

CERN

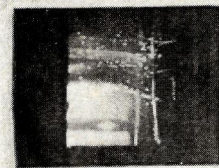
COURIER

No. 12 Vol. 8 December 1968

European Organization for Nuclear Research

1969

ÇA MARCHE !!



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

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

The Laboratory is situated at Meyrin near Geneva in Switzerland. The site covers approximately 80 hectares equally divided on either side of the frontier between France and Switzerland. The staff totals about 2600 people and, in addition, there are over 400 Fellows and Visiting Scientists.

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

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Comment

When adding up the achievements and difficulties at CERN for 1968, the balance-sheet comes out much more favourably than seemed likely at many times during the year. Despite the stresses and strains that many European countries have felt, they have still, in almost every case, expressed, in word and in deed, their confidence in CERN.

Inevitably, the 300 GeV project has been the dominant topic. It is now in the closing stages of its long count down and will take off in 1969. Many times the count seemed to have stopped, or even to be going backwards, but this is hardly surprising when thirteen nations are considering combining in the largest single scientific project in the world. With the naming at the December Council Meeting of J.B. Adams as Director General designate of the new Laboratory and the decision to select the site in June, it is obvious that the days of preparation are nearly over.

For CERN Meyrin, the agreement of budget figures for the next three years has ensured that the improvements programme and the construction of the intersecting

storage rings will be completed as planned. The first stage of the improvements programme on the proton synchrotron was successfully concluded during the year.

Scientific results from Europe were prominent at the Vienna Conference last September. Europe here means CERN, the very large number of Universities and research centres who use the research facilities at CERN, and the national Laboratories — all are interlocked in the development of high energy physics in Europe from strength to strength.

Since the November issue was devoted exclusively to the ISR, this issue contains news gathered during the last two months.

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Cover photograph : A scene of celebration at the annual party of the Nuclear Physics Apparatus Division. The champagne was drunk to celebrate the first ever operation of an ultrasonic bubble chamber. 'Ça marche' ('It works') is written over a picture of charged particle tracks taken in the chamber (see page 316). 'Ça marche' has also a more colloquial meaning, something like 'Things are going well', which lines up nicely for CERN in general, next to the date 1969. (CERN/PI 01.11.68)

40th Session of CERN Council

The Council met on 18-19 December under the chairmanship of Dr. G. W. Funke.

Progress Report

The Director General, Professor B.P. Gregory, introduced the Progress Reports of the Departments and singled out for special mention seven developments in the field of 'instrumentation'. He emphasized that some of examples illustrate that, despite the fact that CERN is a large and highly organized Laboratory, it is still possible for the work of individuals, pursuing individual ideas, to flourish.

1. Streamer chamber

One of the latest products of the evolution of the spark chamber as a particle detector is the 'streamer chamber'. It came initially from the work of the late G.E. Chikovani in the USSR and has been taken up at several Laboratories (for example, Stanford, DESY and Daresbury). The principle of operation was described in CERN COURIER vol. 7, page 219.

The first CERN streamer chamber came into use recently in a search for quarks at the 28 GeV proton synchrotron. Taking advantage of the fact that the tracks, or streamers, which are produced depend upon the ionization caused by the charged particles it was a sensitive device to look for particles carrying a fraction of the electron charge. Quarks are postulated to have charge $1/3 e$ or $2/3 e$ and, for example, a $1/3 e$ particle would produce $1/9$ of the ionization of a conventional particle and thus be clearly distinguishable in the streamer chamber photographs. The CERN experiment using the streamer chamber indicates that if quarks exist their production cross-section at available energies is very low.

2. Proportional chamber

Another spark chamber off-spring is the multiwire proportional chamber (reported in CERN COURIER vol. 8, page 220). In this type of chamber, each wire acts as an independent proportional counter giving out a pulse proportional to the energy lost in the sensitive volume surrounding it. The chamber acts as a virtually continuously sensitive detector which does not need to be triggered and can perform the same duties as a counter hodoscope with the advantage that it is a hundred times cheaper.

A prototype chamber has already performed very well in a secondary particle beam where it gave very clean and instantaneous information on the beam profile. Other properties of this type of chamber are still being perfected but several experiments will probably already use such a chamber in the coming year.

3. DISC counter

The Differential Isochronous Self Collimating counter is a special type of Cherenkov counter developed at CERN several years ago. Its important property is that it can distinguish between particles which have velocities very close to one another.

Such a counter was used early in 1968 in a CERN experiment on high energy particle production by 19 GeV/c protons. It was then transported to the Serpukhov Laboratory in the Soviet Union to be used in a similar experiment at the higher energies available from the Soviet machine — the production of particles by 70 GeV/c protons. The counter proved very efficient at higher energy and distinguished very clearly between negative pions, negative kaons and anti-protons. The results of this first CERN/Serpukhov experiment are to be published shortly.

4. Polarized targets

Promising results from a new type of polarized target (using the dynamic orientation of nuclear spins by cooling of the interaction between electron spins) have been achieved by a CERN group. In polarized targets, the spins of protons are lined up in a particular direction, thus simplifying the interpretation of some particle collisions.

Using organic compounds such as butyl alcohol, which contains five times the number of hydrogen atoms (and hence five times the number of protons available to be polarized) compared with the 'conventional' LMN targets (see CERN COURIER vol. 7, page 28), polarizations of the order of 40% have been achieved. This is low compared with the LMN figure of 70% but still means that the density of polarized protons in the new type is twice as high. One side effect of this work is that use of polarized targets at electron machines is becoming feasible.

5. Bubble chamber studies

To finalize many aspects of the large European hydrogen bubble chamber project, a 1 m model has been built (see CERN COURIER vol. 7, page 143, vol. 8, page 129). Incorporating many of the new features of the large project — such as the expansion system operating from below — it is designed to test thermodynamic and optical properties.

The preliminary work has shown that the expansion system operates as expected and that the turbulence in the hydrogen is low.

6. Ultrasonic bubble chamber

(This very recent achievement is reported fully on page 316).

7. Computer system

Two projects involving the use of a CDC 3100 computer have been implemented during 1968. The first is known as FOCUS and its main purpose is the management of data-links to the central computers (see CERN COURIER vol. 7, page 250). It is being used for 'remote access' to computing. This means that some users can have computing on tap in their offices, where a typewriter console enables them to call for computing, feed in new instructions or receive results.

The second project involves the use of a display console at the computer (see CERN COURIER vol. 8, page 101). It can be used to 'rescue' events recorded on track chamber photographs which the normal computer program has rejected. It can also be used to produce an immediate visual display of mathematical functions fed to it from an adjoining keyboard and to watch the variation of these functions as the parameters are changed.

Professor L. Van Hove presented a brief review of some of the major advances in particle physics which have usually been the product of several years of experimental work and theoretical interpretation.

Electromagnetic interaction

A major contribution from CERN to the understanding of the electromagnetic interaction has been the very precise measurement of the magnetic moment of the muon in the g-2 experiment (see CERN COURIER

vol. 6, page 152, vol. 8, page 244). The result reported at the Vienna Conference in September was more than a factor of ten more precise than the previous measurement (1962) and it shows that quantum electrodynamics — the theory of the electromagnetic interaction — continues to hold good down to distances of $1/25$ the size of the proton.

The importance of accurate measurements in this field is that the theory is highly developed and yields a very precise figure for direct confrontation with experiment. So far the experimental results have not been in conflict with the theory.

A new experiment to push the accuracy of the measurement of the magnetic moment of the muon a factor of ten further still is now under study at CERN. This should reach the borderline where the existence of strongly interacting particles in Nature begins to interfere indirectly with electromagnetism, so that it is no longer possible to consider a purely electromagnetic interaction even for a particle like the muon which is not directly subject to strong interactions.

Strong interaction

The way in which the strongly interacting particles, the hadrons, couple with photons has been greatly clarified in the past year. The most fundamental form of the coupling is via the vector mesons, such as the rho, omega and phi mesons. Experiments at Orsay, DESY and CERN have yielded results which all lie very nicely in the region predicted by various theoretical methods.

The beautiful symmetry properties of the hadrons, which have been known for several years, and which led to the quark model hypothesis, have been investigated further bringing in additional properties concerning mass and spin. At the Vienna Conference, B. French from CERN presented in his report the updated version of graphs relating the square of the mass to the spin of particles, in which known particles fall remarkably cleanly on straight lines. (In connection with this topic, many of the nucleon resonances used in drawing up such graphs were identified in the theoretical work of the phase shift analysis group at CERN, while several mesons were experimentally found by the missing

mass technique to which CERN contributed a great deal.) From this representation it seems that the list of particles can extend to surprisingly high mass and spin. In the field of mesons, one can learn a lot from other experimental results. A striking one is the split of the A_2 meson discovered at CERN by the missing mass technique, and another is the impressive decay chain of heavier into lighter mesons discovered in the 81 cm bubble chamber at CERN.

All this in turn has had important and highly fruitful implications in recent progress towards a theory of strong interactions.

It has become clearer how the strong interaction differs in mechanism from the electromagnetic interaction, where the force between two electrically charged particles is conveyed by the exchange of a photon, itself uncharged. The hadrons also interact by means of an exchange mechanism but here the hadrons themselves are exchanged and all take part on essentially equal footing in the exchange mechanism. Furthermore, the fact that hadrons occur with many different spin values plays an essential part in the mathematical formulation (Regge theory).

One happy revelation is that many aspects of particle interactions become simpler at higher energies. It is now possible to use information obtained at high energy to gain insight into lower energy phenomena, which are often more involved. Also more theoretical information can now be extracted from high energy collisions producing many particles, so that a much larger fraction of the recorded collisions can be put to good use. By 'mapping' the hadrons according to spin and square of mass, theorists have entered into a new, very active phase of progress in understanding strong interactions, and quite a few of these exciting developments took place in the CERN Theory Division.

Weak interaction

The observation of the breakdown of parity symmetry in the 1950s opened the door to a great deal of new knowledge on all forms of weak interaction. In 1964, the observation of the breakdown of charge parity symmetry was expected to be similarly fruitful, but up to now it has been more a source of frustration.

There is still only one particle, the long-lived neutral kaon, observed to exhibit this breakdown. A considerable part of the CERN experimental programme has been given to its investigation (including the first observation of its decay into two neutral pions) but, overall, the problem remains very hard. Experimental numbers often disagree with each other, and theoretical ideas, although numerous, have not helped to advance the field.

On the other hand, another CERN contribution to weak interaction theory has recently proved remarkably accurate in a wide variety of experimental tests. It concerns those decays of the strange particles which produce leptons (muons, electrons, neutrinos). A single parameter introduced more than thirty years ago by E. Fermi, has been adequate to describe the decays of the non-strange particles. In 1963, N. Cabibbo, then a fellow at CERN, made use of a single further parameter, now known as the Cabibbo angle, in an attempt to describe strange particle decays. It now appears that this works beautifully.

300 GeV

With the receipt of the letter of intent from Switzerland (see page 320), six countries — Austria, Belgium, Federal Republic of Germany, France, Italy and Switzerland — have now agreed to participate in the 300 GeV accelerator project.

The Council, following a unanimous recommendation from the Scientific Policy Committee, agreed that Dr. J.B. Adams be offered the position of Project Director. J. B. Adams led the team that built the CERN 28 GeV proton synchrotron and was, for a short time Director General of the Meyrin Laboratory. (A full biography appears on page 310.)

The appointment is initially for one year with the title 'Project Director', but it is the intention that he be nominated Director General of the new Laboratory when this comes formally into being. In the meantime, he will be on the CERN Meyrin staff as a senior scientist.

With this very important step behind them, the Council decided that the remaining decisions on the project should be taken as fast as possible. One of the main

decisions is the selection of the site for the Laboratory. Among other things, knowledge of where the accelerator is to be sited is an important aspect of its final design.

Further information on the proposed sites was presented to the Council by the consultant geologist Dr. L. Bjerrum. It has emerged quite recently that some further geotechnical studies are needed on a few sites. In addition, information on the conditions under which the Laboratory would be accepted into a country have not been received from all Member States proposing a site. Though it could prove difficult to push the geotechnical work to a conclusion quickly, the Council decided that all necessary site information should be presented in time for a final decision on the site to be taken at the June Council Meeting.

Among the six countries who have so far declared their intention to participate in the project, there are five sites offered:

Doberdo	Italy
Drensteinfurt	Federal Republic of Germany
Focant	Belgium
Gopfritz	Austria
Le Luc	France

Another important step which must precede the coming into being of the 300 GeV Laboratory is the ratification of the amendments to the CERN Convention. These amendments make it possible to set up a new Laboratory within the existing CERN Organization and were agreed by the Council a year ago. They are now with European governments for approval and several delegations were able to indicate that their countries will give approval before the June meeting.

