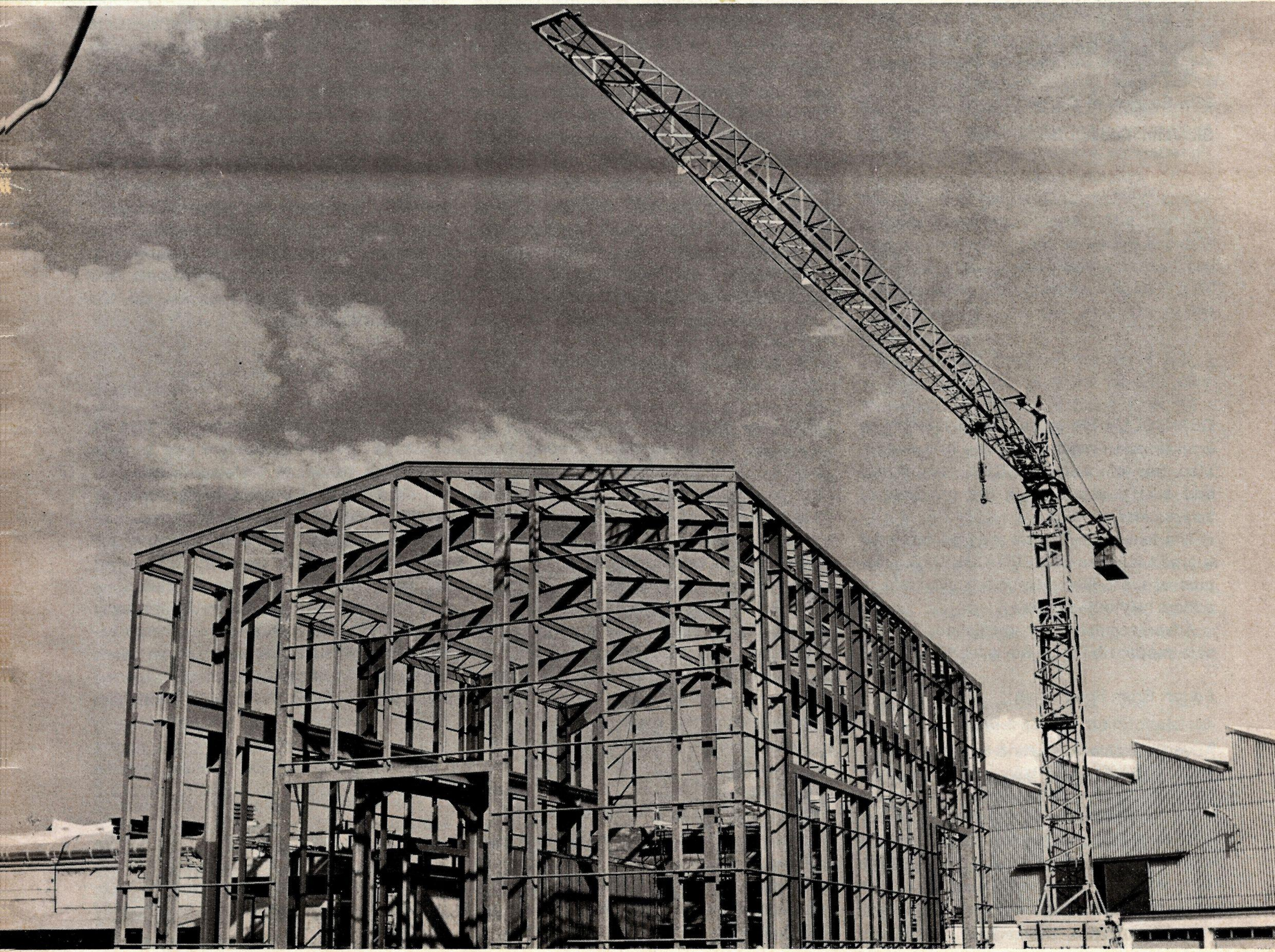
CERN COURIER

No. 10 Vol. 7 October 1967

European Organization for Nuclear Research



Cover photograph: The shell of the new building to house the large heavy liquid bubble chamber, Gargamelle, which is due to arrive from France in 1969. (See the article in CERN News, page 206). The chamber will be used initially for neutrino experiments; the existing neutrino beam-line can be seen coming from the left. (CERN/PI 12.10.67)

Comment

We send our warm congratulations to Professor A. A. Logunov and his colleagues at the Institute for High Energy Physics, Serpukhov, USSR, on the successful operation of their proton synchrotron. Information came as this issue was going to press, that the machine had operated at full energy for the first time on the night of 13-14 October. Proton beams were taken to 76 GeV; Serpukhov now has the highest energy accelerator in operation in the world. We wish the Institute many years of fruitful physics.

Several topics covered in this issue of CERN COURIER hinge together; they concern the next generation of particle accelerators. The news, in the report of the Accelerator Conference held at Cambridge, USA, of the vigour with which the American 200 GeV design team are pursuing their project (page 199) can be grouped with the progress on the European 300 GeV proposal (see the summary of the 35th CERN Council Meeting, page 207). In addition, there is the news of the receipt of the 'letter of intent' from Austria to participate in the 300 GeV project.

The Americans have evolved, in a very short time, a new design for their accelerator, including several novel features. Professor R. R. Wilson leader of the American 200 GeV team, gives mid-1972 as the target date for completion of the machine. The proposed programme for the construction of the 300 GeV means that the European machine will follow in 1976.

As is mentioned in the report on the Council Meeting, concern was expressed at the fact that accelerator physicists from Europe are being drawn to the American project, and ways of setting up the basis of the European construction team in advance of full authorization are now being examined. Experimental physicists are also likely to be attracted away during the several years before the 300 GeV could come into operation.

If Europe is to build the big accelerator, and this is obviously a decision, and not an easy one, for individual European governments, then the sooner the decision can be taken the better. Three European governments, Austria, Belgium and France have now indicated their willingness to participate and other governments are likely to present their position on the project in December.

Contents

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

The text of any article may be reprinted if credit is given to CERN COURIER. Copies of most illustrations are available to editors without charge.

Advertisements are published on the sole responsibility of the advertisers.

Editor: Brian Southworth
Assistant Editor: Bernard Bauer
Advertisements: Micheline Falciola
Photographs: Gérard Bertin

Public Information Office
CERN, 1211 Geneva 23, Switzerland
Tel. (022) 41 98 11 Telex 2 25 48

Printed by: Ed. Cherix et Filanosa S.A.
1260 Nyon, Switzerland

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

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

The Laboratory is situated at Meyrin, Canton of Geneva, Switzerland. The site covers approximately 80 ha about equally divided on either side of the frontier between France and Switzerland. The staff totals about 2300 people and, in addition, there are over 400 Fellows and Visiting Scientists.

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

Cambridge Accelerator Conference

The 6th International Conference on High Energy Accelerators was held at Cambridge, Massachusetts, USA, from 11 to 15 September. It brought together 276 accelerator physicists from throughout the world, including 24 from CERN. The sessions took place in the delightful surroundings of Harvard University close to the location of the Cambridge Electron Accelerator Laboratory, whose staff under the Director, Professor M.A. Livingston, bore the brunt of the organization.

This report covers some of the major topics at the Conference. Several important contributions came from CERN but, since these have been reported or will be reported in CERN COURIER in the normal course of events, the limelight has been given to news from other Laboratories.

The big machines

We group together under this heading the 70 GeV proton synchrotron at Serpukhov, USSR, the 200 GeV machine (though perhaps it should now be written 200-400 GeV machine) to be built at Weston, USA, and the European 300 GeV project.

Serpukhov

At the time of the Conference, commissioning was under way at Serpukhov and V.A. Titov was able to report that an 8 mA beam had been accelerated to the full energy of the injector (100 MeV) for the first time in July. Collimated beams have been taken a quarter of the way around the machine; attention to the vacuum system at various points in the rest of the ring limited the distance to which these beams could be taken. Magnet surveys have confirmed that the required 'good field' can be achieved over the range of field strengths from injection to 70 GeV.

