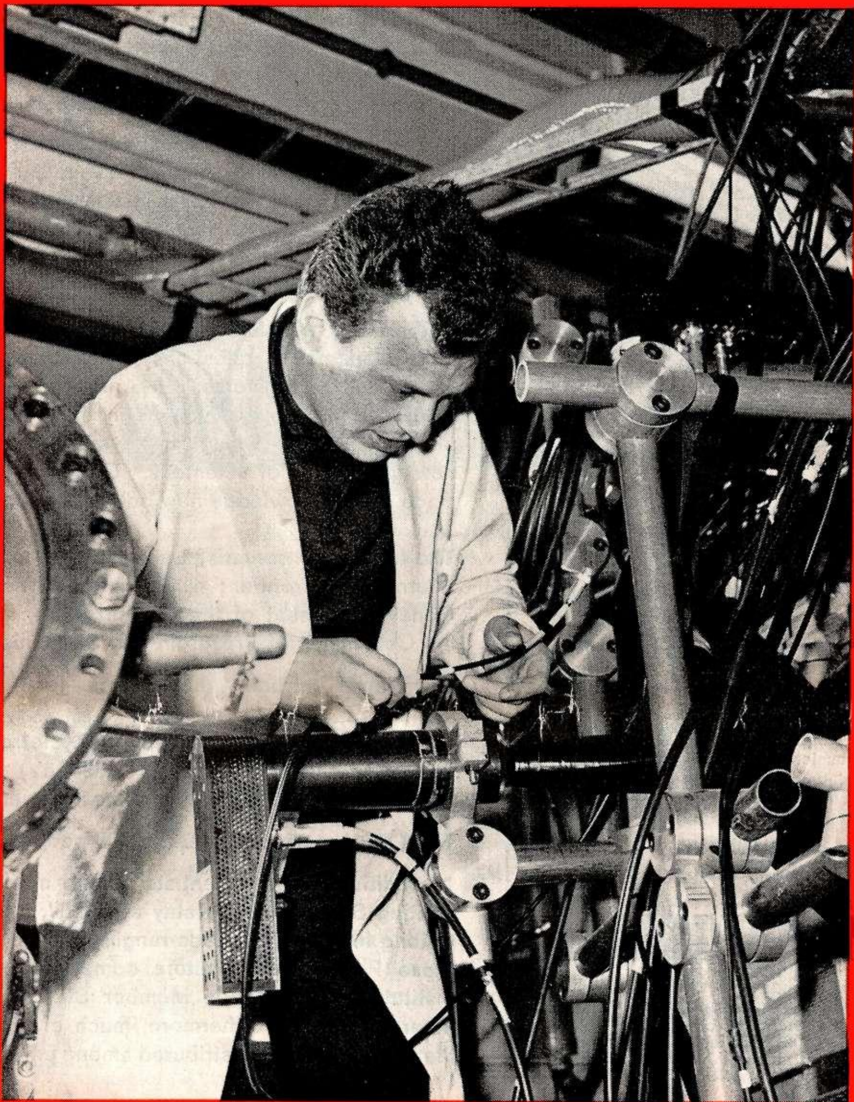
CERN COURIER



CERN/PI 144.10.65

12

VOL. 5

pp. 181-204

December 1965

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

English Edition

Contents

VOL. 5 DECEMBER 1965 NO. 12

The cover photograph shows one of the students who came to CERN during the summer vacation this year, working on the apparatus for an experiment at the synchro-cyclotron. The student is Giovanni Matone, from the University of Bologna. He is seen here helping to mount the experimental equipment for measuring the diffusion of muon-proton 'atoms' through hydrogen gas, forming part of a wider experiment on the capture by protons of muons into 'atomic' orbits (see 'Last month at CERN', p. 185 of this issue).

The tank containing hydrogen gas at high pressure, which acts as a proportional counter as well as providing the target in which the negative muons are stopped, can just be seen on the left of the photograph. The scaffolding supports scintillation counters (some of which can be seen) for defining the incoming beam. An article on vacation students at CERN appears on p. 190 of this issue.

CERN COURIER

is published monthly in English and in French. It is distributed free of charge to CERN employees, and others interested in the construction and use of particle accelerators or in the progress of nuclear physics in general.

Published by the
European Organization for
Nuclear Research (CERN)

PUBLIC INFORMATION
Roger Anthoine

Editor:
Alec G. Hester

CERN, 1211 Geneva 23, Switzerland
Tel. (022) 41 98 11
Telex: 22 548

Printed in Switzerland

The European Organization for Nuclear Research, more commonly known as **CERN** (from the initials of the French title or the original body, 'Le Conseil européen pour la Recherche nucléaire', formed by an Agreement dated 15 February 1952), was created when the Convention establishing the permanent Organization came into force on 29 September 1954.

In this Convention, the aims of the Organization are defined 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.'**

Conceived as a co-operative enterprise in order to regain for Europe a first-rank position in fundamental nuclear science, CERN is now one of the world's leading laboratories in this field. It acts as a European centre and co-ordinator of research, theoretical and experimental, in the field of **high-energy physics,** often known as **sub-nuclear physics** or the **physics of fundamental particles.**

High-energy physics is that front of science which aims directly at the most fundamental questions of the basic laws governing the structure of matter and the universe. It is not directed towards specific applications – in particular, it plays no part in the development of the practical uses of nuclear energy – though it plays an important role in the education of the new generation of scientists. Only the future can show what use may be made of the knowledge now being gained.

The laboratory comprises an area of about 80 ha (200 acres), straddling an international frontier; 41 ha is on Swiss territory in Meyrin, Canton of Geneva (the seat of the Organization), and 39.5 ha on French territory, in the Communes of Prévessin and St.-Genis-Pouilly, Department of the Ain.

Two large particle accelerators form the basis of the experimental equipment:

- a 600-MeV synchro-cyclotron,
- a 28 000-MeV (or 28-GeV) proton synchrotron,

the latter being one of the two most powerful in the world.

The CERN staff totals nearly 2200 people.

In addition to the scientists on the staff, there are over 350 Fellows and Visiting Scientists, who stay at CERN, either individually or as members of visiting teams, for periods ranging from two months to two years. Although these Fellows and Visitors come mainly from universities and research institutes in the CERN Member States, they also include scientists from other countries. Furthermore, much of the experimental data obtained with the accelerators is distributed among participating laboratories for evaluation.

Thirteen Member States contribute to the cost of the Organization, in proportion to their net national income:

Austria (1.95%)	Italy (10.78%)
Belgium (3.83%)	Netherlands (3.92%)
Denmark (2.07%)	Norway (1.47%)
Federal Republic of Germany (22.74%)	Spain (2.18%)
	Sweden (4.23%)
France (18.57%)	Switzerland (3.19%)
Greece (0.60%)	United Kingdom (24.47%)

Poland, Turkey and Yugoslavia have the status of Observer.

The budget for 1965 amounts to 128 760 000 Swiss francs (= $29 800 000), calling for contributions from Member States totalling 126 400 000 Swiss francs (= $29 300 000).

A supplementary programme, financed by twelve states, covers design work on two projects for the future of high-energy physics in Europe — intersecting storage rings for the 28-GeV accelerator at Meyrin and a possible 300-GeV accelerator that would be built elsewhere ●

Last month at CERN

New electricity sub-station inaugurated

Just over a month after it had first been put into service, the new 130/18-kV electricity sub-station at CERN was formerly opened on Friday 15 October, in the presence of representatives of both CERN and the 'Services Industriels de Genève' (S.I.G.), including its Chairman, Mr. J. Ducret.

The guests were welcomed by Mr. P. Germain, CERN's Directorate Member for Technical Management, who gave a summary of the growth of the Organization's demand for electricity during the past few years and some estimates for the future. Then Mr. J. Rouel, Head of the Site and Buildings Division's planning section and responsible for the CERN side of the project, gave a short history of the creation of the sub-station and the overhead line that brings the current from the power station at Verbois.

Mr. Jaccard, Head of the Electricity Service of the 'Services Industriels', followed with a résumé of the problems that had to be faced both in providing a considerable increase in the power supply to CERN and in integrating this supply into the Swiss and French networks. After the ceremonial bringing on to load of one of the transformers, the guests were taken on a guided tour of the sub-station before gathering in the CERN restaurant for refreshments.

This photograph shows the control desk for the 130-kV side of the new sub-station, with the two transformers and some of the bus-bars and their insulators visible through the windows. This part of the sub-station can be controlled either from this desk or from the main control point of the 'Services Industriels de Genève' in Geneva.

The sub-station itself

Since 1957, CERN's electricity supply has come by means of three 18 000-V underground cables from the 'Renfile' station of the S.I.G., at Vernier, with a capacity of 21 000 kVA. However, the maximum demand has risen from 3500 kW in 1958 through 10 000 kW in 1960 and 15 000 kW in 1962 to 22 000 kW in 1964, and the total consumption in 1964 was over 72 million units (kilowatt-hours)*. In fact CERN at present takes about one tenth of the electricity used in the Canton of Geneva. With the further development of the PS and its facilities, and in particular the proposed construction and operation of intersecting storage rings, the requirements will continue to grow rapidly. Within the next ten years the peak demand is expected to approach 90 000 kW and the annual consumption 300 million kilowatt-hours, which may well be as much as a quarter of the total consumption in Geneva.

This situation was attacked some years ago by the joint efforts of the 'Services Industriels' and CERN, and the new overhead line and sub-station is the result. Instead of being supplied from the local 18-kV network of Geneva, CERN is now, in effect, joined directly to the 130-kV circuit that is being established in the Canton.

The 130-kV overhead line linking CERN to Verbois will be continued beyond CERN to Colovrex and then to Romanel (West of Switzerland network). A second line, for 220 kV, on the same towers will serve to supply the Geneva network from the main grid in Switzerland.

The sub-station is in two parts, one belonging to the 'Services Industriels', and the other to CERN. The first comprises an open-air switchyard with a double set of bus-bars at present feeding two transformers, each of 30 000 kVA, which reduce the voltage from 130 kV to 18 kV. The output from the transformers is fed to the second part of the station, and is then taken by underground cable to the CERN 18-kV distribution centre in the Power House.

The new sub-station is fully equipped to receive a third transformer when needed, to bring the total capacity up to 90 000 kVA, and six parallel cables, each carrying up to 15 000 kVA, will link the sub-station with the distribution centre. The latter will be fully completed at the beginning of 1968, and the supply system will then be in a position to meet all the foreseeable electricity requirements of CERN, including those of the storage rings.

* Since the new sub-station was put into service the highest demand registered is 25 800 kW, in October.