During 1969, the budget to continue work on the 300 GeV is divided into two parts — 3.9 million Swiss francs to conclude the present preparatory work (site investigations, etc...) and a provisional indication of 4.3 million to enable the final design of the machine to start. The latter sum will be voted later in the year and may be influenced by the major decisions which are to be taken on the project. Ten Member States agreed to support the 300 GeV studies in 1969 — Austria, Belgium,

Denmark, Federal Republic of Germany, France, Italy, Netherlands, Norway, Sweden and Switzerland.

Budgets

The budget for the basic programme of CERN in 1969 was agreed as 224.6 million Swiss francs. A firm estimate for 1970, 235.9 MSF, and a provisional determination for 1971, 247.3 MSF, were also agreed (all figures at 1969 prices). A provisional determination for 1972, which would normally be made at this time, has not been voted because a major review of the future programme at CERN Meyrin, in the light of the imminent start of the 300 GeV project, is under way. This review will affect the 1972 figure which is the beginning of the period following completion of the proton synchrotron improvement programme and of the intersecting storage rings.

The budgets for the ISR construction over the next three years were agreed as follows — 1969: 88.5 MSF, 1970: 79.4 MSF (firm estimate), 1971: 30.4 MSF (provisional determination).

All these budgets were agreed with a reservation on the personnel figures which were used in drawing them up. The personnel figures are to be discussed at a special meeting early in 1969 and the Director General assured Council that, in the interim, nothing would be done in terms of recruitment of staff, which would prejudice the outcome of the discussion.

The percentage contributions of the Member States to the CERN budgets for the next three years have been revised, in accordance with the Convention. The new figures are based on United Nations statistics of average net national income over the years 1965, 6, 7.

In addition to this revision, no contribution has been entered for Spain. As reported on page 320, a letter announcing the intended withdrawal of Spain from the Organization as from the end of 1968, had been received. The Council was very pleased to learn from the Spanish delegation that this decision is being reconsidered. The Spanish government has already declared that it will continue to support the national high-energy physics

groups, which have developed so well at several Spanish Universities and research centres. The matter will be taken up again at the March Council session.

The percentage contributions are therefore (with the corresponding figures for 1966, 7, 8 in brackets):

Austria	1.96 (1.90)
Belgium	3.77 (3.56)
Denmark	2.26 (2.05)
Federal Republic of Germany	23.27 (23.30)
France	19.90 (19.34)
Greece	0.60 (0.60)
Italy	12.89 (11.24)
Netherlands	4.43 (3.88)
Norway	1.52 (1.41)
Spain	— (3.43)
Sweden	4.59 (4.02)
Switzerland	3.20 (3.11)
United Kingdom	21.61 (22.16)

Appointments

The Council made several appointments for the coming year. Dr. G.W. Funke was re-elected President of the Council and Mr. J. Martin and Mr. A. Chavanne were elected Vice-Presidents. Dr. W. Kummer was re-elected Chairman of the Finance Committee. Dr. E. G. Michaelis was appointed Leader of the Synchro-cyclotron Division for a further two years.

At the end of the session, the Director General expressed his satisfaction and gratitude to Council for the progress which had been made during the year both on the future 300 GeV project and on CERN Meyrin.

John Adams

Project Director

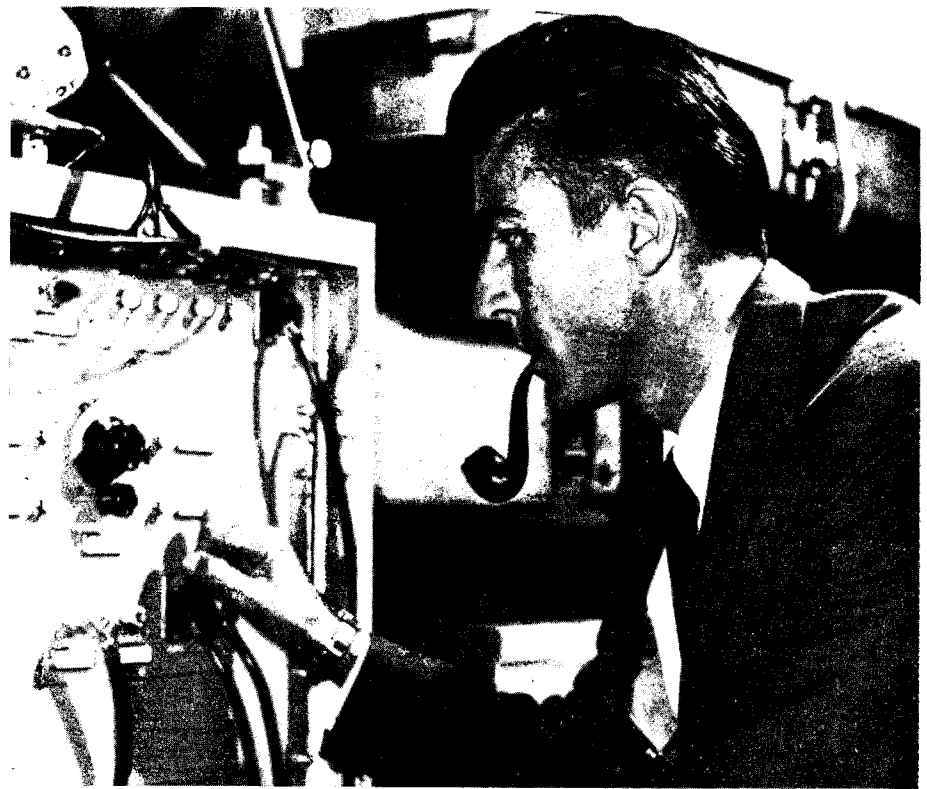
On 18 December, the agreed Council to offer John Bertram Adams the position of 300 GeV Project Director. The choice came as no surprise; J.B. Adams is one of the hero-figures in CERN's brief history - the man who brilliantly led the team which built the 28 GeV proton synchrotron. He then demonstrated both his great technical ability and qualities as a leader.

John Adams was born on 24 May 1920 in Kingston, Surrey, UK. He was educated at Eltham College but had to leave full-time education for financial reasons in 1937. It is therefore mandatory in telling his life-story to point out that, through to 1960 when honorary degrees began to shower on him, he had no qualifications in science. His career might therefore be sub-titled 'How to succeed in physics without officially knowing any'. He himself maintains that, if the essence of university training is to learn from capable men, then he gained this advantage in the places in which he worked in his early years. He was able to rub minds with some eminent scientists who recognized his inherent ability and gave him every encouragement.

From school, he went to work at Siemens Research Laboratory in Woolwich under J.R. Hughes who also taught him in his evening studies. The research was concerned with physical and physiological tests to improve the quality of telephone transmission. In 1940, he was accepted as a graduate member of the Institute of Electrical Engineers.

The same year he moved to the Telecommunications Research Establishment, initially at Swanage moving on to Malvern, which was the centre of so much brilliant work on radar and which produced many scientists subsequently to make their name as accelerator physicists. He worked under P.I. Dee, A.T. Starr and H.W.B. Skinner.

When Skinner moved to the newly established Atomic Energy Research Establishment at Harwell in 1946, he asked Adams to join him in the construction of the 180 MeV synchro-cyclotron — the first high energy proton accelerator to be built after the war. By the time the machine came into operation in 1949, the late Sir John Cockcroft, then Director of Harwell, was well aware of Adams' talent. In 1950, he



concentrated on the development of klystrons working with M.G.N. Hine, and, by 1952, they had produced 20 MW S-band klystrons for use in linear accelerators.

In 1953, Adams, Hine and F. Goward from Harwell (Goward died soon afterwards) became embroiled in the vision of the European Laboratory for particle research. The initial proposal was to build the Laboratory around a 10 GeV proton synchrotron but the idea of a strong focusing machine had just emerged from the USA, holding out the promise of much higher energy for the same money. Adams and Hine (then known as 'the Harwell twins') were prominent in the frantic effort to demonstrate the feasibility of this idea for the European machine, which finally resulted in the proposal for a 25 GeV strong focusing proton synchrotron.

John Adams, then aged 34, was given the responsibility for building this machine and became Head of the Proton Synchrotron Division at CERN.

The story of the intense, exciting years of construction has been told before and will not be repeated here, other than to recall that the synchrotron came triumphantly into operation in November 1959.

To call Adams 'the man who built the PS' is obviously a simplification. The achievement was based on the ingenuity and skill of a large number of people including many first-class machine scientists and engineers. But it was Adams who pulled their efforts together and sustained their enthusiasm. He gained the affection and respect of the whole staff, from the mechanics in the workshop to the beam-dynamics specialists. With his varied background he had insight into what all of them were doing.

He had worked at CERN on loan from the UK Atomic Energy Authority and, when the construction of the PS was complete, he was called back to direct the Culham Laboratory which was to be built up as the main UK research centre on the problems of controlled thermo-nuclear fusion. But before he could move to his new Laboratory, C.J. Bakker, then Director General of CERN, was killed in an air accident and Adams was asked to stay on as Director General for a short time. For a while, he acted in a dual capacity until 1961, when he returned to England to take up his new appointment.

Whilst continuing as Director of the Culham Laboratory, he also walked the corridors of power where science policy was formed in the UK. In 1965, he was appointed 'Controller' in the Ministry of Technology which earned him the nickname of 'Lord High Research' in the press. In this position he had influence over a wide range of research effort in industrial and government research centres.

In October 1966, he was appointed a full-time Member of the UK Atomic Energy Authority as Member for Research. He served on the Advisory Council on Technology and acted as special adviser to the Minister on the deployment of research and development resources.

The news of the election of John Adams as 300 GeV Project Director has been greeted with a wave of enthusiasm throughout CERN. To a great number of people he is inextricably linked with the memories of the adventure of constructing the PS and of those exciting days when CERN first began to take shape. The 300 GeV Laboratory is a sterner proposition worthy of his talents.

News from abroad

H.A. Bethe (left) who was awarded the 1967 Nobel Prize for physics, mainly for his work on the energy processes in stars, tours the magnet ring of the 10 GeV electron synchrotron at Cornell accompanied by the Director of the Laboratory, B.P. McDaniel.

(Wide World Photo)

Cornell

Last year, the highest energy electron synchrotron in the world was brought into operation at Cornell University, USA. The project had been instigated and led by Professor R.R. Wilson prior to his moving to Batavia to direct the 200 GeV project. In tribute to his leadership, the Laboratory housing the synchrotron has been named the Wilson Synchrotron Laboratory and a Dedication Ceremony was held on 10 October.

Advantage was taken of the coming together of electron scientists from many centres to hold a short conference on the day of the dedication, at which reports on electron research were heard from Cambridge, Cornell, Daresbury, DESY, Frascati and Stanford.

At Cornell, the machine is performing well. The maximum operating energy is 10 GeV with beam currents of 3×10^{10} electrons per pulse, 60 pulses per second. The total number of people employed to operate and maintain the facility has grown to 25 with a further 20 providing various service facilities. Sixteen eight-hour shifts for experiments are run per week and an average of 85% useful running time is achieved from the scheduled hours. An external electron beam is planned for the summer of 1969.

The experimental programme began immediately electrons could be squeezed from the machine, before the machine buildings were complete, and results have already been reported. By now the programme is well under way and four other centres are collaborating with Cornell in experiments. This outside involvement is strongly encouraged and is expected to grow as use of the machine develops. The experimental programme has drawn heavily on the experience of electron Laboratories such as Cambridge and DESY, and many of the experiments are extending their work into a higher energy range. The programme is also largely complementary to that of Stanford, tackling particularly those experiments which benefit from the longer duty cycle of a synchrotron.

Experiments on the floor at present include three to test the limits of quantum electrodynamics. Two of them — wide angle bremsstrahlung, and muon pair pro-

duction — are taking data; the third — wide angle pair production — is being prepared. Measurements of rho photoproduction — are taking data; the third — energy range 4-9 GeV and this experiment is being continued to study phi production and leptonic decays. Eventually these measurements will be extended using polarized photon beams. Another experiment is looking at omega photoproduction. Finally, there is an experiment looking at pions and kaons produced near 180° over the energy range 3-10 GeV.

Stanford

Operation of the 20 GeV electron linear accelerator at Stanford USA is going very well. In a test run, the peak energy was pushed to 21 GeV and 20 GeV is the usual operating energy. The intensity is now 45 mA, which is with 90% of the design figure (compared with 15% when operation began over two years ago). This means that about 10^{12} electrons are accelerated per pulse at a repetition rate of 360 pulses per second.



Five pictures per accelerator pulse taken on the Argonne 30 inch hydrogen bubble chamber.

1. Scope traces of the ZGS field, slow Q, and beam spills.
2. Scope trace of the bubble chamber pressure drops.
3. The five pictures.

(Photo ANL)

There have been major advances in the experimental facilities during the year. A 'high-Z' spark chamber has been added to the streamer chamber set-up (see CERN COURIER vol. 7 page 219). The high-Z chamber makes it possible to detect neutral particles and thus compliments the streamer chamber making the whole complex a universal particle detector.