Weston

Perhaps the most eagerly awaited talk of the Conference, and certainly the one which set up the biggest buzz of conversation in the corridors afterwards, was that by R.R. Wilson, Director of the National Accelerator Laboratory (NAL), on the design study for the American 200 GeV machine.

Design work started at Oak Brook on 15 June, with the team under pressure to produce fairly detailed plans and a budget breakdown by 15 October in order to request full authorization for fiscal year 1969 (which runs from 1 July 68 to 30 June 69); the full study will then be prepared for January of next year. If this authorization comes through, Wilson estimates the completion date of the machine as mid-1972.

It is obvious that a main design parameter is the budget figure of $ 240 M. To construct the machine within this budget, which is considerably less than the first cost estimates for a 200 GeV machine which were worked out in the USA, has made the design team look afresh at almost every element of the machine to arrive at solutions which are not only technically sound but which also prune expenditure wherever possible. This has led to several new approaches and an exciting design which has moved away on many aspects from a scaled-up version of the existing high energy machines. Some of the major features (brought up-to-date on 11 October) are described in what follows.

The main ring is 2 km in diameter. It will be built (excavating, not tunnelling) in a corner of the site rather than in the centre; there is space for storage rings alongside (they are also looking at possible by-pass schemes) and ejected beam-lines of up to $4\frac{1}{2}$ km long will be possible across the diagonal of the site. The ring tunnel cross-section will be about 3 m in diameter and the magnet will be positioned close against the wall on one side of it.

Injection will be via a 200 MeV linac and a 10 GeV fast cycling booster 150 m in diameter. The booster will operate at 15 Hz giving 3×10^{12} protons per pulse, filling a single turn in the main ring with twelve pulses during 0.8 s.

The main ring design is for separated function magnets. This means that the jobs of bending the protons around their constant orbit and of keeping the beam focused are done by different magnets. One set of magnets does the bending, another set (quadrupoles) does the focusing (still alternating gradient focusing). The existing CERN and Brookhaven machines (for example) use combined function magnets — bending and focusing being done by the same magnet units by shaping the magnet pole profiles to achieve field gradients in the radial direction. The relative merits of the two systems have been the subjects of hot debate (G.T. Danby from Brookhaven, one of the most articulate proponents of separated function synchrotrons, gave a paper on this subject at the Conference) and it is interesting to note that, as things stand at the moment, the European 300 GeV design is combined function and the American 200 GeV design is separated function.

The ring is packed with as much magnet as possible. It will have 6 long Collins straight sections (54 m) and 6 medium length straight sections (29 m). There are also 'mini-straights' 2.5 m long before the quadrupoles and the magnet lattice is then — quadrupole focusing magnet, set of four bending magnets, mini-straight, quadrupole de-focusing magnet, set of four bending magnets, mini-straight, quadrupole focusing magnet. The bending magnets will be H type, weighing about 10 tons each, constructed with a special coil configuration. The aperture will be 5×10 cm^2, with 4×12.5 cm^2 in some of the magnets.

The magnet field will be about 500 G at injection rising to 9 kG for 200 GeV. The cycle will be 0.8 s filling time, 1.6 s rise time, up to 1 s flat top and 0.6 s fall time. Thus the pulse repetition rate can vary from one every 3 s to one every 4 s at 200 GeV. The design intensity per pulse is 5×10^{13} giving about 1.5×10^{13} protons per second. It is hoped to dispense with rotating machinery (which has been the curse of many an accelerator Laboratory) in the magnet power supply and to tap onto the local grid, following ideas first developed by J. Fox of the Rutherford Laboratory.

Injection, ejection and the radio-frequency system will all be grouped together in a short arc of the main ring. (It is near this arc that the Laboratory buildings, catering eventually for a total staff of about 2000, will be situated on a rise in the ground which has come to be known as Mount Ramsey). The hope is that, once it is built, the rest of the circumference of the ring can be practically forgotten, while clustering together the systems likely to

require regular attention. It is hoped also that severe radiation losses, and therefore attention to radiation problems, will be almost entirely concentrated in this region only about 2 % being distributed around the rest of the circumference. (This seems optimistic in view of the recent shielding studies at CERN where, with full beam on one target, 70 % of the radiation was in the target region and 30 % distributed around the ring.)

Authorization is being requested initially for a 200 GeV machine but it is obvious that with a ring packed with magnet so that a field of only 9 kG is needed to reach 200 GeV, the step to higher energies will be an easy and economical one, involving more power supply and perhaps more r.f. The magnet designers are confident that good field will be retained up to 18 kG (equivalent to 400 GeV) and probably beyond that.

The main reservations expressed in the corridors concerned the risk involved in bringing in the novel features. To keep costs down, the margin for safety has been cut fine and yet reliability is one of the obvious requirements of a national machine serving physicists from throughout the country. But, after hearing them in action at this Conference, there is no doubting the enthusiasm or the confidence of the NAL team.

300 GeV

An invited paper on 'The 300 GeV accelerator in the European programme for high energy physics' was given by E. Amaldi. It was mainly concerned with the work of ECFA which was reported in CERN COURIER vol. 7, page 103.

As a sobering conclusion to this section on the big machines, here is a quote from a recent interview given to The Christian Science Monitor by the Brookhaven physicist S. L. Lindenbaum. 'I'm beginning to think that 200 GeV or even 1000 GeV is not even 'high-energy' physics. It looks as though we may have to go something like 20 000 GeV before we could expect to be in a region where things settle down, where even higher energies will not get us into a new realm of phenomena'.

Proposals for new accelerators

Omnitron

R.M. Main presented a paper on the 'Omnitron', a multi-purpose accelerator designed at Berkeley, USA. The machine consists of a fast-cycling synchrotron and a concentric storage ring, both 32 m in diameter designed to accelerate all ions from hydrogen to uranium. It would be used for research in nuclear chemistry, biology and medicine as well as medium-energy physics providing beams of energy or intensity considerable higher than from existing machines used for research in these fields.

Used as a proton accelerator an energy of 1.4 GeV and an intensity of about 10^{13} protons per second could be reached and for heavier ions energies varying from about 6 MeV per nucleon to several hundreds of MeV per nucleon would be possible depending upon how the system is operated. One method of operation involves acceleration in the synchrotron and transfer to the storage ring from where the ions may be drawn for experiments, giving long spill times, without affecting the acceleration process in the synchrotron. A second method of operation (which is a new concept) involves acceleration of ions with only a few electrons removed, transfer to the storage ring while the synchrotron magnet returns to low field, and then re-injection of the ions, with more electrons stripped off by passing through a thin foil, to be reaccelerated. It is this second method which can give energies of several hundred MeV per nucleon.

Two particular design features: pressures of 10^{-8} torr are required in the vacuum chamber (4x10 cm^2 in aperture) and it is hoped that it may be possible to operate as low as 10^{-10} torr; a double r.f. system is needed to cover the large frequency range and 4 low-frequency and 4 high-frequency cavities would be installed.

About four years would be required for construction at a total cost of about $ 25 M. Authorization was requested for fiscal year 1968, but was not forthcoming.

ING

P.R. Tunnicliffe from Chalk River, Canada, reported on the intense neutron-generator project (ING). The design has now moved away from the use of separated orbit cyclotrons (see CERN COURIER vol. 6, page 114) to the use of a linear accelerator, 1.6 km long, to give 65 mA of protons continuous at 1 GeV. The design features follow those of the Los Alamos machine mentioned below. The facility would be used for solid-state research, low energy nuclear physics, materials science research and isotope production, using intense fluxes of thermal neutrons. The beam could also be used for meson production for medium-energy physics.

Accelerator builders of the world unite at their 6th International Conference. (The photographs illustrating this article are Cambridge Electron Accelerator photographs by R. J. Levy.)

