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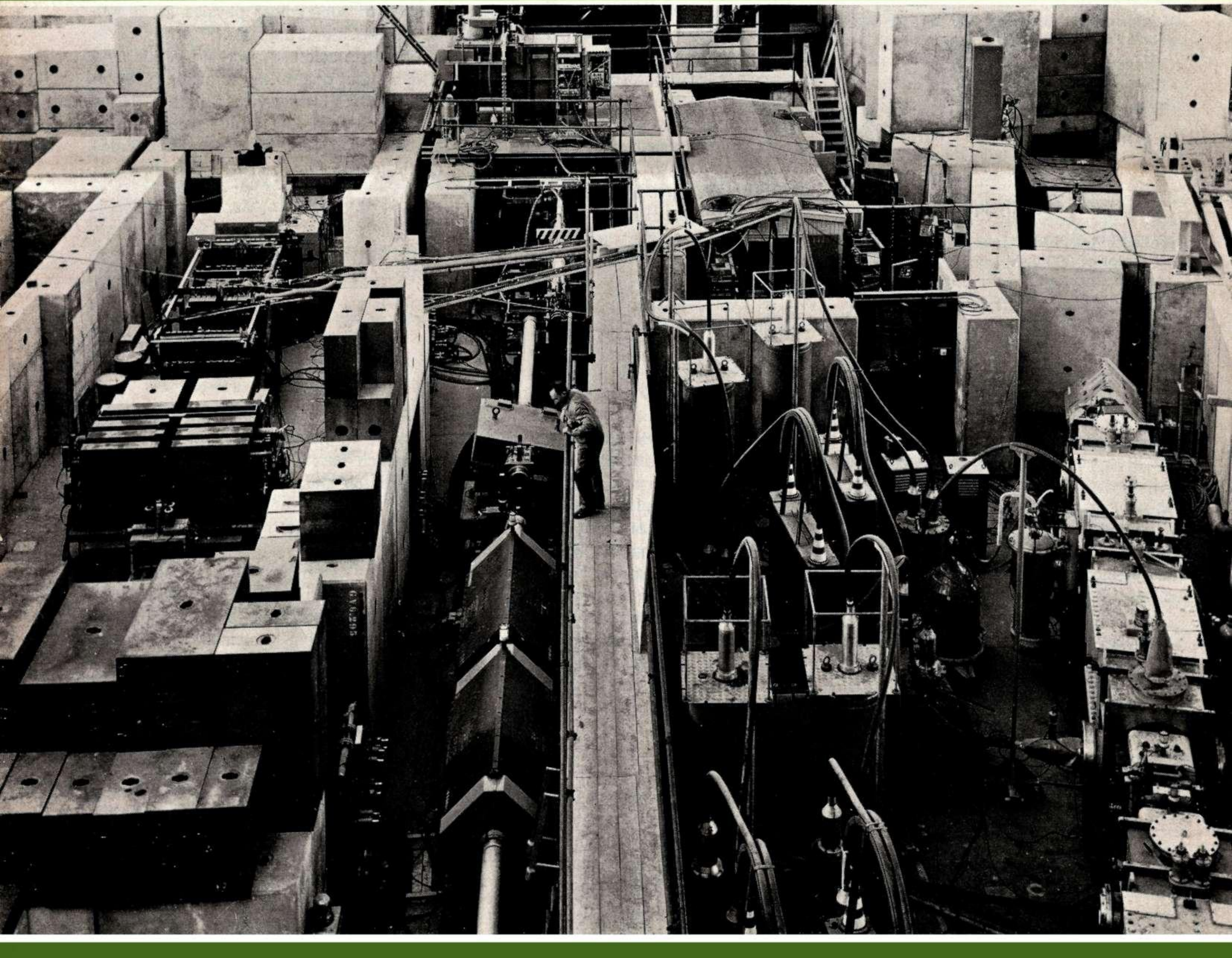

Cover photograph: A general view of the East Hall, the biggest experimental area at the PS. Two ejected proton beams are now available in the area. Beams are drawn from them for counter experiments, nuclear emulsion experiments and for the 2 m bubble chamber. Beam-line equipment, such as quadrupole focusing magnets and electrostatic particle separators, and some of the enormous quantity of shielding blocks which is required, can be seen in the photograph (CERN/PI 345.2.67)

Comment

The main article in this issue covers the experiments at present in progress on the proton synchrotron. These experiments range over most of the topics of current interest in sub-nuclear physics.

Prominent among the experimental facilities are three bubble chambers (an 81 cm hydrogen chamber in the North Hall, a 2 m hydrogen chamber in the East Hall and a heavy-liquid bubble chamber in the neutrino beam-line), the neutrino beam-line itself, the muon storage ring in the South Hall and two polarized targets (one currently in operation in the South Hall and another scheduled to come into operation again in the summer in the East Hall). The use of ejected proton beams onto targets in the experimental halls has been progressively increased in relation to the use of internal targets. Four ejected beam-lines are now available at the proton synchrotron.

The quality of the research programme at CERN depends principally upon the calibre of the scientists from throughout Europe who propose and carry out the experiments but, also, it depends on the quality of the research facilities around the two accelerators. The detection equipment at present available, the range of particle beams which can be used, and the backing of the experiments by track chamber picture analysis equipment and a large computer service, are the results of decisions taken at CERN and supported by the Council many years ago. The scale and expense of sub-nuclear physics research require this long-term planning. Decisions being taken now, will dictate the quality of sub-nuclear physics in Europe in the 1970's and beyond.

European scientists working in this field owe a great deal to the foresight of those who concern themselves with the probable requirements of the future research and to the appreciation by the Member States of the need to look many years ahead.

Contents

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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 mainly 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), which will allow experiments with colliding proton beams to be carried out, are under construction. Scientists from many European Universities and national Laboratories 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, Canton of Geneva, Switzerland. The site covers approximately 200 acres about equally divided on either side of the frontier between France and Switzerland. The staff totals about 2300 people and, in addition, there are over 360 Fellows and Visiting Scientists.

There are thirteen member States participating in the work of CERN. The contributions to the cost of the basic programme, 172.4 million Swiss francs in 1967, are in proportion to their net national income. Supplementary programmes cover the construction of the intersecting storage rings and preliminary studies on a proposed 300 GeV proton synchrotron for Europe.

Experimental Programme at the PS

A survey of the current programme of experiments at the 28 GeV proton synchrotron.

Available beams

Figures 1 and 2 are simplified representations of the layout of beams and experiments around the machine in the three experimental halls.

In the South Hall, a variety of secondary particle beams (the d, m and q beam-lines) are drawn from an internal target in straight section 1. d25 can provide unseparated negative pion, negative kaon and antiproton beams in the momentum range 3 to 15 GeV/c and is at present feeding two experiments using spark chambers. m4 is divided into two branches, m4e and m4b, each of which provide separated beams of positive and negative kaons, antiprotons and negative pions of low momenta (around 2 GeV/c). Both branches are at present in use. q3 is also divided into two branches, q3a and q3b, of which only q3a is in use. They provide low momenta unseparated beams of negative pions and antiprotons. h3, the remaining beam in the South Hall, is a fast ejected proton beam of momentum 10.5 GeV/c, feeding the muon storage ring.

The layout of beam-lines in the South Hall is intended to remain virtually as shown in Figure 1 for the next year, apart from the possible addition of a neutral beam, b15, from the target in straight section 1. In the North Hall, there is a single beam-line, k7, which uses electrostatic separators. It is drawn from the internal target in straight section 6. Low momentum negative kaon (up to 0.8 GeV/c) and antiproton beams are used at present. This beam-line will probably remain as it is over the next year and may then be replaced by one capable of higher momenta.

It is in the East Hall that the most drastic changes have occurred recently. There are now two extracted proton beams, e2 (slow, fast or rapid ejection from straight section 58) and e3 (slow ejection from straight section 62), going into the hall. e2 is the source of the separated beams for the 2m hydrogen bubble chamber. At present two beam-lines to the chamber are drawn from e2 - m6 uses electrostatic separators and provides kaon beams of 2-4 GeV/c, pion beams of over 1 GeV/c and antiproton beams of up to 5 GeV/c; u4 uses radio-frequency separators and can provide kaon beams of up to 14 GeV/c and antiproton beams of up to 17 GeV/c. A secondary beam, a9, for a nuclear emulsion experiment is also drawn from e2. Towards the end of this year, an additional beam-line, k8, will be constructed coming from the m6 beam-line, to provide low momenta kaons to the 2 m chamber, and an extension to u4, to be called u4a, beyond the 2 m chamber will take beams to the heavy liquid chamber in the 'jet area' which will be built in the next few months.