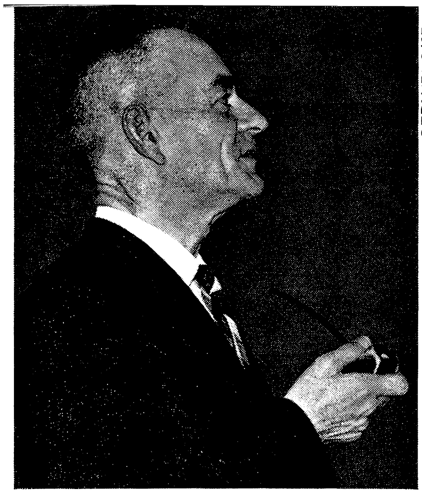
The retiring editor, his successor, and the whole staff of the Public Information Office, send to all readers of CERN COURIER **their best wishes for the coming year.**

SC experiments

The 'holiday' months of August and September saw an intensive exploitation of the synchro-cyclotron at CERN. At first sight paradoxical, this is easily explained in two ways : it is often the most convenient time of the year for university groups to get on with their experiments, and the various conferences held at the end of the summer provide an encouragement to push the work forward so as to obtain results for presentation.

One of the experiments concluded during this period was that on the study of the **x-rays emitted after muons are**

Geneva, Science



CERN/PI 3497

Professor
L. Leprince-Ringuet

'Science et Vie Sociale' (Science and Society), is the general title of a series of lectures, organized by the University of Geneva and a number of international organizations, including CERN, the fifth of which was presented on 29 October.

The lecturer on this occasion was Prof. L. Leprince-Ringuet, Director of the 'Laboratoire de physique' at the 'Ecole Polytechnique', in Paris, and Chairman of CERN's Scientific Policy Committee. All respect is due to him for the fact that, in spite of a heavy attack of influenza, he was still able to display his gifts as a precise and lively speaker before his audience of several hundred in the main lecture theatre of the University.

His talk, introduced by the Rector, Prof. C. Terrier, took the form of a series of reflections, sometimes amusing, often pertinent, and always clear, on 'Scientific development and general culture'. He classed human activities under two main headings, two poles that ought to be complementary. On one hand the scientific pole, rational and speaking a universal language, hostile to the aggressive use of its attainments. On the other, the meditative pole, realm of philosophy and religion, where differences of mentality have full play.

Study of the scientific pole discloses an evolution : the day of the great individualist is past. With the possible exception of a few isolated theorists, the scale of present-day science is that of the team. Moreover, evolution is seen again, at an increasing pace, in the substance of science itself. In 1953 antiprotons, strangeness, resonances, were unknown, and it is only necessary to look at a ten-years' old popular-science book to see how far the application of scientific discovery has progressed.

The speaker then posed the question whether a specialist can at the same time be cultured, or whether the necessity for precision and team work might not erase personality. Prof. Leprince-Ringuet dismissed the latter possibility. A former free 'King of cosmic rays', he knew well the problems of training and running scientific teams. Personalities emerge from research teams, even when individualism becomes submerged by the overriding dictates of machine operating timetables and technical uncertainties.

And culture ? Does that emerge diminished or enlarged from the melting-pot of the scientific age ? For the speaker, to be cultivated is not to be able to discourse on everything but to be able to show 'a possibility of thought, judgement and pronouncement on oneself, on others and on events'.

It is as well to note, he went on, that few specialists are cultivated : trained for team work, they have lacked contact with the masters of thought who, through the humanities, impress a mobility of spirit and a gift of abstraction. Again, if he had no hope of making cultured men from all the specialists, the lecturer nevertheless foresaw a certain amount of teaching of the humanities in technical institutions. But culture does not come only from formal education ; it owes much to the state of mind acquired somewhere between 10 and 20 years of age and resulting from heredity or from environmental influences. Prof. Leprince-Ringuet believes that the adolescent who has been subjected to good influences of this kind will possess a fundamental basic culture that will permit him to specialize without becoming uncultivated.

To conclude, the lecturer examined culture on the scale of the group. Europe benefited from a marvellous cultural inheritance, he remarked, and the uncertainty accompanying its age-long strife has bred a unique artistic potential. Today, on the point of reconciliation, Europe may not only delight in its prodigious fortune but also institute a specific culture of its own, distinct from the American, Soviet or Chinese forms. This can only happen, concluded Prof. Leprince-Ringuet, if Europe's scientific pole is used in support.

The lecturer, warmly applauded, was thanked by Prof. V.F. Weisskopf, CERN's Director General, who at the same time expressed his gratitude to the University, whose active collaboration is of particular value to the international life of Geneva.

Le Cercle de la Presse et des Amitiés étrangères (Press and foreign friendship circle), founded in Geneva in 1920 to provide a link between the local and international communities, dined on 4 November in honour of Prof. V.F. Weisskopf, acknowledging in this way a

---

Last month at CERN (cont.)

captured into atomic orbits (see *CERN COURIER*, vol. 5, p. 68, May 1965). In order to allow as much uninterrupted time as possible for the delicate measurements involved, one of the normal maintenance periods of the SC was suppressed during August and the accelerator ran more or less non-stop for 34 shifts (over eleven days). The results of this experiment, which are the most comprehensive yet obtained in this field, are of importance for a more detailed knowledge of nuclear structure. A new team of physicists, from both inside and outside CERN, is now considering the possibility of adapting the same technique of solid-state detectors to the study of pi-mesic x-rays, in order to obtain information on the strong interaction between pions and nuclei.

A combination of groups from the Universities of Lund (Sweden) and Geneva carried out a series of measurements to calibrate a **polarimeter,** which will be used early next year in a new experiment at the PS on time-reversal invariance in the decay of the lambda particle. The apparatus, consisting of large spark chambers with sheets of carbon as scatterer, enables the polarization of incoming protons to be determined from the relative scattering in different directions. The sparks are viewed by a television camera, which is arranged

and Scientists


CERN/PI 170.6.63

Professor Victor F. Weisskopf

scientist who has added so much to the reputation of Geneva in the world. Mr. Marcel A. Naville, President of the Circle, first of all expressed the deep regret aroused in Geneva by the announcement of the departure of CERN's Director General. Then he read a message from Mr. Albert Picot, former President of the 'Conseil d'Etat' and a leading advocate of the installation of CERN in the countryside of Geneva. Mr. Picot, prevented from attending by a recent operation, expressed in warm terms the affection he has had for CERN since its creation, and the sadness he felt at the departure of its leader.

In his after-dinner address, before some 240 guests, Prof. Weisskopf outlined the role played by CERN — the nerve centre of sub-nuclear physics in Europe, firmly linked with the national laboratories by a permanent collaborative effort and an element of European, or even intercontinental unification, because it is not just international but 'non-national' in character. A novel discussion then developed between the Director General and Miss Jeanne Hersch, Professor of Philosophy in the Faculty of Letters of the University of Geneva, on the theme of 'Scientist and City'. Both presented their ideas on the role of peacemaker that the scientist may be called upon to play, on his possible superiority as a universal adviser, and on the beneficial influence of the scientific mind on international affairs. From this friendly discussion there emerged a qualified agreement on the first point. Thus, whilst Prof. Hersch did not believe that scientific unanimity could serve world peace, Prof. Weisskopf — whilst recognizing that science by itself could not solve all the world's problems — thought that scientific advisers helped to bridge the differences between governments, because their contacts were not constrained by political frontiers. A striking illustration of this was given by the agreement on the cessation of nuclear-weapons tests in the atmosphere, which was due to the influence of scientists.

'What about the responsibility of science to society, the submission of scientists to military activities, for example ?', asked Prof. Hersch. On this point CERN's director regretted that so many scientists were willing to adapt their knowledge to the production of armaments, but, he added, 'the stakes are high, and there is no general rule here : the choice (to take part or not in warlike activities) is always an individual one'.

The opinions of scientist and philosopher came together again on the competence of scientists as general advisers on the conduct of public affairs : both concluded that this was a myth, the scientist does not know everything and has special ability only in his own subject. Both agreed again in affirming that scientific work could exert a beneficial influence on the life of the city, and hence for peace : when the task is subordinated to truth it must lead, by passing on this attitude to other circles, to improved national and international relations.

But if the responsibilities of science are limited, so are its means, and this was the subject of a sizeable digression during the evening. The question of the distribution of the funds devoted to scientific research — a trivial one today — will become acute in the relatively near future, perhaps within a generation. Will we then ask which science is the most useful ? Here Prof. Weisskopf recalled a parallel he had found in reading Paul Claudel ; one of his characters asks another :

> Tell me now, child, who has done mostservice to poor fever patients,
> The devoted physician who never leaves their pillow and bleeds them and takes their life to cure them at peril of his own,
> Or that sort of ne'er-do-weel who one day taking it into his head
> To go to the other side of the world,
> Discovered quinine ?

Having thus attacked the thesis of those who advocate activities providing an immediate return, the scientist made peace with the humanities : 'for science is only a branch of the humanities, not their enemy'.

To end his discourse, which received much warm applause, Prof. Weisskopf gave his friends a final demonstration of his attachment to the shores of Lake Geneva : 'Once in Geneva, always in Geneva', he said with feeling, before disclosing that his return to purely scientific pursuits on the professional plane would not be the end on the personal level, because he would retain a pied-à-terre in the foothills of the French Jura.

R.A.

---

to transmit data on their positions direct to a computer, and by a conventional camera; it is planned to evaluate the pictures with Luciole. After preliminary tests in September the experiment continued for a total of sixteen shifts in the early part of October and over a million photographs were obtained for later analysis.

Another experiment measured the **rate of transfer of the negative muon** from the muon-proton system (where the muon replaces the electron of a normal hydrogen atom) to various other elements. These measurements formed the essential preliminary to an experiment on the rate of capture of the muon by hydrogen now being assembled by the same group, from CERN's NP Division.

Among new experiments begun in August was a new series on the **interactions of positive pions** of 70 MeV with nuclei, by another CERN group. This is an improved, more accurate version, of their earlier experiment, which formed the subject of the cover photograph for the September 1964 issue of *CERN COURIER*. A similar experiment, using **negative pions** of 100-MeV energy, was started at the same time by a different group.

A group from the University of Oxford also came to CERN in September to prepare for an experiment on **pion charge exchange on**

CERN/PI 17.10.65

Not long after the signing of the agreements leasing the new site in France to CERN (CERN COURIER, vol. 5, p. 147, Oct. 1965), work began on the long job of installing the 2.6-km-long fence needed to enclose the area and make it inaccessible from the French side of the frontier. Our photograph shows some of the clearance necessary on the Southern corner of the new territory, near the junction with the existing area, where a new site road will be constructed.

nuclei. This is of particular interest since this is one of the first groups to come from outside CERN as a result of the decisions of the Nuclear Structure Commitee, set up to co-ordinate work in this field at the synchro-cyclotron. The experiment requires an intense beam of pions which is being obtained from the external proton beam of the accelerator.