The neutron source, to give 10^{19} neutrons per second, would be a target of liquid lead bismuth. This target would be surrounded by heavy-water moderator to produce 10^{16} thermal neutrons per cm^2 per second.

The project is now being considered by the Canadian government. The cost is 130 M Canadian dollars and it is estimated that the machine could be completed in 1974.

LAMPF

A high intensity proton linear accelerator which has just passed from the proposal stage, since it received authorization in July at a cost of $ 50 M, is the Los Alamos Meson Physics Facility (LAMPF). It was described in an invited paper on super-intensity proton accelerators and their uses by D.E. Nagle. LAMPF will accelerate protons to 800 MeV with an average beam current of 1mA.

Excavation work has started for the 810 m long machine. The first four tanks will of the Alvarez type taking the beam to 100 MeV, followed by 44 tanks of waveguide type operating in the $\pi/2$ mode.

Linotron

A.A. Kolomensky from the Lebedev Physical Institute, USSR, whose quick wit was one of the unscheduled pleasures of the Conference, described his ideas for a linear accelerator system which could achieve energies many times greater than the nominal energy of the accelerator. He calls such a system a Linotron.

The idea involves bending back by means of a powerful magnet, the particles which have been accelerated through the linac so that they traverse it again in the opposite direction seeing fields reversed as compared with their first passage (i.e. still accelerating, since the particles are moving in the opposite direction). This process can be repeated several times to produce a total energy some multiple of the nominal energy of the linear accelerator.

When the slide projectionist flashed up a diagram showing two arrangements, Kolomensky said 'Here are two possible... or, maybe, impossible ... schemes for such a Linotron'.

Smokatron

The most interesting development in accelerator technology came from Dubna, USSR, in a report concerning a 'collective ion accelerator'. It was dubbed the 'Smokatron' since it accelerates particles in annular trajectories like a series of smoke rings. The ideas have been developed on paper before (for example by W. Walkinshaw of the Rutherford Laboratory) but this is the first time a serious experimental effort has been made. The project was initiated by the late V.I. Veksler.

The details of the work are not at all easy to get hold of, but the underlying idea is to set up a ring of electrons, capture protons in the potential well created by the ring, and then accelerate the ring dragging the protons with it. A comparatively modest peak electron energy would give almost 2000 times the energy to the captive protons.

The Dubna team are working on a model to give 1 GeV protons. Very high electron intensities are needed to produce a deep enough potential well — they start with 200 A for each ring. The electrons are held in their annular trajectories by an axial magnetic field and the rings are shrunk to 5 cm radius. Hydrogen is then fed in and stripped to give the protons. This much has already been achieved and the results agree well with the theory.

The next problems are to inject the rings into a linear accelerator and to accelerate them without losing stability. Specially shaped fields are required ; radiative energy losses have to be compensated ; excitation of the r.f. cavities by the intense electron beam has to be dealt with.

It is hoped to have the 1 GeV model ready early in 1968. The linac is 15 m long with 4 r.f. cavities. The design intensity is 10^{11} protons per pulse at 1 pulse per second. Some parameters for a 1000 GeV machine have been suggested — 1.5 km long with 3000 r.f. cavities ; 10^{12} protons per pulse at 10 to 100 pulses per second.

One further proposal which was not given at the Conference, but which will be an eagerly awaited paper to be published in the Proceedings, concerned a '150 GeV Midlands Accelerator' by L. Riddiford of the University of Birmingham, UK. There was some feeling in the corridors that a machine of this energy ought to be a national facility !

Three times 40 GeV

We have separated out from the section above three proposals for proton synchrotrons of energy around 40 GeV. Two of them come from Europe (France and Federal Republic of Germany) and can be seen as candidates to meet the recommendation of the European Committee for Future Accelerators that there should be 'a proton synchrotron of normal intensity at an energy intermediate between the 28 GeV and the 300 GeV machines'. The third proposal came from Japan.

Japan

The Japanese project was presented by S. Suwa, who leads the design team at the Institute for Nuclear Studies in Tokyo. The design energy is 42 GeV with an intensity of 10^{12} protons per pulse at 1 pulse per 2s. Injection will be at 125 MeV from a five-cavity linac giving 100 mA, into a magnet ring 400 m diameter. Combined function magnets will be used giving a peak field of 12 kG : the vacuum vessel aperture is 7.5 x 16 cm^2.

Since this is their first experience of large accelerator construction, the design has attempted to keep the machine as simple as possible to ensure reliable operation. It is hoped that full approval for the project at a cost of $ 83 M ($ 40 M for the machine itself) will be obtained by the end of this year by which time a site should have been selected. Construction could then start in 1968 and the completion date is given as early 1973.

Saclay

The French project was presented by R. Levy-Mandel from Saclay. The full scheme is for a 45 GeV machine with 10^{12} protons per second but a two-step approach has been considered, going first to 23 GeV. The cost of the first step is estimated at 288 M FF, considerable saving being achieved by using some of the existing facilities of the 3 GeV Saturne accelerator, such as the power supply, shielding, *R. R. Wilson, Director of the National Accelerator Laboratory, USA, giving his animated description of the new 200 GeV design.*

cooling system, beam-transport magnets and the Saturne hall as an experimental area.

The full 45 GeV machine would cost 365 M FF instead of 492 M FF for a machine built on another site. The injector is a 100 MeV, 48 mA linear accelerator, feeding a magnet ring 364 m in diameter. The existing design is for combined function magnets giving a peak field of 12.6 kG ; the vacuum vessel aperture is 8.4 x 14.6 cm². The possibility of using separated function magnets will be examined. An experimental area lay-out has been prepared and was described in a paper by J. Parain. An investigation of relative costs of having beam transport in underground tunnels, excavated channels or in tunnels constructed of shielding blocks came down heavily in favour of underground tunnels.

If the project is authorized, construction could start in 1968. The 23 GeV step could be completed in 1973 and the second step achieved two years later. The start of the new accelerator would lead to the shutdown of Saturne and the Orsay electron linac.

Karlsruhe

The proposal from Karlsruhe in Germany (presented by W. Heinz) has emerged only recently. It is for a 40 GeV machine to give 10^{12} protons per second. Injection into the main ring is via a 30 MeV, 10 mA linear accelerator and a separated function, 2 GeV booster synchrotron with three stacked rings of 100 m diameter. With this high injection energy the vacuum vessel aperture in the main ring, 300 m diameter, is down to 4 x 8 cm² and the magnet size (and thus the main ring tunnel size) is greatly reduced. Peak field is 13.6 kG. The design team have evolved a new unit (which puts their magnet in a particularly favourable light) for comparing accelerator magnets — their magnet gives 16.9 MeV/ton.

The cost estimate is 121 M DM (65 M DM for the machine itself and 56 M DM for the associated buildings). Another year is considered necessary to finalize the design and it is estimated that if authorization were forthcoming, the machine could be completed in 1972.

When the last of these three proposals had been presented, G.K. Green of Brookhaven commented that he considered it unfortunate that none of the designs had incorporated the experience of CERN and Brookhaven concerning such things as the demand for high intensity. Machines of this energy could be expected to serve many users for many years and high intensity is a desirable design feature from the start.

Machines in operation

Several Laboratories reported on the operation of their accelerators. A few of particular interest, since they are machines which have only recently been completed, are mentioned here.

A. Alikhanian was able to announce that the 6 GeV electron synchrotron at Yerevan, USSR, had operated for the first time on 31 July when a beam was accelerated to 3 GeV.

R. Littauer from Cornell University also reported on first operation. The 10 GeV electron synchrotron at Cornell accelerated beams up to 4 GeV in May 1967 (only two years after the start of construction). Construction work is still going on as commissioning proceeds. The magnet field for 10 GeV is very low (3.4 kG) and there are definite plans for acceleration to 15 GeV. The magnets could cope with 20 GeV or above but more r.f. power would have to be provided. No trouble has been experienced with the vacuum — there is no vacuum vessel between the poles of the H magnet and the full aperture (2.5 x 5 cm²) is available to the beam ; pressures of a few times 10^{-6} torr are achieved very easily.

