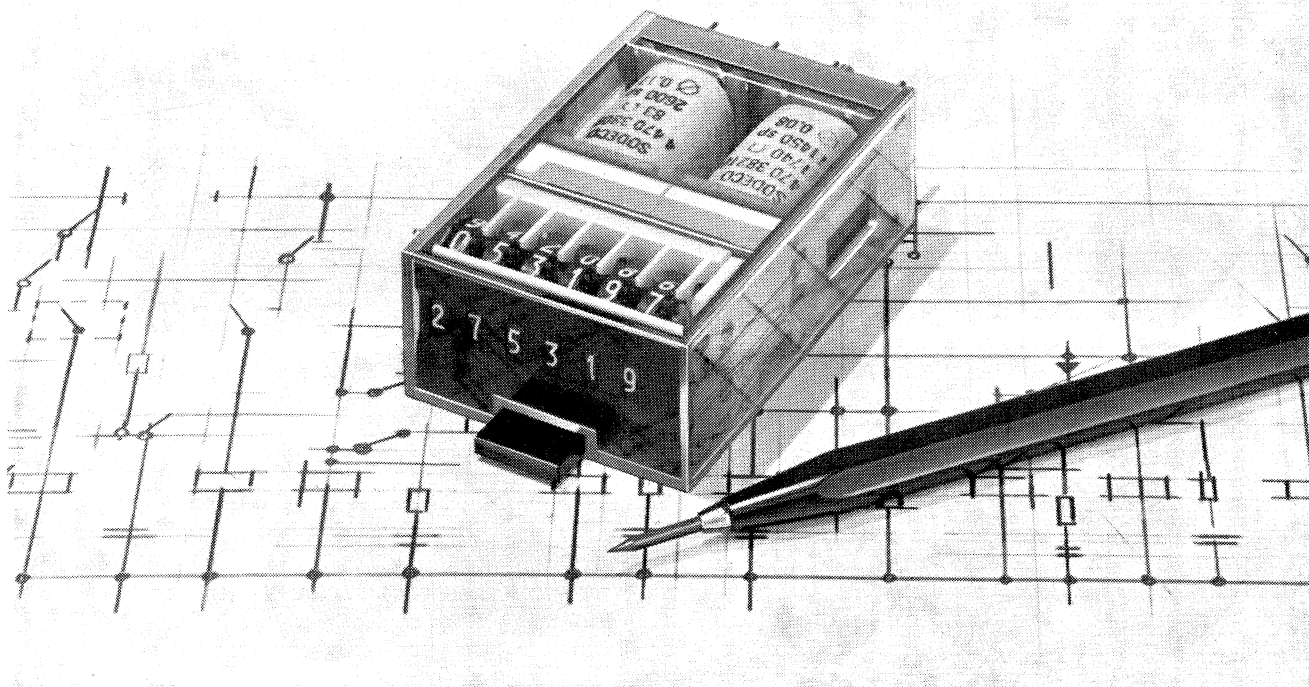
**Great Britain:** 36 East Street, Shoreham-by-Sea, Sussex  
Telephone 4305

**Germany:** Verkaufsbüro München, Kaiserstrasse 10, D-8000 München 23  
Telephone 34 80 16

**France:** Sorelia Electronique, 150 rue de Chatou, 92 Colombes  
Telephone 782.16.39-782.32.79

**Italy:** Boris G. F. Nardi, Via Capranica 16, Milano  
Telephone 2362924-2361394

New design, clear lines,  
and highly efficient performance



**Type RG Impulse Counter**

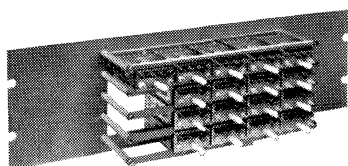
- small dimensions: 1.89" x 0.95" x 2.84" (48x24x72 mm)
- clear figures for ease of reading: 0.16"x 0.08" (4x2 mm)
- high counting speed: 60 impulses per second with great reliability
- plug-in type: easily interchangeable
- long life: over 200 million impulses

