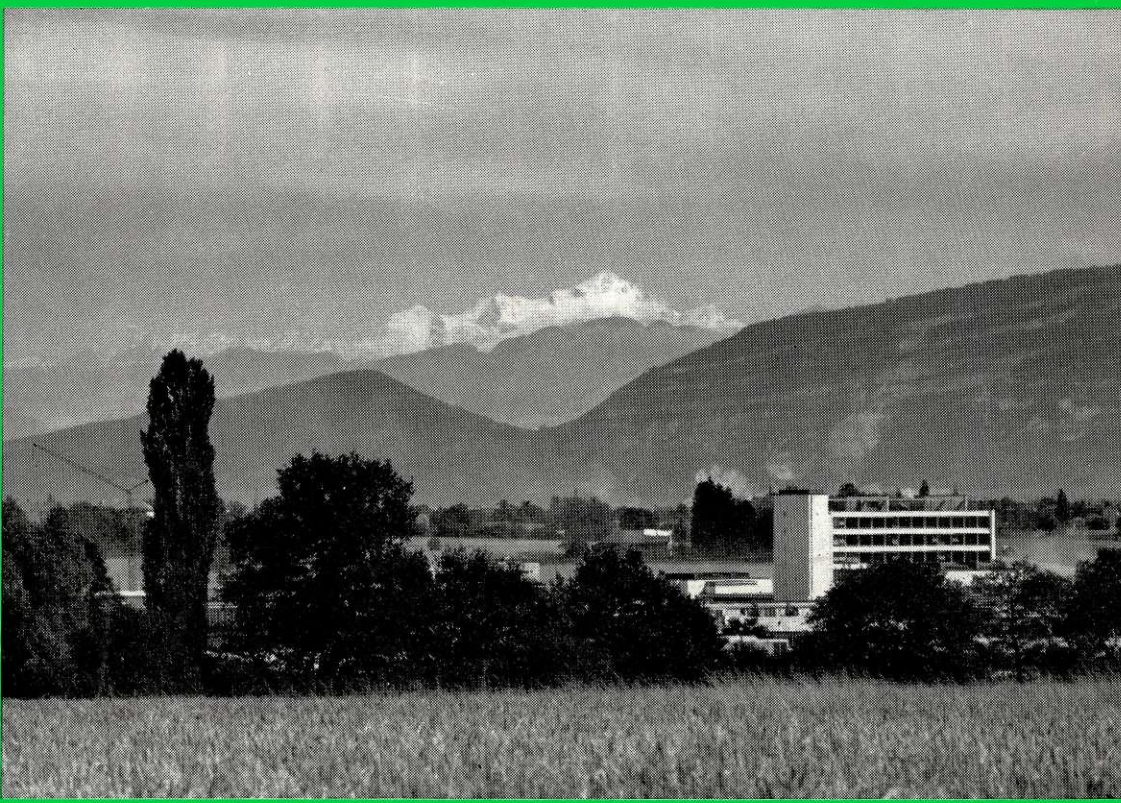
CERN COURIER



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EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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

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

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

Last month at CERN

At about 5 p.m. on the afternoon of Tuesday 6 August, another important stage in the evolution of the proton synchrotron was reached, when a beam of protons was extracted from the accelerator for the first time by means of the **slow ejection system.** This success greatly enlarges the possibilities of the synchrotron and means that when all the tests have been completed, in a few months' time, the physicists should have at their disposal in the South experimental hall a beam of protons whose characteristics can be varied, to a large extent, to suit their requirements. Added to the fast ejected beam, achieved a few months ago, and the versatile system of internal targeting developed during the last three and a half years, the slow ejected beam completes a range of operating possibilities which is unique. The champagne drunk in celebration was well deserved.

It should perhaps be pointed out that the description 'slow' applies to the method of extraction of the beam, and not to the speed of the protons. In principle, protons of any energy produced by the accelerator can be extracted, and a distinguishing feature of the system developed for the PS is that it does not involve a degradation of the proton energy, by scattering in a target for instance. The first tests were carried out with a proton energy of 16 GeV and later ones a 12 GeV.

As described in the June issue of *CERN COURIER* (vol. 3, no. 6, p. 79) the acceleration process of the synchrotron produces 20 bunches of protons travelling around the ring at practically the speed of light. The 'fast' ejection system directs these bunches in rapid sequence on to a target outside the accelerator, in a time of only 2.1 microseconds. In contrast, the 'slow' system directs a more constant flow of protons on to the target for a period of time which is ten thousand times as long. Such conditions are much more suitable for the operation of counter arrays and spark chambers. Both systems depend on the excitation of betatron oscillations in the circulating beam, but otherwise their methods of operation are quite distinct. Slow ejection, as its name implies, is a much more gradual process, and in fact is much more closely linked to the functioning of the accelerator as a whole.

Under normal operating conditions, if a proton is slightly deflected from its path because of, say, a non-uniformity in the guiding magnetic field, it 'oscillates' about its former line of flight, in other words its distance from the centre of the ring changes slightly as it goes round. Because of the design of the magnetic field, the proton never comes back to exactly the same place after each complete revolution and so the oscillation can never build up to any great amplitude. This feature of the magnetic field is, of course, extremely important for the operation of the synchrotron, and so a number of quadrupole and sextupole magnetic 'lenses' were included in the original construction so that the field could be corrected if necessary. In fact it was not necessary, but these same lenses now form the basis of the slow ejection system.

When the protons in the ring reach the desired energy, the radiofrequency accelerating field switches off and the protons continue to circulate as a beam, a few millimetres wide, under the influence of the ring magnets. At this stage, the currents in the correcting lenses are adjusted so that for one particular orbit, larger than that on which the beam is circulating, protons would be subject to unstable betatron oscillations — each time they completed a circuit of the ring they would be deflected further and further out.

The main magnetic field is then slowly and steadily reduced, causing the average proton orbit to expand. When a proton reaches the 'unstable' orbit it is set into rapidly growing oscillations by a quadrupole situated in straight-section no. 99 of the accelerator. Slightly further round the ring is the slow ejection magnet, of the 'septum' type so that its field does not disturb the beam circulating past it. After relatively few turns round the ring, the radial oscillations of the proton is sufficient to carry it into the magnet aperture, where it is deflected out of the accelerator. Because of the spread of the beam, individual protons reach the point of instability at different times, so that the circulating beam is slowly extracted and directed to the external target.

As with the fast ejection system, the ejection magnet is positioned (in this case electromechanically) towards the

Contents

The cover photograph shows a comparatively rare view both of CERN and of Mt. Blanc, some 70 km distant. From the French side of the border, only CERN's Administration building appears above the trees while, recording one of this year's few clear days, Mt. Blanc can be seen rising to its snow-covered peak, 4800 metres high, above the mountains of Savoie. Less far away, Mt. Salève stretches across the picture on the other side of Geneva.

