CERN

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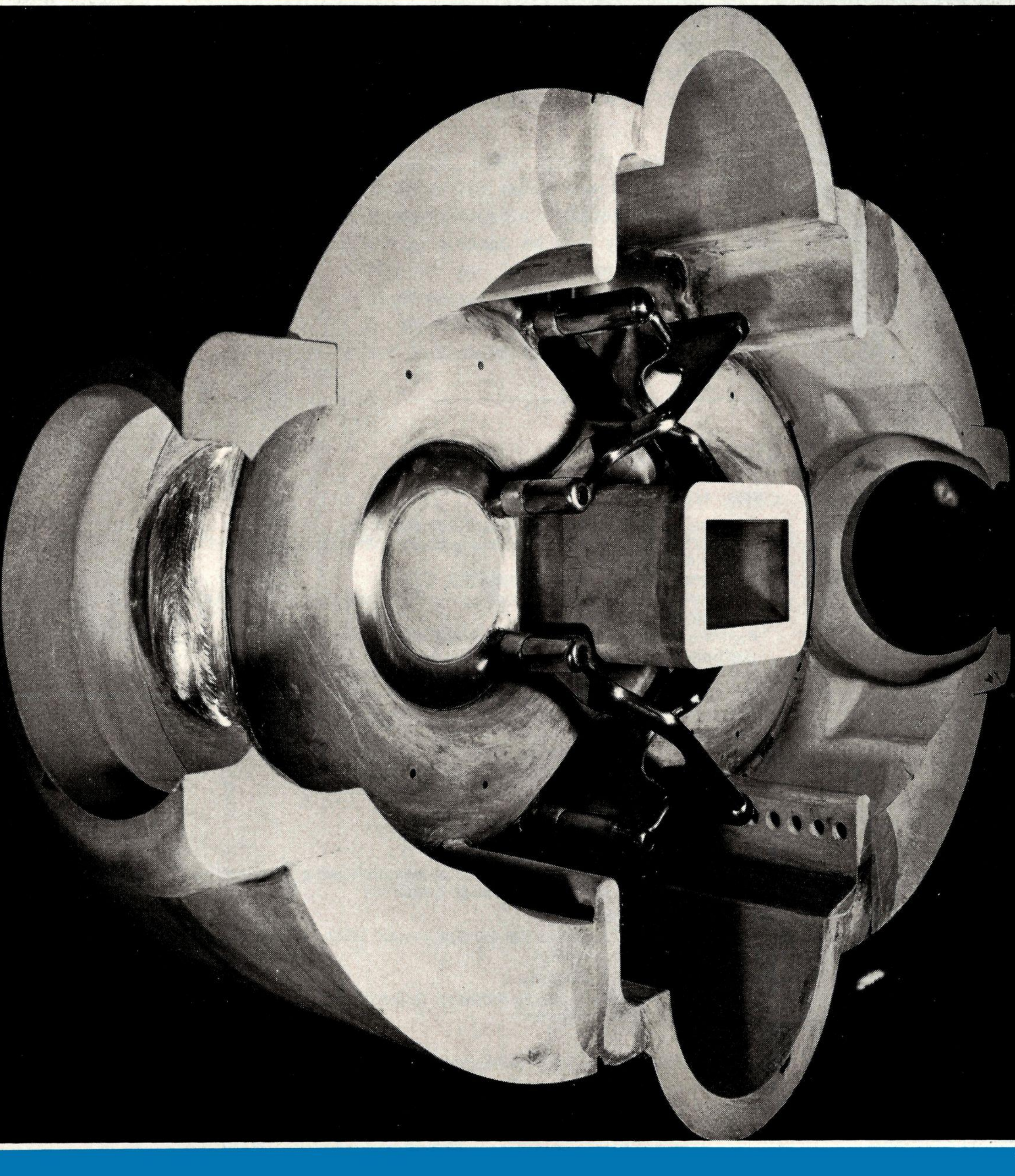

CERN, the European Organization for Nuclear Research, was established in 1954 to '... provide for collaboration among European States in nuclear research of a pure scientifice and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, 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 2350 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

The article on page 28 carries more information on the new accelerator technique which has received a great deal of attention since the Cambridge Accelerator Conference in September of last year. At that Conference, scientists from the Soviet Union announced successful preliminary work with a model using the new ideas, built at Dubna.