When quality counts — specify

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Grand Pré 70  
1211 Geneva 16 (Switzerland)  
Tel. (022) 3355 00 Telex 22 333

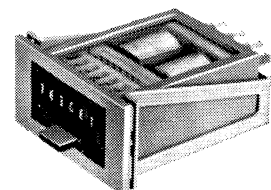
Group of RG counters, flush mounting, fixed by sockets at the rear



RG counters mounted in a statistic control instrument



RG counter with frame and fixing bracket



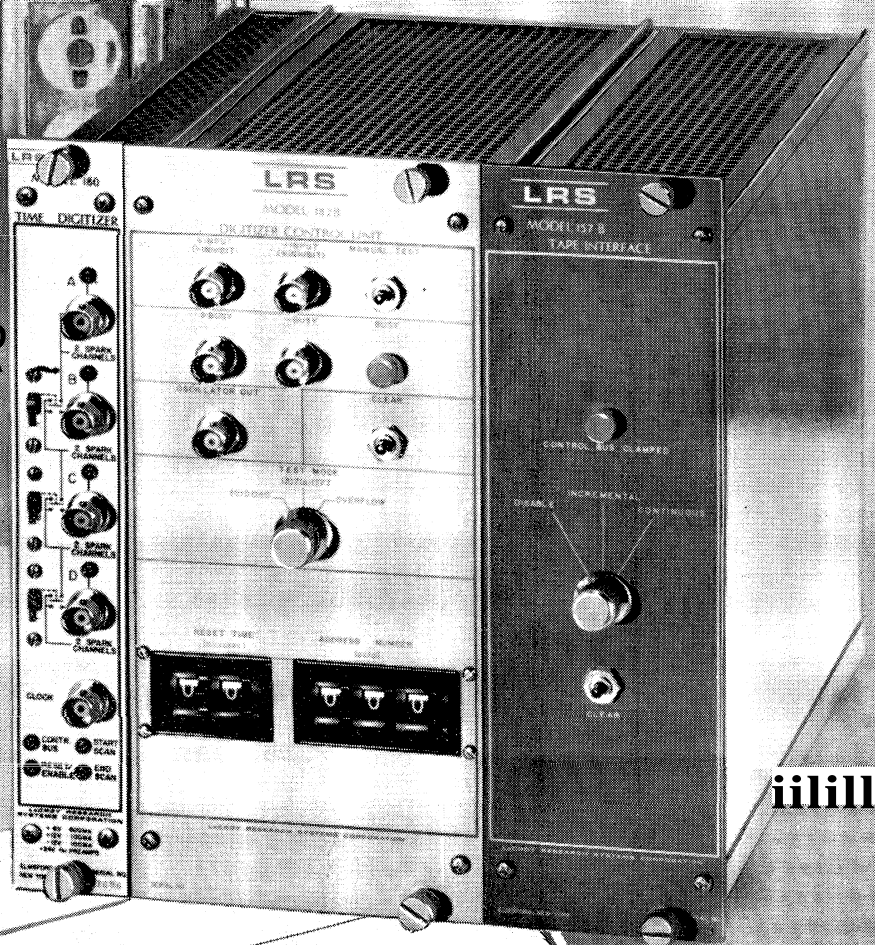


THE INNOVATOR LINE

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with functional simplicity

We've designed our new magnetostrictive spark chamber readout systems for the people who use them. • To do it, we've packaged each system *function* — data acquisition, control, interface and display — in its own AEC module. • This makes the system easier to set up, program<sup>^</sup> operate. It makes it less expensive to change, expand. And without sacrificing performance or flexibility. Without danger of obsolescence. • In short, we have attempted to make the best spark chamber system available. It's that simple . . . that functional.