The recently commissioned e3 beam-line is intended eventually to feed all the counter experiments in the East Hall. Three beam-lines are shown in the figure coming from e3 - b13 is a beam of neutral particles, both p1 and p2 provide unseparated beams of positive and negative pions, kaons and protons in the momentum range 4 to 16 GeV/c. A further beam-line, b14, for neutral particles is to be constructed in the near future.

Finally, a fast ejected proton beam from straight section 74, is used to produce the pions and kaons which decay into neutrinos for the neutrino beam to the heavy liquid bubble chamber and a counter experiment.

No muon beams are available (apart from those available in the neutrino experiments) or planned for the PS in the near future. Proposals to set up muon beams have been discussed but it was decided that, despite the high scientific interest of the proposed experimental programme using muon beams, they would curtail the overall experimental facilities too much. Proposals to set up muon beams will be considered again when the new experimental hall (West Hall), being built in association with the Intersecting Storage Rings project, becomes available.

The current experiments, with brief descriptions, are now listed.

Counter experiments

S 33

This experiment was described in detail in CERN COURIER vol. 6, page 152. It is carried out at the muon storage ring in the South Hall and uses a 10.5 GeV/c ejected proton beam down the h3 beam-line to produce the muons for observation.

The aim is to measure the 'g-2' value of the muon much more accurately than has been previously achieved. Observations on negative muons have been completed and analysis of the data is in progress. Preliminary indications are that the measurement will achieve considerably higher precision.

The polarity of the storage ring magnet is now being reversed so that equivalent observations can be carried out on the positive muon. It is expected that the experiment will be completed in about a year's time.

S 38

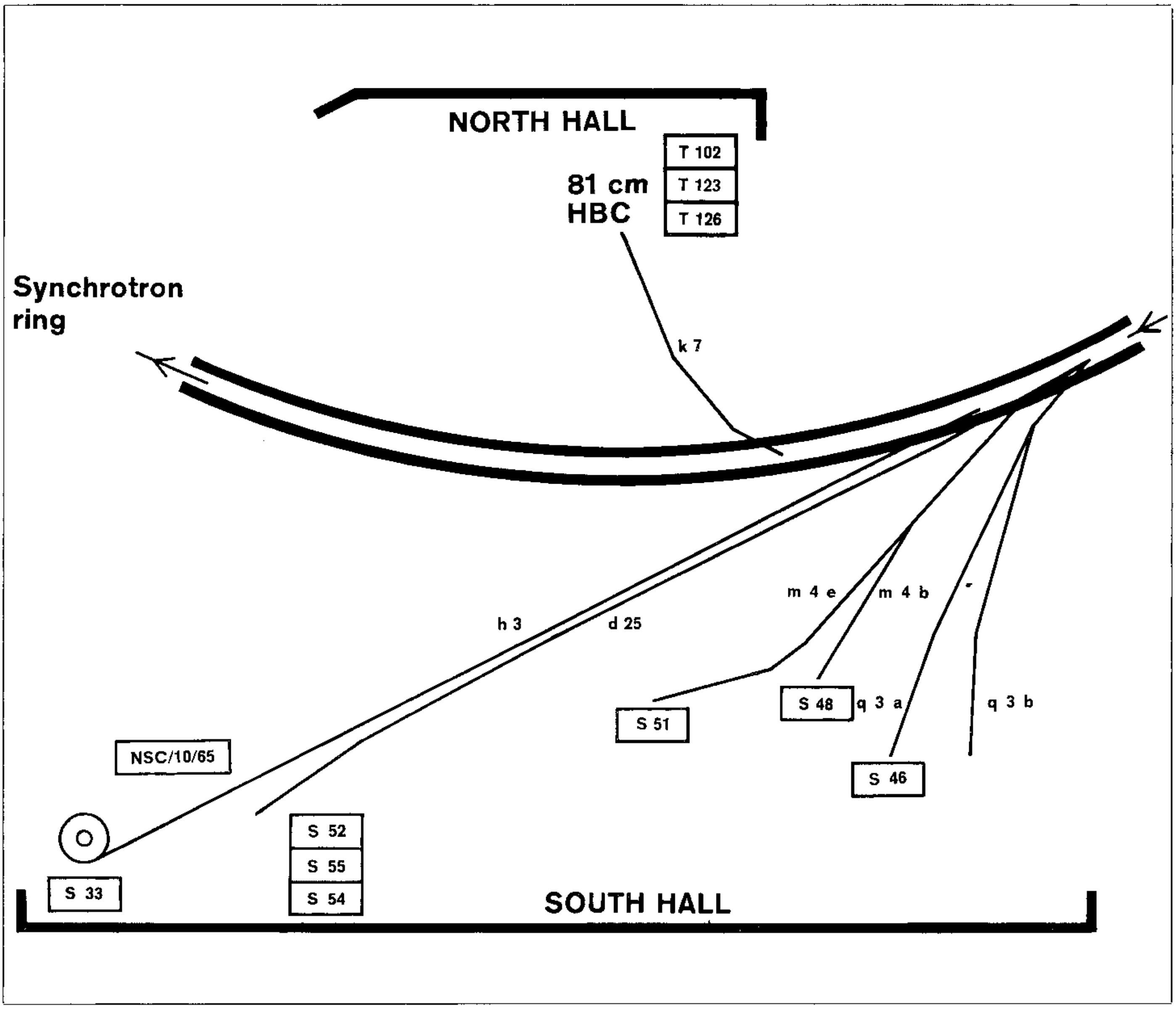
This experiment is being carried out by a CERN group to examine the precise shape of the angular distribution of proton-proton scattering at large angles. The slow ejected beam, e2, in the East Hall provides the incident protons to a hydrogen target. The momentum range between 8 and 21 GeV/c is being investigated.

Both the scattered and recoil protons are momentum analysed and then detected by scintillation counter telescopes arranged to the right and to the left of the direction of the proton beam. The two short branches shown on Figure 2 at the position of the S 38 experiment are the locations of the magnets and counters for momentum selection and detection.

At this momentum range and at large angles, proton-proton scattering depends on the internal structure of the protons themselves. Previously only the general features of these events have been studied. Use of the external proton beam makes a more detailed investigation possible. The same experimental team reported, in Physics Letters, 7 november 1966, an experiment on the same phenomenon carried out at 16.9 GeV/c. The energy distribution at fixed centre of mass angle was predicted, by statistical theory, to show a characteristic structure. The predicted fluctuations were not observed, indicating that large-angle proton-proton scattering is not dominated by a statistical process. The more detailed experiment, S 38, has just been concluded and the results are now being analysed.