M.C. Crowley-Milling reported on the 4 GeV electron synchrotron NINA at Daresbury, UK, which came into operation at the end of 1966. Very intense beams are available from the machine ; currents up to 40 mA have been accelerated to 4 GeV and the average is around 30 mA. An ejected beam is available with efficiencies of around 50 %. It is hoped to inject a position beam early in 1968. The possible addition of a large ring, which would be fed from NINA and which would accelerate the electrons further to 15-20 GeV, is being considered.

Brookhaven

Since the 33 GeV Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory is America's twin to the CERN machine, there was particular interest in the two papers on AGS operation (given by A. van Steenbergen) and the AGS improvements programme — known there as the AGS conversion project — (given by G.W. Wheeler).

Operation

Experimental teams at Brookhaven have exerted the same pressure as those at CERN for higher beam intensities and for multiple use of the accelerated beam on one pulse. The machine intensity has been steadily improved to a peak of 2.2 x 10^{12} protons per pulse and the average intensity is in excess of 1.5 x 10^{12}. Multi-turn injection for 5 to 10 turns is used. The operation time divides into 75% for experiments, 9% for machine physics and the rest for maintenance, start-up and machine failures.

Left to right, A. Merrison, G. Pickavance, E. Amaldi, three of the leading figures from the European accelerator world, pacing the sands at Castle Hill during an afternoon's excursion from the Conference.

There are two fast ejected beams and five internal targets. A slow ejection system is being installed and is expected to be in operation early in 1968. A typical beam pulse will use a fast ejection system and internal targets during the rise time and, initially, one internal target on the flat top which is up to 500 ms long. (The pulse repetition rate is about one every 2.1 s). The machine is almost always operated at nearly full energy (28 to 30 GeV).

Nine or ten electronics experiments are installed in the experimental areas at any one time (two of these are on-line to a small computer) and three hydrogen bubble chambers (76 cm, 79 cm and 2 m) are in use. No neutrino experiments are being carried out at the present time ; one muon beam with two branches is available.

Improvements

The improvements programme is very similar to that of CERN involving an increase in intensity per pulse, an increase in pulse repetition rate and additional experimental facilities. The total cost of $ 47.8 M has been appropriated.

The intensity per pulse will be increased to 10^{13} by replacing the present 50 MeV linac by a 200 MeV, high brightness, linear accelerator. It is being designed to give 200 mA at a pulse repetition rate of 10/s with a pulse length of 200 μs. Initially r.f. power will be available for only 100 mA (an extra 20 MW will be needed to cope with 200 mA). The linac will be 145 m long, with 9 cavities, the last eight of which will have multi-stem drift-tubes for increased stability. The r.f. frequency is 201.25 MH and the peak power 22 MW. Two pre-injectors, using 750 kV Cockcroft-Walton sets and duoplasmatron ion sources, will be available. Design of the system is essentially complete and the ground has been cleared for construction. Estimated completion date is the end of 1970.

The increase in pulse repetition rate involves the acquisition of a new power supply, to double the voltage at the magnet to 12 000 V, and new r.f. cavities to double the energy gain per turn to about 200 keV. The repetition rate would then be a maximum of one per second for 32 GeV with no flat top ; flat-tops of 1 s at 32 GeV or 4 s at 30 GeV would be possible. Tenders for the power supply have been received and it is hoped to have it in operation late in 1969. New r.f. cavities are being designed to provide a peak voltage per station three times higher than at present so that the number of stations can be reduced from 12 to 8. A prototype of the associated r.f. amplifier is being tested.

The increase in intensity and repetition rate necessitates other modifications to the synchrotron ring. Brookhaven already experience considerable problems due to high radiation levels and to cope with the future, practically the whole ring, with the exception of the magnets, is to be renewed. A stainless steel vacuum chamber, with metal seals, will be installed together with 240 sputter-ion vacuum pumps. A more radiation resistant insulation is being used on magnet coils as they are replaced. The problem of attention to damaged magnet coil insulation will be eased by incorporating quick-release devices for the water and power connections on each magnet. The ring tunnel will be reinforced in the regions of the extraction systems and internal targets, to enable more sand to be added on top for shielding.

The new experimental facilities include an addition of a 4 600 m² experimental area adjacent to the existing East Experimental Building, and an additional 2 300 m² to the West Building. The slow ejected beam will be taken into the East extension for electronics experiments and a new fast ejected beam will be set up for the North Area, hopefully to feed a 4.2 m hydrogen bubble chamber (which is not itself part of the improvements programme and has not yet been authorized).

Storage rings

The sessions on storage rings were weakened by the absence of the Novosibirsk team but were given point by the announcement of experimental results from storage rings at Novosibirsk (using the 2 x 700 MeV electron-positron ring) and at Orsay (using ACO the 2 x 500 MeV electron-positron ring). It is rather easy to forget at an Accelerator Conference that this is what we are building accelerators for.

Both Laboratories looked at the rho meson produced by the e^+e^- collision, observing the decay of the meson into two pions. The Novosibirsk measurements were particularly thorough. By varying the collision energy they were able to sweep over the range around the mass of the rho and found a very sharp peak with a mass width of 93 MeV compared with values of 120 MeV and above, coming from previous experiments. This colliding beam method of looking at the rho is much cleaner than the conventional methods since the observation is not complicated by the effects of the presence of other particles such as target nuclei. It confirms that the measured values of mass and width from conventional experiments have to be treated with care until they can be looked at in cleaner situations.

The same experiments on the rho are also saying something about the branching ratio into e^+e^- (by observing the other branching ratio into pions). This is one of the checks on such theories as the quark model and the preliminary results are so far in agreement with theory. An important comment on these results is

A.A. Kolomensky from the Lebedev Institute, USSR, makes a point during discussion in the corridors.

that, for the first time, a significant contribution is being made by colliding beam experiments.

The host Laboratory, with the 6 GeV Cambridge Electron Accelerator, are busy with their project for colliding beam electron-positron experiments up to 3.5 GeV by the addition of a bypass. The bypass is an arc added outside the existing ring spanning about 1/5 of the circumference. In the by-pass, it is hoped to achieve luminosities over 10^{31} per cm^2 per second (the beams will be concentrated as they pass through the bypass so as to yield high interaction rates). A new 100 MeV linac for electrons and positrons is at an advanced stage of installation and it has already been shown that 3 GeV electron beams can be started in the CEA for an hour with the magnet running d.c.

A.M. Sessler reported the work he had done with E. Keil, during his recent stay at CERN, on the 'performance capabilities of proton storage rings'. They have calculated the luminosities which could be achieved in idealized storage rings — in other words they did not work from a given physical arrangement, but fed into their calculations the effects of low β sections and various limitations such as available apertures and phase space densities. Their conclusion is that in terms of luminosities, and therefore interaction rates, storage rings have possibilities far beyond what had been thought. For example, they estimate that with 25 GeV protons luminosities in the range of 10^{36} per cm^2 per second could be achieved.

Superconductivity

The use of superconducting magnets in the design of accelerators and their associated equipment may be of very great importance in the future. The obvious use of superconductivity for d.c. components such as some beam-transport equipment or bubble chamber magnets has already been applied or is being applied in several Laboratories.

Superconducting linear accelerators have been thought about for several years and, following their success with a small-scale cavity, such a project is now being pursued intensively at Stanford. They are doing design work and model studies for a 153 m electron linac to give 100 μA continous beam at 2 GeV. Large scale cryogenics experiments with a 300 W superfluid helium refrigerator are scheduled to start in a few months time. Such a system would be adequate for the 153 m accelerator. Also, a preliminary design study for a 7 GeV proton linear accelerator has been done at Karlsruhe.