**technical notes**

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- 2 SELF-CHECKING, SWITCH-SELECTED PROGRAMMING**—INPUT FORMAT READ OUT WITH DATA.
- 3 FULLY COMPUTER-COMPATIBLE**—PROVISIONS FOR TIME-SHARING OR COMPUTER RE-READ.
- 4 SIMPLIFIED SETUP**—ALL CONTROL & DATA LINES ROUTED VIA ONE DATA BUS CABLE INTERCONNECTED BETWEEN MODULES.
- 5 COMPACT**—8 SCALERS, SPARK PULSE ROUTING CIRCUITRY, INPUT DISCRIMINATORS, CLOCK, & OUTPUT SCANNER ARE ALL HOUSED IN EACH TIME DIGITIZER.
- 6 SYSTEM-ORIENTED**—READOUT RATE DETERMINED BY RATE OF SLOWEST DATA PROCESSOR.
- 7 BUILT-IN TEST MODES**—INITIATED MANUALLY OR UNDER COMPUTER CONTROL.
- 8 EASILY EXPANDABLE**—JUST BY ADDING MULTIPLE TIME DIGITIZERS, NO ADDITIONAL CONTROL OR INTERFACING REQUIRED.
- 9 SELECTABLE MONITORING**—ANY CHANNEL CAN BE SELECTED FOR ON-LINE DISPLAY.
- 10 FULL SYSTEM CAPABILITY**—LATCHES, ADC'S, FAST SCALERS, FIXED DATA ENTRY UNITS, PRESET COUNTER, DISPLAYS ALL AVAILABLE FROM LRS.

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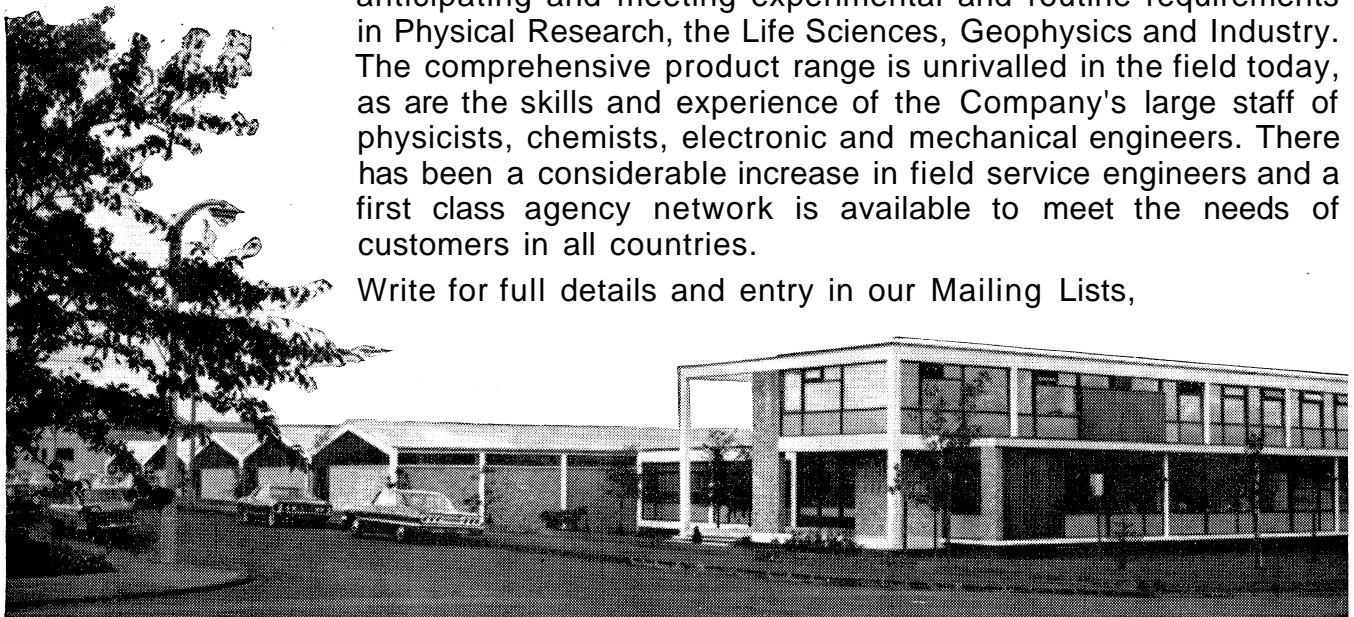
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# rationalisation industry