Two hydrogen chambers are now in operation. A 42 inch chamber has taken over 2 million photographs. An 82 inch chamber (currently the largest in the world), which came into operation in March of this year, has taken over 700 000 photographs. This chamber is, in fact, the famous Berkeley 72 inch chamber enlarged (see the story on L. Alvarez, page 315).

An important beam feeding this chamber is a high energy polarized photon beam which has been quickly brought in to use at Stanford by J. Murray, P. Klein and C. Sinclair following the announcement of a new technique for producing polarized gamma rays. The technique was developed simultaneously at Tufts University, USA, by R. Milburn and at Lebedev Institute, USSR, by M.N. Yakimenko. It involves the Compton scattering of the photons of a laser beam on relativistic electrons. The photons effectively bounce off the electrons picking up very high energy but retaining the polarization properties of the incident laser light. Polarized gamma rays of GeV energies are thus made available. The technique has been taken up at Cambridge Electron Accelerator and at Stanford and is under consideration for Adone at Frascati.

So far, eleven experiments have been completed at the 20 GeV machine and

many results were reported at the recent Vienna Conference. The current research includes 17 experiments and the programme has involved more than 100 scientists from 15 American Universities.

Argonne Multiple Pulsing

On 18 November, the 30 inch hydrogen bubble chamber at Argonne was successfully 'quintuple pulsed' in an engineering run. In this mode of operation the chamber is expanded and photographed five times during each pulse of the Zero Gradient Synchrotron (ZGS).

In an earlier test in October, the chamber expansion system was successfully tested in this mode. In the new test, the accelerator targetting system, beam-line logic, magnetic shutter and computer monitoring, as well as the bubble chamber systems, were all tested together in the five pulse mode. The interval between pictures was 160 ms and the time between ZGS pulses was 3.8 s. With some modifications to the beam shutter and camera data box, physics runs in the five pulse mode are expected to start early in 1969.

The 30 inch chamber has been the work-horse bubble chamber at the ZGS, having taken over eight million pictures so far. It is cylindrical in shape with a volume of 200 litres, has three vertical pistons, and operates in a highly uniform magnetic field of 32 kG. It was constructed at MURA and came into service in an electrostatically separated beam at the ZGS in 1964. Picture output has increased from 0.4 million in 1965, to 1.9 million in 1966, 2.4 million in 1967, and 3.5 million during the past year. In the last period a total of 18 experiments were completed, with hydrogen or

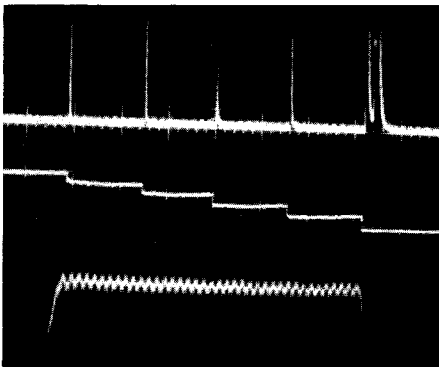
deuterium, with 70 mm or 35 mm film format, and with or without tantalum converter plates in the chamber. Double pulsing, with beam spills at the beginning and end of the ZGS 600 ms flat-top, was introduced in 1966. Triple pulsing, with an additional spill in the middle of the flat-top, was introduced last year. Up to 67 400 pictures per day have been recorded in this mode.

It has proved possible to maintain essentially the same chamber operating conditions, from single up to quintuple pulsing, with fully automatic temperature and pressure stabilization of the chamber. Set points used for hydrogen are 26.5°K, or vapour pressure of 64 psi, with the static pressure 20 psi above and expanded pressure 20 psi below the vapour pressure. Further tests are planned for higher multiple pulsing rates and optimized operating conditions.

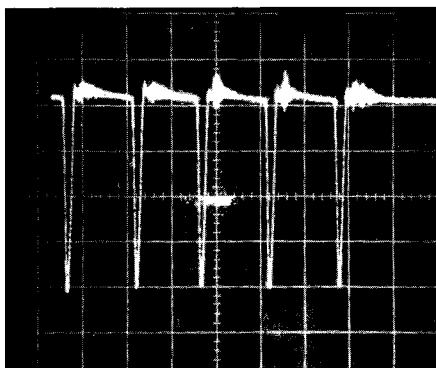
Batavia

On 1 December, a 'ground-breaking' ceremony took place at the National Accelerator Laboratory where the USA 200/400 GeV accelerator is being constructed. Over 1000 people came together, despite the snow, to attend the ceremony which took place at the intersection of the linac and the booster ring.

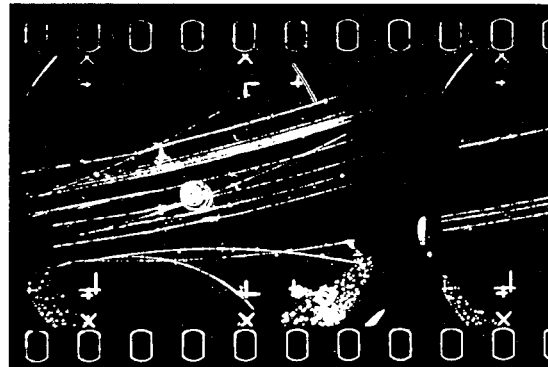
Construction of prototype underground enclosures for the Booster Ring and for the Main Ring are under way. The Main Ring prototype is 200 foot long, half the length being of steel and half of concrete to compare the two types. The detailed design of the Booster building has been completed. The building is scheduled to be ready by May 1970 to enable the



1.



2.



3.

Booster to produce 10 GeV beams by July 1971.

Storage Rings

We now have more information on the storage rings studied at Batavia which were briefly mentioned in the last issue (p. 291).

An intensive effort to design a proton-proton colliding beam facility for the 200/400 GeV accelerator began in July. In addition to the NAL staff, many accelerator physicists and high energy physicists from various universities and laboratories in the USA and a few people from CERN (G. Cocconi, E. Keil, B. Montague, W. Schnell) participated.

The bypass — storage ring concept, which had been developed during the summer of 1967, was abandoned early in the study, chiefly because the accelerator would be inoperable for normal experiments during the time that colliding beams were in use. A design involving two concentric rings with six beam intersections was adopted.

A maximum energy of 100 GeV at a maximum magnetic field of 20 kG was chosen; this field is attainable with an iron magnet, and the energy is sufficiently higher than that of the CERN ISR to make the NAL facility uniquely interesting. This choice also leaves open the possibility of using high-field (40-80 kG) superconducting magnets to store beams of higher energy (200-400 GeV) with the same ring geometry. Since the construction of the storage rings is unlikely to begin for many years and since superconducting technology is progressing rather rapidly, this may well be technologically and economically feasible at the time of construction.

Some of the other main features of the design are as follows: the average ring radius is fixed as 1/3 km. A separated function FODO lattice is used for economy. Momentum and β matching magnets are inserted in all six beam crossing regions to produce the desired beam properties at the intersection. Two of the six crossing regions, where the beams are travelling outwards, are used for injection (one for each ring). In the same regions two beam dump systems using fast kicker magnets are to be installed to dump the beams whether on command or by interlock, in case of component failure. The remaining four beam crossing regions are to be used for experimentation.

It is expected that a minimum of 20 pulses from the accelerator, at 5×10^{13} protons/pulse, could be stored in each ring to give a stored beam of 10^{15} protons (equivalent to a current of 23 A). This gives a luminosity of about $2 \times 10^{32}/\text{cm}^2\text{s}$. With an average pressure of 10^{-9} torr in the rings, the stacked beam lifetime is between 12 and 120 hours depending on the mode of operation required by the specific experiments in progress.

For the 20 kG iron core magnet either conventional copper coils or superconducting Nb-Ti coils may be used. The preliminary cost estimate for the rings, not including equipment for experiments, gives about \$ 80 million using magnets with copper coils and about \$ 70 million using magnets with superconducting coils.

Synchro-cyclotron conversion

The eighteen-year old, 380 MeV synchro-cyclotron at the Nevis Laboratories of the

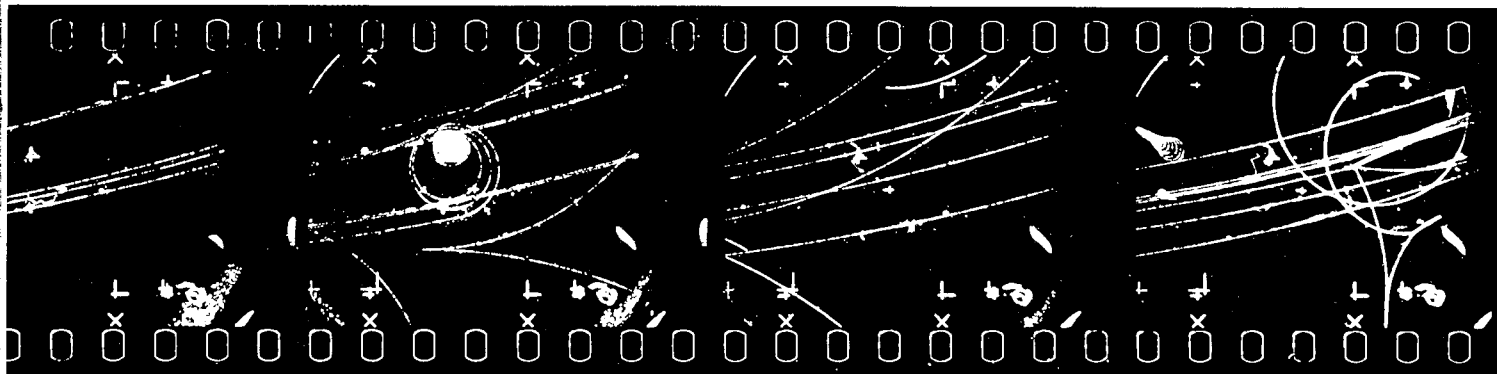
University of Columbia, USA, is to be upgraded with the help of a \$4.4 million grant of the National Science Foundation.

The energy of the machine will be increased to 500-600 MeV and, by adding a spiral ridge configuration to the magnet and increasing the repetition rate from 70 to 300 Hz with a new r.f. system, the average beam current will go from 1 μA to 10-50 μA . Other improvements will include a new vacuum chamber, more shielding to cope with the increased intensity, a new extraction and beam transport system, and an enlarged experimental area.

It is hoped that the new components will be ready for testing at the end of 1969. They could then be installed in 1970 and the experimental programme restarted at the end of 1970 or the beginning of 1971.

Physicists from the TRIUMF cyclotron project in Canada (see CERN COURIER vol. 8, page 136) have carried out tests on negative hydrogen ion stripping in high magnetic fields using the 50 MeV proton linear accelerator (PLA) at the Rutherford Laboratory. Negative hydrogen ions were accelerated to the full PLA energy and were stripped in a field of 23 kG. The purpose was to check the hydrogen ion lifetime at the electric field strengths they will experience in TRIUMF; the lifetime was well known only for higher electric fields.

The tests indicated that the ions have a lifetime about three times shorter than estimated. The original design of the cyclotron had allowed for such a contingency and only minor adjustments are required to maintain the original beam specifications of 100 μA of 500 MeV protons.



International collaboration in electronics

Representatives of almost all large European Laboratories and Universities met in May of this year to complete a series of discussions on a modular electronics system, which is now known as CAMAC. The first official announcement of the agreement reached in May was made in 'Nuclear Instruments and Methods' on 15 September. The agreement represents an important advance in standardization throughout Europe.

Many research centres have felt, for some time, the need for a modular mechanical system to be used with compact integrated circuitry. When small, cheap computers came onto the market this need increased, perhaps especially in sub-nuclear physics research. Up to now, various local solutions have been evolved — virtually one for each research centre! This imposed restrictions on the interchangeability of equipment and meant that the manufacturers of electronic equipment had no guarantee of a large market when building units of a particular system.

NIM standard at CERN

From information supplied by I. Pizer

CERN first broached this problem by adopting the NIM standard, which was originally specified by the Atomic Energy Commission in the USA to achieve standardization in government centres throughout the United States. This was taken over by CERN with a minor modification in that LEMO coaxial connectors are used instead of BNC (BNC-LEMO adaptors are available).

A new series of instruments in this NIM standard has been designed in the Nuclear Physics Division for use in counter experiments. At the present time, the designs of six instruments are completed and have been passed to European electronics firms for manufacture. They are — Shaping amplifier; Linear gate; 5-fold coincidence; Fixed level discriminator; Logical OR; Delay. Other instruments are in the design stage including — 5-fold strobed coincidence; Attenuator; Triple dual-coincidence; Fan-out; etc...

The use of the small LEMO connector makes it possible to build most of these instruments in the narrow (34 mm) module leading to very compact instrumentation even for large experiments. Some five hundred of the units have been successfully used in experiments at CERN. The use of NIM modules and the NIM system will continue at CERN for some time to come, until the need for computer control of these fast-logic instruments becomes paramount.