A really important advance would be possible, if it could be shown that the use of high field superconducting magnets was feasible under the pulsed conditions involved in the operation of a synchrotron. A paper on this subject was given by W.B. Sampson from Brookhaven. There is no sign of a breakthrough yet, but the progress of their work will be followed with great interest.

Special Sessions

Two informal discussion sessions were organized for the last day of the Conference on high intensity effects and on boosters. This followed the example of the Frascati Conference two years previously, where a special session was organized on the initiative of A.M. Sessler and proved very successful. After a few days of a formal programme, it becomes obvious in the corridors which are the bubbling topics and the chance to discuss these fully in an informal manner is very useful.

On space charge, many of the long-known effects are now well understood and possibilities exist to reduce them. However, the number and variety of considerations which need to be taken into account is formidable, especially now that the stringent requirements of storage rings are being considered in the initial design of accelerators. The problem of getting through transition which loomed large a few years ago is no longer considered a problem in itself but to get through transition without serious effect on the beam quality is still a worry.

On boosters, the controversy concerning fast-cycling versus slow-cycling systems is still alive. The question hinges on whether one accepts the long filling time into the main ring, implicit in a fast-cycling booster, or whether one believes that multiturn ejection from a slow-cycling booster, giving much shorter filling-time, will be mastered in the near future.

Designing a booster is, in fact, more complicated than designing a main ring. This is basically because the main ring is much more demanding about its input from the booster than the experimenters are about their input from the main ring.

And that statement on priorities of machines versus experimenters seems a most appropriate note on which to end a report of an Accelerator Conference.

CERN News

Charles Mallet

It was with deep regret that we received the news of the death on 1 October of Mr. Charles Mallet, a senior member of the Study Group on the 300 GeV accelerator project in the ISR Division.

Charles Mallet had a distinguished career. In 1938, he was appointed engineer in the Ponts et Chaussées (Public Works Dept.) in France and went to Algeria to work in the Irrigation Service of the Department of Oran. From 1943 to 1945, he was Secrétaire général de la Reconstruction in Tunisia, Ingénieur en Chef du Service des Etudes et Travaux. He was responsible for the construction of 70 bridges, in particular, the one at Djedeida, which was the first large pre-stressed concrete bridge to be built. He was involved in the construction of the port of Tunis, la Goulette, in the reconstruction of the ports of Sousse, Tunis and Sfax, numerous town-planning schemes and in the development of a system of dams for supplying drinking water to Tunis.

He spent the years from 1945 to 1950 in Algiers as Ingénieur en Chef des Etudes Générales et Grands Travaux, Directeur de l'Hydraulique, and supervised the construction of the dams at Oued Sarno and Foum el Cherza and the Siphon at Fergous. From 1950 to 1959, he began a career as a private consultant engineer in Morocco.

Having returned to the civil service in 1959, he was seconded to CERN in Geneva as Head of the Site and Buildings Division. Since October 1965, he had been a leading member of the Study Group for new accelerators in the ISR Department, responsible in particular for the geological and geotechnical study of the sites proposed for the European 300 GeV synchrotron.

Charles Mallet published numerous articles in scientific and technical journals throughout his career. His book « Les Barrages en Terre » (Editions Eyrolles, 1951) is a standard reference book all over the world. His last book, « Problèmes de fondation des grands accélérateurs de particules » was published this year. It was written in collaboration with Jean Gervaise, who is also a member of the Study Group on new accelerators.

Austria supports 300 GeV

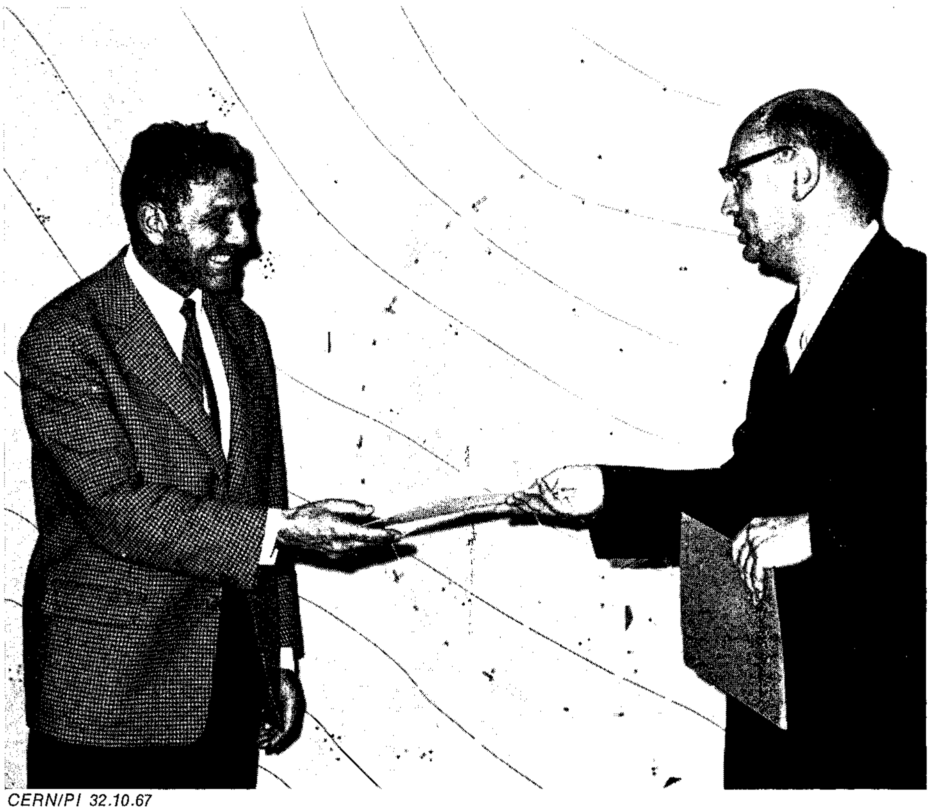
On 11 October, Mr. R. Martins, Ambassador and Permanent Representative of Austria to the International Organizations in Geneva, handed a 'letter of intent' to the Director General, Professor B. Gregory, from the Austrian Minister for Education, Mr. Th. Piffl-Percevic.

The letter stated that Austria is prepared to collaborate in the European 300 GeV accelerator project, provided that there is a strong participation from the other Member States of CERN and that 80 % of the estimated cost is covered by all the States collaborating in the project, before it begins. The scale of financial support will be decided on the basis of the financial arrangements prevailing in the Organization at present (Austria's contribution to CERN is currently 1.90 %).

This decision of the Austrian Government means that the number of Member States who have stated their willingness to join the 300 GeV project now stands at three — the other two being Belgium and France.

CERN/PI 4296

Charles Mallet photographed in August 1961 working at CERN as head of the Site and Buildings Division.

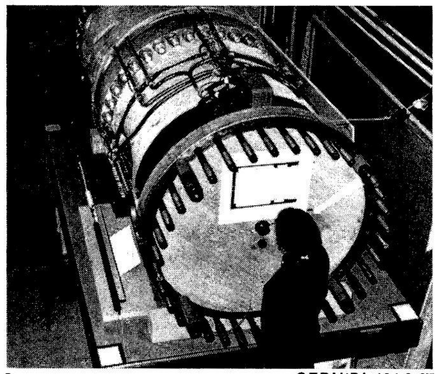


CERN/PI 32.10.67

The Austrian Ambassador, Mr. R. Martins hands to the Director General the letter of intent to join the 300 GeV project. In the background is a model of a possible site layout for the accelerator.

Photographs taken on the Family Day.

1.



2. *CERN/PI 184.9.67*

Family Day

The Family Day on Saturday 23 September attracted 2351 people to CERN. The figure is known exactly because people were counted through the gates in order to identify the 60 000th visitor to CERN. This was Madame Pinaud, wife of Claude Pinaud from Finance Division, who received from the Director General (photo 1) a free ticket to Berne (or the equivalent) for herself and her family. This prize was kindly donated to CERN by Swissair.