## RADIATION DETECTORS

Plastic Scintillators NE 102A, 103, 104, 105, 110

Rod, Sheet, Well Counters

Alpha Particle Detectors

Flow Cells, Light Pipes

Liquid Scintillators NE213, 220

Loaded Liquid Scintillators

Liquid Scintillator Tanks

Gel Scintillators

Neutron Detectors

Scintillation Chemicals

Glass Scintillators

Crystal Scintillators—

Nal(Tl), CsI(Tl)CsI(Na)

LiI(Eu), CaF<sub>2</sub>(Eu), Stilbene

Semiconductor Detector Systems

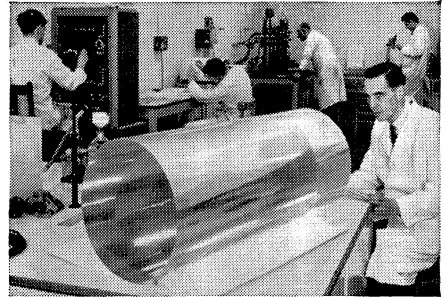
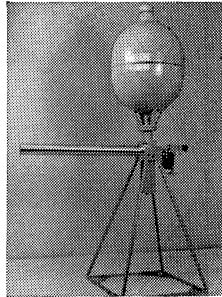
Lithium Drifted Germanium and

Silicon Detectors

Cryostats and Low Noise

High Resolution Amplifiers etc.

Plastic scintillator detector (right), sheets now available up to 2m in length  
Cryostat system (left) for use with semiconductor detectors



## LABORATORY INSTRUMENTS

International Series (to USAEC  
TID-20893 standard)

7000 Series

Harwell 2000 Series

6000 Computing Scaler

Wells Series

Edinburgh Series

Head Units and Probes

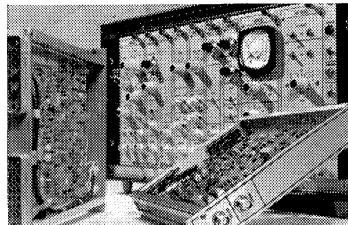
Automatic Sample Changer Units

Multi-channel Analysers

Neutron Activation Analysis

Integrated Circuit Spectrometers

Research and development in progress at Edinburgh (right)  
International Series modules (left)



## MEDICAL & BIOLOGICAL SYSTEMS

Scinticameras

Scintiscanner

Renal Function Analysers

Pulmonary Function Analysers

Whole Body Monitors

Low Level Counting

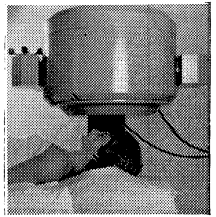
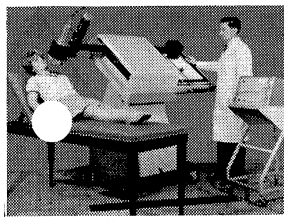
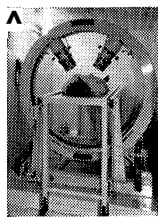
Shielded Caves

Steel Rooms

Renography Systems

(Edinburgh Series)

Brain tumour investigations with the Scinticamera (right)  
Scintiscanner, for general medical scanning (middle)  
Whole human body radiation monitor (left)



## HEALTH PHYSICS EQUIPMENT

Reactor Effluent Monitor System

Iodine-131 Monitor

Portable Scaler NE 5013

Plutonium-in-Air Monitors

Portable Scintillation Spectrometer,  
NE 8433

Gas & Gamma Monitors

Dosemeters

Radiological Densitometer

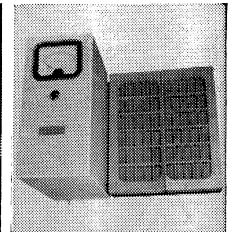
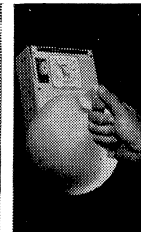
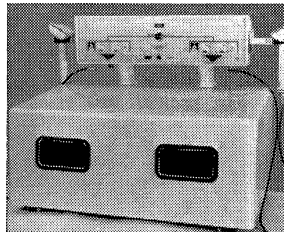
Contamination Monitors