Among experiments carried out earlier this year was one on the **decay of the neutral pion into three gamma rays,** by a group of physicists from CERN and the University of Heidelberg (Fed. Rep. of Germany). The results, which were presented at the Oxford Conference and later published in *Physics Letters**, are of particular theoretical interest since they also are concerned with the problem of CP invariance, discussed in the September issue of *CERN COURIER* (vol. 5, pp. 131-132). If the strong and the electromagnetic interaction are both invariant under the operation of charge conjugation (C), the neutral pion can never decay into three gamma rays, only into two ; if not, recent theory suggests that emission of the third gamma ray might be possible a few times in every million disintegrations.

In the CERN experiment, no certain example of the three-gamma decay was found, which enables an upper limit of five times in a million to be put on its occurrence. Although this figure is a hundred times less than the previous experimental estimate, and proves that the three-gamma decay must in any case be very rare, it is, unfortunately, still just too high to enable any definite conclusions to be drawn concerning the new theory.

2-m bubble chamber reaches 500 000

The period from the middle of September to the middle of October at the PS (weeks 38-42 inclusive) was devoted principally to bubble-chamber experiments, although a certain amount of the primary proton beam continued to be available for the various electronics experiments in the South and East experimental halls. The CERN 2-m hydrogen bubble chamber began its second main run in week 39, and on 15 October the number of good photographs obtained with this chamber passed the first half million.

During this period also, the first tests were made with the new radio-frequency-separated beam, u_1, which originates in a target struck by the ejected proton beam from straight-section 58.

* Physics Letters, vol. 19, pp. 253-255, 15 Oct. 1965.

With great regret we have to announce the sudden death, on 18 november 1965, of one of the early members of the CERN staff, Dr. J.A. NEWTH, leader of the cosmic-ray group in the years 1955-58. Since then he has been at Imperial College, London, but has continued to work closely with CERN and retained many contacts here. All those who had the good fortune to work with him will keep in memory a personality with great intellectual and human qualities.

All our sympathy goes to his family at this time.

Changes at head of SB Division

On 1st October 1965, Mr. **Ch. Mallet** relinquished his post as leader of the Site and Buildings Division to join AR Division, where he will take part whole-time in the site studies for a 300-GeV accelerator. Mr. **P. Tirion** has been appointed Acting Division Leader of SB Division. At the same time, the Directorate Member for Technical Management, Dr. **P. Germain,** has assumed special responsibility for problems affecting the long-term policy of the Division ●

THE END OF A CHAPTER

This issue of *CERN COURIER* marks the end of a chapter in the history of the publication of the monthly review of the European Organization for Nuclear Research. Its Editor, **Alec Hester,** is leaving the Public Information Office to take up duties, elsewhere in CERN, which he feels are more in line with his scientific leanings and which will, perhaps, be less exacting.

The editing and production of our periodical, with limited means, requires not only very definite intellectual qualities, for collecting and processing information from all over the Laboratory, but also considerable physical and moral toughness to cope with the many dictates of production which are the lot of every editor.

It is only right to tell Alec how much his efforts have been appreciated, since he began in 1961 to pack into *CERN COURIER* the wealth of information which is now its hallmark.

It is mainly thanks to his drive that *CERN COURIER*, which now has a circulation of 6000 copies (French and English versions combined), has risen from the rank of 'internal information journal' to that of 'world spokesman for European sub-nuclear physics'.

Alec Hester will fortunately still be in our midst, in the Library, where his talents and experience will remain available to his CERN colleagues, both scientists and others, and to his successor. The latter is **Brian Southworth,** who has also had considerable experience 'in the trade', as editor of a similar publication, *Orbit*, at the Rutherford High Energy Laboratory in the United Kingdom.

Roger Anthoine

Job evaluation

by **Ch. FIVEZ,** Head of Salary Administration Section, Personnel Division

In the June 1962 issue of *CERN COURIER* (vol. 2, no. 6, pp. 4-5) there was an article, under the same title as this one, giving a general idea of job evaluation. The publication date of that article coincided with the end of the first series of annual job surveys at CERN.

The fifth series has now just started, and it may be useful at this stage to restate the basic principles of job evaluation and to examine the results of four years' activity in this field.

This need for an evaluation system became apparent when it was necessary to relate a large number of jobs, of different types and levels, to a scale of grades, or, in other words, when a grade had to be attributed to each existing job and every new job that might arise in the future. Although job evaluation is not an exact way of measuring work, it allows the relative value of different jobs to be determined in an orderly and rational manner. The evaluation is based on a study or analysis of each post, and it is made by determining the relative value of various factors which are common to a large number of posts of different types.

In the 1962 article, the basic aim of job evaluation was summarized in five words : 'Equal pay for equal work'. This aim is still the same. It should be understood, however, that 'pay' means the salary or basic remuneration related to each grade, without taking into account any allowance or indemnity paid to a staff member because of his length of service or his family or personal circumstances (for example, family allowances, non-resident allowances, etc.). A sound method of determining appropriate grades for all jobs ensures that jobs having the same value are assigned to the same grade, and since the basic payment is a function of the grade, the desired aim is achieved.

The table below shows the results of the last four series of annual job surveys. The number of reclassifications includes all changes indicated by the analysis and evaluation of jobs, including alterations to the occupational codes, titles, grades etc. The last column indicates how many staff members have been promoted following the analysis and evaluation of their jobs.

Year	Total staff*	Number of posts reviewed in %	Number of reclassifications in %	Number of promotions in %
1961-62	1235	88	35	24
1962-63	1694*	84	33	21**
1963-64	1790	84	19	22**
1964-65	2032	83	11	11**

* From 1962-63, supernumeraries are included.
** Including promotions resulting from the previous year's survey.

The large number of reclassifications and promotions during the first two years reflects the effort that was made to obtain as soon as possible a fair alignment of the grades of existing jobs. It seems that after the third series of annual surveys a satisfactory alignment of grades was reached, and that since then the only reason for a reclassification has been a change in the functions or responsibilities of the staff member.

In practice, the annual job survey takes place as follows. The Personnel Division representative compares a current description of the job with the results of the previous year's analysis; in most cases, the job has not changed and the description remains valid. Sometimes, however, it is seen that a staff member now performs more difficult tasks, or has greater responsibilities. He may have gained particular experience or learned certain techniques, and therefore his supervisor has given him more valuable work to do. A new job description will then be prepared and evaluated, so that the appropriate level in the scale of grades can be determined. If the change in duties results in a 'reclassification', the supervisor of the person concerned has to consider whether to recommend an immediate promotion to the higher grade or to postpone this action for the time being in favour of an adjustment, that is an extra step within the grade. Such an adjustment will encourage the staff member to progress in his work and will bring him closer to the next higher grade, although without offering him any guarantee of a later promotion. In very rare cases it may be decided that no action should be taken, but to wait and see how the staff member develops in his job.

This decision to be taken by the supervisor, on the basis of the job evaluation, is not an easy one. Many factors have to be taken into account, such as the relative situation of other people, the probable career of the person concerned, and the fact that there should be at least three years' time interval between successive changes of grade. This stage of the procedure represents one of the most important aspects of personnel management.

During the last four years the techniques of job surveying have been improved, both to enable the basic aim to be achieved with more precision, and also to allow the 'by-products' of job evaluation to be exploited. The occupational codes have been altered, enabling improvements to be made in the grouping of related jobs into 'families' of occupations. Among other benefits, this allows statistics showing the distribution of personnel between the various professional categories to be produced quickly and accurately. The job descriptions are reviewed every year, brought up to date and re-evaluated. This means that information is always available about the nature and value of each staff member's work assignment. The diagram on the next page shows a typical final result of a job survey. With this diagram the job surveyor can check whether the grades allotted to various posts correspond to the levels in the employment hierarchy of the Organization, whether the chains of command and responsibility agree with what is written in the job descriptions, and whether the posts are correctly situated in the organizational framework. A supervisor can use this type of diagram and the job description for other purposes, for example, to plan a reorganization of part of his section, or the creation of a new department, or to establish budget estimates.

One of the disadvantages of the job-evaluation

The curious world of the quark

by **John DAVY,** Science Correspondent of *The Observer* London*

Five hundred of the world's most expensive scientists from 30 countries were gathered in Oxford last week to discuss 'elementary particles'.

They are expensive because they do their work with the most complex and enormous machines devised by man, the particle accelerators, or atom smashers. They are imbued these days with a mood of breathless expectancy, coupled with a sense of approaching crisis. They believe that high-energy physics, burrowing ever deeper into matter, may be about to break into 'a quite new level of reality', as one of them put it.

But the European contingent, especially the British, had a haunted air : they are wondering if their fellow citizens will foot the bill.

The question is now acute, since the doorway into the 'new level of reality' is a new generation of much larger accelerators. America is about to go ahead with hers — a machine six and a half times more powerful than any yet built.

£ 70 m. a year from Europe

For Europe a similar, slightly larger machine is proposed, a collaborative effort on the pattern of the European Centre for Nuclear Research**, near Geneva. It would cost £ 130 million to build, and would engage about 1000 physicists (mostly as visiting teams from contributing countries). It would demand European support (embracing national programmes) to the tune of at least £ 70 million a year.

Lord Bowden, Minister of State for Science***, opened the meeting ominously. He made comparisons with the builders of the great pyramids and cathedrals. He suggested the motives of high-energy physicists were equally 'non-logical'. He spoke of the growth of science, which if allowed to continue would swallow the entire national product by the end of the century. But high-energy physicists see themselves (as did, presumably, the cathedral builders) as an essential element in the culture of their times. They were emphatic last week that refusal of a European machine will mean the death of high-energy physics in Europe within 10 years.

While Treasuries might cheer, the whole intellectual climate in science would be changed, say the physicists (who are admittedly not exactly disinterested parties). A lot of able people would be out of a job — and the effects in education and the universities would be far-reaching. Exploration of the foundations of matter would become an American monopoly.

Scientists' two major obstacles

In trying to sell their subject, the scientists face two major obstacles. The first is that they can promise no

* This article was first published in 'The Observer' on 26 September 1965 and is reprinted here by kind permission of the Proprietors.

** Although not an official title, this is commonly used as an explanation of the abbreviation CERN.

*** Lord Bowden has since relinquished his Government appointment and returned to his post as Principal of the Manchester College of Science and Technology.