The day was blessed with beautiful weather which showed the site at its best. The various Divisions had prepared displays of their work. The 600 MeV synchro-cyclotron was open and was a very popular attraction as also was the computer room and the display of the Nuclear Physics Apparatus Division (photo 2 shows a visitor confronted with the heavy-liquid bubble chamber which has now been replaced for neutrino experiments by one of larger volume). The Proton Synchrotron Division scored a great success with its ping-pong ball and compressed air model of the way in which the linear accelerator works (photo 3).

The Staff Association also had an exhibition and the various clubs had displays (such as the very sophisticated stand of the Club Hippique, photo 4) or were in action (or waiting to go into action like the basket-ball players in photo 5).

Films were shown in the Main Auditorium, the Council Chamber and the Theory Conference Room. Coaches toured the impressive excavation work on the Intersecting Storage Rings site. Parents could even free themselves of their children in a specially prepared playground.

Waiting for 'Gargamelle'

While the engineers and technicians at Saclay are busy with the construction of 'Gargamelle' the large (12 000 litres) heavy liquid bubble chamber, the Technical Services and Buildings Division at CERN are preparing the buildings and equipment needed to receive the new chamber at the end of the neutrino beam-line. The chamber is scheduled to come into operation in 1969 and the cost of its construction is estimated at 12 million Swiss Francs.

The main building, where the chamber will be placed is 30 m long and 17 m wide, with 9 m in height under the crane bridge. The crane can support 60 tons and the foundations will withstand 30 tons/m². Various safeguards are necessary in the construction of the building because of the use of propane, a potentially explosive liquid, in the chamber. The wall panels will be of light material which will break off if the internal pressure rises to 500 kg/m². The building has concrete foundations, a metal frame (see the cover photograph), light panelling (a material called 'Durisol', which is made of compressed wood fibres, will be used) and a light alloy ('Aluman') roof.

Construction work began on 16 February this year and has proceeded since then, apart from the weeks when the present neutrino experiments were running. The foundations were completed on 17 June. They involved pouring 184 m³ of concrete and using 12 tons of reinforcement. (The work was carried out by the Société Aixoise de Construction.) Ventilation shafts were sunk in the floor to evacuate the propane in case of leaks. The main building work which remains to be done is to prepare the large concrete block (150 m³ of concrete with 12 tons of reinforcement) which will support the chamber itself. The block will be faced with special material and will support 150 kg/cm².

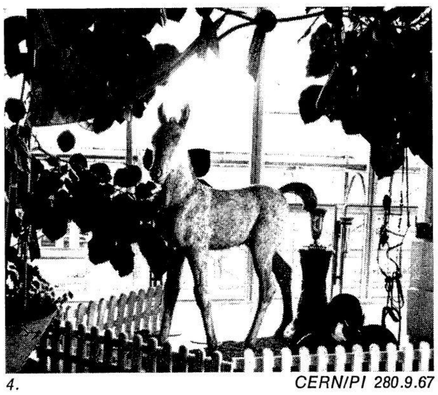
Assembly of the frame of the building, which weighs 138 tons, took place from 5-22 September. Positioning of the main cross beams each weighing 15 tons, was the trickiest operation.

When the present neutrino experiments are finished, the preparation of the 'Gargamelle' building will be started again. The completion date is mid-January 1968 and installation of the various power supplies, ventilation system, etc. can then begin.

ISOLDE

Late news — On the evening of 16 October, proton beams from the 600 MeV synchro-cyclotron were directed for the first time onto the target of the isotope separator on-line, ISOLDE. Isotopes were produced and separated in sufficient quantities for experiments to be carried out. The technical performance of the equipment was up to expectations and the shielding was proved to be adequate. After this very encouraging start, the various components will be optimized in preparation for the experiments. (For a description of ISOLDE, see CERN COURIER, vol. 7, page 23.)

3. *CERN/PI 177.9.67*



4. *CERN/PI 280.9.67*

5. *CERN/PI 189.9.67*

35th Session of CERN Council

Tête-à-tête during the Council Meeting:
1. P. Lapostolle (left) and Prof. F. Perrin, French delegate to the Council
2. The President, Dr. G. Funke (sitting), and Dr. K. Herndl, from Austria
3. The Director General, Prof. B. P. Gregory (left) and the chairman of the Scientific Policy Committee, Prof. G. Puppi.

The Council held its 35th meeting at CERN on 21 and 22 September, with Dr. G. Funke as President. The meeting opened with tributes by the President to the late Sir John Cockcroft and the late Professor Arnold Schoch.

The Convention

The main purpose of this special session was to carry the revision of the CERN Convention to its final stage. This revision is to enable the proposed new Laboratory, which would house the large 300 GeV accelerator, to be operated under the same Council, Scientific Policy Committee and Finance Committee as the Laboratory at Meyrin. It has been obvious that the Member States attach great importance to ensuring that the revised Convention retains the spirit of the existing one, which has worked so well for many years. It has proved to have the right safeguards for the participating countries and yet to have sufficient flexibility to meet the somewhat unpredictable needs of sub-nuclear physics research.

Since the June Council session, there have been meetings of specialists in Stockholm and Geneva attended also by legal experts and the wording of the Convention, on such topics as the preservation of the rights of existing Member States (some of whom, for example, may not be able to join in future projects), voting procedures, financial provisions, etc., has been improved. The programme of activities of the Organization is to be specifically defined in the Convention though other activities could be added. Initially, the basic programme will comprise just the one programme of the Meyrin Laboratory (involving the 28 GeV proton synchrotron and the 600 MeV synchro-cyclotron) to which all Member States must belong. The construction of the intersecting storage rings at the 28 GeV machine, and the construction and operation of a Laboratory with a proton synchrotron for energies about 300 GeV are activities which can be added to the basic programme at a later date. The 300 GeV, in particular, is expected to be added once the machine is operational. Any change in the programme shall require approval by a two-thirds majority of all Member States and participating countries, but the Meyrin Laboratory can cease to be part of the basic programme only if no participating country votes to the contrary.

There was considerable discussion on the desirability of feeding into the Convention itself some stipulation about control of the financial ceiling associated with a project, to be tied to the stipulation on control of the minimum period of participation in a project. The UK delegation in particular was concerned to guard against the possibility of being committed to a project of escalating costs and to have, at the outset, a very clear idea of financial commitments in order to be able to prepare reliable forward estimates for the national science budget.

Up to now, such a stipulation has not been specifically written into the Convention and the necessary financial framework has appeared in the 'working document' associated with each project. This method is rather more flexible, since a working document can be modified more easily if a major change in aims or circumstances arises, under the control of the Council by a majority decision, whereas the Convention can only be changed by a unanimous decision. CERN will prepare a working document on the 300 GeV project to be considered at committee meetings in November prior to the next meeting of the full Council on 13 and 14 December.

Apart from the above topic which will be the subject of further discussion, the revised Convention emerged from this Council meeting with the general approval of all the Member States. The wording of some sections remains to be polished and it is hoped that the final version will be ready for the December meeting to be passed to governments.

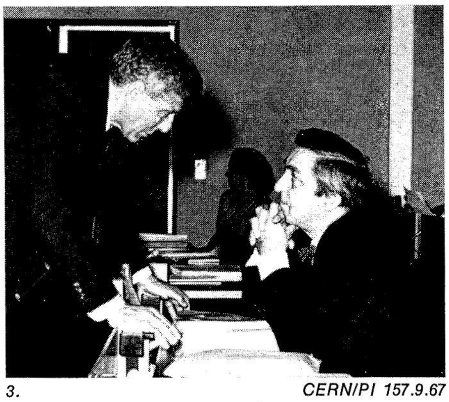
300 GeV project team

Professor E. Amaldi and Professor W. Jentschke conveyed some of their impressions from the recent Cambridge accelerator conference (see page 199). They both remarked on the vigour and enthusiasm of the team which has been set up under Professor R. R. Wilson in the USA for the 200 GeV project. Professor Amaldi emphasized that the USA accelerator may well be in operation earlier than previously anticipated and that it was most important for Europe to regard the estimated completion date of 1976 for the 300 GeV project as a latest date and not one which could be moved back. Professor Jentschke said he was convinced that the American machine would be improved to 400 GeV very soon after its initial operation.