CAMAC: new European data-handling standard

From information supplied by F. Iselin

The CAMAC system (originally known as IANUS) is a new system well adapted to the data handling field. It has evolved from discussions involving all members of the ESONE committee (European Standard for Nuclear Electronics) including CERN, triggered by the AERE (UK) delegation to the committee in autumn 1966. Working groups, on logic and mechanical aspects, were set up and a series of meetings then took place in Munich, Geneva, Grenoble, Harwell, Karlsruhe, Saclay and Berlin, and at each one the evolution of the system came nearer to the final solution.

By the beginning of 1968, the system had evolved to a stage where it seemed to suit everyone's major requirements. Final agreement came at the May meeting in Rome where there were representatives of Universities and research centres (national and international) from Austria, Belgium, Federal Republic of Germany, France, Italy, Netherlands, Switzerland, United Kingdom and Yugoslavia.

During the evolution of the system, contact was made with the USAEC-NIM committee who were kept aware of the developments. Two joint meetings took place where the ESONE proposals were discussed. Obviously, compatibility between the two systems was a major item. The interest of the NIM delegates in the new European system suggests that it may find its way into the data handling field in the USA also.

It was decided at the May meeting of ESONE to set up an executive group to sustain the contacts with the NIM committee and to tackle any problems which might arise subsequent to the agreement on the system. The members are: H. Bisby (UK) — Chairman, M. Sarquiz (France), H. Klessman (Germany), B. Rispoli (Italy), F. Iselin (CERN) and W. Becker (Euratom) — Secretary of ESONE.

Technical features

Mechanical —

Plug-in modules are inserted in a standard crate 5 units high (221.5 mm) and 475 mm

wide. The rear of the crate is equipped with 25 printed circuit double sided connectors (2×43 contact pins). Each connector corresponds to a unit-module position (station). The opening of the crate accepting the 25 stations is 430 mm (25×17.2). One module is 17.2 mm wide, which is exactly half a NIM module. Any module can be built using $17.2 \times N$ in width and one printed circuit connector. The front panel arrangement is fully compatible with NIM units which can be inserted using an adapter fixed on the AMP connector of the NIM unit.

The circuit card does not slide directly in the guiding slots but is mounted between two extruded metal pieces which are then used as guiding pieces. These give rigidity to the card and simplify the mounting of front and rear panels.

Logic —

The 86 contact pins are used for the following functions:

24 — input of data; 24 — output of data; 5 — 32 coded functions; 1 — absolute selection of station; 4 — 16 coded sub-addresses; 4 — Inhibit, Clear, Busy, Initiative; 2 — timing strobes; 1 — response from module; 1 — call from module; 14 — power supply lines (mandatory: $\pm 6V \pm 24V$); 5 — free available patching pins; 1 — spare line.

This provides a basic framework for data manipulation. Discussions are going on to define some 'outside of the bins' philosophy since this is necessary to guarantee module compatibility.

A major step has thus been made in the collaboration of European research centres for an electronic system with mechanical and logic features offering wide applications, meeting present needs and building-in flexibility for the future. One direct result will probably be substantial support from industry. The system is now proprietary and may be used in fields other than that of nuclear physics.

The CAMAC system will be fully described in an ESONE report now being published and in a final EUR 4100 report.

Luis Alvarez

Nobel Prize for Physics

The 1968 Nobel Prize for Physics was awarded to Luis Alvarez of the Lawrence Radiation Laboratory, Berkeley, USA, for his 'decisive contributions to particle physics, in particular, the discovery of a large number of resonance states made possible through his development of the technique of using hydrogen bubble chamber and data analysis'.

Alvarez has applied himself in a variety of fields during his life in physics; in practically all of them he has achieved some outstanding work. He was born in San Francisco on 13 June 1911, the son of a distinguished medical man. It was in his father's laboratory that he learned to use his hands on electrical and mechanical apparatus, eventually spending two summers as an apprentice in a scientific instrument maker's machine shop. This stood him in good stead in later years when he needed to convert ideas into practical apparatus, and in University years he could get things done 'when the professional machinists were all working for the full professors'.

The University was that of Chicago where he took all his degrees through to Ph. D. in 1936. He was initially aiming for a degree in chemistry but 'seven straight Bs' in his chemistry courses helped to convert him to physics. This was immediately after A.A. Michelson's era at Chicago and he was therefore greatly influenced by things optical.

As a graduate student he built some of the first new fangled Geiger-Muller counters which in turn led to his first major scientific work. Prompted by A. Compton, he took his counter to the roof of Geneva Hotel in Mexico City and, at the same time as T. Johnson, looked at the cosmic ray intensity to the East and to the West. By proving that more cosmic rays came from the West, they showed that, given the effect of the earth's magnetic field, the incoming cosmic rays were positively charged.

From Chicago, Alvarez joined E.O. Lawrence's team at Berkeley and moved in time from Instructor in Physics (1938), to Assistant Professor (1939), to Associate Professor (1941) and to full Professor (1946). Those early years under Lawrence, through to the war, were very fertile. He demonstrated K-electron capture in nuclei;

developed a method of producing slow neutron beams and of neutron time of flight measurement and achieved the first acceleration of heavy ions in a cyclotron. Together with J. Wiens he made the first mercury 198 lamp and showed that its pure spectral line structure made it an ideal standard of length. This mastery of equipment led to several important experiments. Using his slow neutrons he investigated, with K. Pitzer, the scattering of neutrons in ortho and para hydrogen and, with F. Bloch, measured the magnetic moment of the neutron.

Another major discovery, in 1939 with R. Cornog, concerned tritium (hydrogen 3) and helium 3. A team in the UK under Rutherford had evidence of these isotopes and the arguments suggested that tritium was stable and helium 3 radioactive. Alvarez calculated that he could make enough of them by bombarding deuterium with the LRL 37 inch cyclotron to detect them as accelerated ions using his new technique on the 60 inch cyclotron.

While testing the background on the 60 inch cyclotron, with ordinary helium in the ion source, before using the activated deuterium, a very astute observation and interpretation showed them that helium 3 is a stable constituent of helium. Immediately afterwards, they showed that tritium is radioactive.

The war years took Alvarez to MIT to follow up the great technical achievements of the UK physicists in the use of radar. His inheritance from Michelson here proved invaluable, playing a part in three successes that marked his intrusion into radar. The first was the development of GCA (Ground Controlled Approach), the 'blind-landing' system for guiding planes down. It involved the construction of arrays of radar antenna acting like one of Michelson's diffraction gratings.

Similar arrays were built into the large wings of B-29 bombers for Alvarez's second radar achievement known as Eagle. This enabled radar maps to be taken in all weathers and allowed high altitude blind bombing. The third achievement was the MEW, microwave early warning system, which proved an extremely useful and versatile device.

From 1943 to 1945, he joined the team engaged on the atomic bomb project



under R. Oppenheimer at Los Alamos. Again he had to turn his hand to something different — this time the development of the implosion method for setting off bombs, in contrast to the more conventional gun-assembly method. The implosion method was the detonator of the first plutonium bomb.

While at Los Alamos, he conceived a new type of linear accelerator using techniques he had mastered during his radar days. The structure is known as the 'Alvarez-structure' and has been used in linear accelerators throughout the world (for example, in the 50 MeV linear injector of the CERN proton synchrotron). Alvarez and his colleagues built the first 32 MeV linac using the new structure within two years.

After the war, Alvarez realized that he had been away from the rapidly developing field of particle physics for too long. He had to decide, on returning to Berkeley, whether to retire into a scientific administrator's office with his press cuttings or to start learning again. He settled for the latter and took on two first class graduate students, L. Stevenson and F. Crawford, as research assistants on condition that he would in fact be their research assistant. This radical approach brought him back into the front line within a few years.

In 1952 came D. Glaser's brilliant invention of the bubble chamber and Alvarez was one of the first to realize its enormous potential. Glaser had used xenon in a tiny chamber to show what could be done. Alvarez began developing the same year a liquid hydrogen chamber, building in sequence a 4 inch, a 10 inch, a 15 inch and then a 72 inch chamber. The 72 inch (with a

CERN News

cross-section of 20 x 15 inches in a field of 15 kG) was regarded as an almost impossible monster when it was first proposed. Lawrence told Alvarez 'I don't believe in a big chamber at this time, but I do believe in you'. His faith was rewarded for in 1959 Alvarez and his colleagues brought the chamber into operation and it began physics in the Spring of 1960. Within the next two years it contributed results which marked a turning point in the development of particle physics.

This turning point concerned the discovery of resonances. One mysterious resonance had been found on the Chicago 450 MeV synchro-cyclotron in 1952 but it was the Alvarez group which showed that resonances are a general phenomena of particle physics. With the 72 inch chamber fed by the 6.2 GeV Bevatron, they found the first strange particle resonance Y^* (1385) and the first boson resonance K^* (893) and many others, so that they still have to their credit a very high proportion of the resonances so far identified.

In parallel with this bubble chamber work, Alvarez realized that new techniques would be needed to handle the huge volume of information that they could produce. As early as 1955 he tabled the basic parameters for semi-automatic measuring machines. Such machines were constructed and perfected, beginning with the 'Frankenstein' and now with the 'Spiral Reader'. Computer programs and techniques for the analysis of the output of these machines were also developed, particularly with the help of F. Solmitz.

Alvarez is currently leading two exotic projects. One is to X-ray the pyramids of Egypt using a spark chamber array to look at the cosmic ray muon flux. The purpose is to locate any hidden cavities in the pyramid structure which could be the sealed tombs of the Pharaohs. The second is HAPPE (High Altitude Particle Physics Experiment). Spark chambers with a superconducting Helmholtz coil to give complete magnetic analysis of events will be sent up in balloons to study the interaction of ultra-high energy cosmic rays (1000 GeV range) with particles in the upper atmosphere.

It is this life of achievement that has been recognized with the award of the Nobel Prize.

It works!

On 20 November, the seemingly unimpressive bubble chamber picture shown below was taken in a small glass chamber filled with liquid helium on a test rig in the South Hall. The story behind the picture makes it no longer 'unimpressive', for those bubbles represent an outstanding success which could eventually have a great impact on the world of particle detectors. The photograph shows the first charged particle tracks ever to be recorded in an 'ultrasonic bubble chamber'. The success was announced in NATURE on 21 December.

The principle of bubble chamber operation requires that a volume of liquid (ones typically in use being hydrogen, deuterium, helium, propane and freon) be subjected to a pressure cycle around the pressure at which it boils. Before a charged particle beam is fired into the liquid the pressure is released so that boiling can take place. The ionized particles that the beam particles leave in their wake form centres for

the formation of bubbles and therefore boiling takes place first (the bubbles of gas appear first) along the tracks of the charged particles. Photographs of these tracks can be taken before general boiling of the liquid occurs and the pressure reapplied ready for the next burst of particles.

The necessary variations in pressure have, up to now, been applied by bulky expansion systems involving compressors, pistons, diaphragms... Some idea of the scale of such systems can be gained from the descriptions of the two huge bubble chambers now under construction for CERN — the 3.7 m hydrogen chamber (CERN COURIER vol. 7 page 143) and Gargamelle, the heavy liquid chamber (CERN COURIER vol. 8 page 95).

It has been realized for many years that, in principle, it should be possible to use sound to do the job of applying pressure to a bubble chamber liquid. Sound is, by definition, a pressure disturbance travelling through a medium.

In order to have a sufficiently short



1. The first charged particle tracks ever to be recorded in an 'ultrasonic bubble chamber'.
2. The ultrasonic bubble chamber test rig in the South experimental Hall where it can receive particles from the PS. Notice the small window through which the photographs were taken and the polaroid camera on the right.

wavelength for bubble chamber operation ultrasound is needed. This means sound waves at a frequency higher than audible sound, higher than 20 kHz (not to be confused with 'supersonic' which refers to travelling faster than the speed of sound). Thus operation of an ultrasonic bubble chamber may disturb any nearby colony of bats but is not audible to the human ear. The techniques of producing ultrasonic waves have been known for many years and have found a wide variety of applications. For example, there has been extensive use for cleaning purposes where the pressure disturbance shakes the dirt off objects.