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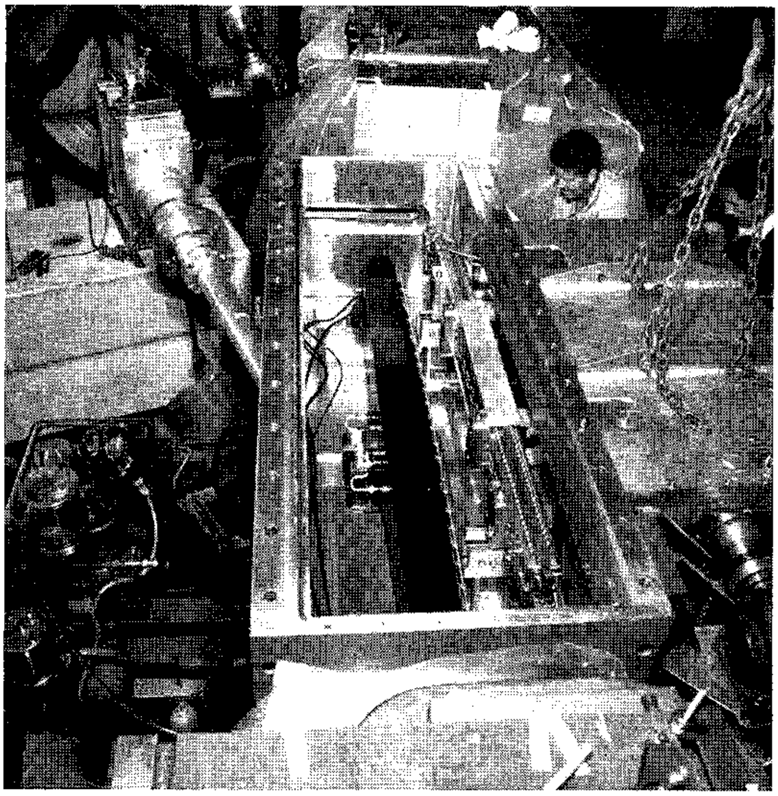

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This photo shows how the two ejection magnets are arranged inside their vacuum box. The long black object is the fast ejection magnet, which moves up and down when in use, while above and to the right of it is the slow ejection magnet, which moves from side to side. Part of the hydraulic equipment for the fast magnet can be seen to the left of the box ; the mechanical positioners for the slow magnet are in the casing to the right. The ejected beam travels very close to its undeflected trajectory at first, and the two tubes seen leading from the vacuum box are for conventional beams of secondary particles.

end of the acceleration part of the cycle, and the current in it is pulsed because of the high values required. The whole process described above takes place in about 20 thousandths of a second, though the actual time for which the external beam exists can be varied to some extent.

Successful use of slow ejection system, which is being developed by members of the Proton Synchrotron Machine Division, depends on very fine control of the accelerator and many detailed improvements have been and are being made to that end. Since the position of the beam circulating on its 200-metre-diameter circle must be accurate to a few tenths of millimetre, extremely precise and reproducible operation is required. All the magnetic fields must be reproducible from pulse to pulse of the accelerator and have the minimum of 'ripple'.

For the first and subsequent observations during August, the ejected beam was directed along the track normally used by the fast ejected beam and stopped at the entrance to the first bending magnet of the pulsed transport system. Television cameras, photographic paper, x-ray film, nuclear emulsions, scintillation counters and solid-state radiation detectors were all used in investigations on the trajectory and its dependence on the various parameters involved.

The synchrotron itself continued to run very satisfactorily, and several new records of **beam intensity** were set up. On 21 August (by coincidence, the first day of the Dubna conference), currents of over 60 mA were being injected from the linac into the accelerator, and for one period of 1000 pulses (nearly an hour) the average accelerated beam intensity (at 24.8 GeV/c) was 8.3×10^{11} protons per pulse. The highest single pulse registered that morning was of 9.06×10^{11} protons.

As in the previous month, half the time scheduled for nuclear physics was devoted to further runs for the **neutrino experiment.** The main experiment during the other two weeks, in the North hall, used a pion beam striking a liquid-hydrogen target to study the production of **'strange-particle' resonances.** Eighty per cent. of the circulating proton beam was used by the internal target giving rise to this pion beam, the remaining twenty per cent. in each pulse striking another target to give rise to secondary particles collected into four different beams serving experiments in the South hall.

In the East hall, the **new beam,** o_2, which is to provide separated particles for the 1.5-m British bubble chamber, was installed, using new survey methods for the alignment. Three reference marks were used, in line and separated from each other by a distance of 40 metres, each being positioned with reference to three of the permanent grid points previously set out for the hall. The misalignment of the central reference mark with respect to the line joining the outer two was measured as only 0.2 mm. Moreover, no misalignment could be detected between the reference point in the East hall itself and those in the East target area inside the ring.

There, a new target, operating within the gap of magnet unit no. 60, was successfully tested mechanically. Later, for about 16 hours, the target was arranged to be struck by the beam once every twenty seconds, enabling the calibration beam for the future o_2 beam to be tested.

Around the middle of the month, CERN's Director-general, Prof. V.F. Weisskopf, and twenty other physicists and engineers of the Organization left for the U.S.S.R., to take part in the **International conference on high-energy accelerators** held at Dubna during 21-27 August.

This conference at present takes place every other year, alternating with the International conference on high-energy physics, which was held at CERN last year. It deals with the large machines that make the experiments possible rather than with the results of the experiments themselves. Like the high-energy-physics conference, it is held in turn in the U.S.A. (at Brookhaven National Laboratory in 1961), the U.S.S.R., and CERN (scheduled for 1965).

The largest group of CERN participants (eight people) went from the Accelerator Research Division, and others from the Proton Synchrotron Machine, Synchro-cyclotron Machine, Nuclear Physics Apparatus, and Engineering Divisions. Among the twenty-one papers contributed from CERN were a number dealing with design aspects of both a possible 300-GeV proton synchrotron and storage rings for the present synchrotron, as well as the electron storage-ring model in the Accelerator Research Division. Other papers dealt with the changes that have occurred at the 28-GeV synchrotron during the past two years, the two beam-ejection systems, particle separators, and the separated beam designed for the 1.5 m bubble chamber ●

CERN Building Continues

CERN/PI 25.8.63

Although the exceptionally wet summer has caused a considerable amount of interruption and delayed the overall progress to some extent, the appearance of the CERN site continues to undergo a steady transformation. In the aerial view shown here, taken in the early part of August, some of the biggest building projects stand out particularly clearly, and comparison with earlier views published in *CERN COURIER* will give those not familiar with the site some idea of the recent changes.

Easily seen in the centre of the photograph (labelled 9) is Laboratory 4, then practically completed. At the end of August the Typing Pool and Document Reproduction Services moved into this four-storey building, to be followed later by the whole of the Personnel Office and members of the Theory, Data Handling, Nuclear Physics and Synchro-cyclotron Machine Divisions. The MSC Drawing Office is accomodated on the top floor, where a specially fitted conference room will also provide greatly needed new facilities, though at a later stage. A new dark room for the Public Information Office's photographic section will be fitted out on the first floor.

Adjoining this building, the car park is being extended as far as the access road from the East entrance. The extra area (10), aided by a rearrangement of the parking layout, will bring the capacity of this park up to 300 cars.

Further parking space is being arranged on the other side of the site (3), between the East bubble-chamber building and the Nuclear Physics Apparatus building. The large mound of earth that has occupied this space for some time has been removed to the area between the synchro-cyclotron and the main road from Geneva to St. Genis (8). The 'catcher' for the external proton beam of the cyclotron is located here, and the extra shielding, about 3000 cubic metres of earth altogether, will ensure that the increased intensity of the beam can be used for longer periods of time without exceeding the statutory limit for the total radiation outside the CERN boundary. (This implies, incidentally, that people camping permanently on the side of the road next to the cyclotron would not be in any danger.)