Their device was then nick-named the 'Smokatron' since it forms electron rings and accelerates them like a series of smoke rings ; protons could be made to sit inside these rings and be pulled along as the rings are accelerated. Recently, the name 'Vekslertron' has become popular — it pays tribute to the late Professor V. I. Veksler who initiated the work at Dubna. More sober names for the same thing are 'collective ion accelerator' or 'coherent field accelerator'.

Since the Conference, a group at the Lawrence Radiation Laboratory in the USA has proposed a similar model to test the basic principles and to provide experience for any potential application to a full-scale device. They have also added new names including 'ERA' — for 'Electron Ring Accelerator'.

There has already been tentative thinking in the Soviet Union on machines of this type for energies in the hundreds of GeV region. They may be capable of accelerating at the rate of up to 600 MeV/metre (compared with conventional proton linear accelerator rates of 3 MeV/metre) ; of very high intensities and of accelerating a variety of ions... and they could cost less money. On the other hand, they would probably impose heavy demands on r.f. power ; involve difficult problems of ensuring beam stability, and produce beams which would need severe doctoring before being useful for important conventional experimental techniques (particularly 'electronics' experiments). This last point which concerns their usefulness as machines for doing physics should really be the most important question of all.

Nevertheless, radical developments in accelerator technology do not arise every day, and perhaps not since the introduction of the strong-focusing principle, used in the present highest energy synchrotrons, has so much interest settled on a new idea.

But before any sensible comparisons can be made concerning its potentialities for the future, it is important to check experimentally the basic principles, to confront the problems of design and thoroughly to think out and test the possibilities for exploitation. This involves many years of work, and it is excellent that the strong accelerator team at LRL can add their effort to the pioneering work at Dubna.

Contents

Cover Photograph: This work of modern sculpture is a 'full-aperture kicker magnet' — the first of its kind. A series of tests started on the magnet recently and its performance has proved very satisfactory. The story of the magnet and its application can be found on page 26. (CERN/PI 6.10.67)

CERN News

Europe's biggest superconducting magnet

A superconducting magnet, the largest and most powerful ever constructed in Europe was operated at CERN in January. The magnet is in a test assembly where one of a series of model studies, in preparation for the construction of the large European bubble chamber, is being carried out.

The large hydrogen bubble chamber, which in its latest design is 3.7 m in diameter with 22 m^3 of 'useful volume', is being financed by CERN, the Federal Republic of Germany and France. It is scheduled to come into operation at CERN in 1972, positioned at the end of a large new experimental hall alongside the intersecting storage rings. (A full description of the project can be found in CERN COURIER vol. 7, page 143).

Many new techniques are required to extend the size of the existing largest bubble chambers (of which the CERN 2 m chamber is a typical example) to that envisaged for the European chamber. One of these techniques is the use of a superconducting magnet to achieve an accurate field of 35 kG over the useful volume of the chamber. As at present conceived, the magnet will consist of two identical cylindrical coils surrounding the chamber separated by an air gap of 50 cm, where spacers will be positioned to withstand the attractive force of about 8500 tons acting between the coils when they are powered. No main iron flux-return path will be needed but the whole chamber will be housed in a screen of low-carbon steel to prevent the huge stray field from affecting other equipment. The dimensions of each coil are estimated as 4.7 m internal diameter, 5.7 m external diameter and 1.6 m high. Each will be fed by a current of from 8000 to 10000 A from supplies capable of 10 to 20 V. To achieve the extremely low temperatures, where superconductivity comes into effect, each coil will sit in a bath of liquid helium.

No superconducting magnet on this scale has ever been built and a variety of tests are necessary before fixing the details of the final design. One of the most important of them is to select the materials and construction method for the superconducting strip of which the coils will be wound.