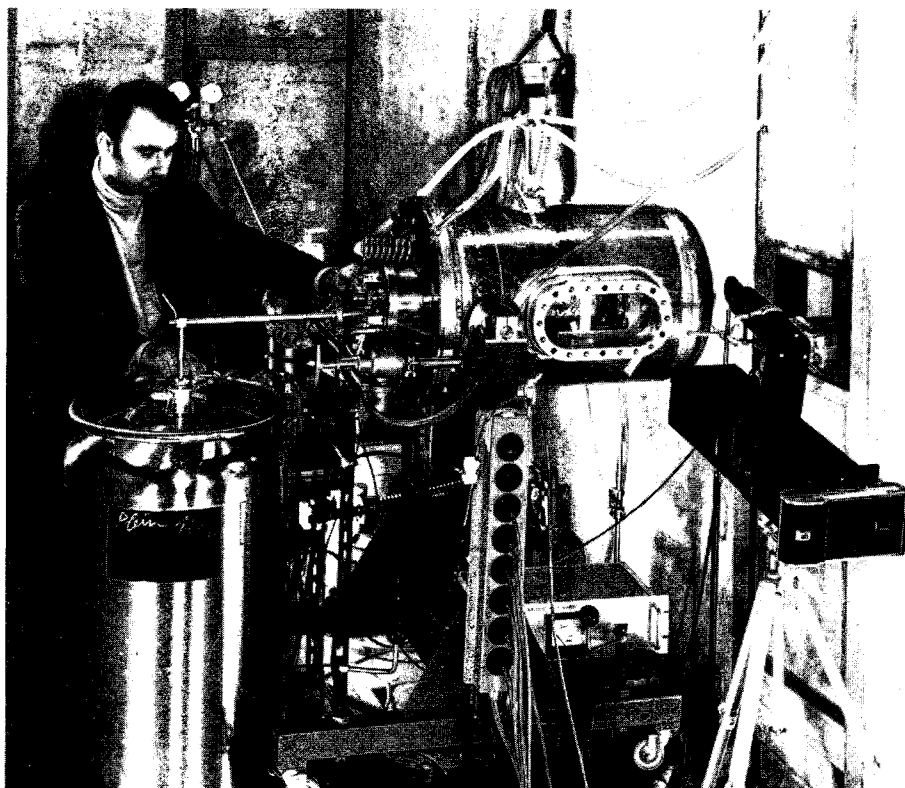
For about ten years, people have carried out research on ultrasonic bubble chambers. Work has been in progress in Japan, USA and USSR and at CERN under the late A. Schoch.

In 1966, an American scientist, A.H. Rogers came to CERN. He stirred up enough enthusiasm to mount a small scale effort with a helium chamber in C.A. Ramm's Nuclear Physics Apparatus Division. The scientists who worked with him, and who finally carried the effort to success when Rogers returned to Stanford a few months ago, were R.C.A. Brown and H.J. Hilke. (Hilke had previously tried ultrasonic operation with freon.)

Rogers (and also A.L. Hughes and Schoch) had pointed out that helium was the bubble chamber liquid most amenable to ultrasonic treatment, although with helium the cryogenic problems introduce more difficulties.

A small helium chamber was set up in the South Hall where it received pions and protons from the synchrotron. Inside the chamber are two piezoelectric crystals 7 cm in diameter, spaced 5 cm apart (this spacing can be varied up to 25 cm). The crystals generate the sound waves using the piezoelectric effect — an alternating potential difference applied across the faces of the crystal causes it to change its physical dimensions, thus sending out pressure waves. In the bubble chamber, the frequency at which this occurs is 110 kHz.

The spacing of the crystals and the



CERN/PI 185.11.68

selection of the frequency is such that 'standing waves' are set up between them. This means that if the pressure is examined across the chamber from one crystal to the other there are, separated by a distance about 0,5 mm, positions where the pressure disturbance is zero and positions where the pressure disturbance is maximum, swinging alternately above and below the static pressure applied in the chamber.

This static pressure is set very closely above the pressure at which the helium boils. When the sound wave is switched on, the pressure in half of the regions of maximum disturbance swings below the boiling pressure and, if charged particles have created ionization in these regions bubbles are formed. (Perhaps it will help to grasp this idea to notice that in the photographs the lines of bubbles are not continuous as in the conventional chamber but are broken into little segments corresponding to the regions which were sensitive to bubble formation.)

The big unresolved question was whether normal beam particles from an accelerator, which cause comparatively low ionization in the liquid, would be able to produce bubbles of sufficient size before the pressure swings into the opposite direction. It was possible that low ionizing particles would yield too small bubbles which would be snuffed out of existence when the pressure swing occurred. The bubbles are far too tiny to be photographed before this pressure swing and in fact they have to exist for some fifty to sixty pressure cycles before they have grown to visible dimensions. The vital answer from the CERN experi-

ments is that it is possible to grow visible bubbles.

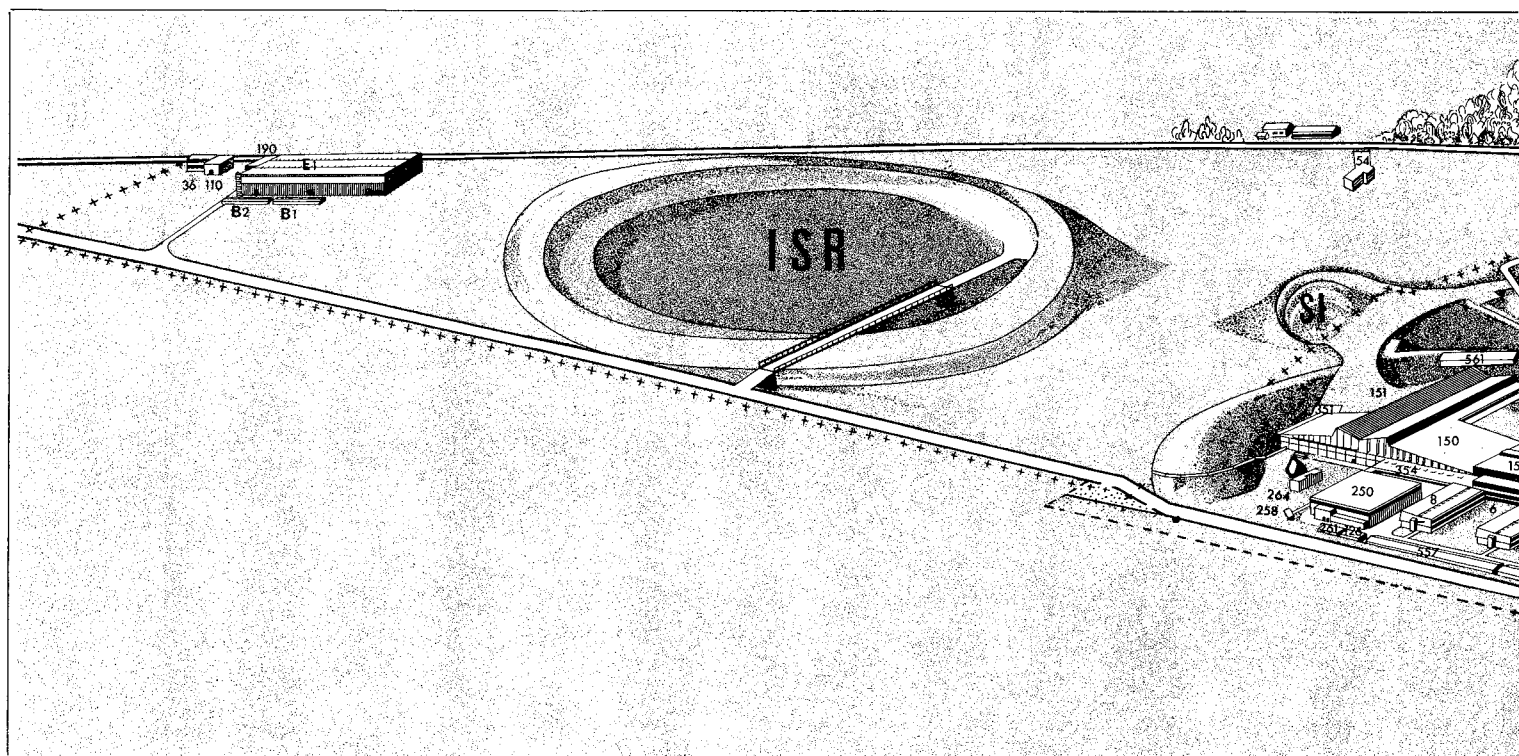
A great deal of work to refine techniques, to establish optimum operating conditions and so on, needs to be done before ultrasonic chambers can appear as standard items of particle detection systems, but the attack on the problem is likely to be greatly intensified now that it has been shown, at last, that the principle works.

There are several advantages to be gained from perfecting the ultrasonic chamber. The large pressure systems would be replaced by crystals which might make it possible to cycle the chamber extremely rapidly. Existing pressure systems can only with difficulty cycle more than a few times per second (see for example the information on the excellent achievement at Argonne where a large chamber has been pulsed five times in one accelerator cycle — page 312). But the ultrasonic chamber could potentially be almost continuously sensitive. It could for example be used as the detector/target, to give precise information on the vertex of an event, in conjunction with a counter system which would control the flash so that only photographs showing the interesting events would be taken.

The possibilities using an ultrasonic chamber will no doubt emerge more fully as the technique is progressively mastered. C.A. Ramm summed this up very nicely when announcing the success to his Division. He quoted Benjamin Franklin's reply to someone questioning the use of a new invention... 'What is the use of a new born baby?'

Perspective view of CERN

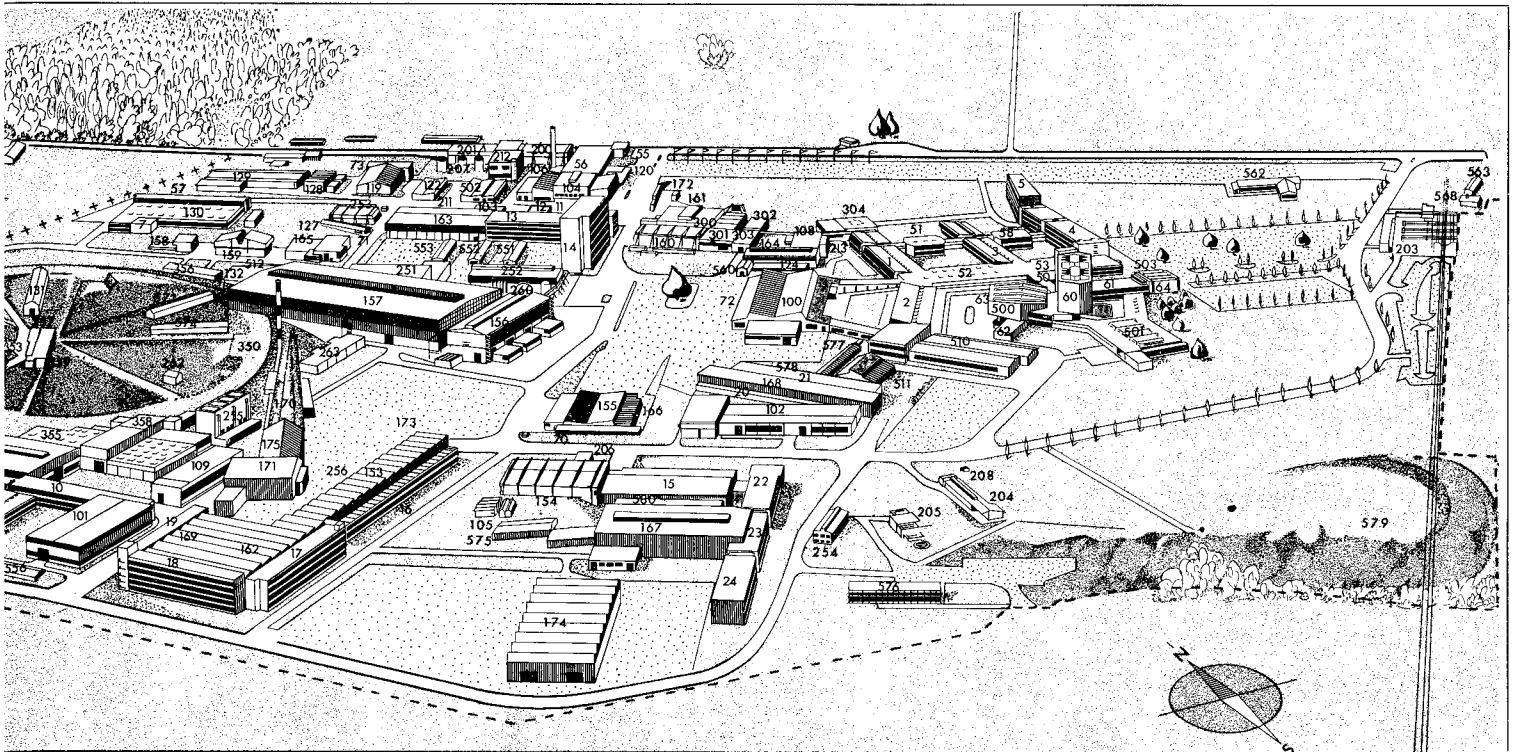
up to date on 1 January 1969



<i>Dénomination ou utilisation</i>	<i>Numéros des blocs</i> <i>Block number</i>	<i>Name or purpose</i>	<i>Dénomination ou utilisation</i>	<i>Numéros des blocs</i> <i>Block number</i>
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Plan perspectif du CERN