Job evaluation
(cont.)

GROUP X

1 Senior Engineer	200-2	12

SECTION A

1 Electrical Engineer	202-5	10
1 Technical Assistant (Mechanical)	301-1	8
1 Pipefitter	512-1	6
1 Assistant Craftsman	500-1	4
1 Technical Assistant (Electrical)	302-14	7
1 Technical Draughtman (Electrical)	404-1	5
1 Senior Operator (PS Power Supplies)	602-1	7
8 Operators (PS Power Supplies)	602-3	6
1 Assistant Operator (PS Power Supplies)	602-2	5

SECTION B

1 Electrical Engineer	202-5	10
1 Electrical Engineer	202-2	9
1 Technical Assistant (Electrical)	302-2	8
1 Technical Assistant (Electrical)	302-1	8
1 Electrician	517-1	6
5 Assistant Craftsmen	500-1	4
1 Craftsman Helper	914-1	3

SECTION C

1 Electrical Engineer	202-5	10
1 Technical Assistant (Electrical)	302-15	8
1 Technical Assistant (Electrical)	302-13	7
1 Senior Operator (PS Power Supplies)	602-1	7
11 Operators (PS Power Supplies)	602-3	6
3 Assistant Operators (PS Power Supplies)	602-2	5

Number of identical posts

Occupational code

Number of the description within the code

Grade of job

system is that although it allows the level of a post to be calculated with reasonable accuracy, it does not provide any measure of the performance of the person in the post. For this reason a merit-rating scheme is being studied at the moment. If the practical results are satisfactory and offer enough guarantee of objectivity, this system of appraisal could be applied jointly with the system of job evaluation at CERN. It might then be possible to improve the payment system so that everyone receives a fair remuneration after taking into account both the value of his post and the quality of his performance ●

From 19 to 25 September 1965, physicists from many parts of the world, though mostly from Europe, gathered together for the Oxford International conference on elementary particles. Their discussion centred around the new results, both experimental and theoretical, obtained in the field of sub-nuclear physics (otherwise known as elementary-particle or high-energy physics) during the past year and on ideas for future work.

Usually in CERN COURIER we try to summarize the information made known at such a conference (and this may still be done for this particular one), but it is also interesting sometimes to know how it is viewed by someone outside the field of specialization. We are therefore pleased to be able to reproduce this article by John Davy, of The Observer, London, in which he describes the general atmosphere of the conference, underlining a certain apprehension that exists about the future of the fundamental research activity that formed its subject and indicating why physicists are so anxious to carry forward the investigations that have produced so many intriguing results in the past few years.

practical rewards — although as a matter of history, each new advance into a deeper level of the interior of matter has come to have profound practical importance (culminating in the bomb and nuclear power).

The second obstacle is that most of the people in the world who really understand the subject were at Oxford last week talking to one another — and it is only with the greatest difficulty that they can talk comprehensibly to anyone else.

Some reasons for their current high state of excitement could, however, be glimpsed through the formulas at Oxford last week. To begin with, a beautiful harmony has emerged in the sub-atomic world over the past two years — but no one knows what is producing the music. To find out, bigger accelerating machines are needed.

Discovery of a new 'chemistry'

To understand the present situation, an historical perspective is helpful. The early chemists gradually identified a variety of chemical elements; then, in 1869, Mendelejeff showed how they could be arranged in a coherent and elegant pattern, the Periodic Table. With this, the existence of new elements could be predicted, together with some of their properties. But an explanation of the pattern did not come until physics probed inside the elements and found the atom.

Today physics has discovered a new 'chemistry' — a wealth of 'elementary particles' which emerge from within the atom when its nucleus is bombarded by accelerators. Many of these particles decay into other particles in tiny fractions of a second, and for a long time little sense could be made of them.

Then theoreticians in several countries, including Professor Murray Gell-Mann in California and Professor Abdus Salam, in London, began to glimpse an elegant mathematical pattern into which the particles could fit.

They predicted the existence of a new, hitherto unknown, particle. And in February 1964, loosing a wave of euphoria among physicists, the big American accelerator at Brookhaven found the now famous omega-minus particle.

The mathematical harmonies of the sub-nuclear 'periodic table' were firmly established. Since then the mathematics have been developed into a still more elegant expression, to embrace relativity.

But what lies behind the pattern? The breathtaking possibility is that it may be possible to break through it and find the 'atoms' of the nuclear particles. These — still hypothetical — entities have been christened 'quarks', in an allusion to *Finnegans Wake*. ('Three quarks for Muster Mark', wrote Joyce obscurely).

If quarks exist they will be massive — huge packages of bound energy. Only much bigger accelerating machines, with energies to match, are likely to reveal them.

Quite new level of reality

The nuclear world has some strange properties, but the quark world could be more curious still. If it can be explored, quite new ideas of space, time and causality may have to be developed. This is 'the quite new level of reality' into which the physicists at Oxford last week can hardly wait to look.

There is a second aspect of high-energy physics, where confusion and mystery reign. It concerns the 'weak' forces of radioactivity. The most trying problems arise from an American discovery in 1964 concerning particles called K-mesons, which decay by weak interactions. It has undermined a fundamental assumption of physics — that physical events are reversible without violating any physical laws.

If you hold up a mirror to a nuclear particle, the reflection represents another particle which can (and does) exist. Similarly, a series of physical events should make just as much sense run backwards in time as forwards.

The K-meson observations have shown that in the world of weak interactions this is not so. The universe cares, so to speak, in which direction the arrow of time is flying. Something very fundamental must be peeping out here.

Awe-inspiring prospect

Perhaps the most awe-inspiring prospect, which is still no more than a hunch among physicists, is that we may be on the verge of a mighty merging of sub-nuclear physics and cosmology. The study of the very large may be about to throw light on the very small, and vice versa.

The newly discovered 'quasistars', with their inexplicably huge energies, are looking to high-energy physics for ideas. And out of this synthesis might come some light on one of the deepest questions of all. It is this: the fundamental particles are turning out not to be fundamental at all. But the forces which affect them appear to be very fundamental indeed. There seem to be four: gravity, the electromagnetic forces, the nuclear forces (released in the bomb) and the mysterious 'weak' forces. Why are there four? How are they related? Can they be unified? No one knows. But the men at Oxford last week can see the next step ahead — if society will pay for them to take it ●

Vacation students at CERN, 1965

by **R. N. MILLIGAN**, Personnel Division

During the popular holiday months this summer, the normal CERN population decreased considerably as staff vacations or departed to conferences and summer members took advantage of the fine weather for their schools. Their absence was partially compensated, however, by a sizeable influx of visitors, many of whom came to CERN under the vacation-student programme. But it was only one of the secondary aims of this programme, when it began with 56 students in 1962, that participants should 'provide assistance to CERN groups'; the principal purpose was rather to give a widely representative number of European students an idea of CERN and its work*.

In 1965 a hundred young graduates and undergraduates, specializing in physics, electrical or electronic engineering, or mathematics, at 67 different universities in the Member States, spent from two to four months at the Laboratory. Since 1962 the number of places available has increased by over 20 % every year, but the level of interest has risen at a similar rate so that in 1965, as in earlier years, it was only possible to accept one in five of the candidates.

Selection

The selection was carried out in collaboration with the leaders of the groups that had requested students, on the basis of confidential reports submitted by Professors and supervisors, and care was exercised to ensure that each Member State was adequately represented. Those chosen were told briefly of the assignments foreseen for them and offered appointments under which CERN paid travel expenses and a subsistence allowance for the duration of their stay in Geneva.

Accommodation was arranged for most of the students at the 'Cité Universitaire' and other Geneva University student centres. These are situated rather a long way from CERN, on the other side of Geneva, but most students considered their standard of comfort compensated for the inconvenience of their location.

Experimental work

On arrival at CERN, each student was directed to the appropriate group, where he then took part in its day-to-day activities. About a third of the students were in the Nuclear Physics Division, where most were occupied in preparing or running experiments, for example, the study of resonance production in pion-proton interactions, or research into the quadrupole structure of heavy nuclei.

Another twenty-seven students, who were allocated to the Track Chambers and Data Handling Divisions, were largely concerned with the analysis of bubble-chamber photographs, using the CDC 6600 computer.

Most of the others joined the Nuclear Physics Apparatus, Proton Synchrotron Machine and Accelerator Research Divisions, where they were given assignments in applied physics and engineering, such as studying high-voltage vacuum breakdown phenomena, evaluating particle detectors for monitoring PS beam losses, and computing beam blow-up in storage rings due to multiple scattering.

Lecture courses

A special series of over 50 lectures was arranged to supplement the students' practical experience and to give them an insight into the work of other groups at CERN. Many senior staff members and visitors gave individual lectures or short courses in the series, which lasted for a period of two months. The subjects covered a very wide range of interests. Typical individual lectures were those on 'The place of high-energy physics in modern scientific research', by V.F. Weisskopf, 'The future of bubble-chamber physics', by B. P. Gregory, 'High-energy elastic scattering', by A. M. Wetherell, and 'Electro-physics of gases', by C. G. Morgan (University College of Swansea). Courses were given on 'Theoretical studies of strong interactions', by H.G. Burkhardt, 'Theory of weak interactions', by M. Veltman, and 'Computer programming, based on the CERN Fortran language', by F. Louis. There were also lectures on the proton synchrotron and synchro-cyclotron accelerators and the CDC 6600 computer, followed by guided visits to the installations.

The lectures were very well attended by the students; moreover, many staff members and visitors took advantage of the opportunity to learn about current developments in groups other than their own.

1966 Programme

For 1966 it is proposed to continue the scheme on the same general lines as this year, but with a few alterations. The most significant of these will be to limit participation to students who have had at least three years of University training, rather than the two-year minimum required in the past. More advanced students should have a better understanding of the many different activities that they will encounter at CERN, both in the formal training offered by the lecture series and the practical laboratory experience. It is also expected that they will be able to make a more effective contribution to the work of the group that they join ●

* See also CERN COURIER, vol. 4, p. 8, January 1964.

APPLICATIONS FOR 1966

University students wishing to take part in the CERN Vacation Course in the summer next year should request application forms early in 1966 by sending a post card to the following address:

The Fellows and Visitors Service,
Personnel Division,
CERN,
1211 Geneva 23 / Switzerland.

The closing date for the receipt of application forms will be 1st MARCH 1966, and the results of the selection will be announced about 6 weeks later.