Hand & Clothing Monitors

Farmer Electrometers and Dosemeters

Foot Monitor (right)

Neutron Monitor (middle) Hand and Clothing Monitor (left)



## INDUSTRIAL INSTRUMENTS

On line measurement and control of:

Thickness

Mass per Unit Area

Basis Weight

Coating Thickness

Density, Moisture Content

Level

Package Weight

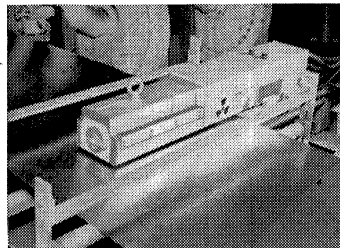
Elemental Composition

X-ray Fluorescence Spectrometers

Spectrometers for Geophysical  
Measurements

Moisture and Density Measuring Equipment (right)

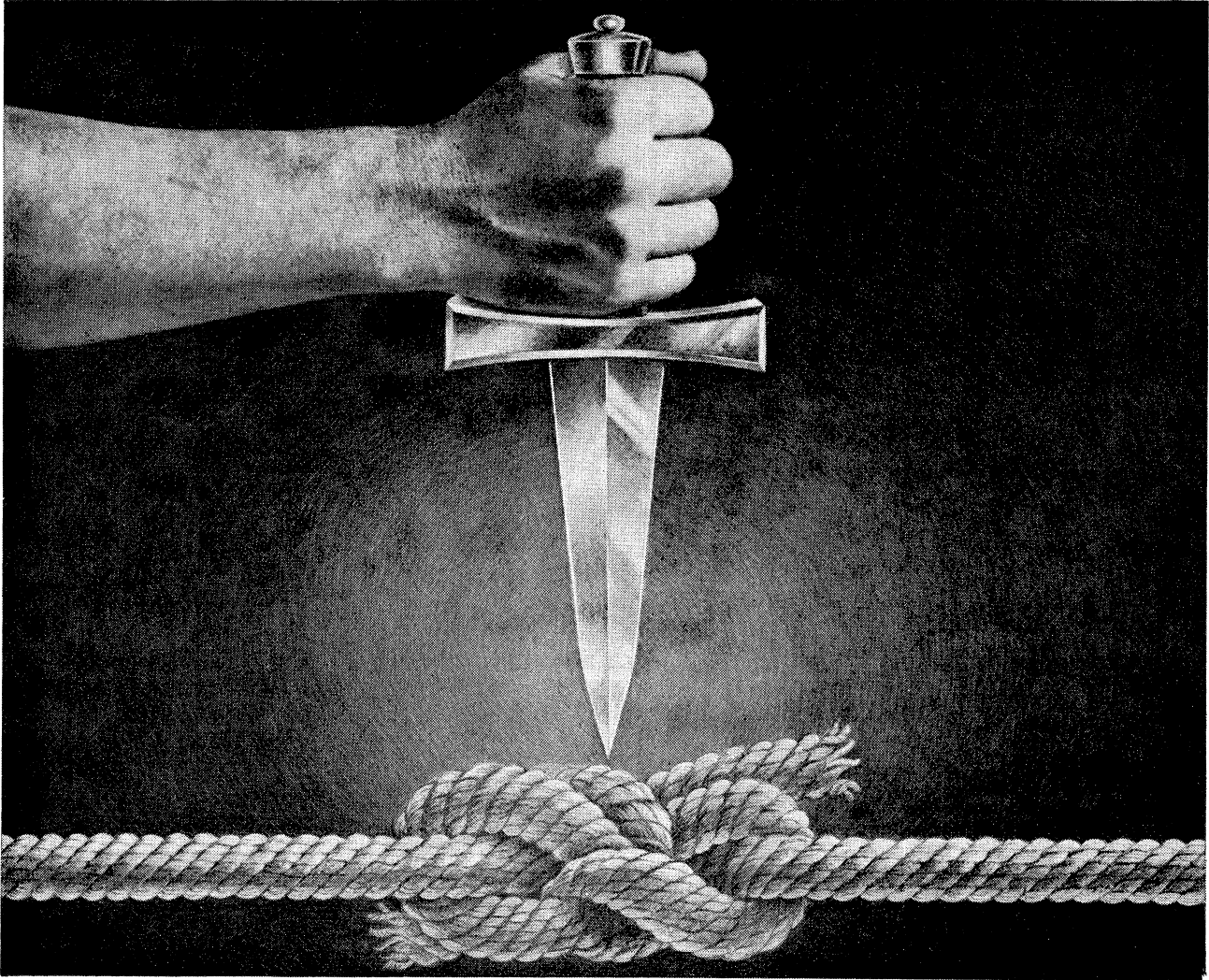
Measuring head carrier on continuous annealing line (left)