S 46

This experiment is a collaboration between CERN and Karlsruhe. It is set up in the q3a beam in the South Hall. Negative pion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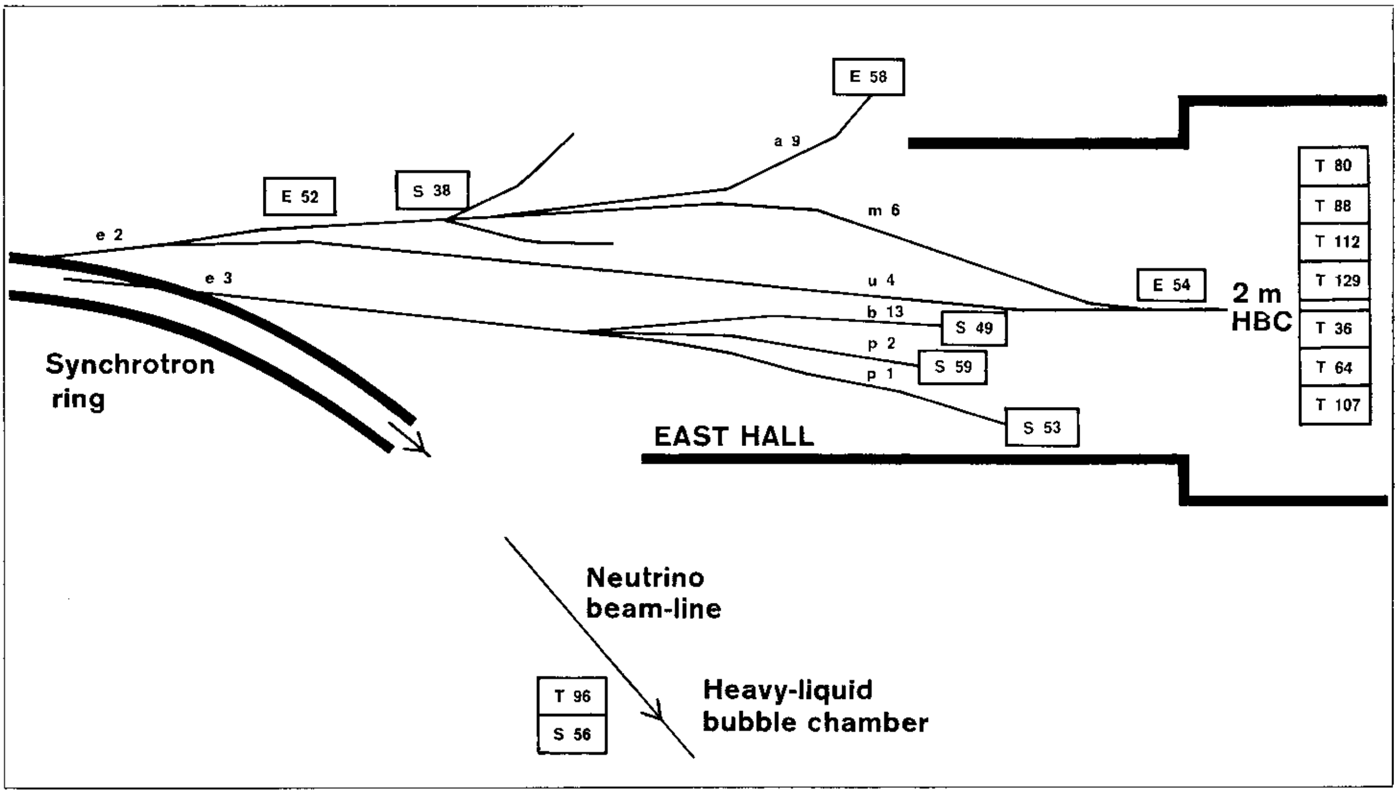
S 52
S 55
S 54
S 33
SOUTH HALL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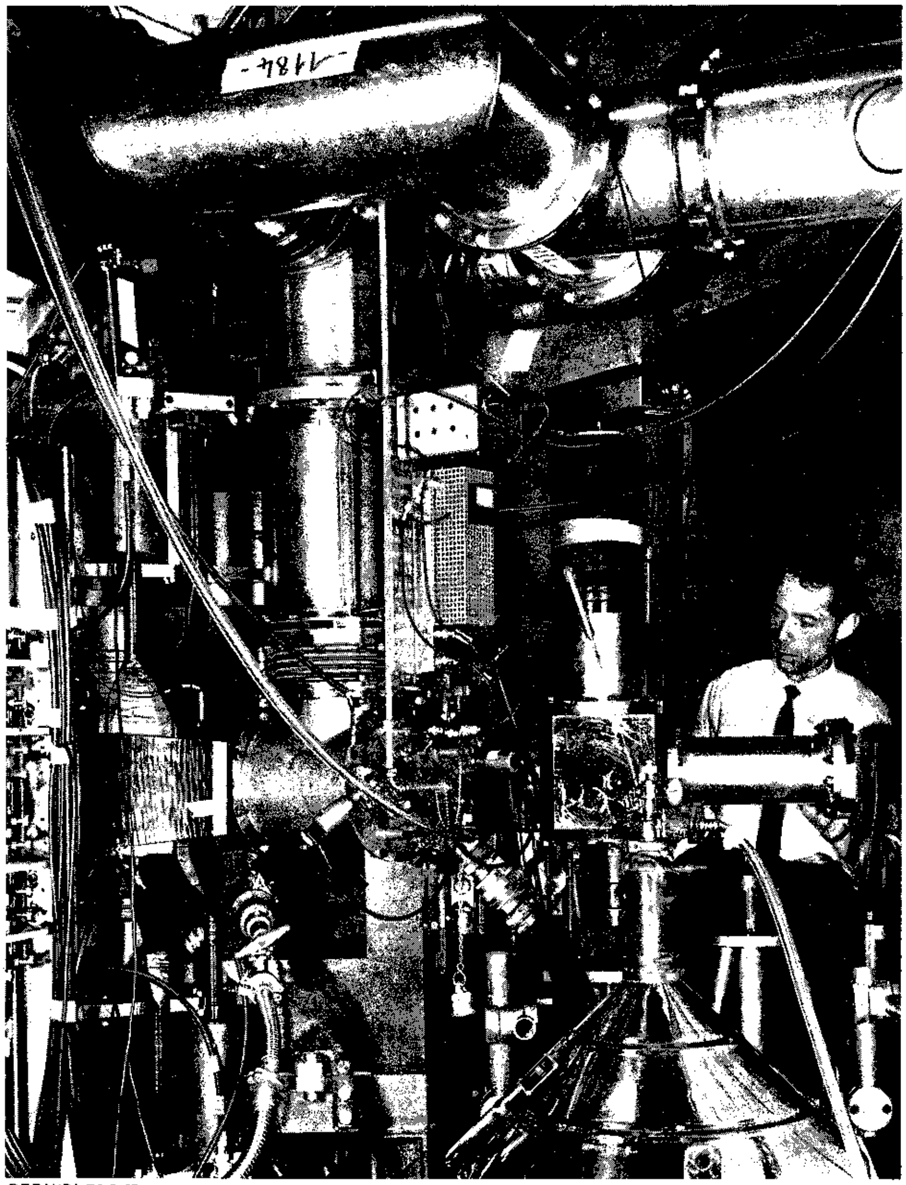
b 13
S 49
p 2
S 59
p 1
S 53
Synchrotron
ring
EAST HALL
Neutrino
beam-line
Heavy-liquid
bubble chamber
T 96
S 56

Left: Simplified representations of the layout of beams and the location of experiments (identified by their code numbers in boxes) in the three experimental halls at the proton synchrotron.
Right: The polarized proton target assembly used in the experiment on kaon-proton scattering (S48).



CERN/PI 76.2.67

beams with momenta between 0.7 to 2.8 GeV/c are used onto a hydrogen target to produce neutral meson resonances with masses below 1 GeV. The interaction observed is pion plus proton giving a neutron and a neutral meson.

A neutron missing-mass spectrometer (see CERN COURIER vol. 7, page 31) is combined with a system of optical, thick-plate spark chambers closely surrounding the target. Special scintillation counters give the angle at which the neutron is emitted and its momentum, and from these observations on the neutron the 'missing-mass' of the neutral meson can be determined. Charged particles and electron showers initiated by gammas from the decay of the resonances can be photographed in the spark chambers.

The purpose of the experiment is to search for new neutral meson resonances and to check on the existence of doubtful ones, and also to observe the way in which the resonances decay. One important question which this investigation may answer is whether scalar resonances, predicted by SU_3 theory and the quark model, exist. From the interpretation of data on other resonances, there seems to be indirect evidence for the existence of scalar mesons, (σ with a mass around 400 MeV and ϵ with a mass around 700 MeV) but there is as yet no direct observation. In this experiment, these resonances will be looked for and their decay into two neutral pions can be observed. The experimental equipment was tested in 1966 when the well established neutral mesons η and ω were clearly seen. Data taking began at the beginning of this year.

S 48

This experiment is a collaboration between scientists from Holland and CERN who began setting up their experiment in November 1966. They look at the elastic scattering of negative kaons, with momenta between 1.5 and 3 GeV/c, on transversely polarized protons. The kaon beam is from the m4 beam-line in the South Hall and the polarized target, constructed at CERN, is the usual LMN type. Further detection equipment consists of 80 scintillation counters and two Cherenkov counters.

Since the incoming beam contains kaons, pions and antiprotons, Cherenkov counters are used to distinguish the kaons. A scintillation counter hodoscope detects the scattered kaon and the recoil proton, and the electronics are arranged to reject all events which produce more than two outgoing particles. The data is recorded on magnetic tape and analysed using the CDC 3800 and 6600 computers.

The experiment is designed to measure the polarization distribution of the scattered kaon over a range of energies where several resonances are known or suspected. In particular, the region around 2 GeV/c incident kaon momentum, where recent counter experiments have revealed several new possible resonances, is being investigated in detail.

S 49

This experiment is a continuation of the investigation of interference in the decay of the long-lived and of the short-lived kaon into two charged pions. The topic has been covered several times previously in CERN COURIER (see for example vol. 6, page 195, vol. 5, page 131).