Frascati accelerator conference

The fifth International conference on high-energy accelerators was held from 9 to 16 September, this year, at the Italian National Laboratory at Frascati, near Rome. In the following report, compiled largely from accounts of the conference kindly given by F. Ferger and W.C. Middelkoop (both of CERN's AR Division), an idea of the scope of the papers presented, and current progress in the whole field of particle accelerators, is given under the four main headings of accelerators and storage rings, experimental apparatus, new developments, and physics with future accelerators. Such a report cannot be comprehensive – only the published proceedings can include everything – and it is recognized that some personal preference in the choice of topics is inevitable. In particular, the important Russian contribution to the conference is perhaps not fully represented, largely owing to the language problem, which, in spite of simultaneous interpretation, often did not enable the full significance of the papers to be grasped.

After those at CERN (1956 and 1959)*, Brookhaven (1961) and Dubna (1963)**, the fifth International conference on high-energy accelerators, sponsored by the International Union of Pure and Applied Physics, took place at the Italian National Laboratory at Frascati from 9 to 16 September 1965. Some 300 physicists and engineers participated, from over 80 different laboratories in 19 different countries of the world.

From the very concentrated programme, it is impossible to compile a full account covering the eleven long sessions as such. Instead, it is hoped to give a general impression of current work in the field of particle accelerators, including some of the physics experiments carried out with these machines, as revealed by the papers read at the conference.

ACCELERATORS AND STORAGE RINGS

Performance of existing accelerators

A number of papers were presented, according to custom, on the current performance of existing accelerators, including some that had come into operation since the previous conference. For example, the ZGS at Argonne is working more or less as designed, with beam intensities around 8×10^{11} protons/pulse at 12.7 GeV. Work is in progress on a system to decrease the synchrotron oscillations (of particles about the mean position of a bunch). This would involve the rather difficult feat of detecting the oscillations in any bunch and applying a corresponding correction signal, to that bunch only, at a later point in the orbit.

Another accelerator that, in itself, has come well up to expectations is 'Nimrod', the 7-GeV synchrotron of the Rutherford Laboratory***. Indeed, its very success has introduced problems, because the vacuum chamber, of glass-fibre-reinforced epoxy resin, already shows signs of radiation damage, owing to the high beam intensities obtained. At the Bevatron, Berkeley, a considerably increased beam intensity (5.5×10^{12} protons/pulse, 11 pulses/min) has led to major operational changes. A fast ejection system is used to extract the proton beam from the machine and the use of internal targets has now been almost entirely discontinued in order to keep the induced radioactivity within reasonable limits.

Among the ideas put forward for improving the beam intensities of existing accelerators was one from Brookhaven (for the AGS), envisaging the use of an intermediate storage ring to increase the number of particles injected at each pulse, and one from CERN, foreseeing two intermediate synchrotrons for the same purpose.

New large accelerators

One session was devoted to design studies and the development of superhigh-energy accelerators, that is accelerators giving appreciably higher energies than the Brookhaven AGS and the CERN PS.

The only machine under construction in this category is the 70-GeV proton synchrotron at Serpukhov in the U.S.S.R., on which a progress report was presented. Apart from its size, it is very similar to the largest proton synchrotrons already in existence, and it is expected to give about the same performance. It should come into operation in 1967.

The greater part of the session was used for the presentations of the European plans for a future 300-GeV proton accelerator and the American plans for a 200-GeV machine. These plans are now very advanced and provide a comprehensive technical basis for government decisions. The conference gave, of course, no indication of how and when such decisions will be taken.

The two projects show a high degree of similarity, indicating that there is a natural line to follow for such studies, which is to base the design on alternating-gradient steel magnets. The similarity also reflects the close world collaboration existing in this field, although when it comes to details the reports did contain differences, for example on the r.f. acceleration systems.

Storage rings

A number of papers were presented on the CERN design for intersecting storage rings for protons, as well as projects for electron storage rings at Frascati, MURA, Orsay and Stanford. Of rather more interest at this stage, however, were reports on rings that have already operated, including those at Novosibirsk (U.S.S.R.), for electrons and positrons at 300 MeV, and at Stanford (U.S.A.), for colliding beams of electrons at 300 MeV. In general, the story has been one of unpredicted instabilities which have occupied the theorists for a long time in elucidating their causes. For example, serious beam instabilities were encountered at Stanford in the beginning, but additional

---

* CERN COURIER, no. 3, October 1959.

** CERN COURIER, vol. 3, pp. 143-145, November 1963.

*** The mechanical breakdown of the magnet-supply generators is a separate issue.

correction devices have now enabled the intensities in the two rings to be raised to values where electron colliding-beam experiments are possible at reasonably high interaction rates.

A considerable amount of discussion on the beam instabilities took place at the conference, from which it emerged that most of the problems are now reasonably well understood. It is also true to say that the large effort put into explaining the various effects encountered has resulted in a notable advance in the understanding of the complex behaviour of high-intensity beams of fast charged particles. Such knowledge will be of great use not only in the design of storage rings but also of accelerators in general.

Electron accelerators

The SLAC, 20-GeV linear accelerator at Stanford is now expected to come into operation in the middle of 1966. Three-quarters of the 240 'modules' are now installed and the first two sections of the accelerator have been in operation since early 1965 for tests. Plans for starting physics experiments as soon as the accelerator is available are also well advanced.

Other reports were presented on improvements to the research capability of the 6-GeV Cambridge Electron Accelerator (U.S.A.) and the 1.5-GeV electron synchrotron at the California Institute of Technology, as well as construction progress with the 2.3-GeV synchrotron at Bonn and the 10-GeV machine at Cornell. Details were also presented of a French project for a 12-GeV electron synchrotron.

Linac theory

There has been a renewed emphasis on the theory of linear accelerators, particularly for protons. Among the papers in this field presented at the conference were a number from CERN, where several new ideas have been put forward. There seems now to be a better understanding of the interactions that take place between the beam and the accelerating system and of the way in which energy flows into the accelerating structure. New forms of structure have also been suggested, among them the cross-bar structure, developed jointly by the Rutherford Laboratory (U.K.) and CERN, consisting basically of a hollow tube with transverse parallel bars appropriately spaced and aligned alternately horizontally and vertically.

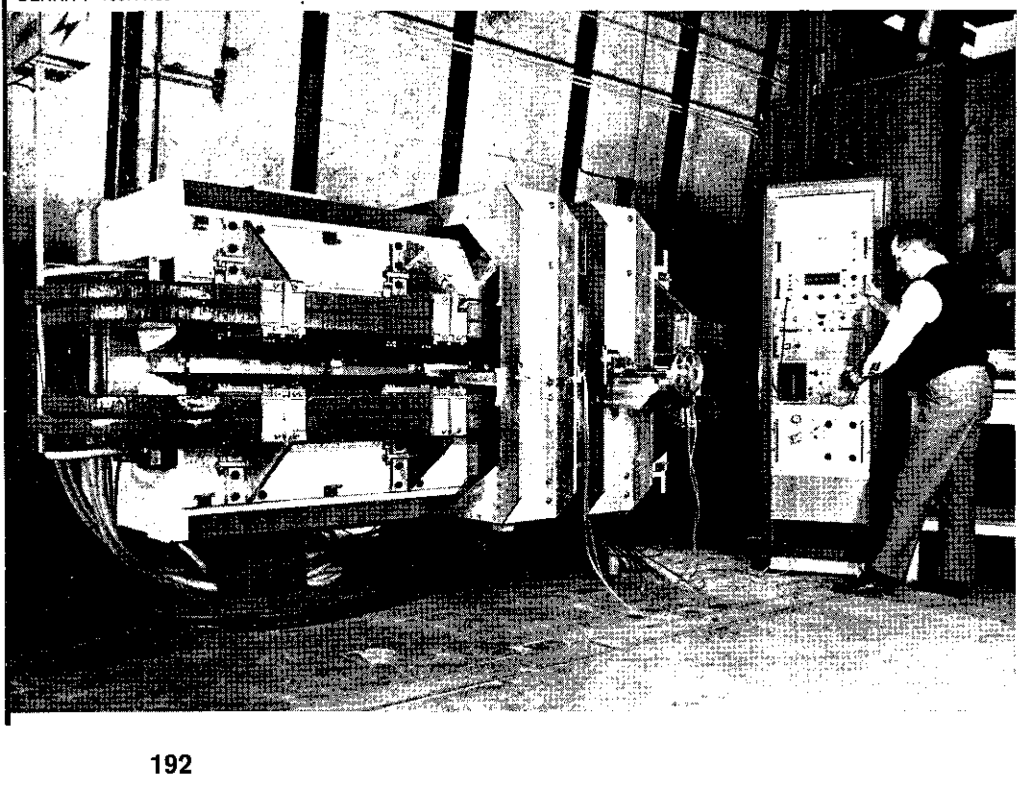
Stability criteria

One of the characteristics of the superhigh-energy synchrotrons now being designed is that the synchrotron oscillations in the beam become of the same order of magnitude as the betatron oscillations. Extension of the existing theory shows then that certain new limitations are placed on the design, in order to ensure beam stability, and these lead further to more severe tolerance limits on the voltage and phase of the radio-frequency supply.

In general, although high-energy physicists in the Soviet Union are sufficiently occupied with the construction of the Serpukhov synchrotron not to have any detailed plans for any further accelerator step, they are doing a considerable amount of work in the theory of acceleration systems. For example, a paper was presented by physicists from the Radiotechnical Institute in Moscow providing some interesting contributions to the study of automatic orbit control in accelerators up to 1000 GeV. Work in this field is also being carried out at Berkeley and some of the results were presented to the conference.

Since the Dubna conference of 1963, the idea of 'non-linear focusing' has been developed further in the Institute of Physical Problems in Moscow, and the latest results were presented at Frascati. These indicate that in spite of the large betatron oscillations allowed by this system of focusing the beam does remain stable.

CERN/PI 138.11.65



Whilst discussion at Frascati ranged over the whole field of high-energy accelerators and the work that is done with them, work in the New Accelerators group of CERN's Accelerator Research Division is concentrated on design and model work for the intersecting storage rings and the proposed 300-GeV synchrotron. This photograph shows measurements being carried out on the magnetic field of Model I of a magnet unit for the intersecting storage rings. The magnet is shorter than those used in the CERN proton synchrotron (2.5 m instead of 4 m). It also differs from the PS magnet by the fact that the punched laminations are held together by tension bars welded along the sides, instead of having the laminations glued together. The magnetic field is of about the same magnitude as that of the PS magnet, but covers a bigger volume ; the profile of the pole faces can be clearly seen in the photograph. The vertical frame attached to the magnet is the support for the measuring apparatus, the controls of which are being operated by Christian Roy.