Prominent in the foreground of the photograph (1) is the site of the new sub-station for CERN's electric power supply, on which work was begun in June. The present supply has a maximum loading of 23.7 megawatts, of which some 14-15 MW are now in regular demand. Operation of the CERN 2-m hydrogen bubble chamber, expected

News from abroad

ANTIXI ZERO

The one remaining undiscovered particle in the list of quasi-stable, or so-called 'elementary' particles (those in table 1 of the listing in our May issue — p. 66) has been detected in an experiment at Brookhaven, U.S.A., reported in *Physical Review Letters* on 15 August.

Using a beam of separated antiprotons, of momentum 3.69 GeV/c, from the 33-GeV AGS (alternating - gradient synchrotron), physicists from the Brookhaven National Laboratory and Yale University obtained some 300 000 photographs showing interactions between the antiprotons and protons in a 20-inch (51-cm) liquid-hydrogen bubble chamber. Three photographs were found in which the tracks left by charged particles enabled the physicists to deduce that production had taken place of an antixi particle with no electric charge, the antixi zero.

An antixi zero, produced by antiproton annihilation, leaves no track in a bubble chamber, and the antilambda zero and pi zero into which it decays also leave no tracks. However, in one of the photographs in particular, the positive pion and the antiproton from the decay of the antilambda were identified, as well as the negative xi also formed by the annihilation. Measurements on the tracks of these particles then established the chain of events, leading back to the production of the antixi zero. The measurements also enabled the lifetime of the new antiparticle to be determined, confirming the expected value of about 10^{-10} second.

Although predicted some years ago, on the basis that every 'particle' has a corresponding 'antiparticle', there is a certain satisfaction in actually 'seeing' an example or two of this rare and somewhat elusive form of matter. What is perhaps more important is that the particles and antiparticles so far discovered now form a complete 'family', with no gaps, and the discovery of any further particles with a lifetime of this order or longer would require the creation of completely new groupings.

NIMROD

The proton synchrotron, 'Nimrod', at the Rutherford High Energy Laboratory at Chilton, U.K., produced its first fully accelerated beam on Tuesday, 27 August, with an energy of 6.5 GeV and intensity of 4.9×10^{9} protons per pulse. Within an hour an energy of 8 GeV had been achieved, and the beam current was later increased to 10^{10} protons per pulse at the design energy of 7 GeV. Development will now be concentrated on increasing this intensity to 10^{12} protons per pulse and preparing the programme of high-energy physics experiments.

Nimrod, which cost some £ 11 million (135 million Swiss francs), is the second accelerator to be operated by the National Institute for Research in Nuclear Science (N.I.R.N.S.), the organization set up in 1957 to provide for common use by British universities and similar institutions the large and costly equipment needed for fundamental research which is beyond the scope of individual universities.

The accelerator has a single ring-shaped electromagnet, 47.25 metres in diameter and weighing 7000 tons. Its toroidal vacuum chamber is made from epoxy resin reinforced with glass fibre. Protons are injected by a 15-MeV linac, and make about a million revolutions, in rather less than three quarters of a second, before reaching full energy. The accelerator produces 28 pulses of protons each minute at its design energy. *(U.K.A.E.A.)*

in 1964, would add another 8 MW to this load and obviously allow no possibility of any other extra demands from new buildings or equipment. The new substation has therefore been planned, in co-operation with the 'Services Industriels de Genève' and the canton of Geneva, to accept current from a new 130 kV power-distribution line from the generating station at Verbois, and transform it to an 18 kV supply for primary site distribution. Initial operation would make available up to 38 MW, thus solving the immediate supply problem, while later a maximum of 90 MW is envisaged, should this be needed for running storage rings for the synchrotron.

Further round the new road from the East gate, work was also begun in June on the Surface-treatment Building (2). This will be a single-storey building of about 750 square metres floor area, bringing together all the various operations which have to be carried out on metallic and other surfaces. These include such things as sandblasting, polishing and electroplating of large surfaces, as well as more delicate treatments involving photo-engraving and etching. A special section will deal with the production of 'printed circuits' used now in large numbers for the 'wiring' of electronic apparatus. Special drainage and ventilation facilities have had to be provided.

Just out of the picture, at (4), work was begun in June on an extension to the NPA Building, on the new piece of land made available to CERN by the canton of Geneva. Partly an enlargement of the equipment hall, partly new laboratories and offices, the total amount of extra floor space will be about 2500 m². Although the hall will be just a continuation of the existing building, the adjoining office section will be one floor higher than the present one and will also have a basement.

A less obviously visible alteration has been made in the West workshop (5), where an intermediate floor, of reinforced concrete supported on steel columns and beams, has provided an extra 540 m² of working area.

On the other side of the site (7), modifications are being made to the carpenter's shop of the Site and Buildings Division, and in the same area a small annexe is being put up to the SB workshop to provide special facilities for changing transformer oils and other such work. Nearer the road, a third fuel-oil storage tank will be erected next to the existing pair (6), of the same diameter but 15 metres high instead of 10 metres ●

What is CERN for?

Why have the European nations been spending 70 to 90 million Swiss francs every year for an enterprise such as ours in Geneva and, incidentally, another 240 million per year at home on similar work? Why do we support, or why should we support, such basic research?

The usual argument is this: from the point of view of the common man — the taxpayer — basic science should be supported since, so far, every basic discovery has led to important applications later on. I may remind you of the well-known story of Faraday who replied to a sceptical member of the government, when asked what was the use of his strange experiments about the magnetic effects of electric currents: 'I don't know, but I am sure that some day you will be able to collect taxes from its applications'. Faraday was right, though it was a good many decades before the taxes began to roll in and, even then, they came from the 'grandchildren' of Faraday's ideas and not from the ideas themselves.

There are three stages in our scientific attack upon the structure of the atom: first, the study of the structure of the electron shell, second, the study of the atomic nucleus, and — lately — the study of the inner structure of the constituent of the nucleus: the nucleon.

The electron shell is responsible for the behaviour of atoms under ordinary conditions prevailing on earth. This is why the basic science which studies it — the true atomic physics — is such a rich source of rather direct technological applications in optics, electronics, metallurgy, chemistry, and even biology.

The structure of the nucleus comes into play only under conditions of energy exchange which are rarely found on earth; the radioactive phenomena are examples. Only in the interior of stars — so we have reason to believe — are nuclear processes predominant. Nuclear physics would have been a very esoteric science had man not succeeded in creating conditions in nuclear reactors where some nuclear processes such as fission play an important role. But it was by the skin of our teeth; the fusion process seems to resist our attempts to tame it. The reasons are significant: matter cannot be contained under conditions where thermal energy is comparable to nuclear energies unless other very large forces, such as the gravitational field inside a star, or perhaps some sophisticated high magnetic fields, are brought into play.

The phenomena in which the nucleon structure comes into play — the phenomena discovered and observed at CERN, which can be called 'sub-nuclear physics' — involves energies of such order that even the centre of stars is not hot enough to excite them. We observe them in nature only very rarely, namely when cosmic rays impinge on the earth. Perhaps they play an essential role in some of the great cataclysms of star explosions or in the whirl of matter at the centre of galaxies. **It is extremely improbable that the experimental results obtained at CERN will in themselves ever be of practical importance** since they refer to conditions of matter which are far more remote from our own conditions than the nuclear phenomena. Is it, then, justified to ask the governments and the taxpayers for such large sums to support 'sub-nuclear physics'?