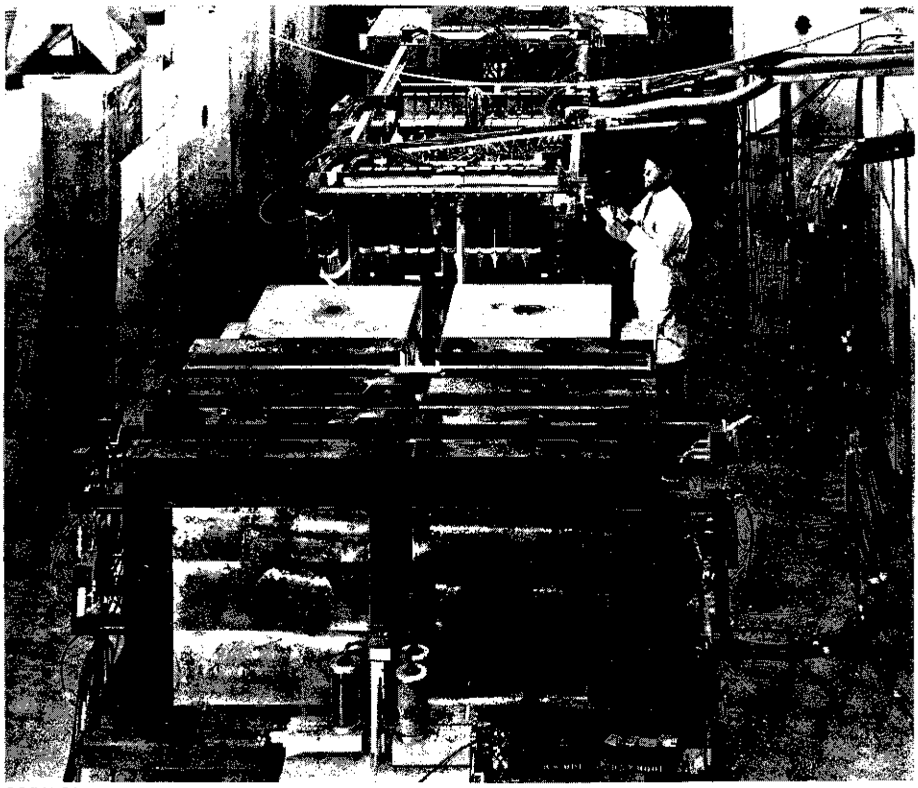
In the new experiment, a neutral beam, b13, derived from the slow ejected proton beam, e3, in the East Hall, provides the flux of neutral kaons and the observation of interference is being carried out close to the primary target. Spark chambers and magnets are used to detect and analyse the positive and negative pions.

A related experiment, which is not yet set up in the experimental hall, will also use a neutral beam, b14, drawn from e3. This will investigate interference in the decay of long-lived and short-lived kaons into two neutral pions (see CERN COURIER vol. 7, page 31).

S 51

This experiment is set up in the m4e beam-line in the South Hall. A negative pion beam of about 2.5 GeV/c momentum is directed onto a hydrogen target. The interactions producing neutral mesons (particularly ρ, ω or ϕ) and a neutron are observed by time-of-flight measurements on the neutrons. An array of heavy plate spark chambers will be set up to observe decays of the mesons into electron-positron pairs.

The experiment is a search for electromagnetic decays of the mesons which will give information on the interaction of the



CERN/PI 4.2.67

The symmetrical array of detectors, (spark chambers and counters) used in the S 49 experiment to investigate the interference in the decay of the long-lived and the short-lived neutral kaons. The experiment is set up in the East Hall in a neutral beam drawn from a target in the ejected proton beam-line, e3.

electromagnetic field with matter. Also measurements will be made on the ω - ø 'mixing angle'. This will check the theoretical work which has reconciled the physically observed ω and ø mesons with the octet predicted by SU_3 theory.

The Bologna-CERN team is now testing the large, neutron detection equipment in preparation for the final experiment. They have observed the ø meson (which has a low production cross-section) and have also investigated the supposed existence of the S^0 meson (This is reported in CERN News, page 69). The electron detectors are being put in position during the present PS shut-down.

S 52

This experiment is a collaboration between CERN and ETH Zurich. It is set up in the d25 beam-line in the South Hall using unseparated negative pion beams of momenta 6 GeV/c on to a hydrogen target. The interactions producing neutral mesons (η, ω, etc.) and a neutron are observed and a spark chamber array in a magnetic field is used to measure the decay modes of the neutral mesons — in particular, into positive and negative pions and a gamma.

S 53

This experiment is being carried out by a CERN team in the p1 unseparated beam drawn from e3 in the East Hall. They are looking at the angular distribution of both positive and negative pions in the momentum range, 4 to 20 GeV/c, scattered from protons in a hydrogen target at large angles (up to 180°) relative to the incident pion direction. Much more intense pion beams (especially of positive pions) can be obtained using the ejected proton beam than are possible from internal targets.

The detection equipment includes a digitized wire spark chamber system with an on-line computer and is designed to measure the momenta and directions of all the particles involved in the interaction. To do this, three spectrometers are used. One spectrometer, which includes the hodoscope pictured on the cover of the last issue of CERN COURIER, measures the incident pions. The other two are large aperture spectrometers using wire spark chambers with ferrite core read-out systems, connected to an IBM 1800 computer which is in turn linked with the CDC 6600.

It is estimated that the system will be able to collect data at least ten times faster than systems of comparable resolution previously in use at CERN. It is also very versatile and it is probable that a number of experiments (such as kaon and antiproton scattering, scattering from a polarized target and inelastic scattering) can be done with virtually the same equipment. This detection array may therefore be in use for several years.

The experiment aims to carry out a full survey of the scattering of positive and negative pions on protons at wide angles, up to the highest energies possible. Only proton-proton scattering has been thoroughly surveyed up to now. Testing of the equipment, prior to actual data taking is now under way.

S 54

This experiment by a team from Saclay will begin on the d25 beam-line in the South Hall on completion of S 55. A longitudinally polarized proton target and a spark chamber polarimeter will be used in an investigation of pion-proton scattering with incident negative pion beams of momenta 5 to 18 GeV/c.

S 55

This experiment is being carried out by a collaboration between Orsay and Pisa. It is one of the two experiments set up in the d25 beam in the South Hall using negative pion beams in the momentum range 6 to 11.2 GeV/c. The purpose of the experiment is to look at the interaction of the pion and proton producing a neutral kaon and a lambda or sigma particle. The negative pions are directed on to a special hydrogen target which was designed and built at Saclay.

The hydrogen target is surrounded by a cylindrical spark chamber and followed by a further system of optical spark chambers. These detect the charged decay products of the neutral particles produced in the interaction — in particular, they detect the short-lived neutral kaon decaying into a positive and a negative pion and, using interposed lead plates, they give good gamma ray detection also.

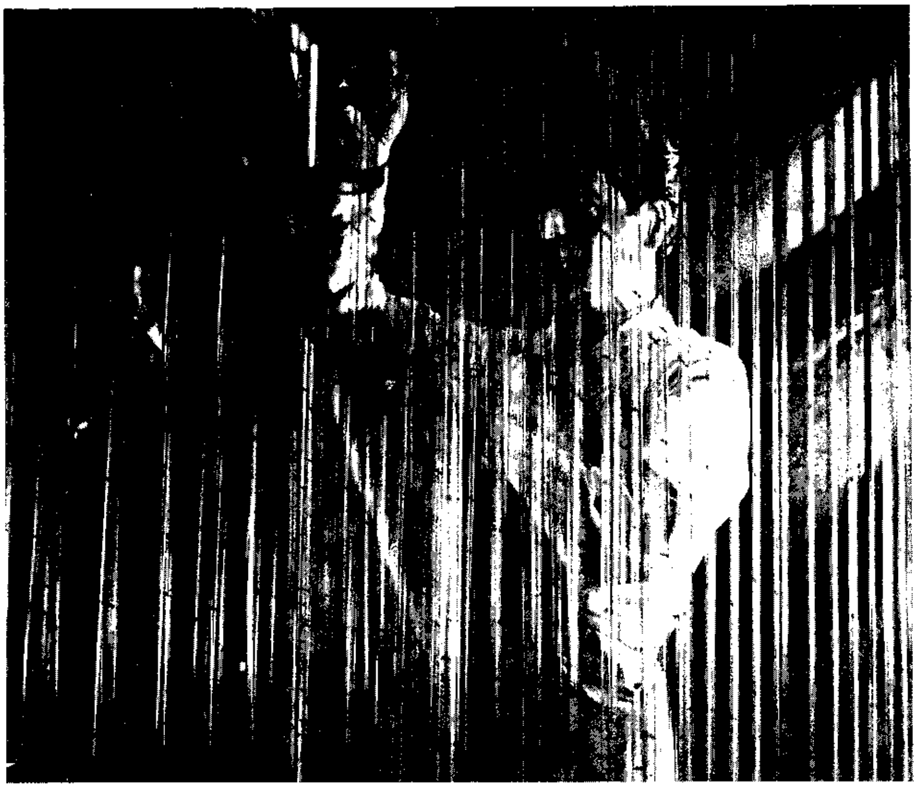
The experiment began in September 1966 and about 3000 good events at 11.2 GeV/c were collected. The pictures are measured and analysed both at Orsay and Pisa. Further information is now being gathered at lower moments.