EXPERIMENTAL APPARATUS

Among the developments in experimental apparatus described at the conference was a rapid-cycling hydrogen bubble chamber, constructed at Princeton (U.S.A.), which is 30 cm long and capable of 19 operations per second, about 50 times faster than other chambers in current use. Another innovation on this chamber is the use of a trigger system for the flash lamps and film advance, operated from appropriately placed particle detectors, so as to reduce the number of photographs of unwanted events.

Papers were presented from CERN on the microwave r.f. particle separator, still the only one in operation in the world, and the latest improvements to the electrostatic separators, also unsurpassed elsewhere. Other CERN contributions reported on the two years of operation of the fast ejection system at the PS and the more recent resonant ejection system (described in the October issue of *CERN COURIER*). Papers were also presented from other laboratories on the design or operation of beam-extraction systems.

NEW DEVELOPMENTS

A 'positron source'

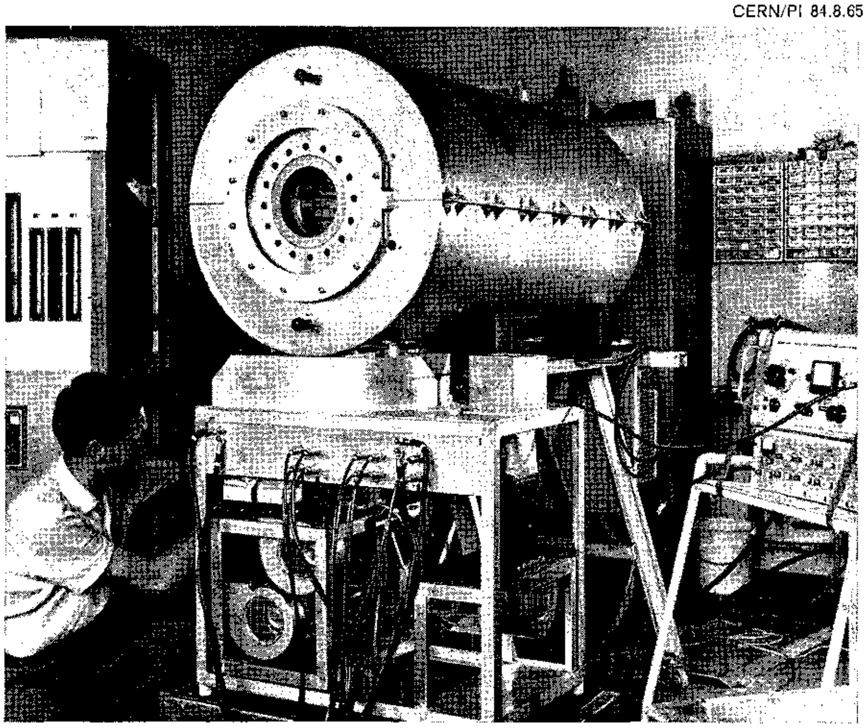
A highly interesting device reported from Novosibirsk was an electron/positron converter which, by an ingenious storage method, greatly increases the efficiency of positron injection into storage rings. Positrons have so far been obtained by conversion of gamma rays, which have in turn been produced by the impact of a primary accelerated electron beam on a target. In the proposed converter, a separate low-energy electron beam is directed on to a target and produces positrons. These emerge into a region of fairly low gas pressure and are confined within a certain volume by a specially shaped magnetic field ('magnetic bottle'). The magnetic field also focuses them and directs them into a second region, of rather higher pressure ($\sim$1 Torr) where their energies rapidly drop to thermal values corresponding to their surroundings. Conditions are so chosen that this process happens in a time much shorter than the average annihilation time, so that relatively few positrons are lost. The positrons are then extracted by an electric field, accelerated and injected into the storage ring in the same way as an electron beam. By using a continuous (or rapidly pulsed) electron beam incident on the converter and collecting positrons during the whole time between storage-ring injector pulses, the system can be arranged to provide positron pulses equal in intensity to the electron pulses injected into the ring.

Applications of superconductivity

Among the more striking achievements reported at the conference were a number of developments in the application of superconductors to high-energy-physics apparatus.

At Stanford, work is being directed towards the use of superconducting cavities for linear accelerators, which would have considerably reduced power losses. Recently, both cylindrical cavities and sections of travelling-wave guide have been produced with a Q-value (quality factor) of 5×10^9, representing a substantial advance on the values of about 10^5 obtained conventionally. These cavities were made of copper, electroplated with lead, and were operated at a temperature of 2° K (—271° C), where the lead is superconducting. The frequency used was 2.8 GHz (2800 Mc/s) and the remarkably high electric field of 150 kV/cm was obtained with an input power of only 4 watts. As always, advantages have to be paid for: the 'filling time' of the cavity, that is the time for the voltage on the cavity to reach its final value, is about one second and the relation between resonant frequency and length of the cavity is so critical that a change in length of less than 1 Angstrom (10^{-8} cm) completely detunes the cavity. However this has not prevented the workers at Stanford from building a small accelerator, of two sections, which has accelerated electrons to 0.5 MeV.

CERN/PI 84.8.65



Another piece of apparatus under test at CERN for the storage rings is the accelerating cavity seen here in one of the laboratories of the AR Division. Six such cavities will be used for each ring, their prime purpose being to accelerate each bunch of protons injected into the ring from its injection orbit to its final 'stacked' orbit. It is essential that the operation of the cavity should not be influenced by the presence of the beam (beam loading) and a feed-back coupled amplifier is being developed to provide the necessary low source impedence. Major problems remaining to be overcome are those of stability and control of the radiofrequency voltage. Working on the equipment here is Pierre Bricchi.

Another achievement was reported from Argonne, where a 25-cm liquid-helium chamber has been operated with a superconducting magnet giving a field of 60 kilogauss.

At Brookhaven, a small superconducting quadrupole magnet has now been successfully constructed, as well as a 120-kilogauss solenoid, and many of the reasons (mostly technological) for earlier lack of success in this field have been elucidated.

Microtrons

An interesting paper on the last morning reminded participants at the conference that there are other uses for accelerators than physics at higher and higher energies. The microtron, a compact circular electron accelerator can give high-intensity (100 mA or more), stable, continuous beams at reasonably high energies (30-50 MeV) suitable for industrial and medical use.

Although development of these machines seems to have been mostly in the U.S.S.R., there are signs that they may become more popular in other parts of the world. In fact an intriguing design was presented from Stanford, combining the advantages of a superconducting linac with those of the microtron in a 'race-track' design. The aim is to produce a continuous beam of 100 μA at 200 MeV.

PHYSICS WITH ACCELERATORS

Although this was essentially a conference on accelerators and their associated equipment, rather than on the physics experiments carried out with their aid, the organizers deliberately introduced into the programme a number of papers in the second field, in order to bring together both builders and users.

Thus, there was a paper from Berkeley on the experimental-physics considerations underlying the experimental areas and other facilities proposed for the 200-GeV synchrotron in the U.S.A.. In a similar field, details were presented from CERN on the physics that could be carried out with intersecting storage rings. Of growing importance is the use of on-line computers, in which the data from the experimental apparatus is fed directly to a computer for analysis and computation and the results obtained almost immediately. A general survey of this practice was presented in one of the invited papers and another contribution gave details of the operational experience and probable development of the missing-mass spectrometer at CERN. In another CERN contribution, an attempt was made to predict some of the results to be expected from electron-positron colliding-beam experiments in the light of the results already obtained with the experiment at CERN on proton-antiproton annihilation into lepton pairs. A review paper on 'physics with photon and electron beams' was presented, in which the energy, intensity and quality requirements of the experimental physicist for accelerated electron beams were defined.

In the absence of very large accelerators, the possibility remains that cosmic rays might still be utilized to provide data in the superhigh-energy range, and a proposal for pion-proton and proton-proton scattering experiments was discussed. The cost of the installations for this kind of experiment is very high, however.

Adding to the interest of the discussion on storage-ring instabilities and the ways of overcoming them were two papers on the physics results already obtained. In one of these, the data on electron-positron interactions provided by the Frascati ring AdA, operated at Orsay, were recalled, whilst in the other the latest (preliminary) results were presented on electron-electron scattering at 300 MeV in the Princeton-Stanford rings. About 400 events had been measured, resulting from 135 hours' data collection in 300 hours of running. Within the limits of experimental error, the results did not appear inconsistent with what would be expected from the laws of quantum electrodynamics.

THE CONFERENCE IN GENERAL

The conference was opened in the presence of the Italian Minister of Industry and President of the National Nuclear Energy Committee (CNEN), Mr. Lami-Staranti. In a short speech, he referred to the honour brought to Italian science, and physics in particular, by the presence of the conference in Frascati and to the importance attached by the Italian government to fundamental research. This was followed by a formal welcome from Prof. L. Mezzetti, Director of the National Laboratory at Frascati and chairman of the conference's organizing committee. The opening address was given by Prof. V.F. Weisskopf, Director General of CERN, who spoke of the aims of the conference, stressing the importance of an intimate co-operation between those who have to face the industrial problems of building accelerators and those whose scientific requirements determine to what use the accelerators are put.

During the conference, two sessions were held each day, in the morning usually from 9 a.m. to 1 p.m. and in the afternoon from 3.30 p.m. to 7 p.m., with a 1 ½-day break at the week-end. In spite of a very crowded programme, many participants took advantage of the possibility of visiting the Frascati facilities, including the large storage ring Adone, for electrons and positrons of 1.5 GeV, now under construction. Among the social occasions, the reception by the Mayor of Frascati and that by the Mayor of Rome were particularly appreciated.

On the final morning, the conference was addressed by Mr. Arnaudi, Italian Minister for Scientific Research, who spoke of the importance of fundamental research, and especially of the necessity for international co-operation in this field. The proceedings were then summed up by Prof. E. Amaldi, President of the Italian National Institute for Nuclear Physics and also chairman of the European Committee on Future Accelerators. No startling new developments had been announced at the conference, but steady progress had been made in a number of directions, notably in the understanding of beam behaviour in accelerators and storage rings and in the applications of superconductivity to the instruments of sub-nuclear physics research ●

BOOKS

Elementary-particle physics, by Gunnar Källén (Reading, Mass., Addison-Wesley Publishing Co. Inc., 1964 ; $ 15.00), is a volume of the *Series in Advanced Physics,* which has Morton Hamermesh as Consulting Editor.

As pointed out by the author, most books of this kind are a somewhat expanded and modernized version of a course given by the writer at some university in a certain year. The present book is no exception, being based on a course on phenomenological elementary-particle physics given in the academic year 1961-1962 in the department of theoretical physics at the University of Lund, Sweden. The bibliography is updated to include part of 1963, extending in a few cases to work published in 1964. As a result, the book represents the most up-to-date text on the physics of elementary particles that can be found in a library at the present moment. This fact alone, although ephemeral, is by itself a good reason for the student to read the book or at least parts of it.