à jour au 1 janvier 1969



Name or purpose	Dénomination ou utilisation	Numéros des blocs Block number	Name or purpose
Goods reception	Bâtiment des compresseurs (ECB)	252	Compressor building (ECB)
Wood stores	Bâtiment de préparation hydrogène liquide (HL)	253	Hydrogen Liquefier building (HL)
Central chemical stores	Bâtiment de distillation du propane	254	Propane distillation building
PS chemical stores	Tours de réfrigération	255	Cooling towers
Store for hydrogen cylinders	Station des génératrices du bâtiment NPA	256	Generator room for NPA building
Intermediate store	Abris des dewars d'hydrogène liquide	258	Shelters for liquid hydrogen containers
Storage Hall	Sphère de sécurité	260	Safety sphere
Garage	Annexe Générateur sud	261	Annex to South generator building
Cable store	Stockage propane	262	Propane storage building
Stores	Bâtiment redresseur No 3	263	No 3 rectifier building
PS south experimental Hall	Hall Compr. (HE) B.E.B.C.	276*	B.E.B.C. compressor room (HE)
PS north experimental Hall	Hall Compr. (H2) B.E.B.C.	277*	B.E.B.C. compressor room (H2)
Extension to PS south experimental Hall	Bâtiment abritant le synchro-cyclotron	300	Synchro-cyclotron building
Equipment hall, NPA building	Salle d'équipement de l'appareillage auxiliaire	301	SC equipment room
Experimental hall, AR building	Bâtiment des génératrices auxiliaires	302	Auxiliary generator building
Experimental hall, (Adams hall)	Bâtiment des équipements de radio-fréquence	303	RF equipment building
Experimental bubble chamber building (EBCB)	Bâtiment de la salle de contrôle et de comptage	304	Control and counting rooms
East experimental hall (Apron)	Anneau du Synchrotron à protons	350	Proton-synchrotron ring
Building No 1 for testing hydrogen targets	Bâtiment de l'accélérateur linéaire (Linac)	351	Linac building
Building No 2 for testing hydrogen targets	Bâtiment central	353	PS central building
SC neutron room (experimental hall)	Bâtiment de la salle de contrôle et de comptage	354	Main control room and counting rooms
SC proton room (experimental hall)	Bâtiment de la génératrice principale et annexes	355	Main generator building and annexes
	Bâtiment Ejection est	356	East ejection building
	Extension bâtiment central	357	Extension to PS central building
	Extension bâtiment génératrice principale PS	358	Extension to main PS generator building
	E lanceur	360*	Booster
	Annexe lanceur	361*	Booster annex
Extension to NPA hall	Amphithéâtre du bâtiment d'Administration et Hall d'entrée	500	Auditorium and entrance hall of Administration building
TC experimental hall	Restaurant et cafétéria	501	Restaurant and coffee lounge
SC hall	Salle du Conseil	503	Council Chamber
Cryogenics building	Bâtiment de la calculatrice CDC 6600	510	CDC 6600 computer building
Extension to Adams Hall	Baraque Wilson	511	Wilson hut
New AR hall	Bâtiment contrôle zone est	512	East area control building
NP hall	Baraque 2	551	Hut 2
2nd extension to NPA hall	Baraque 3	552	Hut 3
Neutrino	Baraque 4	553	Hut 4
Gargamelle	Baraque 6	556	Hut 6
Isolde	Baraque 7	557	Hut 7
Neutrino control station	Baraque 11	560	Hut 11
FK11 hall	Baraque 12	561	Hut 12
B.E.B.C. connecting hall (E2)	Cantine CERN No 2	562	CERN canteen No. 2
Bubble chamber hall	Baraque E	563	Hut E
B.E.B.C. experimental hall (BE)	Chaufferie et douches des dortoirs	568	Heating plant and showers for dormitories
Power house (PH)	Baraque de stockage	573	Stores hut
PH central extension	Baraque MPS	575	Hut for MPS Division
Main 130/18 kV electricity sub-station	Jardin d'enfants	576	Nursery school
Pumping station and reservoir	Baraque Bureau DD	577	Hut, office for DD Division
Sewage purification plant	Baraque Bureau DE	578	Hut, office for DD Division
South-east electricity sub-station	Baraques d'entreprises	579	Contractors' huts
Oil tanks	Baraque ISR	580	ISR hut
Valve room and reserve supply at entrance to cooling water circuit	Hall Ouest	E1	West Hall
Sub-station for Laboratory wing 13	Bureaux provisoires ISR	B1	ISR hut
Jura sub-station	Bureaux provisoires ISR	B2	ISR hut
SC sub-station			
ISR zone water tanks (PST)			
Water tower			
South generator building (GBS)			
East generator building (GBE)			

* En projet

* To be built



Switzerland joins

On 10 December, the President of the Swiss Confederation, Mr. Willy Spühler, forwarded a letter to the President of the CERN Council, Dr. G.W. Funke, announcing that Switzerland is prepared, in principle, to participate in the construction of the 300 GeV accelerator. Thus Switzerland joins five other European countries — Austria, Belgium, Federal Republic of Germany, France and Italy — who have already sent 'Letters of Intent'.

The Swiss decision is subject to ratification by parliament, possibly following a referendum, and to a ceiling on its financial contribution, which is based on the participation of the six countries who have so far agreed, and on a maximum expenditure of 1335 million Swiss francs (1967 prices). At the same time the letter expresses the hope that more countries will agree to participate.

The decision was motivated particularly by the wish to sustain the outstanding European co-operation achieved in the field of high energy physics which has produced such fruitful relations between CERN Meyrin and national research centres.

Position of Spain *

At the beginning of November, it was learned that Spain would have to withdraw from the European Organization for Nuclear Research with effect from the end of 1968. A provisional warning that this might prove necessary had been received from the Spanish government at the beginning of August. As reported in CERN COURIER, page 237, the Council at its October meeting had agreed to a reduction in the contribution of Spain for the coming years (to 50% of the nominal proportion) but the government still did not feel able to continue its support.

In his letter conveying the news to the Director General, Sr. Enrique Perez Hernandez, the permanent delegate of Spain to the CERN Council, stressed that the reasons for his government's decision are exclusively the result of prevailing financial difficulties. The government recognizes without the least reserve both the usefulness and efficiency of CERN and still

regards CERN as an Organization of the highest value. The government also recorded its appreciation of CERN's contribution to the development of nuclear science in Spain over the past years.

Spain has been a Member State of CERN since January 1961. Its contribution to the budget over the past three years was 3.43%. Over the past few years several strong high energy physics groups have grown up in Spanish Universities and research centres.

ISR Users Meeting

On 23 December, the second major gathering of physicists from throughout Europe who are interested in experimentation on the Intersecting Storage Rings was held at CERN. The purpose of these meetings has been to enable the physicists to participate in the discussions from which will eventually evolve the initial experimental programme at the ISR. As at the first meeting in June (see CERN COURIER vol. 8 page 128), over a hundred scientists came from outside CERN.

A further indication of the great interest in using the ISR is that 29 research centres from 10 Member States have sent 'Letters of Intent' (not to be confused with Letters of Intent to join the 300 GeV project which have not arrived quite so quickly or in such profusion) expressing desire to carry out colliding beam experiments. Some of these letters contain proposals for experiments which are fairly fully worked out. Several possible experiments had already been discussed by physicists from CERN itself at the June meeting. The December meeting was therefore predominantly concerned with discussion of proposals from other European groups.

The decisions as to which of these experiments should be mounted on the ISR ready for first operation in the summer of 1971 need to be taken quickly so as to give at least two years for their preparation. To this end, the meeting discussed the organization of the experimental programme and decided to establish an ISR Experimental Committee (ISRC) which will be similar in structure and in purpose to the Committees which have served so well in the organization of the experimental programme of the proton synchrotron.

Professor W. Jentschke was chosen as the Chairman of the ISRC.

It is the ISRC which will receive and judge the proposals for experiments and will make recommendations as to which experiments should be accepted to the Nuclear Physics Research Committee. The NPRC then takes the final decisions, taking into account the overall CERN experimental programme and the available resources.

It is intended that the ISRC will have a maximum of twelve members chosen from outside groups, from physicists at CERN and from ISR machine specialists. As with the other committees, individuals will serve for a few years and then make way for others.

Another urgent decision concerns the choice of a large, general purpose magnet system which will be installed in one of the two interaction regions which will be initially equipped for experiments. Three systems have been proposed and their relative merits were discussed at the meeting.

Professor Gunnar Källén

Professor Gunnar Källén, of the University of Lund (Sweden), died on 13 October in an air accident near Hannover. With his tragic death, Europe loses one of its most eminent theoretical physicists and CERN loses an excellent friend and supporter.

Born in 1926, Källén had a brilliant and rapid scientific career. He studied in Sweden, initially in electrical engineering but afterwards turning to physics. He was soon attracted by profound problems requiring advanced mathematical methods and quantum electrodynamics proved to be the field of his major scientific achievements in the years 1945-1955. He concentrated mainly on developing a new approach to the theory of renormalization which was, at that time, perhaps the most important topic in theoretical physics. His method differed from that of others working in the field in two major respects. First, he systematically used the Heisenberg picture instead of the so-called interaction representation. Even more important was his emphasis on the use of exact relations, i.e. relations which should be satisfied by the exact solutions of the field equations. In this way, he was able to formulate

precisely and attempt to answer the question of the infinity of the renormalization constants.

In Källén's work of this period were many ideas and techniques, in a more or less developed form, which have subsequently acquired fundamental importance in the application of field theory to particle physics. His early use of the spectral representations, of the reduction formulas and of what later came to be known as dispersion theory techniques, all have, directly or indirectly, basically affected the development of strong interaction theory.

Källén's work in quantum electrodynamics led him to be one of the first to study exact analyticity properties implied by the general principles of local field theory, and he obtained important results in collaboration with A. Wightman and J. Toll. Also worthy of mention was the importance for the theory of renormalization of the work done by Källén and Pauli on the Lee model, where they discovered the possibility of 'ghost' states (i.e. bound states corresponding to particles appearing with a negative probability).

Källén did not limit himself to the development of general theory, but used his own methods to obtain the solution of difficult concrete problems, as in the calculation of the fourth order vacuum polarization. After accepting a chair of Theoretical Physics at the University of Lund, he showed keen interest in experimental particle physics and the experimentalists at the Lund electron-synchrotron profited greatly from his advice. As a University Professor, Källén built up in Lund an active group of young theoreticians which he introduced into his critical and profound approach to research.

He was also keenly interested in the development of European collaboration in physics. After having been for a few years a member of the early Theory Group of CERN working in Copenhagen, he kept in contact with the Theory Division of CERN in Geneva where he spent the summer of 1967. He also represented Sweden on the European Committee for Future Accelerators, and it is when flying down to Geneva for the ECFA meeting of 14-15 October that he died in a plane accident.

Safety Group

Although small in number (16 people), the Safety Group is of importance to all members of CERN, for it supervises the application of safety standards on the CERN site, on behalf of the Directorate. How well it fulfils its role as 'guardian angel' can be seen clearly from the graph at the end of this article.

The Safety Group operates —

- a. By laying down safety standards which are generally based on national standards in force in the Member States or in the USA, or on international standards.

The draft standards drawn up by the Group are discussed at meetings of specialists such as the Electrical Co-ordination Committee or the Hydrogen Working Committee, on which the relevant Divisions are represented. A definitive text is then established and passed to the CERN Safety Committee, which has representatives of all the Divisions. In its turn, this Committee submits the text to the Directorate for final approval.
- b. By publishing safety bulletins drawing attention to matters of general importance.
- c. By acting as an advisory body on safety matters for the Directorate, the Divisions and the personnel.
- d. By supervising installations, equipment and working methods from the point of view of safety, and in certain cases, by being directly responsible for applying safety standards.
- e. By carrying out destructive or non-destructive tests on materials.
- f. By helping the industrial medical officer to obtain the best possible working conditions and by checking to see whether medical restrictions applied to the work of certain staff are being observed.

Organization

The Group is divided into three sections — industrial safety; dangerous fluids and fire prevention; technical checking and inspection.

Industrial safety section :

This section is responsible for safety in

the electrical field, in the workshops, in civil engineering, in the experimental areas, and for industrial health. It lays down standards and is responsible for carrying out periodic inspections. It also has the task of checking new installations when they are started up (and, in some cases, has acceptance tests made).

Dangerous fluids and fire prevention section :

This section is concerned with safety in the use of dangerous liquids and gases, especially in the bubble chambers, the liquid hydrogen targets and the Cherenkov counters. It draws up standards, provides advice on the construction of installations and buildings, and supervises their application. Where fire prevention is concerned, it examines the available means of preventing explosions and of quickly extinguishing fires at their source and stipulates what fire-fighting equipment is necessary.

Technical checking and inspection section :

Because of the special statutes of CERN, no external body is responsible for making checks on the site. This task is therefore carried out by this section, at least where lifting equipment, tanks and pressurized systems, and the quality control of materials are concerned. All new installations are inspected before being taken into service and an approval certificate is issued when such installations are delivered. The section also has a laboratory for carrying out destructive and non-destructive tests on material.

Recent Standards

Two standards put forward by the Safety Group came into force during 1968.