The pion-proton to lambda (or sigma) - kaon interactions has been studied using bubble chambers up to a momentum of about 4 GeV/c and the present experiment extends this investigation to higher momenta. This type of survey has already been carried out for the pion-proton to neutron-neutral pion interaction. The two interactions are similar from the point of view of SU_3 theory and Regge pole theory and the results will be assessed on the basis of the predictions of these two theories.

S 56

This experiment, being carried out by a CERN-Fribourg collaboration, is set up in the neutrino beam-line. It is designed to test more precisely, a law of 'muon conservation' — that the muon neutrino always transforms to a negative muon and that the muon anti-neutrino always transforms to a positive muon. A spark chamber array, in association with the magnet of the heavy liquid bubble chamber, will identify the

A curtain of bubble chamber film; the films are being hung up to dry after processing. The picture gives an idea of the volume of information coming from research with bubble chambers. The two hydrogen bubble chambers at CERN took 2 161 000 pictures in 1966; 1 423 000 of these went to Universities throughout Europe for analysis.



CERN/PI 35.3.67

muons and determine their sign. The data is collected at the same time as the neutrino experiments in the bubble chamber are in progress.

S 59
This experiment by a team from CERN, Orsay and Pisa will probably begin around September of this year. Positive and negative pion, positive and negative kaon, and proton and antiproton beams in the momentum range 4 to 20 GeV/c, derived from the slow ejected beam e3 in the East Hall, will be available for scattering experiments using a transversely polarized proton target and counter hodoscopes.

Bubble chamber experiments

The following experiments are in the programme for the 2 m hydrogen bubble chamber:

Using the m6 beam-line -

T 80
This experiment is a CERN, Orsay collaboration known as the 'fast-antiproton group'. An antiproton beam of momentum 3.6 GeV/c (about 20 particles per photograph) is used to produce strange particle events for measurement. 100 000 photographs will be taken, beginning in the summer, bringing the total number of pictures in this experiment up to 400 000. The group hope eventually to have a total of 600 000 photographs. The experiment repeats one already performed but will have at least 10 times the statistics.

More information will be obtained about the characteristics of the production of hyperon-antihyperon pairs. New mesons will be looked for and their production mechanisms studied.

T 88
This experiment is being carried out by a group from Ecole Polytechnique. They used a beam of antiprotons of momentum 2.5 GeV/c to produce lambda — anti-lambda pairs and examine the relation between their polarizations. They will also analyse events wtih the short-lived neutral kaon to study $K\pi\pi$ systems, and will investigate the annihilation phenomena of the proton and antiproton system. They took 150 000 pictures which they are now analysing.

T 112
This experiment involving Ecole Polytechnique, Oxford and Saclay uses negative kaon beams with momenta in the range 2.8 to 4.5 GeV/c to examine particle production processes. They look at the production of strange particles and are gathering more statistics on the properties of baryonic and bosonic resonances. 400 000 pictures will be taken.

T 129
This experiment is a collaboration between CERN, Collège de France, Institut du Radium and Liverpool. They are using an antiproton beam of momentum 1.2 GeV/c to study particularly the quantum numbers of the D° meson (a kaon, anti-kaon, pion resonance). Pictures which give kaon, anti-kaon and three or four pions, when the anti-proton is annihilated in the chamber, will be measured. 200 000 photographs will be taken.

Using the u4 beam -

T 36
This experiment is a collaboration between Hamburg, Padua and Pisa. They are taking 100 000 photographs of anti-protons, with a momentum of 12 GeV/c, to study the general characteristics of high energy proton-anti-proton interactions (inelastic processes and annihilation cross-sections). They also look at strange particle states and other interactions.

T 64
This experiment is a collaboration between Aachen, Berlin, CERN, Imperial College London and Vienna. They use a negative kaon beam of momentum 10 GeV/c and are taking 200 000 photographs to look at the production and decay, and the quantum numbers of resonances (especially the $K\pi\pi$ resonance of mass about 1800 MeV, which was discovered in the first series of pictures taken by this collaboration). They also investigate reaction mechanisms at high energy and the production of the sigma minus and omega minus particles.

T 107
This experiment is a collaboration between Aachen, Berlin, Bonn, CERN, Krakow and Warsaw involving 100 000 photographs of negative pions with momentum 16 GeV/c. They are studying high-energy interactions, quasi two-body processes, and resonances. Their results will be compared with those already obtained with a positive pion beam of momentum 8 GeV/c.

Three experiments have been approved for the autumn of this year when the 2 m chamber will be filled with deuterium. 300 000 photographs will be taken with positive pions (150 000 each at 9 GeV/c and 12 GeV/c) and 100 000 with positive kaons at 3 GeV/c.

The following experiments are in the programme for the 81 cm hydrogen bubble chamber using the k7 beam line -

T 102
This experiment is being carried out by a group from Heidelberg. It is a continuation with increased statistics of the experiment which established the $\Lambda\Sigma$ parity to be positive. They are scheduled to take a million pictures of stopped negative kaons over a period of about two years. The experiment measures the leptonic decay rates of the positive and negative sigma and the lambda (testing conserved vector current, the $\Delta S = \Delta Q$ rule, and symmetry breaking in the Cabibbo theory) and

the sigma zero - lambda zero form factor ratio (including a test of time reversal invariance). The experiment also studies hyperon-proton scattering.

T 123

This experiment is a collaboration between CERN, Collège de France and Liverpool. They are taking 200 000 photographs of 700 MeV/c anti-protons to study in particular the production of the C^0, D^0 and E^0 mesons. They look for the annihilation of the anti-protons giving kaons and pions.

T 126

This experiment is being done by the CHS collaboration (CERN, Heidelberg and Saclay). They are carrying out a systematic study of negative kaon interactions in the region near 1 GeV/c kaon momentum. The kaons are drawn from the k7 beam line and pictures are taken at intervals of about 20 MeV/c in the kaon momentum.

This investigation has been under way since the summer of 1964 and has covered the momentum region from 800 to 1200 MeV/c. Among the results of this study are the determination of the quantum numbers of the hyperon resonances Y_0^* (1820), Y_1^* (1760), Y_0^* (1700) and a first partial-wave analysis of the $\bar{K}N$ interaction in this momentum range.

The study has now been extended to lower momenta (500-800 MeV/c) where about 200 000 photographs had already been taken up to the beginning of 1967. A further 150 000 have been approved and the next run will begin in a few months' time. The study will provide long needed information on the existence and properties of hyperon resonances in the mass-range around 1660 MeV.

The heavy liquid bubble chamber is currently being used for the neutrino experiment -

T 96

The experiment, being carried out by a CERN group, was described in detail in CERN COURIER vol. 6 page 211. They are studying the interaction of the neutrino and the proton, using propane in the bubble chamber to provide the target of free protons. The first experimental run took place in April before the PS shutdown began and will be reported in the next issue of CERN COURIER.

Emulsion experiments

E 52

This experiment, a collaboration between CERN, Valencia and Warsaw, intends to use an ejected proton beam with momentum over 10 GeV/c, to study heavy fragments emitted in the interaction of high energy protons with complex nuclei. They have been testing equipment in an ejected proton beam.

E 54

This irradiation has been carried out for the 'European K^- Collaboration' (University College London, University College Dublin, Dublin Institute for Advanced Studies, Université Libre de Bruxelles, East Berlin and Warsaw), and groups in Belgrade, Delhi, Clermont-Ferrand and Strasbourg. They used the separated beam, u3, when it was not in use for the 2 m bubble chamber, to provide negative kaons of momentum 10.1 GeV/c, particularly to study hyperfragments. They received about 400 000 kaons incident on their emulsion stacks. This involved 5000 pulses from the PS at up to 100 negative kaons per pulse. The beam group from Track Chambers Division put considerable effort into the development of the beam specifically for this experiment.

The European K^- Collaboration has been active for some years. In 1953, the Warsaw group observed a hyperfragment (a nuclear fragment in which a lambda hyperon is trapped in the nucleus) for the first time, and, ten years later, the same group observed a double hyperfragment (two lambdas trapped in the nucleus).

Studies of hyperfragments give information about binding energies in the nucleus, the presence of the neutral lambda as opposed to the neutron imposing different conditions on the way the nucleus is bound together.

E 58

This experiment, a collaboration between Ankara, CERN, Lausanne, Munich and Rome, is a continuation of the experiment to measure the magnetic moment of the lambda hyperon (described in CERN COURIER vol. 6, page 85). They use a secondary beam, a9, produced from a target in the fast ejected proton beam, e2, in the East Hall.