The book, as envisaged by the author, is directed towards the physics student who wants to specialize in the field of elementary particles. It should be pointed out, however, that the student in question should have a good theoretical background and a main interest in theoretical physics. In particular, he should have a thorough knowledge not only of ordinary non-relativistic quantum mechanics but also of the Dirac equation, and some knowledge of field quantization.

In conformity with this purpose, all experimental details have been left out and the emphasis directed towards theoretical methods and techniques applied to specific problems as illustrations. This, of course, is the correct theoretical approach, but it may leave the unbiased reader under the impression that the field of elementary-particle physics is, after all, only a collection of theoretical calculations, here and there approximated by some experimental result. As for the biased experimental reader, he may sometimes wonder : for example, when, concerning the experimental numbers quoted, he learns that 'some precautions have been taken that the values given are not entirely ridiculous'. Hopefully, this was not done on the basis of a comparison with the theoretical calculations !

The book is divided into three main parts : strong interactions of non-strange particles (191 pages), strong interactions of strange particles (59 pages) and weak interactions (199 pages). In addition, a large introduction (38 pages) deals extensively with subjects like notations, definitions, the list of elementary particles, relativistic kinematics and S-matrix properties. The methods by which the masses of the elementary particles have been measured are reviewed in detail.

The part on the non-strange strong interactions is mainly devoted to the properties of the pion. A good survey of its spin and parity determination is given ; the concept of isotopic spin is developed up to its applications in connexion with the formalism of second quantization. The scattering of pions by nucleons is then discussed from a phenomenological point of view (a good collection of the relevant experimental results is presented), although with a tendency to dedicate more space to such quibbles as the Yang ambiguity than to the more physical content of the scattering experiments. Directly connected with this attitude, the treament closes with a pessimistic note on the practical use of scattering techniques for the determination of the quantum numbers of the nucleon resonances. A chapter is dedicated to the formal theory of pion-nucleon scattering, dealing in particular with the static model and the forward dispersion relations. Pion photoproduction and multiple pion production in pion-nucleon collisions and $\bar{p}\,p$ annihilations are given one chapter each. The old-fashioned approach to pion resonances by means of the extrapolation method is given perhaps too much emphasis in view of the scarcity of results it has produced. Some of the resonances are discussed in detail, like ϱ, η and ω.

The second part, on the strong interactions of strange particles, gives a somewhat hurried view of the properties of these particles, of their quantum numbers and of the scattering of K-mesons on nucleons. A careful compilation of all the existing scattering data can be found in the section devoted to the phenomenology of the K-nucleon interaction. Unfortunately here again, as for the case of pion-nucleon scattering, a critical attitude pervades the treatment of the scattering experiments, all to the detriment of a reasonable understanding of these phenomena. It must be said, however, that ample space is dedicated to a very useful phenomenological approach like the Dalitz-Tuan analysis of the low energy $\bar{K}N$ problem. A number of strange resonances are discussed and some of the methods for the determination of their spin and parity are explained.

The part on the weak interactions is probably the most expanded and detailed section of the book. A general introduction on symmetry properties deals clearly and exhaustively with concepts like space and time reflections, charge conjugation, G-parity and CPT, all the time remaining very near their physical significance and without making explicit recourse to group-theoretical arguments. In a well-organized series of chapters, the behaviour under weak interactions of the nucleon, the μ, the π, the K and the hyperon is systematically examined.

At the end, three appendices (40 pages) summarize the main concepts and formulae relative to angular momentum, the Dirac equation and the second quantization. Excellent author and subject indexes close the book.

A final remark about the topics which do not appear ; the main absentee is the electromagnetic interaction, for which the author feels that exhaustive treatments already exist in several textbooks. Nucleon-nucleon scattering has been left out, considering that its pedagogical value is already exploited in the analogous problem of π and K scattering. Subjects like diffraction scattering in general and higher symmetry schemes among elementary particles have been considered too controversial at the present stage to be included.

M. Ferro-Luzzi

Also received:

Light scattering from dilute polymer solutions, edited by D. McIntyre and F. Gornick (New York, Gordon and Breach Science Publishers Inc., 1964 ; $ 5.95) — vol. 3 of *International science review series,* presenting 33 papers (including five English translations) covering the basic literature on the use of light scattering as a probe for the measurement of the molecular properties of polymeric solutes.

Reviews of plasma physics, vol. 1, edited by M.A. Leontovich (New York, Consultants Bureau Enterprises Inc., 1965 ; $ 12.50) — translation from the Russian edition of 1963 but incorporating new material ; comprehensive introduction to 'classical' plasma physics containing papers on orbit theory, collisions in fully ionized plasmas, plasma transport phenomena, and plasma thermodynamics.

The propagation of gamma quanta in matter, by O.I. Leipunskii, B.V. Novozkilov and V.N. Sakharov (Oxford, Pergamon Press Ltd., 1965 ; £ 5) — edited translation of 1960 Russian edition ; essentially describes the theory of the propagation and absorption of gamma quanta, including the effects of multiple scattering, primarily for applications in reactor technology.

Two-group reactor theory, by J.L. Meem (New York, Gordon and Breach Science Publishers Inc., 1964 ; $ 20.50) — written for the graduate student working for a higher degree in nuclear engineering ; emphasizes the engineering analysis of nuclear reactors rather than the underlying reactor physics.

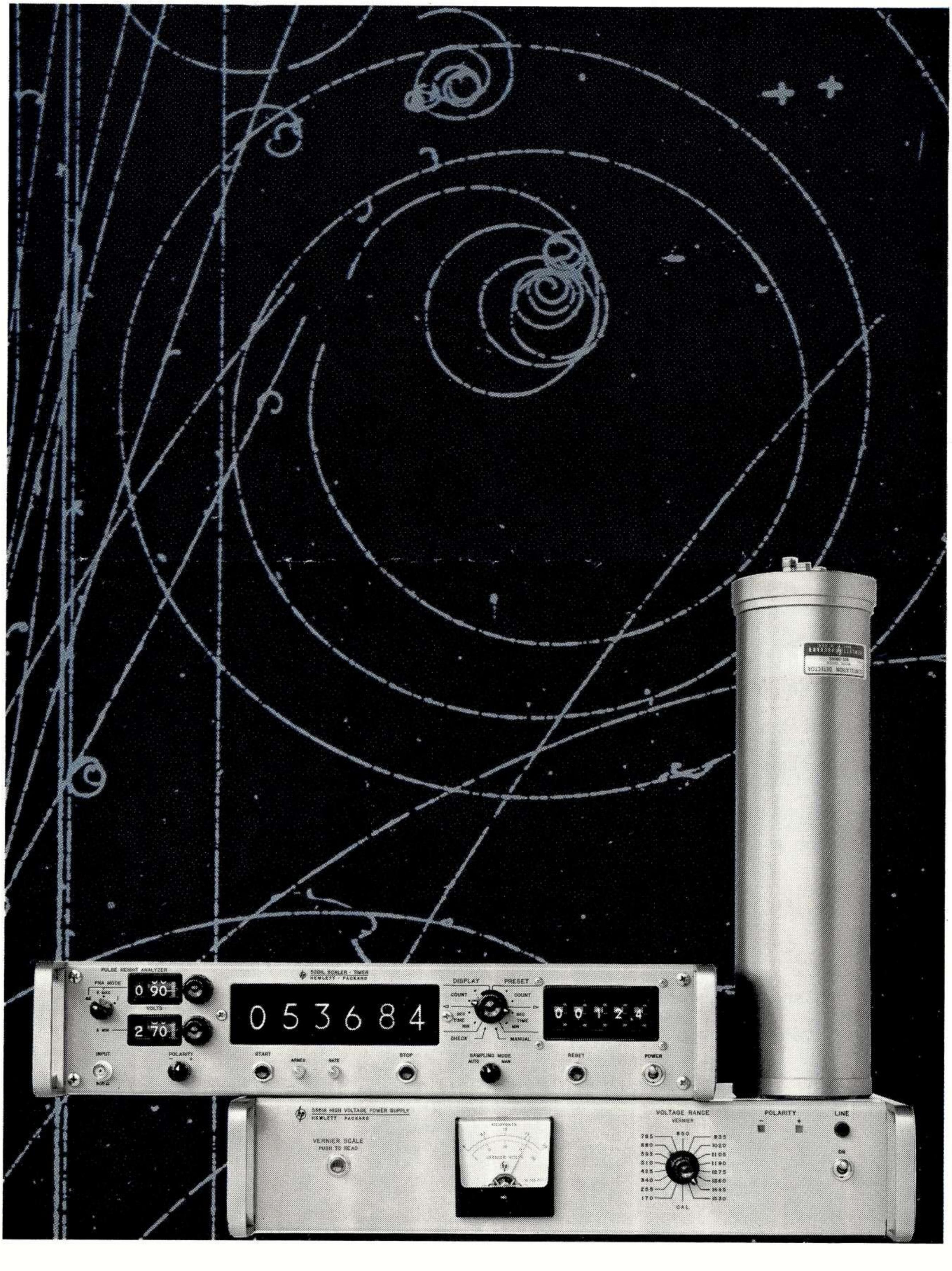
Energetics in metallurgical phenomena, vol. 1, edited by W.M. Mueller (New York, Gordon and Breach Science Publishers Inc., 1965 ; cloth $ 19.50, paper $ 9.50) — subject matter of eight one-week lecture series at the first Seminar on energetics in metallurgical phenomena, University of Denver, 1962.

L'oxydation des métaux, tome II, monographies, by J. Bénard (Paris, Gauthier-Villars, éditeur, 1964) — second volume, dealing more with practical applications of oxidation phenomena, of book reviewed in *CERN COURIER,* vol. 2, no. 11 (November 1962), p. 11.

Unit processes in hydrometallurgy, edited by M.E. Wadsworth and F.T. Davis (New York, Gordon and Breach Science Publishers Inc., 1964 ; paper $ 9.50 for each of 3 volumes, cloth $ 47.50 complete) — vol. 24 of series on *Metallurgical Society Conferences;* based on papers presented at the International symposium held at Dallas, Texas, in 1963.

Deformation twinning, edited by R.E. Reed-Hill, J.P. Hirth and H.C. Rogers (New York, Gordon and Breach Science Publishers Inc., 1964 ; cloth $ 25.00, paper $ 11.50) — vol. 25 of series on *Metallurgical Society Conferences ;* proceedings of the Conference at Gainesville, Florida, in 1963.