Professor G. P. Puppi commented that there is no real criterion for a precise selection of maximum energy in this new

1. CERN/PI 160.9.67

2. CERN/PI 158.9.67



3. CERN/PI 157.9.67

high energy range. The 300 GeV design has been optimized for its technical feasibility and its overall reliability. It is a sound basis for going ahead. Professor Puppi also reported for the Scientific Policy Committee on the desirability of selecting the 300 GeV project leader and the top staff of the construction team as soon as possible. This has been done for the 200 GeV project in the USA, which has still not received final approval, and has helped a great deal in raising enthusiasm for the project. It has also made possible the recruitment of accelerator physicists from America and from Europe. If selection of the 300 GeV team is not initiated soon, Europe may well lose some of its best people to the American project.

The President was authorized by the Council to work out methods of setting up the 300 GeV project team.

Site selection procedure

Mr. J. H. Bannier presented an interim report of the Site Evaluation Panel (J. H. Bannier, Netherlands; A. Chavanne, Switzerland; J. K. Bøggild, Denmark, each representing countries who have not offered sites for the 300 GeV Laboratory). The panel has the task of establishing criteria and procedures for the selection of a site and, on this basis, of making a first evaluation of each of the nine remaining site proposals. The preliminary work was presented to Council to ensure general agreement with the lines being followed.

On the question of criteria the panel have drawn up a list of factors in three categories.

The first concerns the construction and development of the Laboratory, including such factors as the size and shape of the site, the possibilities for extension, etc.

The second concerns the operation of the Laboratory, with consideration of the availability and quality of cooling water, availability and price of electricity, etc.

The last category concerns features directly affecting the personnel. These include housing, education, etc.

Information on these factors for the respective sites is contained in the site reports presented to the Council in June 1967 (CERN/644/Rev.), and in the replies given to a questionnaire concerning social matters. Dr. Bjerrum, the consultant geologist, continues his work clarifying data in the site reports. Mr. Bannier remarked that some selection on the basis of the technical aspects, particulary the first category, had effectively already been applied in narrowing the number of site proposals down to nine. They could all be expected to be acceptable and fairly close as regards these factors. This increases the relative importance of the other two categories. For all three categories, the selected site should be well above the acceptable minimum.

Social and personnel aspects will have a great influence on the success of the 300 GeV Laboratory. Whereas technical faults can usually be cured by greater expenditure, failure to attract the right personnel to the site could be a very damaging fault and most difficult to cure. Whereas the research physicist will undoubtably be lured to the big machine no matter where it is situated, the laboratory will be in competition with other attractive projects for its vital engineers.

The Site Evaluation Panel is working towards having its report ready for the December Council meeting, giving their first evaluation of the sites and suggesting the procedure for the final selection.

Serpukhov; Bubble Chamber

The meeting concluded with two brief reports from the Director General, Professor B. P. Gregory, on the progress of the collaboration with Serpukhov and of the construction of the very large hydrogen bubble chamber.

Design of the fast ejection system and of the radio-frequency separators, to be provided by CERN for the 70 GeV proton synchrotron at Serpukhov in the USSR, are well advanced and will be presented for discussion at Serpukhov very soon. Agreement is near on the first electronics experiment to be carried out by a joint CERN-Serpukhov team as soon as the experimental programme starts at the machine.

The Steering Committee for the hydrogen bubble chamber project has met and has taken all the necessary decisions to start construction of the chamber.

Sir John Cockcroft

With the death of Sir John Cockcroft at Churchill College, Cambridge, on September 18, CERN has lost a father figure in more senses than one. The technique of investigating the make-up of the nucleus by bombardment with other nuclei or nuclear components of high energy, goes back to the very early days of the discovery of radioactivity. In the beginning, this technique was limited to the use of natural radioactive decay products of significant energy but low intensity. Only when physics insight could be allied with the advancing technology of electrical engineering did the technique assume a new power. Cockcroft and Walton's proton accelerator of 1932, which for the first time demonstrated the transmutation of an element by artificial means, not only opened the way to our present world of particle physics but was a major milestone along the road of the 'atomic age'.

John Cockcroft was born in 1897 at Todmorden in Yorkshire, England, and soon showed his intellectual qualities. He gained a scholarship to Manchester University, but war interrupted his academic career and after serving in the Signals he returned to Manchester to become a student apprentice at Metropolita-Vickers the well-known electrical engineering company, now AEI, and to study at Manchester College of Technology. He was encouraged to move to Cambridge where having gained high mathematical honours from St. John's College he became one of the fortunate young men to come under the influence of the fabulous Rutherford. There his engineering training and mathematical ability were a major asset to the team.

Particle physics research did not however hold him and during the latter part of the thirties he was engaged upon research into the secrets of radar which was to assume such military significance. It was here no doubt that he was able to gain experience in the complex world of military science which was to assume such importance with the development of nuclear weapons and was to bring the scientist down for ever from his ivory tower to the very forefront of public life.

For his pioneering work in particle physics he received an FRS and in 1951 the Nobel Prize, but it was as founder of the UK atomic energy effort and then head of the Atomic Energy Research Establishment, Harwell, and Member of the AEA for Research that his name became a household word the world over. He was knighted in 1948, made KCB in 1953 and awarded the O.M. in 1957.

From being head of the joint team in Canada, he was called to London in 1945 to start the planning of the UK programme and he was the first to see that the hopes of a return to a pre-war academic approach to the new physics could no longer be entertained. To the establishment of Harwell and to its subsequent running he brought his own individual flair which still left a sense of University life even when the exigencies of military and commercial interests had made the exchange of information even internally difficult.

To his colleagues and staff his reticence at times could be disconcerting but it was a characteristic that was respected by the non-technical political authorities, who in the post-war era were so much out of their depth. Coupled with a strong personal decisiveness and a not inconsiderable political acumen he was a valued consellor of governments and he was an outstanding example of the post-war scientific man of influence. At the same time, he had an understanding of the importance of information media and a natural skill at handling the press or presenting new ideas to the public.

The early structure of NIRNS, the National Institute for Research in Nuclear Science, who initiated the two national high-energy physics Laboratories in the UK, as well as the pattern of University reactor development owed a great deal to the personal intervention of Sir John.

During the formative days of CERN, the UK retained the status of observer, but this did not prevent his playing a major part in the preparation of the Organization and it will be remembered that the UK was the first to ratify the Convention. He continued for some years to participate fully in the work of the Scientific Policy Committee and his interest in the work of CERN intensified when he became, in 1958, the first Master of Churchill College.

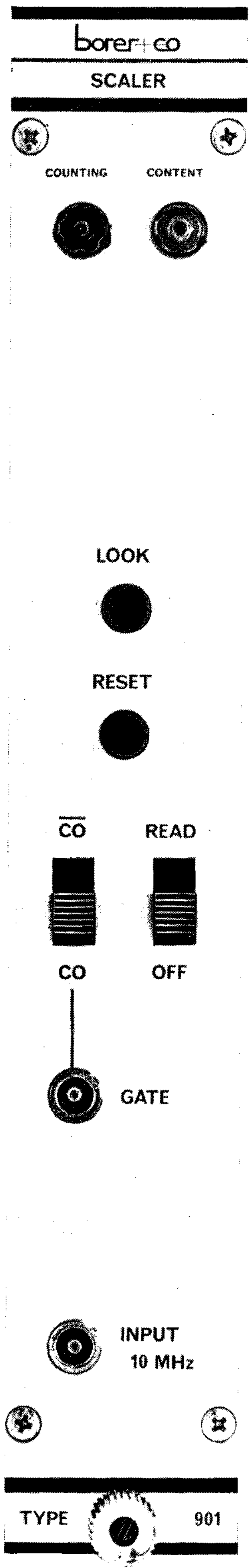
The news of his death will have shocked and surprised the many who have come under his influence. At the 21st birthday party at Harwell in January of this year, where the illusion of time inversion was almost complete, the passing years had seemed to touch him least of all.