The new experiment is intended to improve the accuracy achieved in the previous measurements (reported in full in Nuovo Cimento, 21 November 1966). The lambda is produced in the interaction of a negative pion (of momentum 1.05 GeV/c) with a proton in a polyethylene target, and its subsequent decay into a negative pion and a proton is recorded in the emulsion. The lambda passes, from the target to the emulsion, through a very high magnetic field (210 kG or higher from a pulsed magnet). Measurement of the direction of emission of the pion in the decay indicates how much the direction of the magnetic moment of the lambda has been rotated by the magnetic field; this is proportional to the value of the magnetic moment.

Some production-type exposures with all the equipment in operation were taken just before the PS shutdown began on 16 April. These exposures are now being analysed to see whether any modifications are needed before the next production run in the summer.

The CERN Emulsion Group has also continued to provide services for smaller-scale exposures which are called for from time to time. For example, exposures at the PS have recently being organized for Professor Morand of the Sorbonne, Paris, for Dr. Blue of the University of Texas, USA and for Dr. Deka of Cotton College, Assam, India. They are also providing large quantities of emulsion and assisting in the processing and scanning of the exposures to measure particle fluxes through the neutrino shielding.

Nuclear chemistry experiment

NSC/10/65

This experiment is being carried out by a group from Orsay led by Professor Bernas. They are using the fast ejected protons in the h3 beam-line in the South Hall to examine nuclear reactions at high energies. The nuclear products are examined by a mass spectrometer in an arrangement similar in principle to the ISOLDE project (see CERN COURIER vol. 7 page 23) without the chemical separation stage. This group has already made notable contributions in this field including the identification for the first time of isotopes of rubidium and cesium with high atomic number.

No evidence for S° meson

In contrast to our usual practice of announcing new candidates for the ever-growing list of identified particles, we can report this month an experiment at CERN which indicates that one of the particles whose existence has been accepted for the past two years can be crossed off the list.

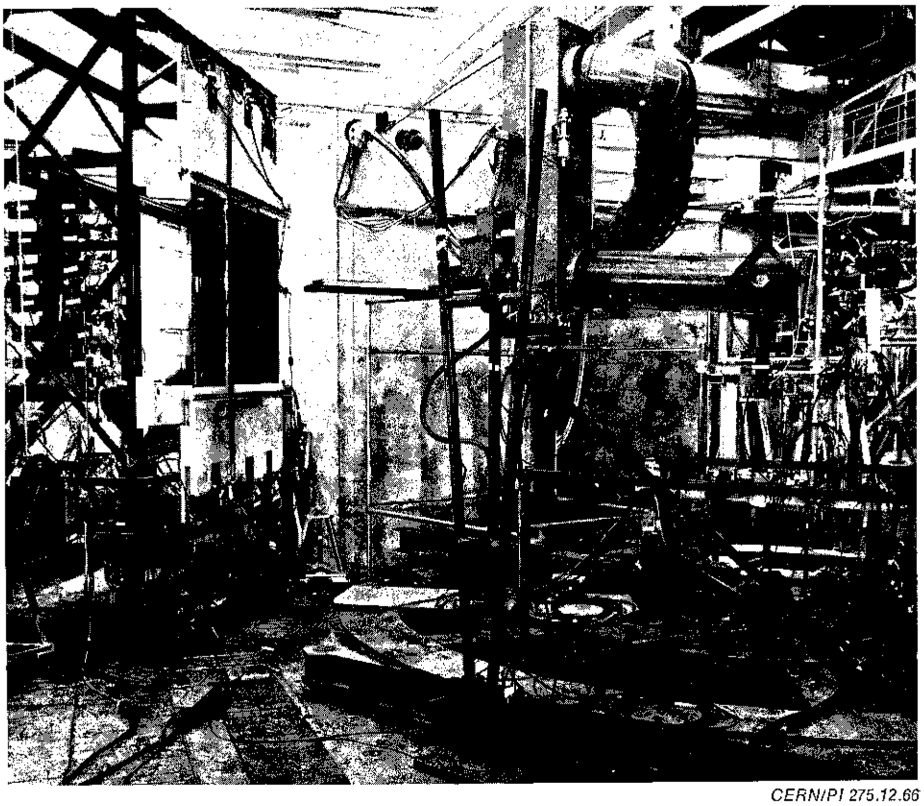
The particle concerned is the S^0 meson of mass 730 MeV. Its importance lay not only in the obvious interest of a newly identified particle but in the fact that its existence seemed to remove a strange anomaly observed in the behaviour of the rho (ϱ) meson. The ϱ meson, of mass 760 MeV, is a two pion resonance and can exist in neutral and in positive and negative charged states. Experiments have investigated the decay of the ϱ into two pions. For the charged states, a forward-backward asymmetry over the mass width of the ϱ, in the angular distribution of the pions, is observed, which changes sign, passing through zero at the mass value corresponding to the ϱ peak. For the neutral ϱ, however, the asymmetry remains practically constant over the mass width.

This could be explained by the existence of other neutral mesons, decaying into two pions, of mass very close to the ϱ which interfere with the ϱ decay so that, although the ϱ^0 may actually behave in the expected manner, the fact that decays of other neutral mesons are being observed at the same time, results in an apparent constant value for the asymmetry. A counter experiment, carried out in 1965, reported the observation of a neutral meson, named S^0, with a mass of 700 MeV, which seemed a possible explanation of the ϱ^0 anomaly.

The present CERN experiment (see page 65) needed to survey the mass region around the ϱ mass in preparation for their investigation of electromagnetic decays of neutral mesons. The experimental team (a Bologna-CERN collaboration) ' consisted of A. Buhler-Broglin, P. Dalpiaz, T. Massam, F.L. Navarria, M.A. Schneegans, F. Zetti and A. Zichichi. They used a negative pion beam of momentum 1.52 GeV/c onto a hydrogen target (10 cm long, 4 cm diameter) and calculated the missing-mass of the neutral meson by time of flight measurements (accurate to $\pm$ 0.3 ns) on the neutron produced in the interaction.

The neutron detector is placed 4 m from the target at an angle of 20° to the pion beam direction and consists of 12 plastic scintillation counters, each $100 \times 18 \times 18$ cm³. Each counter is viewed by two photomultipliers, one at each end, to give the momenta and positions of the neutrons. The angular acceptance of the counter array is 14°. Using a special counting technique, the experimental team were able to record, in narrow time intervals, neutrons with a wide spread angular distribution. This technique has made it possible to carry out measurements so far without the use of a computer.

The arrangement enabled the previous counter experiment, which claimed the observation of the S^0, to be precisely repeated. About 150 events corresponding to the well-established omega (ω^0) meson were observed and on the basis of this figure



Some of the equipment for the experiment, S 51, which will look for the electromagnetic decays of neutral mesons. The neutron detector, used in the preliminary investigation which showed no evidence for the S° meson, is on the left. The array of twelve large plastic scintillation counters can be identified by the white rectangular marks on the ends of the counters.

CERN/PI 275.12.66

A large magnet being lowered down to the underground beam-line which will take protons from the synchro-cyclotron to the ISOLDE laboratory. The photograph was taken during the two week shut-down of the SC in April, which was principally for the installation of this beam-line.

CERN/PI 47.4.67

The opening session of the European Conference on Molecular Biology on 4 April in the CERN Council Chamber. The President, Mr. Olivier Reverdin, on the right, is addressing the delegates. On the left is Professor Gregory and in the centre Mr. Willy Spühler.

CERN/PI 7.4.67

some 350 to 600 events corresponding to S^0 should have appeared in the course of the experiment. In fact the results showed no evidence for the existence of the S^0 and we are left with the anomaly of the ϱ behaviour.

Molecular Biology Conference

The European Conference on Molecular Biology, convened and organized by the Swiss government, was held at CERN from 4 to 6 April, under the presidency of Mr. Olivier Reverdin (Switzerland). Representatives from 16 countries (the thirteen Member States and the three Observer States of CERN) attended the conference and eight international organizations also sent observers.

During the opening session, Mr. Willy Spühler, Conseiller fédéral and Chef du Département politique suisse, gave the address of welcome to the delegates. He said that he was convinced of the high interest of molecular biology not only for the scientists themselves but also for the whole of humanity. He defined molecular biology as 'giving meaning to the phenomenon of Life at the level of molecules constituting living cells'. He concluded by saying that the Swiss government had decided to call the conference to give those European countries who wished to make a combined effort in this field of fundamental research, the chance to review the situation and to examine the possibilities of co-operation.

Professor Gregory, Director General of CERN, said that the presence of representatives from the Member States and Observer States of CERN was a good augury for the success of the conference. The existence of EMBO, an organization set up by many of the leading molecular biologists in Europe, indicated the enthusiasm of the scientists to form an international organization. In molecular biology, as in other fields of science, it was vital to preserve research in the universities and to maintain the balance between research and teaching.

In conclusion, Professor Gregory said that if the decision was taken to set up a European Laboratory for molecular biology there would be real value in placing it in the neighbourhood of CERN. Such a decision would be warmly welcomed by the European Organization for Nuclear Research.