**Agents:** AUSTRALIA: Long Industrial Equipments Pty. Ltd.; BELGIUM & LUXEMBURG: Nucleobel S.A., Brussels; DENMARK: Hans Buch & Co. A/S, Copenhagen; FRANCE: Nucleofrance, Paris; GERMANY: D. S. Forster, Munich (N.E. Personal Representative); HOLLAND: Skaalar, Delft; Inteehmij N.V., The Hague; Negretti and Zambra, Zeist; ITALY: Ing. Silvio Garrone S.R.L., Rome; Fontanella; Milan; NORTHERN EUROPE: J. A. G. Lemmens (N.E. Personal Representative); NORWAY: Solberg and Anderson, Oslo; SWEDEN: Falico AB, Stockholm; SWITZERLAND: High Energy and Nuclear Equipment, S.A., Geneva; Max-Neukomm S.A.R.L., Chexbres/Vevey; U.S.A.: Nuclear Equipment Corporation, San Carlos; Isotopes Inc., New Jersey; and, also Angola and Mozambique, Argentina, Austria, Brazil, Canada, Chile, Hong-Kong, Iran, Iraq, Jamaica, Nigeria, Malaysia, North Borneo, Peru, Philippines, Sarawak, Spain, Syria, Tanzania, Thailand, Uganda, Uruguay.