There is no doubt that the answer to this question is positive, although one encounters great difficulties in formulating the reasons, simply because they cannot be expressed in terms of an immediate financial or material return. The problems of 'sub-nuclear' physics are today the basic questions of science. They are the perennial questions of 'why' in the structure of matter. Why are the proton, neutron and electron the fundamental constituents of matter? Why are there nuclear and electric forces between them which determine the course of the universe? Ultimately this most fundamental frontier of science will reveal to us the connexions between the phenomena of the infinitely large and the infinitely small; the questions of the origin of the universe and the nature of elementary particles. These questions are of basic significance for all our endeavours, from which not only our technology stems but also our existence as thinking human beings. Physical science today is so advanced that the frontier of fundamental problems has been shifted to regions which are so different from conditions on earth that direct technological applications are most improbable. It would be imprudent, however, to exclude them completely. Nobody expected in 1932, at the start of nuclear physics, that this field had practical applications. **The new ideas themselves may not have any technological consequences, but the 'grandchildren' of these ideas may.**

The reasons for supporting 'sub-nuclear physics' are really based on different grounds from that of direct technical application. The pursuit of fundamental questions was and is the spearhead of science. It attracts the most sophisticated brains and it supplies vitality and vigour to the scientific community which benefits the totality of scientific development. If this spearhead were blunted, physical science as a whole would suffer. Basic science has always attracted and produced the best students, who later on have often gone into more directly practical fields. Scientific activity in any field, practical or impractical, is a search for explanation. If the efforts towards the most fundamental explanations were reduced, the spirit of inquiry would eventually disappear from science. Technology also would suffer from this, since it is the same spirit that creates new ways of exploiting nature here under terrestrial conditions.

Therefore every society that wants to be in the forefront of practical technology must also be vigorously engaged in basic science. It is the very root of the culture and tradition from which our technology grows. To apply again the simile: it is the 'mother' of all scientific ideas and therefore the 'grandmother' of future technological progress.

The value of basic research, then, can be expressed in brief by the following three points:

1. It is an important frontier of knowledge,
2. It is the spearhead of science as a whole,
3. It is the breeding place for new ideas.

Fundamental science clearly plays a dominating role in our culture; its study is the greatest adventure of the human mind.

Adapted from the speech given by Prof. V. F. Weisskopf, Director-general of CERN, at the Annual Luncheon of the Parliamentary and Scientific Committee, in London, on 21 February, 1963.

CERN contributions to high-energy physics

Although it is not often possible to give details in *CERN COURIER*, the steady stream of scientific papers published as a result of work carried out wholly or partly at CERN bears witness to the important position that the organization now holds in the field of fundamental research. A look at some of these papers shows, too, the broad range of the work and its interrelation with that of other laboratories. 'CERN', in the context of scientific advance, means not just the laboratory at Meyrin together with its staff members, but collaborating laboratories outside as well as inside Europe, and 'visitors' from all parts of the world.

The most common way of publishing new results is to send a 'letter' to one of the scientific journals. Many of the CERN contributions can be found in *Physics Letters*, a fortnightly publication which specializes in this kind of communication, and a study of the four issues for June and July gives a good idea of the scope and importance of both the scientific results and the collaboration.

For example, the issue of **1 June** contained further results on the **beta-decay of the positive pion.** This very rare, but interesting process was discovered at CERN last year in an experiment using pions produced from the synchro-cyclotron, and more extensive data have since been obtained.

When a positive pion emits a positron and a neutrino, leaving a neutral pion, this latter immediately disintegrates into two gamma rays. The experiment thus depended on the detection of the pion when it was brought to rest in a target, which acted also as a counter, followed by the simultaneous occurence of a positron and two gamma rays, detected by other counters. In the initial experiment, 14 such events were registered ; in the run reported in June, nearly a hundred thousand million pions were stopped in the target, at a rate of 50 000 per second, and 38 'good' events were obtained. Great care was, of course, necessary to eliminate all 'background' events that might accidentally simulate a real one. Combining all the results, it was deduced that this particular mode of decay happens once for every 100 million cases of the normal decay of the positive pion into a muon and a neutrino. This conclusion is consistent with the predictions of the so-called 'conserved vector current' theory. It shows that the quantity known as the 'weak vector charge' of the positive pion is the same as that of nucleons and leptons, to within about 10 %, and helps to confirm that the conserved-vector-current theory is essentially correct, at least under the sort of conditions covered by the experiment.

Another contribution gave the results of a related experiment in which negative pions were stopped in targets containing hydrogen chemically bound to heavier atoms, giving neutral pions as one of the reaction products. Apart from its use as a convenient source of such pions for calibration purposes, this reaction is of interest since it involves the formation of a **'mesonic molecule'**, in which the negative pion takes the place of an electron for a short time. In the CERN experiment, the fraction of stopped pions undergoing this reaction was measured for four different targets, including one of hydrogen gas.

Of the five physicists contributing to one or both of these communications, three are CERN staff members and two visitors from the Nuclear Physics Laboratory of the University of Grenoble, France.

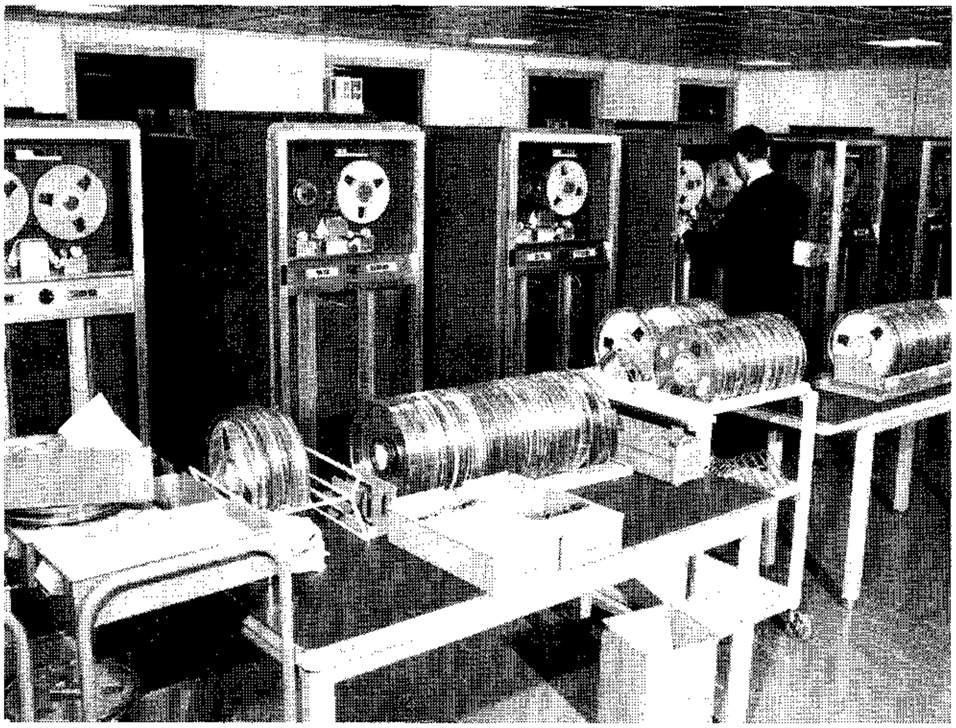
There was also a paper recalling the 'double hyperfragment', found in a nuclear emulsion as a result of an exposure at the CERN proton synchrotron, described recently in *CERN COURIER.* The author is in the CERN Theory Division, on leave from the University of Nijmegen, Netherlands.

Using the results of some theoretical calculations from the University of Chicago, (published in the same issue of *Physics Letters*), which in turn were based on the value of the energy binding the two lambda particles into the hyperfragment (deduced from the experimental findings), he has carried out some calculations on the **interaction that exists between two lambda particles.** The results lend support to the idea that the interaction is due to the exchange of one or more pions between the two particles. It is of interest here to note also that the calculations involved the assumption that the sigma and lambda particles have the same parity, in accordance with the recent CERN findings (noted in *CERN COURIER*, June 1963, p. 78).