In the words of Dr. Funke, President of the CERN Council 'We shall remember him as one of the great men who made it possible — first by his pioneer work in particle physics and later by helping to create CERN — for us to be at CERN, where new generations of scientists continue the search not only for a better knowledge of nature but also a better understanding of man'.

Sir John Cockcroft examining bubble chamber photographs at CERN during his visit in 1962.

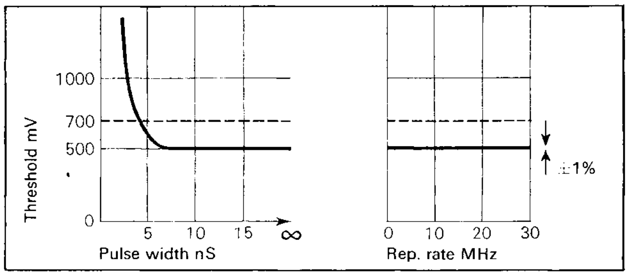
CERN/PI 6085

If you want to be certain of your scaler counting accuracy ■ ■ ■ ■ ■ ■ ■ read on



The input-and gate-circuits of the new AEC-NIM-Module Scalers are designed to enable you to forget about pulse conditioning! A useful two-lamp feature shows actual operation of each scaler. The 'counting' lamp flashes when the scaler accepts a pulse. The 'content' lamp indicates difference from zero.
By pressing the 'look' button of any scaler the contents can be seen on a central display unit.
A wide range of readout equipment is available.
The scalers can be interfaced to fast on-line computers with a readout speed as high as 32 x 10⁶ bits/sec.

Input characteristics Scaler Type 902



Many different types are available to meet your specific requirements.
Counting speed of 10, 30 or 100 MHz
with or without input discriminator
with or without gating facilities, coincidence or anti-coincidence

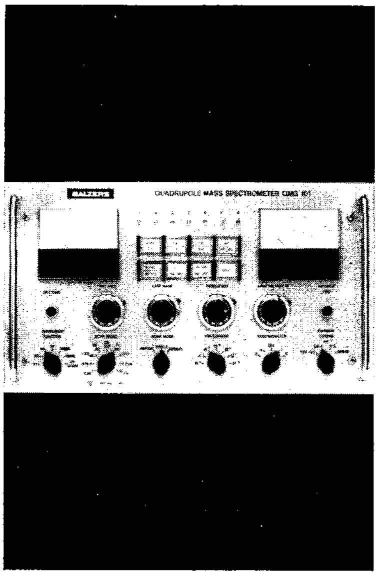
Please ask for full technical literature!

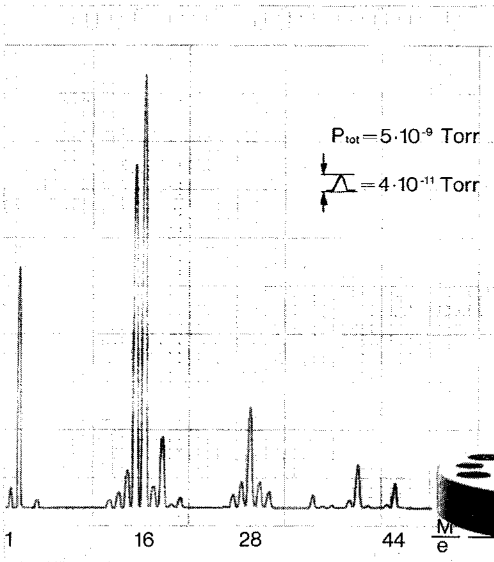
ELECTRONICS
borer+co

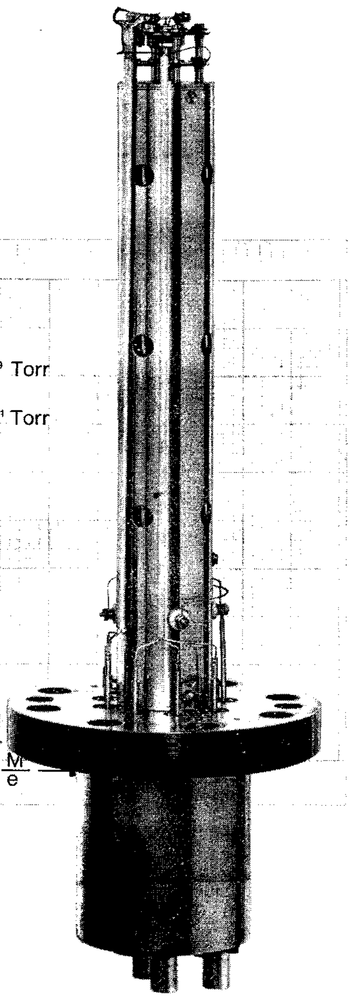
Switzerland: Heidenhubelstrasse 24, Solothurn
Telephone 065/2 85 45
Great Britain: 36 East Street, Shoreham-by-Sea, Sussex
Telephone 4305
Germany: Verkaufsbüro München, Kaiserstrasse 10, D-8000 München 23
Telephone 34 80 16
France: Sorelia Electronique, 150 rue de Chatou, 92 Colombes
Telephone 782.16.39-782.32.79
Italy: Boris G. F. Nardi, Via Capranica 16, Milano
Telephone 2362924-2361394

Partial Pressure Measuring Instrument QMG 101

Sensitivity $10^{-13} - 10^{-14}$ Torr
Mass range 1—400







- Accurate and rapid residual gas analysis in high and ultra-high vacuum systems;
- Measurements in space simulation chambers and particle accelerators;
- Residual gas measurements in work processes;
- Leak detection in high and ultra-high vacuum systems.

. . . a few typical fields of application where partial pressure measurement is particularly useful.
For many requirements of research, and to an increasing extent in industrial production, accurate and rapid information on the gas composition in high and ultra-high vacuum equipment is essential. A high standard of efficiency is required of the measuring instruments. In view of the very wide field of application, greater reliability in operation, more compact construction and simplicity of operation and maintenance are expected.

BALZERS partial pressure measuring instrument QMG 101, which symbolises our many years of experience, satisfies these requirements to a large extent. With this instrument residual gases can be analysed rapidly, reliably and with high sensitivity; as a quadrupole mass spectrometer, it works on the principle of mass separation in the high frequency, electrical quadrupole field.

Major features of the QMG 101

- Two mass ranges can be selected: 1 to 100, 10 to 400. Choice of mass setting.

Any mass number can be selected, linear throughout the whole range or partial range in fuely staged scanning speeds.
- Partial or total pressure measurement.
- Sensitivity to 1000 A/Torr (with multiplier).
- Secondary electron multiplier (multiplier) for improving the sensitivity and oscillographical recording of rapidly changing processes.
- Good resolution ($\frac{M}{\Delta M}$ 10 % = 100)
  The resolution can be readily adjusted to suit particular problems and reproducible setting.
- The analyser can be baked-out up to 400° C. The high precision rod system provides perfect and reproducible mass separation, and can be very easily dismantled and re-assembled if necessary.
- Open, immersion ion source, which can be effectively out-gassed by ion bombardment. The hot cathode is protected against excessive pressure rise, and can be changed without additional adjustment.
- Very compact construction; the complete supply and control instrument is contained in only one 19″ rack unit.
- Indicating instruments and controls are clearly visible for simplicity of operation.
- The instrument is non-magnetic and therefore free from stray magnetic fields.

BALZERS will be pleased to supply full details.

BALZERS®

HIGH VACUUM TECHNIQUE

BALZERS AKTIENGESELLSCHAFT
für Hochvakuumtechnik und Dünne Schichten
FL-9496 Balzers · Fürstentum Liechtenstein

DN 1500 e