During the conference, which was held in closed session, a broad exchange of views led to the conclusion that the states represented were conscious of the importance of molecular biology and of the desirability of fuller European co-operation in this field. The conference also recommended that the European governments ensure the continuation and development of EMBO. This organization was invited to pursue its studies into what might become a European Molecular Biology Laboratory, the creation of which EMBO had recommended.

A second European Conference on Molecular Biology will be held before the end of the year. In the meantime a working group will prepare the draft of an appropriate structure for European co-operation.

The CDC 6400 computer arriving at Cointrin airport on 30 March. The main installation work at CERN was completed over the following few days and commissioning of the computer began on 3 April; this represented a gain of about two weeks over the original schedule. Prior to its dispatch from Minneapolis the 6400 was submitted to the stringent CERN reliability test and showed a reliability of 98.5%.

The Austrian Minister of Education, centre, sees the proton synchrotron ring during his tour of the Laboratory on 7 April.

Below: A group of Swiss Members of Parliament, visiting CERN on 13 April, listen to an explanation of an experiment (S 52) at the proton synchrotron.

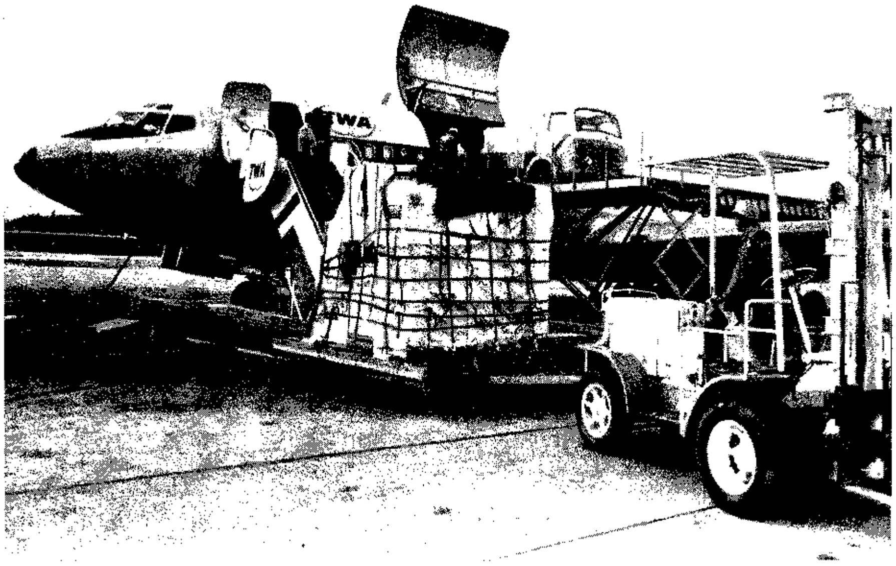


Photo Interpresse

CERN/PI 170.4.67

CERN/PI 212.4.67

Visits to CERN

Two important groups of visitors were welcomed at CERN in April.

On 7 April, Dr. Theodor Piffl-Percevic, the Austrian Minister of Education, accompanied by several other senior Austrian officials including Dr. R. Martins, the Ambassador to the United Nations at Geneva, and Dr. W. Kummer and Dr. W. Thirring who have represented Austria as delegates to the CERN Council, visited CERN. They toured the site meeting many Austrian scientists working at the Laboratory. The Director General, Professor Gregory, and other senior members of the staff discussed the present research programme and the future of sub-nuclear physics in Europe, with the Austrian officials.

On 13 April, twelve members of parliament from the Swiss Finance Commission, led by Mr. F. Hayoz (President) and Mr. A. Kaiser (Secretary) visited CERN. They were accompanied by Professor U. Hochstrasser, Swiss delegate for atomic affairs and Mr. E. Valloton, Swiss delegate to the CERN Council.

Professor L. Van Hove welcomed the visitors, in the absence of the Director General, and spoke to them of the present and future work of CERN and of the part played by Switzerland in this work.

The visitors toured the main areas of interest in the Laboratory and spoke to Swiss scientists and engineers working at CERN.

Concerts

The series of concerts of classical music organized jointly by CERN and the Geneva studio of the Swiss Broadcasting Service began with a very successful evening on 6 April. The Michel Corboz Vocal Ensemble from Lausanne was acclaimed by a large and enthusiastic audience in the CERN Main Auditorium.

Two concerts remain in the series:
18 May: Brigitte Buxtorf (flute), Catherine Eisenhoffer (harp) will present a programme including compositions by Fredrick the Great, Bach, Inghelbrecht, Roussel and Debussy.
1 June: Stephan Romascano (violin), Ron Golan (viola), Edgar Fischer (violoncello) and Denise Dupont (piano) will interpret works by Schubert, Hindemith and Schumann.

Conferences

The 1967 CERN school of physics will be held at Rättvik in Sweden from 21 May to 3 June. This is the sixth in a series of courses organized by CERN for young experimental physicists in Europe.

Colloquia

The following colloquia will be held in the CERN Main Auditorium.
18 May: Professor M. Fierz from E.T.H. Zurich will talk about 'Newton's Mechanics'.
25 May: The speaker will be Professor K.H. Krebs from Ispra; the title of his talk is not yet available.

Book Reviews

The Transport of Charged Particle Beams

by A.P. Banford (London, E. and F.N. Spon Limited, 1966, 65 sh.)

This book is intended for a wide range of readers, from the student to the mature research worker. For the former, it provides an introduction to the subject and for the latter, it provides a good survey with the particular advantage that it is rich in references. It is especially instructive for those experimentors who use beam-transport systems but have never yet studied the detailed design of their beams.

The first three chapters are introductory and contain a summary of those equations from electromagnetism and relativistic mechanics which are necessary to understand what follows. The concept of phase space is introduced and the matrix description of beam-transport elements is discussed in detail. The fourth chapter deals with beams from accelerators in terms of phase space, and discusses the factors which influence them. Standard elements are then described and the properties relevant to their use for beam-transport, or, in some cases, for spectroscopy, are investigated. There is an interesting chapter on specialized beam-transport devices, some of which are, by now, rapidly becoming standard equipment. The three final chapters present methods for the design of beams, with practical advice and examples taken from existing beams. They describe beam installation, commissioning and operation including some down-to-earth advice on the problems which can occur at each stage.

As a user of particle beams, I found the last four chapters particularly interesting. However, in fairness to readers with little experience in this field, for whom the early chapters, especially, are intended, it should be pointed out that there are some mistakes and some topics which are not described very clearly; for example, Clarendon type is not always used to denote vectors, also co-ordinate systems require rather more time than usual in order to understand them. In particular, the formal proof of Liouvilles theorem (though not the explanation of its meaning)) is unclear; a puzzled reader should refer to the paper from which this proof is quoted.

The description of the principles of beam-transport and of the properties of beam-transport elements is sufficiently detailed for the scope of the book; calculations are usually restricted to first order and results are expressed in terms of the minimum number of basic formulae.

The book is generously illustrated and the author has taken care when describing the properties of beam-transport elements to discuss them in terms of phase space by reference to clear diagrams. Also, these diagrams are well positioned in relation to the text. Numerical results are given, where relevent, to promote a clearer understanding. The quantity of references is large (the introduction on the cover claims that there are over seven hundred, but I have not checked this) and they are very well presented, grouped conveniently at the end of each chapter. A classified bibliography is given together with subject and author indices.

T. Massam

Introduction à la Physique Atomique

by L. Kerwin; translated into French by Michel de Celles. (Presses de l'Université Laval, Québec and Gauthier Villars, Paris; 50 NF).

The author, who is Director of the Physics Department at Laval University and assistant Secretary General of IUPAP, aims to give students of science an overall view of the present description of the material universe as revealed by the physical sciences.

The book begins with chapters on the atomic structure of matter (covering kinetic theory of gases, specific heats, Van de Waals forces, mean free paths, and Brownian movement), electricity (Faraday laws, Millikan experiment, electron properties, protons), and energy (thermal spectra, laws of radiation, spectral lines, photoelectric effect). A chapter on relativity describes the theories concerning space and time.

After giving this basic information, the author assembles it to describe the different models of the atom (developed by Thomson, Rutherford, Bohr, de Broglie, etc.) covering the Bohr model of the hydrogen atom in detail. Electron shell structure, the Pauli exclusion principle, the wave description of matter and the uncertainty principle are introduced. Larger structures, molecules and crystals (including an explanation of the emission and absorption of X-rays), are then described.

The internal structure of the atom takes the author on to radio-activity, nuclear particles, and the chart of isotopes, covering neutron-rich nuclei (reactors and low energy physics) and the unstable proton-rich nuclei (accelerators and high energy physics). This section is necessarily rather brief but nevertheless includes a list of the world's largest accelerators at the time the book was first published (1963).