New Reliability in Nuclear Instrumentation

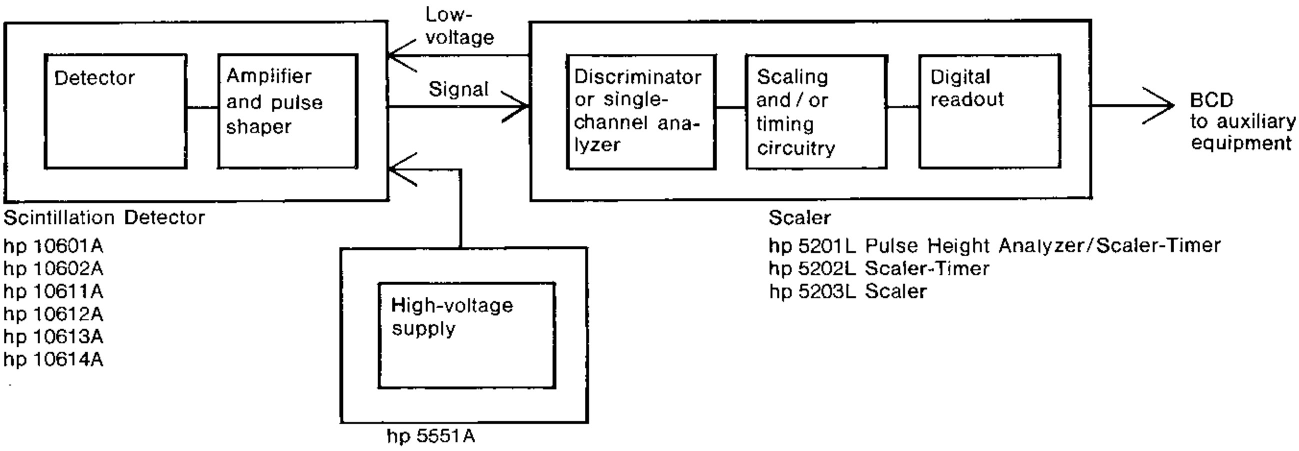


from Hewlett-Packard

Over 14 years of extensive experience in digital instrumentation, particularly electronic counters, was used in developing these first nuclear instruments from Hewlett-Packard. They are the beginning of a complete instrumentation program for detecting, counting, displaying, and recording nuclear events.

Advanced hp circuit design, components, and manufacturing technique offer you significantly increased reliability. Also, packaging concepts new to the nuclear instrumentation field give you more flexibility in combining individual units for specific applications.

Here, in block diagram form, are the new Hewlett-Packard instruments:



Notice that a complete scintillation detector is in one unit, single channel analyzer/scaler-timer function in a second, while a third provides stable driving voltages. Both the single channel analyzer and the scaler-timer are in a single hp module. The detector includes NaI (Tl) crystal and photo multiplier tube plus amplifier.

THREE SCALER-TIMERS OFFER BROAD VERSATILITY

5201L – A scaler-timer with a single channel pulse height analyzer (ideal for differential gamma ray analysis)

5202L – A scaler-timer with an integral discriminator for growth counting.

5203L – A scaler without timer. Can be manually operated, externally gated or slaved to a 5201L or 5202L

Both the 5201L and 5202L will totalize counts, count for a preset time or register time for a preset count. All three instruments have a multiple pulse resolution of 200 nsec and are available with a choice of BCD outputs (±1-2-4-8) or (+1-2-2-4).

SCINTILLATION DETECTORS

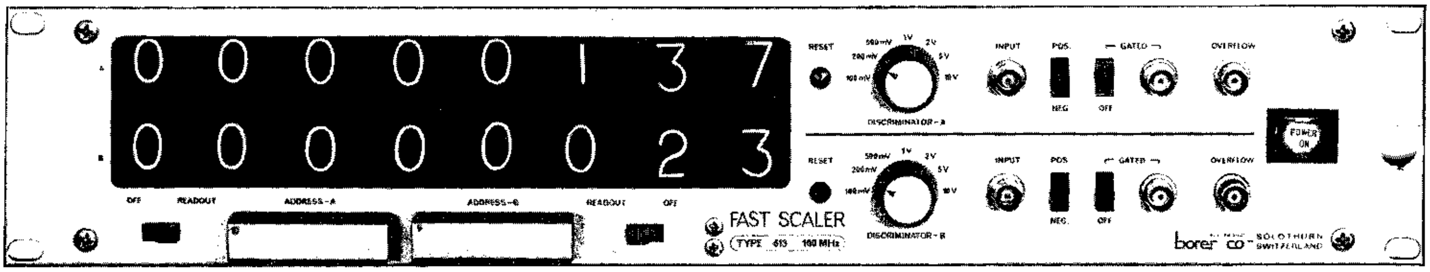
(3x3 or 2x2 inch; solid or well) are extremely stable, well shielded units which feature high resolution combined with focus control. Premium selected crystals and photo multiplier tubes are integrated in these detector assemblies. In addition, solid state amplifiers are included which have gain and pulse shaping capability to drive directly into a single channel analyzer. No additional linear amplifier is necessary.

The 5551A is a stable, highly regulated supply offering an output of 170 to 1615 volts.

For maximum reliability in value-priced nuclear instrumentation call your Hewlett-Packard Field Office.

NEW!

DOUBLE SCALER 613 with high resolution, corresponding to 100 Mc/s. 2 × 8 decades, decimal display, input for positive or negative pulses of min. 2.5 ns. Adjustable sensitivity Automatic readout. Other types for 2+20 Mc/s.



100 Mc/s

Other products :

READOUT LOGIC 630 Control unit for automatic readout up to 98, 6 or 8 decades - scalers.

DRIVE UNIT 642 Simultaneous control of recording instruments such as output writers, tape perforators etc.

PARAMETER UNIT 650 For insertion of identification and information to be read out together with the scaler contents.

OUTPUT WRITER 494 with typing head. Operates at an output speed of 14 characters/s.

HIGH SPEED TAPE PUNCH 493 for 110 characters/s, self contained power supply.

TAPE READER 494 for 10 characters/s.

borer ELECTRONIC co - **SOLOTHURN SWITZERLAND**

Heidenhubelstr. 24 Tel. 065 / 2 85 45

Great Britain: 36, East Street, Shoreham-by-Sea, Sussex, tel. 4305

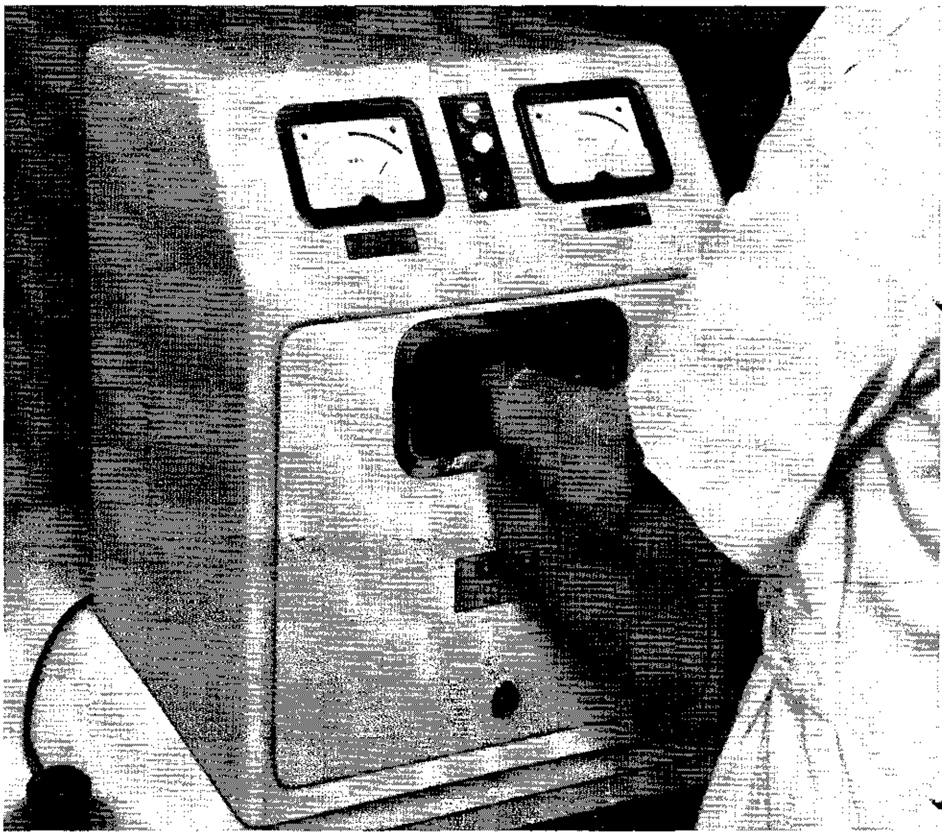
Germany : Gärtnerstr. 60, 8 München 54, tel. 54 54 97

France : Sorelia Electronique, Courbevoie/Seine, 48, bd de la Mission Marchand, tel. 333 60-15


50881765

EMI ELECTRONICS MAKES
A WORLD OF DIFFERENCE

SAFETY
IS OUR BUSINESS



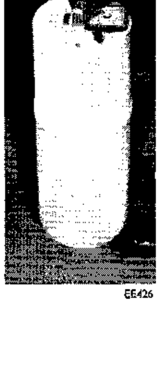
EMI NUCLEAR HEALTH EQUIPMENT MEETS EVERY NEED

In the time that it takes you to read the first few lines of this advertisement you could be completely checked by an EMI radiation monitor. This happens every day so that thousands of people working in nuclear establishments go home safe from radioactive contamination. The new generation of EMI Nuclear Health Monitors, the largest range in Europe, includes instruments to meet the needs of establishments large or small. The monitors illustrated are but two of the EMI range which includes, Hand and Clothing Monitors, Hand Monitors, Foot Monitors, Floor Monitors, Beta/Gamma and Neutron Dose Ratemeters, and Air Monitors, as well as the Wells series of modular nucleonic instruments. If nuclear safety is your business, send now for full details of the EMI range.

EMI | **EMI ELECTRONICS LTD**
NUCLEONICS DIVISION · HAYES · MIDDX · ENGLAND · TELEPHONE: HAYES 3888

Above: Single Hand Monitor Type HM2 is an economical solid state instrument ideal for universities and hospitals using radio isotopes. Has audible and visible indicating systems

Right: Neutron Monitor Type NM1. Detects thermal, intermediate and fast neutrons. Battery operated—plug in printed circuits. Employs neutron Rem counter encased in polyethylene. Logarithmic ratemeter calibrated from 0.1 mR/hr—10 R/hr



EE426