The first deals with push-buttons and pilot lamps showing whether machines are in operation or not. There used to be some confusion due to the often contradictory provisions of national standards. In order to eliminate this confusion, CERN adopted, from the beginning of 1968, the standards of International Electrotechnical Commission, in force since July 1967. The result of this is that :

- a. all installations must be fitted with red 'stop' push-buttons and green 'start' buttons.

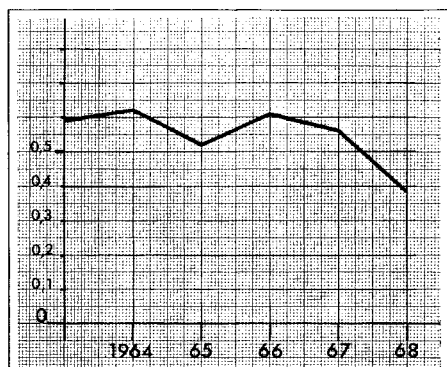
The graph shows the variation in accident rate at CERN in recent years. (An 'accident' for this purpose is defined as an accident which prevents a person working for at least two days.) The figures record the number of accidents per 100 000 manhours worked. The rate compares favourably with other research centres.

b. pilot lamps for electrical components must show a red light when a piece of equipment or a circuit is live, and a green light when it is 'dead'.

The second standard deals with the colour of electrical connector wiring. When CERN was founded, there were no strict rules on this subject, and customs were not uniform even inside individual countries. CERN therefore made its own arbitrary rules, stipulating that green and violet should be used for the live wire, grey for neutral and black for earth. Since then, however, several countries have adopted black to indicate the live wire. Also, CERN wished to bring its standards into line with those in France, which are stricter in some respects than those of the Swiss Association of Electricians (although the latter nevertheless remain the basic rules used at CERN).

After discussions, involving representatives of interested Divisions and experts appointed by the Swiss and French authorities, it was decided to adopt the international standard CEI 173 with regard to the colour of the earth wire (yellow and green) and the French standard which, regarding the neutral wire as a live conductor, requires that installations must contain a device whereby this wire can be disconnected from the mains. A recommendation has been made that black be avoided for the live wire in all CERN equipment or, where this is impossible, that the end of the wire be colour-coded differently.

In conclusion, it is appropriate to point out that the Safety Group is available to all personnel for help in solving any problem.



Generator sets

Because of the extension of the CERN site and the construction of the ISR, and also because of the increase in the number of other installations at CERN, it has become necessary to provide higher-powered emergency motor-generator sets. These will ensure that the most important services and equipment and certain essential auxiliaries to the accelerators (such as the vacuum pumps) the lighting system, ventilation and heating equipment, etc., will still operate if there is a breakdown in the mains supply.

The diesel engines of the two new sets (see CERN COURIER, vol. 8, page 206) have just been installed and on-load testing will begin in January. They increase the emergency electric power from 1320 to 7650 kVA, which is more than 20 % of the present peak consumption.

There are now three sets installed and one of them will operate permanently, in synchronism with the ordinary mains supply. This means that switch-over will be instantaneous, whereas, previously, bring-

ing in the emergency set took at least eleven seconds.

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Starting device	compressed air

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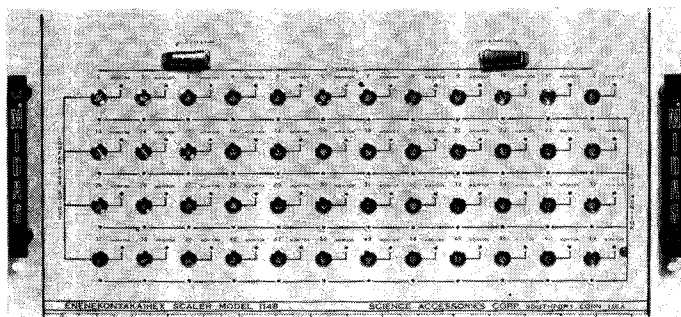
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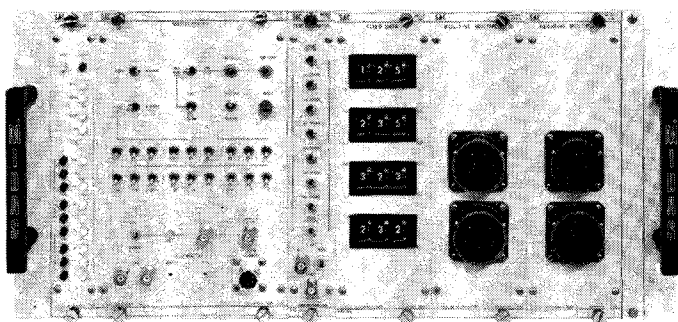
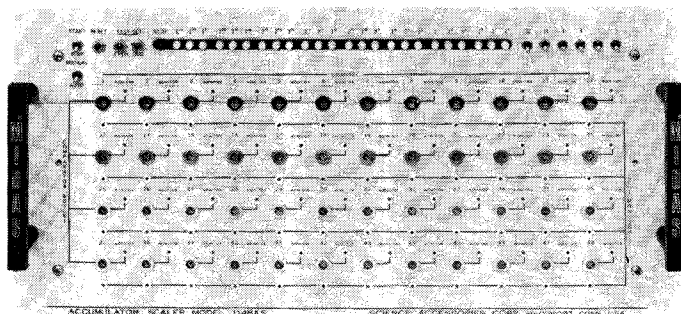


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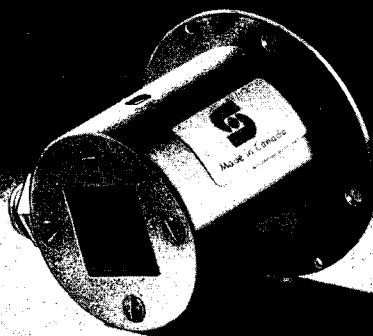
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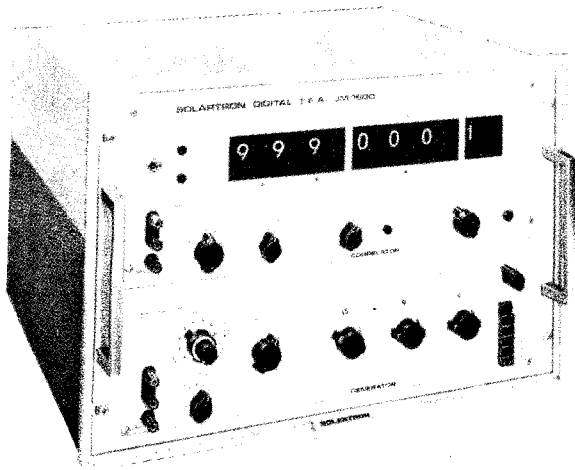
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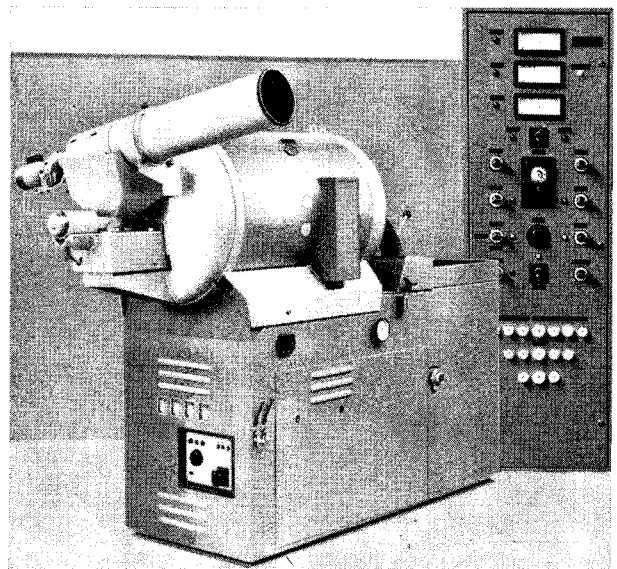
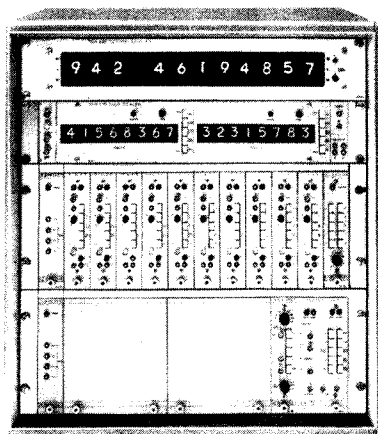


Figure 7

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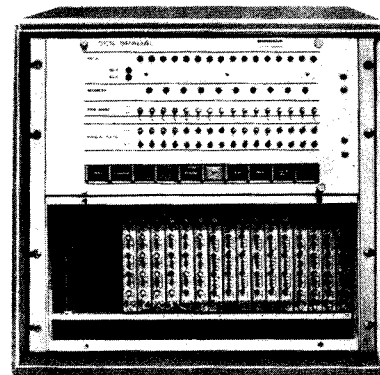
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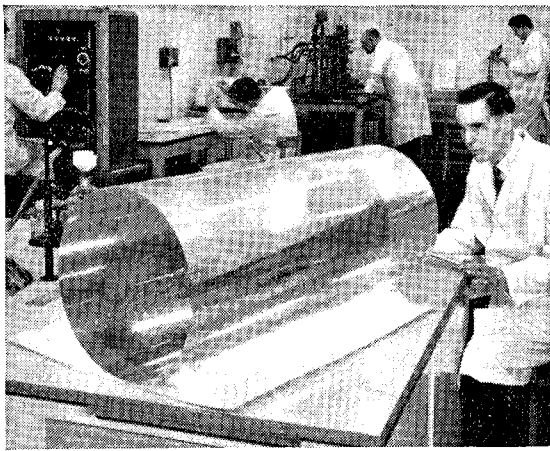
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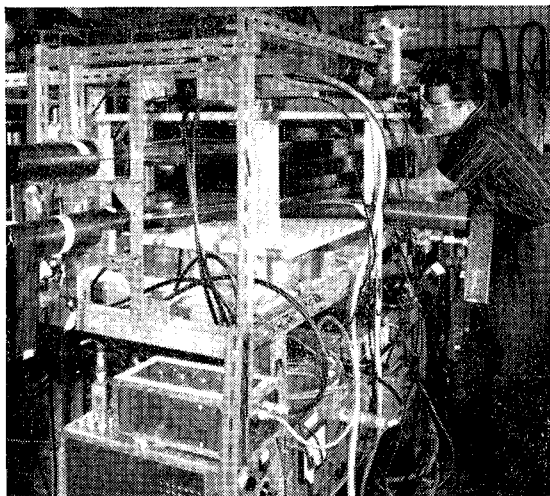
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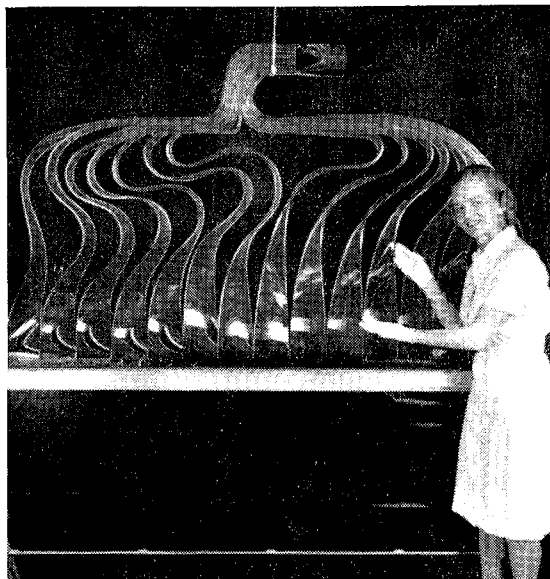
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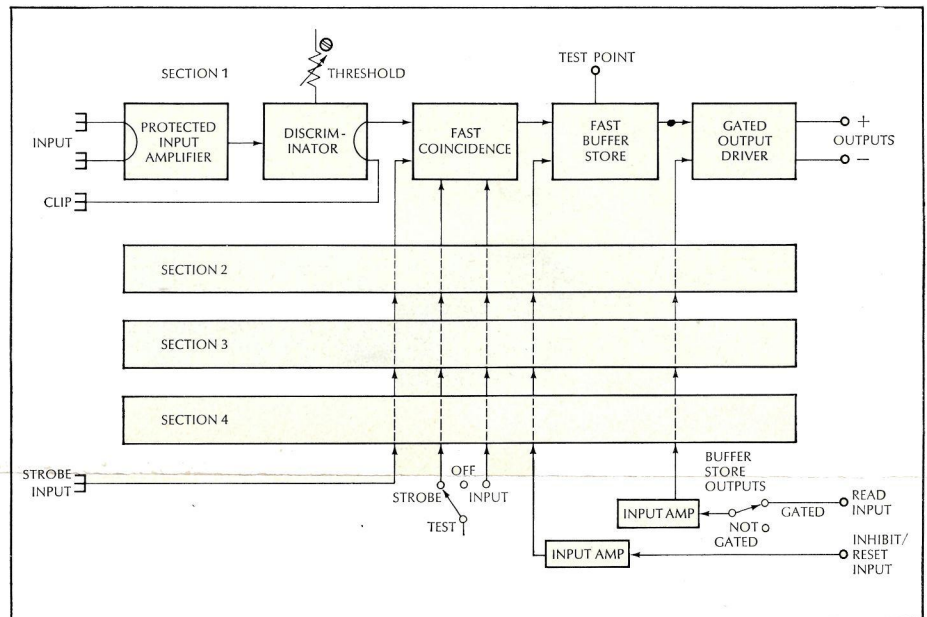
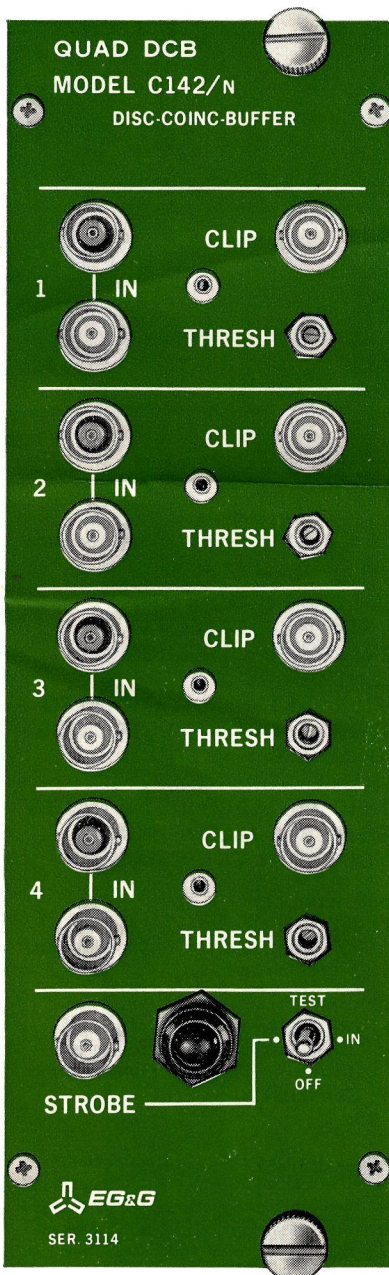
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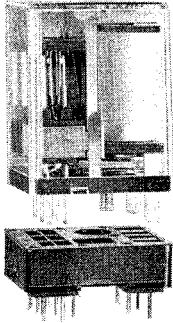
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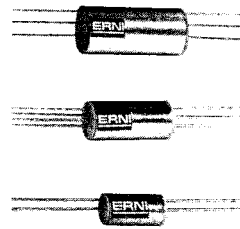
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Dimensions:

MINIRID A	Ø 8 × 12 mm
MINIRID B	Ø 8 × 18 mm
MINIRID C	Ø 8 × 23 mm
MICRORID A	Ø 6 × 12 mm
MICRORID B	Ø 6 × 18 mm
MICRORID C	Ø 6 × 23 mm

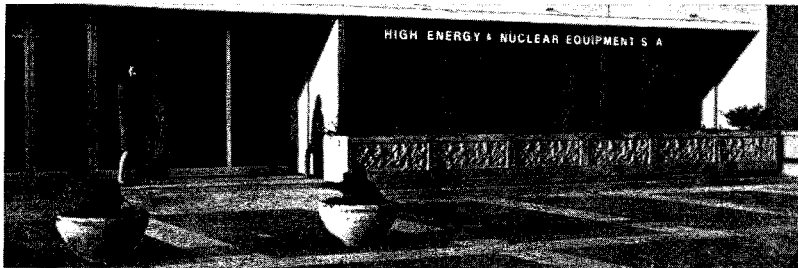
Operating voltage 2 ... 24 V DC

Max. switching	power	28 W
	voltage	500 V
	current	1 A

ERNI + Co. Elektro-Industrie
CH-8306 Brüttisellen-Zürich
 Telephon 051 / 93 12 12
 Telex 53 699

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HIGH ENERGY and NUCLEAR EQUIPMENT S.A.



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For information concerning the equipment available from the Companies for which we act as exclusive consultant-agent please refer to the full page advertisement in the October issue of CERN COURIER or ask us for a copy in English or Spanish.

Technical liaison, supply and maintenance centre for:

NUCLEAR ENTERPRISES LTD
LABEN, SIMTEC, C.S. ITALIA
20th CENTURY ELECTRONICS LTD
LAN-ELECTRONICS LTD
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D.A. PITMAN LTD
JOHNSTON LABORATORIES INC.
SCIENTIFIC RESEARCH INSTRUMENTS
ELECTRONICS & ALLOYS INC.
THE CYCLOTRON CORPORATION

Telephone numbers:

Geneva: 022/34.17.07 /05
 Madrid: 257.22.00 (ask for Miss Johnson, Steno Services)

Telex numbers:

Geneva: 23429 answer back "stiff ch"
 Madrid: 27686 answer back "hilma e"
 (attention: Miss Johnson Steno Services)



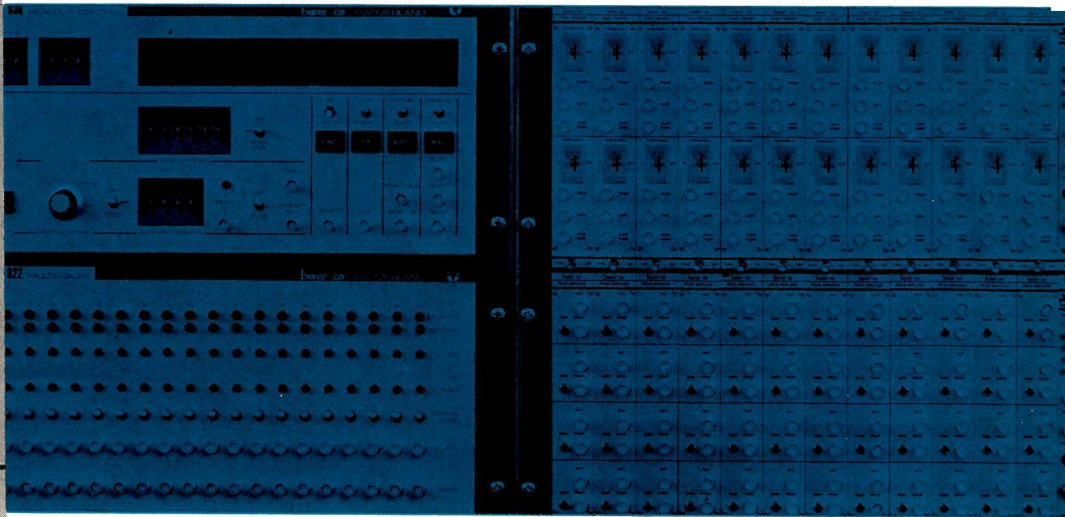
A lot happens in a month! In fact, too much to relate in an advertisement such as this! Example: Nuclear Enterprises have just released and distributed to approximately 20 000 physicists, life scientists and engineers, their 40 page issue of a new Diary of Developments packed with interesting data. If you have not received a copy please ask us to send you one. Another example is the news that SIMTEC can supply 25 mm depth silicon detectors which will « look at » 970 keV electrons with 5 keV resolution, stop 80 MeV protons 200 MeV alphas, and 10 MeV electrons. They can also supply a wide range of low cost planar Ge detectors with specifications matching the best from other sources of supply. If you want to know more, contact us.

We hope you all had a good Christmas and we wish you a happy, healthy & prosperous New Year.



HIDAC means easy and reliable high speed data acquisition!

The HIDAC system applies to spark chambers, hodoscopes, spectrometers and time of flight measurements. It is kept up to date even in some years by the permanent introduction of new modules, which helps to automatise and expand your experiment.



Time to Digital Converter 909

The TDC 909 consists of two independent channels for digitizing the sonic transit time of spark chambers. It consists of a special discriminator input-circuit giving low jitter triggering of the subsequent 16 bit binary scaler, which counts the pulses from a clock-generator with a maximum speed of 20 MHz. The threshold of the input-discriminator is variable from 0,5 to 4,5 Volt in steps of a 0,5 Volt. For multiple-spark-detection with wire-spark-chambers, a special overflow-output is provided, by passing the second and all the following pick-up signals, which can be used to trigger second or further channels. In this way there is no limit to the multiple-spark-detection by switching TDC's in cascade. The double-spark-resolution is 0,5 μ s or 2,5 millimeters for wire-spark-chambers. Using the LOOK-button the contents of this 16 bit binary scaler are displayed on the central control unit in decimal form.

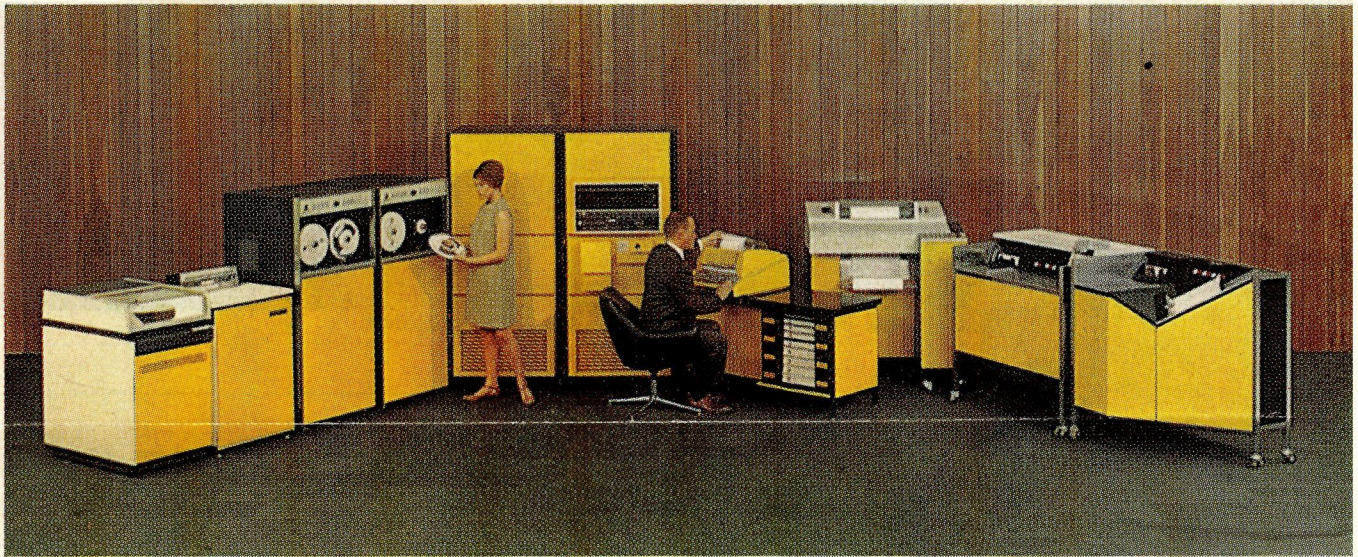
The HIDAC Data Acquisition System is designed for collection of all data in experimental high and low energy nuclear physics. Many special units are available for particular applications, such as recording of data from spark chambers, Hodoscope-arrays, time-of-flight measurements, pulse-height information and counting-rates up to 100 MHz. This equipment was conceived from the many special units over the last few years, together with the latest requirements for ON-LINE control. Our programme does not only consist of a single component for the system, but we have a fully integrated range from spark chambers to interface of computers. We do not claim to have developed this system entirely ourselves, but with the help of our many customers it therefore covers most the requirements in the field. On the left one the modules is introduced.

Great Britain: 36 East Street, Shoreham-by-Sea, Sussex
Telephone 4305
Germany: Verkaufsbüro München, Kaiserstr. 10, D-8000 München 23
Telephone 34 80 16
France: Sorelia Electronique, 150 rue de Chatou, 92 Colombes
Telephone 782.16.39-782.32.79

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Introducing Honeywell Series 32



**32-bit real time computer system with
nanosecond speeds and the lowest cost per
instruction in its class**

The announcement of this Series represents Honeywell's entry into the medium-to-large scale scientific computing market. Designed around 'state of the art' components and subsystems, the Series 32 is the most powerful computer system in its class. Series 32 is backed by a library of scientific and real time software routines, total application support and full range of peripherals.

The Series 32 is flexible. You can start small, expand as your requirements grow . . . from a minimum 8K memory with one central processor and input/output processor to a maximum system with 131,072 words of memory, four central processors and four input/output processors. The Series 32 is applicable in many areas : trainers/simulators, message switching/data retrieval, general purpose

scientific, and physical sciences. The Series 32 has extensive software packages ; basic operating system, loaders, macro assembler, fixed and floating point math libraries, extended FORTRAN IV, and many others. For full details please write to Honeywell Controls Limited, Computer Control Division, 73 Route de Lyon, Geneva. Geneva 44 25 50.

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