In anticipation of data now being collected in the neutrino experiments at CERN, and as a possible help in their interpretation, two members of the CERN Theory Division, one a staff member, the other a Fellow, published some calculations on the production of the **'intermediate boson'** which might be created as a result of neutrino interactions. This particle is still hypothetical, and theory does not allow its mass to be estimated with any certainty. Two possible values were thus assumed in the calculations, and in each case the cross-section for production of the boson (a measure of the probability of its formation) was worked out for various values of the neutrino energy.

Any calculations of this kind have to be based on certain assumptions and approximations, but the derivation presented by the CERN physicists was more exact than earlier ones carried out in the U.S.A. The results indicated that the boson (if it exists) is less likely to be produced than had been previously thought. Even further refinement of the calculations was suggested, to take into account the continuous movement of the nucleons in the 'target' nucleus, but the computation was beyond the capacity of the 709 computer at CERN.

Yet another paper, in this same issue of *Physics Letters*, gave the results of a study by three physicists at the 'Centre de Recherches Nucléaires de Strasbourg' of nuclear emulsions exposed at the CERN proton synchrotron. Looking for **hyperfragments** produced by



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Many of the results quoted in this article were obtained with the aid of CERN's electronic digital computers. Some of the many reels of magnetic recording tape are seen here in the 709 computer room, together with the tape units which form the main route into and out of the computer. Experimental or theoretical data, and instructions for each step of the calculations, were recorded initially on tapes like these, enabling them to be fed automatically into the main computer as required. Intermediate answers and the final results were also recorded by the computer on tape in these units. In September, new units were being installed as part of the replacement of the 709 by a 7090.

negative pions of momentum 17.2 GeV/c, they found several rare ones, with electric charge greater than 4, and obtained useful results both on the modes of disintegration of the hyperfragments and on the binding energy of the lambda (that is the energy holding this particle in the hyperfragment).

The issue of *Physics Letters* of **15 June** contained the results of a study of the **elastic scattering of antiprotons by protons,** at antiproton momenta of 3.0 GeV/c and 3.6 GeV/c. In this type of scattering the antiproton escapes annihilation and the concentration of scattered particles in the forward direction gives rise to the characteristic 'diffraction peak'. The experiments reported showed that the peak was much narrower than in the corresponding proton-proton scattering and the amount of scattering through large angles was also considerably less. Backwards scattering of the antiprotons is particularly interesting, since backwards scattering of protons from protons cannot be measured as it is impossible to distinguish the particles. Results for the polarization of antiprotons were also given. These were obtained by observing two successive scatters of the antiproton. Polarization measurements had not previously been reported for such high energies, the previous highest being 1.7 GeV at Saclay.

The results were obtained by examining some sixty thousand photographs taken with the Saclay/École Polytechnique 81-cm liquid-hydrogen bubble chamber exposed to a separated antiproton beam at the CERN proton synchrotron last year. Scanning and measuring teams at CERN, the Institute for Experimental Physics, in Hamburg and the Desy project, Hamburg, were responsible for analysis of the photographs. Of the nine physicists involved at CERN, five were Fellows, from Paris, Milan, Warsaw, Vienna and Madrid.

Continuing their study of the probable behaviour of **intermediate bosons involved in neutrino interactions,** the two authors previously mentioned published a further letter in this issue of *Physics Letters,* giving the results of some calculations on the 'polarization' of the bosons. The results were given in terms of the distribution in direction of the pions or muons formed by the rapid disintegration of these supposedly short-lived particles.

Even more indicative of the way in which numerous laboratories participate in the experiments using one or other of the CERN accelerators was another letter in this issue, giving further evidence for the **f^0 meson.** From the results, a value of two for its spin (one of the characteristic properties of any particle) had also been deduced. This work was also based on photographs taken with the 81-cm bubble chamber, this time exposed to negative pions of momentum 4 GeV/c as part of a programme of studies carried out by a collaboration of six laboratories in the Universities of Aachen, Birmingham, Bonn, Hamburg, London (Imperial College) and Munich. Twenty-four physicists were involved in this part of the work. The existence of the f^0 meson was first reported from CERN and from the U.S.A. last year, and measurements of its spin were carried out by a collaboration between CERN, the École Polytechnique (Paris) and the University of Milan.

The issue of **1 July** contained a letter from another CERN Fellow, attached to the Theory Division, on the subject of **neutrinos.** He also had performed some calculations on the angular distribution of muons, considering those formed by the interaction of neutrinos with neutrons and comparing his results with the limited data, so far available from the experiment at Brookhaven last year. This comparison indicated that the experimental results were compatible with current ideas on weak interactions, but that the angular distribution by itself would give little information on the hypothetical boson.

Another letter gave the first results of a novel experiment being carried out by a team consisting of two CERN physicists and two visitors at the proton synchrotron. Much work has been done, particularly in the U.S.A., on the interaction between a proton and an electron, mainly with a view to discovering the internal structure of the proton. However, in addition to the 'space-like' structure studied in these experiments, the proton has a 'time-like' structure. The interesting feature of the CERN experiment now under way at CERN is that for the first time this time-like structure is being investigated, by studying a very rare reaction in which a **proton and an antiproton annihilate to form an electron and a positron** (anti-electron). The results reported in July were of the initial runs, designed to prove the apparatus and search for the occurrence of the reaction.

Antiproton annihilations were obtained in a polythene target and a complex system of spark chambers, scintillation counters and gas and lead-glass Cherenkov counters ensured that the pairs of electrons and positrons could be identified among the hundred-thousand times more intense pion reactions. However, out of the first 130 million annihilations no pairs were found, a result which for a start confirms the fact that the proton has a structure and does not act as a 'point' particle.

There was also another contribution from the Aachen, Birmingham, Bonn, Hamburg, London, and Munich collaboration, concerning the **interaction of a negative pion and a neutral pion to form a neutral omega meson** (without destroying the negative pion). First, the films arising from the same exposure of the 81-cm bubble chamber to negative pions were searched for events in which one of the pions collided with a proton and produced an additional three pions — one negative, one positive and one neutral (the mass of the extra pions being created from the energy of the incoming pion). Calculations on the tracks of these pions then showed that three-quarters of the 93 examples found were due to the formation and subsequent rapid decay of an omega meson. Theoretical considerations indicate that this omega is formed from a neutral pion emitted by the proton during the interaction with the pion, and the experimental results were found to be not inconsistent with this view. It was thus possible for the cross-section for the formation of the omega from the neutral pion to be calculated, for different total energies of the interacting particles. This was done by means of two different theoretical formulae. The work was reported by thirteen physicists from five of the collaborating laboratories.

A joint paper from twenty-one physicists in five European laboratories, including CERN, appeared in *Physics Letters* on **15 July,** giving the results of a study of **negative xi hyperons.** After exposure of the École Polytechnique's 1-m heavy-liquid bubble chamber to a separated beam of negative kaons, of momentum 1.45 GeV/c, at the CERN proton synchrotron, the photographs obtained were scanned and analysed at the École Polytechnique, CERN, University College of London University, the Rutherford Laboratory (Chilton, U.K.) and Bergen University (Norway).