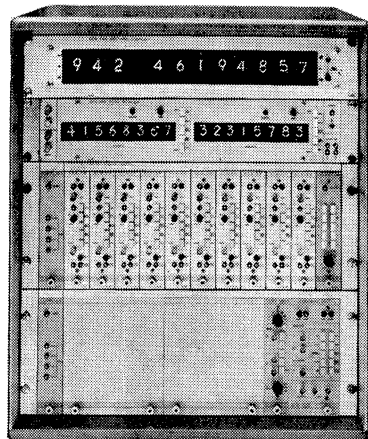


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**100 Mhz**

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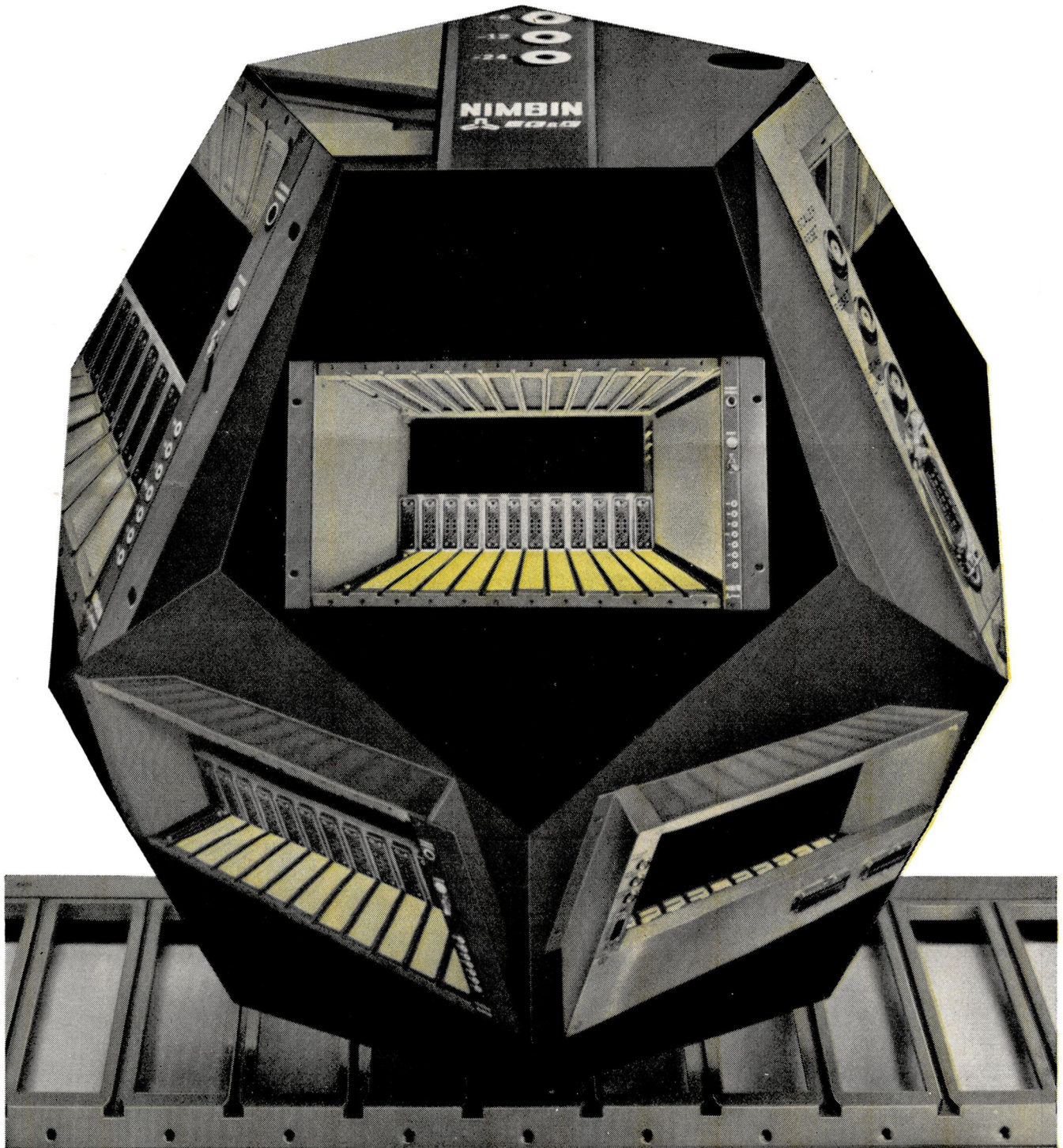


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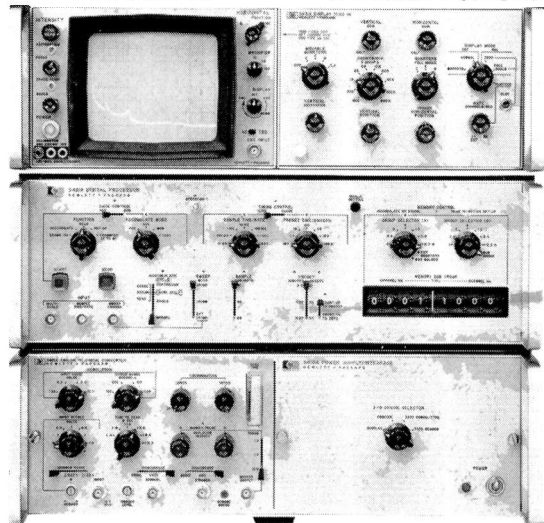
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