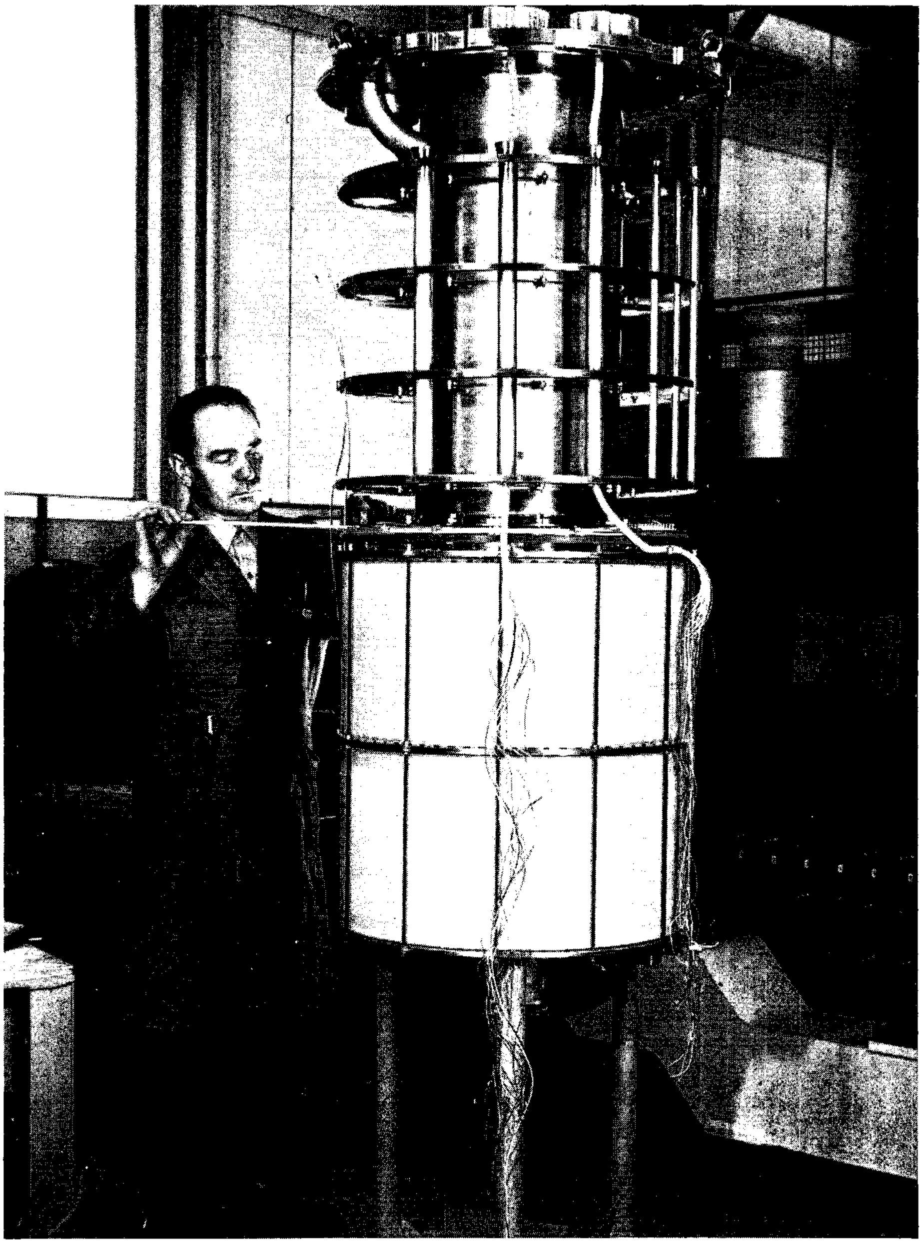
The test assembly has been christened BRARACOURCIX (which evolves from 'bras raccourcis', meaning something like 'with might and main', while paying tribute to that pinnacle of French literature 'Asterix le Gaulois'). It is the result of the work of the construction group of the large European bubble chamber in collaboration with industry and the cryogenics laboratory of Physics II Department at CERN.

Two superconducting coils, with dimensions 40 cm internal diameter, 70 cm external diameter, 33 cm high, are immersed in a cryostat filled with almost 70 litres of liquid helium at — 269° C. One coil (produced by Compagnie Générale d'Electricité, France) is constructed from a composite conductor consisting of titanium-niobium alloy wires (the superconductor) in a stabilizing sheath of very pure aluminium. The other (produced by Siemens, Germany) also uses titanium-niobium alloy but with high quality copper as the stabilizer. Altogether, seven kilometres of superconducting strip are used.