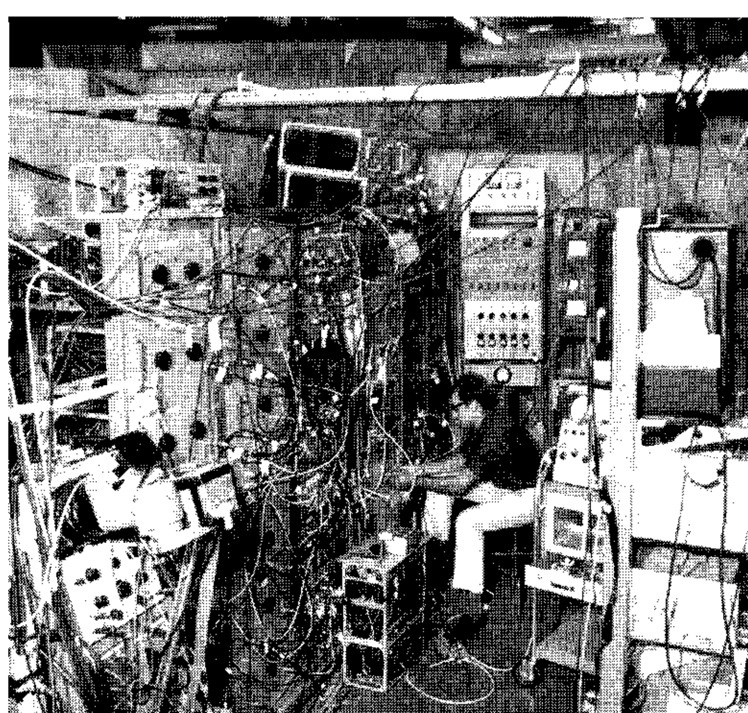
From some 210 000 photographs, each containing on the average three kaon interactions, 320 examples were found of the production of Ξ^- particles in which all the particles, both in the production and in subsequent decay reactions, were clearly identified. From these the mass of the Ξ^- particle was deduced as 1321.4±0.6 MeV, and the mean life as 1.91×10^{-10} second. Other examples requiring more detailed analysis are still being investigated. Because of the larger number of events measured, these values are more accurate than those available until recently, and they are in agreement with other new values obtained in the U.S.A. This agreement among results obtained using different techniques is an indication that possible experimental bias has been eliminated from each of the experiments.

A previous result from the same collection of bubble-chamber films (published in *Physics Letters* on 1 March) was that the mean life of the Ξ^0 hyperon was 3.9×10^{-10} second, from which the ratio of the lifetime of the Ξ^0 to that of the Ξ^- is seen to be 2.0. Although the experimental uncertainty is still rather large, this result confirms a prediction of one of the 'selection rules' given by the theory of weak interactions, which is that in non-leptonic decays of strange particles, the value of the isospin quantum number changes only by $^1/_2$ ($\Delta I = ^1/_2$ rule).

Two of the Ξ^- particles whose tracks were seen in the CERN photographs seemed to interact with a nucleus in the bubble-chamber liquid to produce an excited state of the neutral xi, Ξ^{0*}. This state has a mass of about 1.53 GeV and decays back into a Ξ^- and a π^+. This excited xi had previously been observed in the U.S.A. in another reaction ($K^- + p \rightarrow \Xi^{0*} + K^0$).

In the same issue, a letter from the head of the CERN Theory Division gave some calculations on the **theory of diffraction scattering,** extending a well-known theorem of the Soviet physicist Pomeranchuk. One of the conclusions arising from these calculations is that for cases when the diffraction peak does not change with increasing energy, the diffraction scattering of an anti-particle from a target nucleon becomes the same as that of the corresponding particle, at sufficiently high energies ● **A.G.H.**

CERN/PI 138.8.63



Some of the complex electronic equipment used for the experiment to detect electron pairs from antiproton annihilation. The recording oscilloscope in the left foreground photographs the signals from scintillation and Cherenkov counters, providing vital information to be read in conjunction with spark-chamber photographs. To the right of it, the third rack is used for making all the connexions for the ' logic ' which makes the primary selection of wanted from unwanted events. Other racks contain scalers, delay lines, power supplies, and other auxiliary instruments.

George H. HAMPTON

CERN/PI 30.9.63E

Directorate Member for Administration

Like his predecessor S. A. ff. Dakin *, CERN's new Directorate Member for Administration was trained as a scientist. George Hampton, who took up his duties with the organization at the beginning of September, was born in 1920 in Manchester, England, and studied at the King's School, Macclesfield and Balliol College, Oxford University. As a senior boy at school — one of England's earliest 'Grammar Schools', founded during the sixteenth century — he had his earliest taste of 'administrative' responsibility. At Oxford, in a College whose history goes back 700 years, he studied chemistry and obtained his degree in 1940.

Then, like many others of his age he joined the Royal Air Force, as a communications engineer, and during the war served in England and various countries in the Mediterranean area. In Yugoslavia he was introduced to international co-operation of the kind found at CERN, when he served in the so-called Balkan Air Force, in a mixed wing that included Greek, Yugoslav and Russian, as well as British units.

In 1946 he returned to England and was then faced with the decision either to continue in aviation or to return to chemistry. He chose the former, and joined the Ministry of Civil Aviation as a communications engineer. This soon took him back to Cairo, and he spent the following two years flying between there and Singapore, acting as a technical adviser in the drive to establish radio facilities for the rapidly developing Civil Aviation Service.

After some years back in London he transferred, in 1954, from the technical to the administrative side of the Ministry, which by then had become the Ministry of Transport and Civil Aviation. Because of a principle that administrators should not be drawn from the ranks of the corresponding technical staff, he had to leave aviation and deal instead with road transport. His main concern was with international problems, and it was then that he came to know Geneva, visiting the city some four times a year for meetings which were drafting a convention for unified contracts of carriage and a standard code of international road-transport regulations.

He was actually on holiday in Switzerland when he was offered the chance of joining the United Kingdom Atomic Energy Authority. This was in 1956, the year in which the first nuclear power station at Calder Hall started operating. The Authority was expanding rapidly at this time, and when he arrived at Risley as a member of the headquarters staff of the Industrial Group, Mr. Hampton had an ideal chance to investigate in some detail and gain a better understanding of numerous administrative problems that came to light during the building up of the organization. As one example, he made a special study of the rate of growth of the Dounreay establishment in the far North of Scotland. As another, he investigated the administrative and legal aspects of water supplies — and discovered that if the Authority bought a lake they might own the water that fell into it as rain but certainly not the rest !

This experience stood him in good stead when the accident to the Windscale plutonium-producing reactor posed numerous problems of administration and of public confidence, which had to be solved rapidly. Some time after this he became Secretary of the Authority's factory at Capenhurst, where the fissile isotope of uranium, uranium-235, was being extracted from natural uranium by the gaseous diffusion process. He was there for two years and then returned to the headquarters at Risley, as Deputy Personnel Director. It is from there that he has come to CERN, where, he says, he had often thought he would like to work.

The Directorate, which he has now joined, consists of three full-time members, in addition to the Director-general, and one part-time. Prof. G. Puppi is the member for Research, M. G. N. Hine is the member for Applied Physics, and P. Germain part-time member for Technical Management (in addition to his duties as head of the Proton Synchrotron Machine Division).

As member for Administration, Mr. Hampton is responsible for all matters affecting budgets, personnel, contracts and general administration of the organization, and for its external relations. His varied experience has given him strong views on the subject of administrative responsibility and he belongs to those who recognize the danger that people in administrative jobs can come to look on administration as an end in itself. This danger has always been less of a problem in CERN than in many other organizations because the building and operating of a new piece of equipment, the planning and successful execution of another experiment, give a continuing sense of purpose to everyone concerned. Even so it remains essential for administrative staff to be conscious of the fact that even if the teams at the accelerators cannot manage without them, they owe their very existence to those teams.