Sections on the measurement of mass, the interchangeability of mass and energy, mass defect and finally a chapter on elementary particles, conclude the text. This final chapter is very well written, allowing for the speed with which information on elementary particles becomes out-dated.

The book does not aim to cover the subject in detail — its title is well chosen. It can be considered as a reference book and as an instructive introduction. At the end of each chapter there is a list of other books (both in English and in French) and of exercises on the topics of the chapter. Much useful information (such as the chart of isotopes) appears in the annexes, and the book concludes with an index.

R.A.

News from abroad

Director of 200 GeV Lab.

Professor Robert R. Wilson from Cornell University has been appointed Director of the National Accelerator Laboratory at Weston, Illinois where the USA 200 GeV proton synchrotron will be built. Professor Wilson, who has been at Cornell since 1947, is at present in charge of the construction of the highest energy electron synchrotron in the world — a 10 GeV accelerator which is scheduled to come into operation towards the end of this year.

The 200 GeV machine will be managed by the Universities Research Association (an association of 46 universities in the USA). Detailed design work will begin in July. In an attempt to reduce the capital cost of the machine, it is now intended to incorporate fewer experimental areas and to accept, initially, a lower proton beam intensity, compared with the original design study done at Berkeley.

New value for 2e/h

Scientists from the University of Pennsylvania, USA, have achieved a more accurate value of the ratio 2e/h (e — electron charge, h — Planck's constant). The accuracy of measurement of this fundamental ratio has now reached 6 parts in a million, and the new figure leads to a revision of several basic physical constants (such as the fine structure constant). 'Best values' for the electron charge, the electron rest mass and Planck's constant are changed.

The experiment (reported in Physics Review Letters, 20 February) which yielded the improved value for the ratio, was a solid-state physics experiment involving the a.c. Josephson effect in superconductors. This effect concerns the quantum jumps in the current which can flow between two superconductors separated by a very short distance, at discrete values of the voltage across the junction which is irradiated by microwaves. The voltages at which the quantum jumps in the current occur are proportional to the microwave frequency, the constant of proportionality being 2e/nh (n — an integer).

The new value for 2e/h is 483.5912 MHz /μV with an error of $\pm$ 0.0030.

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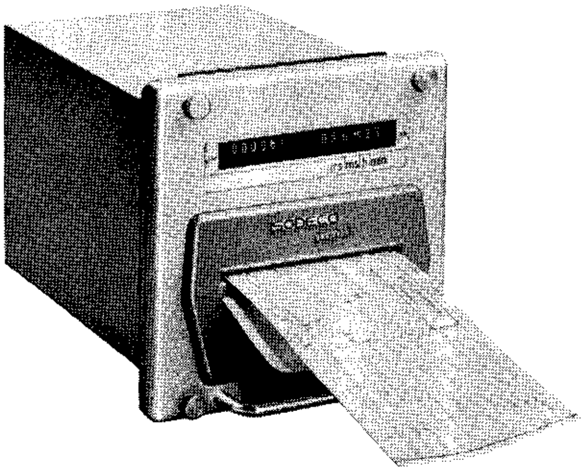

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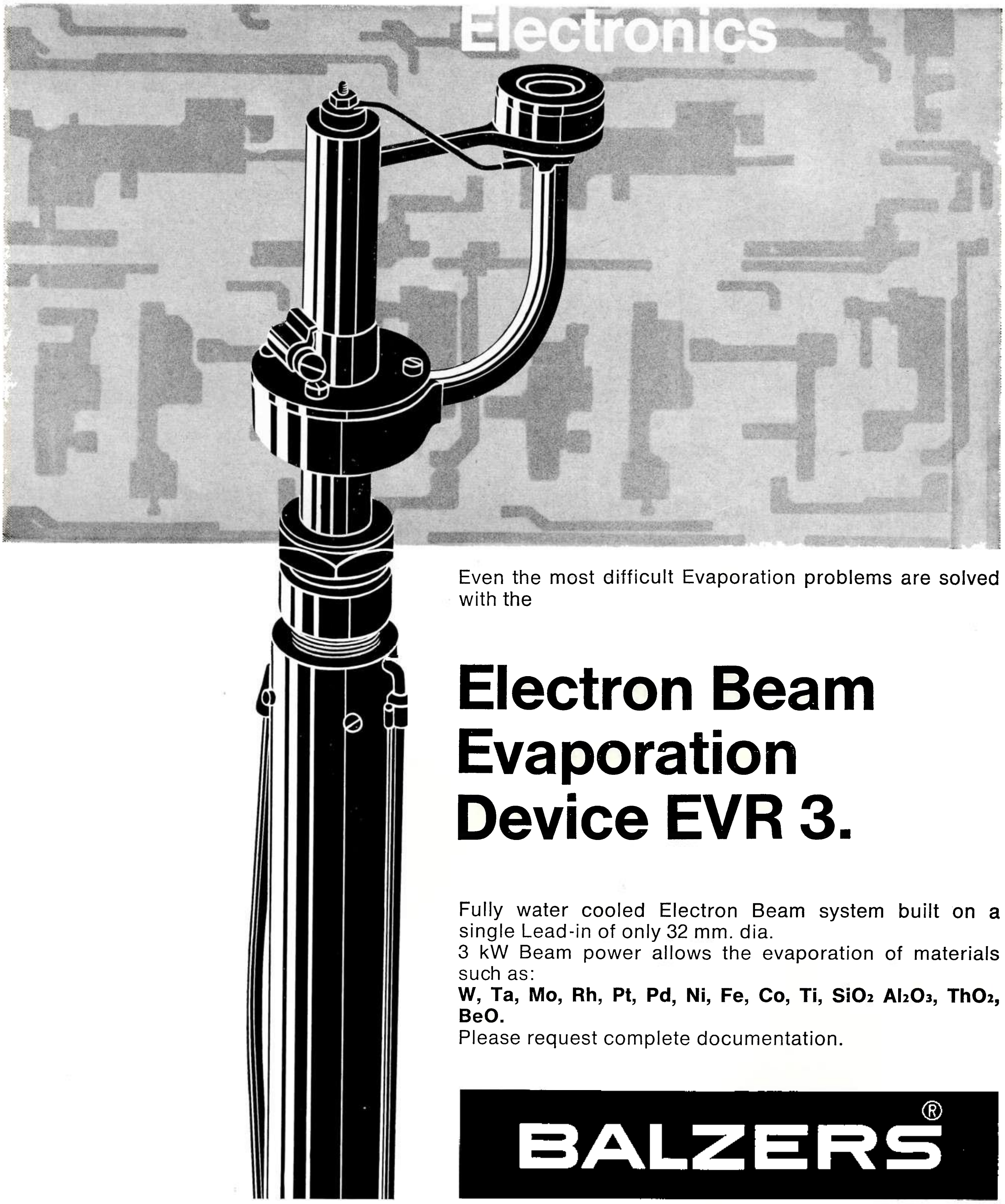

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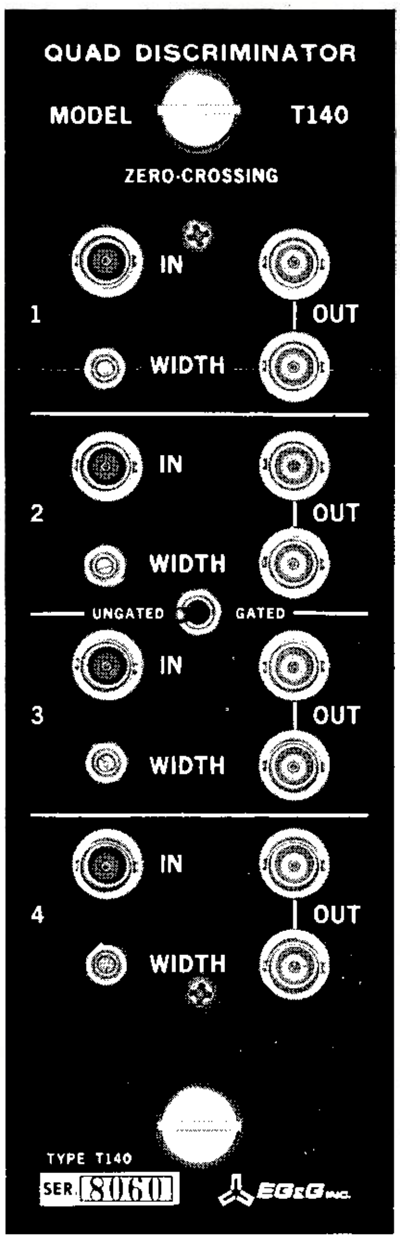

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