In Mr. Hampton's view, every member of an organization should be aware of the part he plays in the whole, without forgetting that he remains just a part. He quotes the story of the scientist-turned-administrator who was told by his friends that in future he should look in the mirror every morning when he shaved and say to himself : 'I am evil — but am I a necessary evil ?'. George Hampton knows that his job is necessary, and is determined to minimize its evil nature to the best of his ability ! ●

*CERN COURIER, vol. 2, no. 6, June 1962

BOOKS

L'Économie de l'énergie dans les pays en voie de développement (the economics of energy in the less developed countries), by Pierre Sevette (Paris, Collection Tiers-Monde, Presses Universitaires de France, 1963; 16 Fr.).

This is an excellent book, a clear and comprehensive summary of the sources of energy which are, or could be, available to mankind. The author, Professor at the 'Institut d'Études du Développement économique et social' of the University of Paris, is Director of the Energy Division of the United Nations Economic Commission for Europe, and thus has access to the most useful sources of documentary material.

The first part of the book is devoted to the criteria to be observed when drawing up plans for developing natural power resources. The author deals successively with the inventory of resources, the determination of requirements, the cost of investments, the cost of production, the transport and storage of energy, the substitution of one form of energy for another, the reliability of supply and the present conditions of investment.

The second part of the book reviews special problems which the development and use of the different forms of energy may pose in the less-developed countries. Here, the author deals successively with conventional, primary or secondary, new, non-commercial, and also nuclear energy. A detailed study is made of some of the conventional kinds : coal, natural gas, water power, petrol, and electric power. Special mention is made of recent technical advances in the mining of coal, the problems entailed in utilizing a multi-purpose water reservoir, the present position of petroleum concessions, the financing of new electric power schemes and new means of producing electricity.

The new sources of energy include artificial rain, sea swell, the steam and hot water inside the earth, the differences of temperature between the depths of the seas and their surface waters, tides, the wind, and the sun.

Non-commercial energy of vegetable, mineral or animal origin, which is of particular importance in the less-developed countries, is analyzed in detail.

With respect to nuclear energy, a study of the capital cost per kW installed and of the price per kWh shows that nuclear energy will not be an economic proposition in the less-developed countries for some time yet.

In a series of annexes, associated problems are examined, such as arbitration between individuals and the State, the validity of the concessions in the event of succession of States — for example after a colony achieves independence —, the legal aspects of developing successive water courses for purposes other than navigation.

This book brings together in one volume the economic, technical and legal aspects of energy. It would be especially useful to all those whose work deals with these questions in the less-developed countries, but it is both entertaining and instructive for the layman who wishes to be well-informed.

R. A.

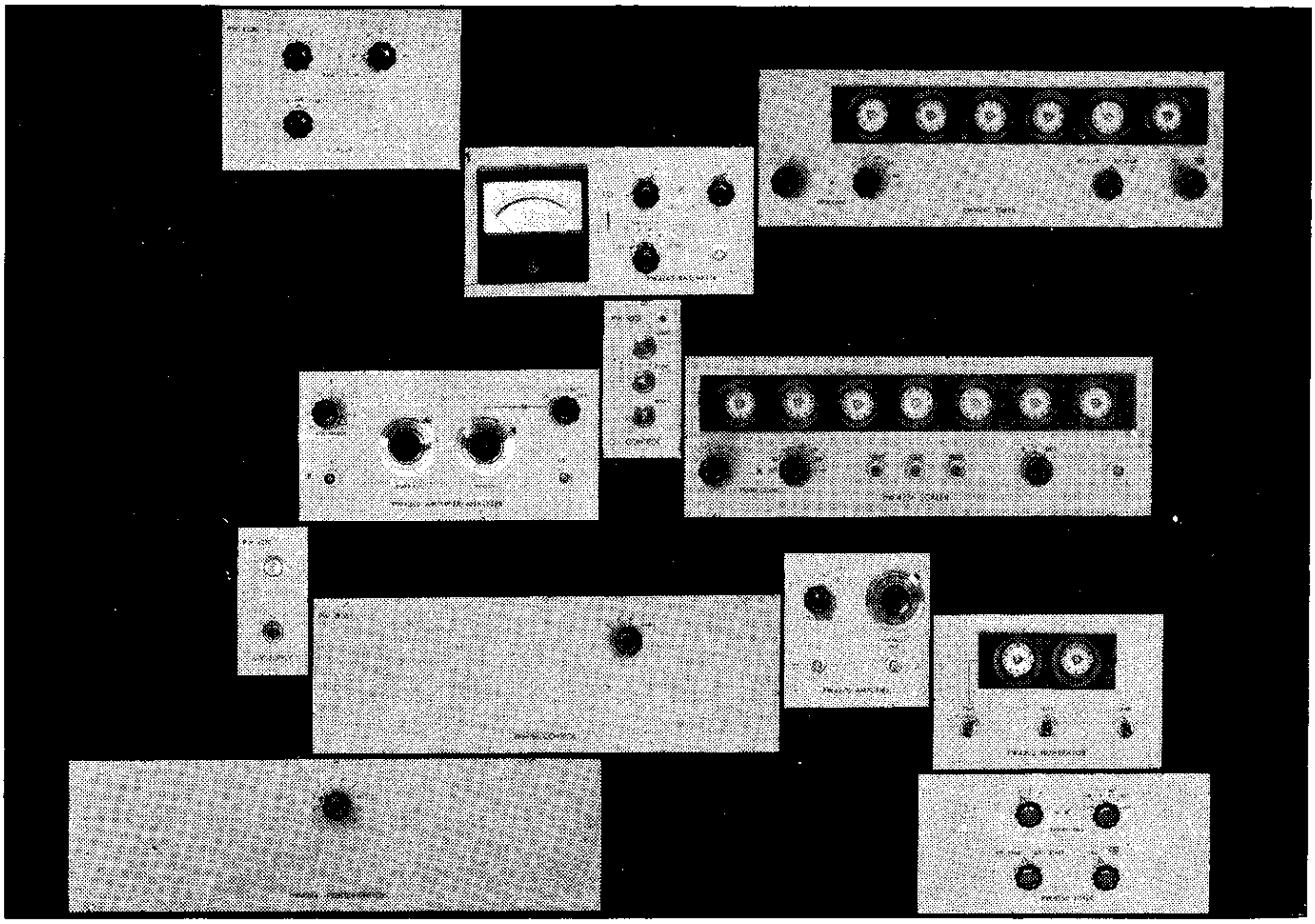
Environmental radioactivity, by Merril Eisenbud (London, McGraw-Hill, 1963 ; 97 s.).

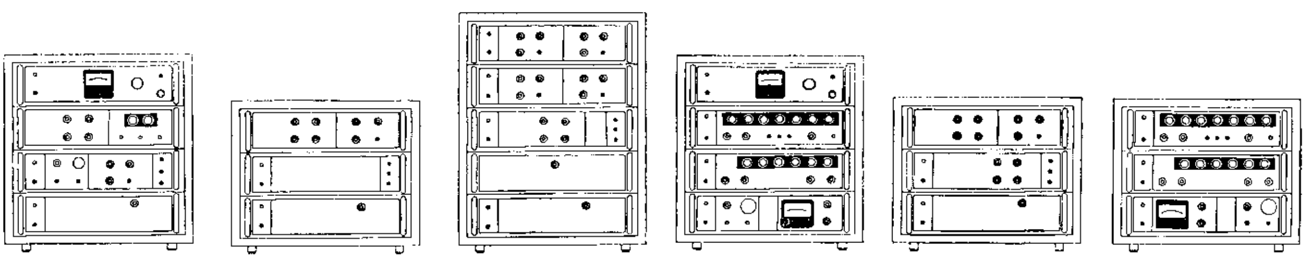
Since the discovery of natural radioactivity more than half a century ago, and particularly since the discovery of fission, considerable knowledge of radioactivity and radiation has been accumulated. The evaluation of its influence on living organisms and the problems of environmental radioactivity, have been of special importance.

Dr. Eisenbud's book represents an effort to assemble information on the present state of this subject. It starts out with a rather broad and general discussion of the biological basis for radiation protection, including protection standards and practices. Then the book deals with the way in which radioactivity is transported in the atmosphere, in the food chain from soil to man, and in water. In greater detail, the author describes the environmental radioactive sources and gives an account of the experience that has been obtained with environmental radioactivity.

The book is rather lengthy (430 pages) and in very general terms. It is more a general textbook than a source book for a specialist on radioactivity, and can be read and understood by people with little or no background in this specialized subject.

J. B.





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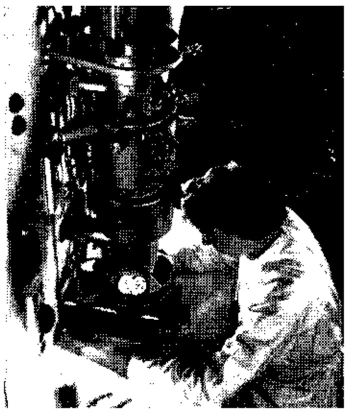

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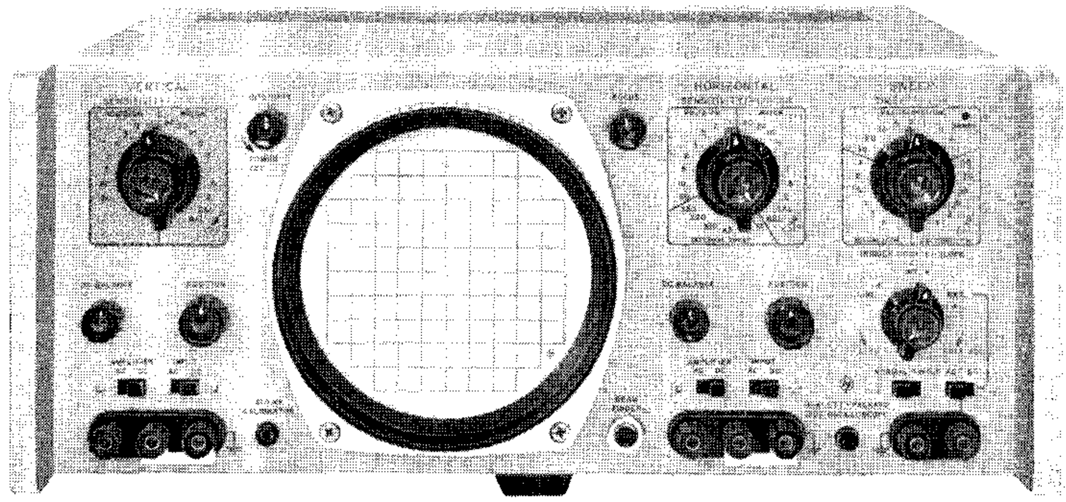

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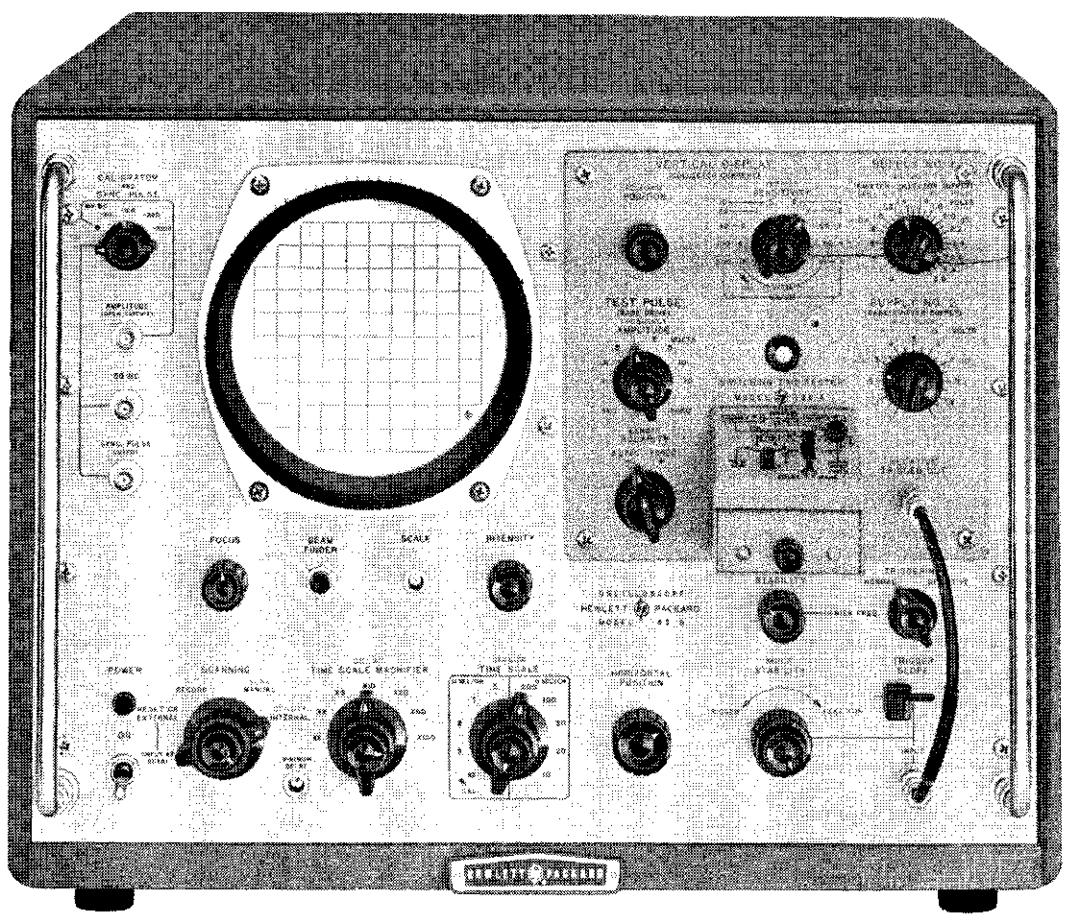

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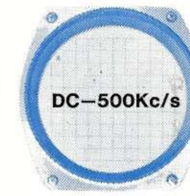

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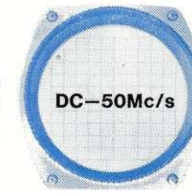

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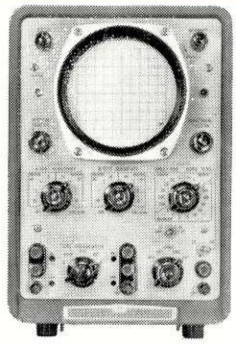

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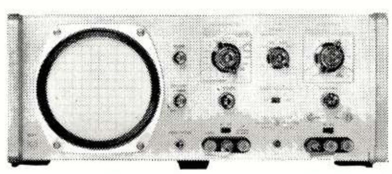

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