The coils were fed with a current of 1000 A giving a magnetic field of over 60 kG at the centre of the system. It is in this field that samples of the different types of composite conductor will be placed to examine their properties. In particular, the conductor has to be able to operate at liquid helium temperatures, carrying a current of 8000 to 10000 A in a field of 51 kG, without producing heat.

To safeguard the test assembly against any fault in the superconducting coils, some preliminary experiments were carried out. The danger involved can be appreciated when one realizes that 2 MJ of energy are stored in the coils when they receive maximum current. If trouble develops, a switching arrangement dumps the energy in two external resistors. On testing this safety device everything operated successfully when transferring 1.2 MJ to the external resistors, but when this was increased to 1.7 MJ, eddy currents heated and distorted a radiation screen causing damage inside the cryostat.

The tests will begin again shortly and it is hoped, before the end of the year, to have examined the characteristics of different superconducting strips sufficiently thoroughly to place a contract for the magnet conductor of the large European bubble chamber.



CERN/PI 3.12.67

BRARACOURCIX — *a test assembly, including Europe's largest superconducting magnet, to be used in examining various superconductors to select the best type for the huge magnet of the large European bubble chamber.*

Superconducting quadrupole for CERN

The Ministry of Technology in the UK has placed a contract worth £ 25 000 with the Oxford Instrument Company to produce a superconducting quadrupole which will be sent to CERN on a long-term loan. The Ministry's purpose is to enable industry to cut its teeth on a specific project employing superconducting techniques which are expected to grow in importance for applications not confined, of course, to accelerator Laboratories.

The quadrupole lens will be the most powerful ever built in Europe with a magnetic field gradient of at least 5.5 kG/cm over a cylindrical aperture 70 cm long and 10 cm in diameter. The magnetic field at the superconducting coil will be about 50 kG.

The project has involved, in addition to the Oxford Instrument Company, the Culham Laboratory in the UK (where there is a strong team of experts on superconductivity techniques) and people from CERN itself, led by A. Asner. CERN drew up the specification for the magnet, designed and built a coil-winding model and are providing the stainless steel pole-cores, the coil-winding gear and the cryostat.

About 4 km of composite superconductor, to be supplied by Imperial Metal Industries, will be used in the construction of the four coils. The conductor consists of sixteen niobium-titanium wires embedded in a strip of copper. As a prelude to building the quadrupole, a solenoid has been wound with this conductor and has been successfully tested at Oxford. It gave an overall current density of 120 A/mm^2 at a maximum field of 54 kG.

The Oxford Instrument Company is responsible for the construction and testing of the magnet. It is hoped that the coil will be wound on the first pole ready for testing by the end of March.

And more to come?

To round off this flurry of news about superconductivity coming into its own at CERN, we can mention three other possible applications of superconducting magnets which are being considered :

a) A magnet for the Omega project. The Omega project is an item in the second stage of the improvements programme at the proton synchrotron, and is intended to provide a major piece of equipment for electronics experiments. The group studying this project concentrated on the use of spark chambers in a magnetic field and is designing a superconducting magnet.

b) A magnet for a still more refined version of the muon storage ring experiment. This experiment, which is coming to its close at the proton synchrotron, measures the g-2 of the muon to very high accuracy. Thinking about a new version is in its early days, but the possibility of using a superconducting magnet presents the challenge of producing a magnetic field stable and reproducible to something like one part in a million. This sort of precision has never been asked of a superconducting magnet before.

c) A magnet for a new polarized proton target. The magnet in this special type of target is used to pull the spins of the protons into line thus yielding extra information when the particle collisions take place. The possibility of using the extremely high fields available from superconducting magnets to do this job is receiving serious consideration.

Getting there faster

There was brief mention in the January issue (page 7) of the problems of powering the kicker magnets for the new Booster which will inject protons into the PS at much higher energy. Had it not been for considerable advances over the past few years in the technology associated with these ejection magnets, the whole Booster project as now conceived would have been impossible.

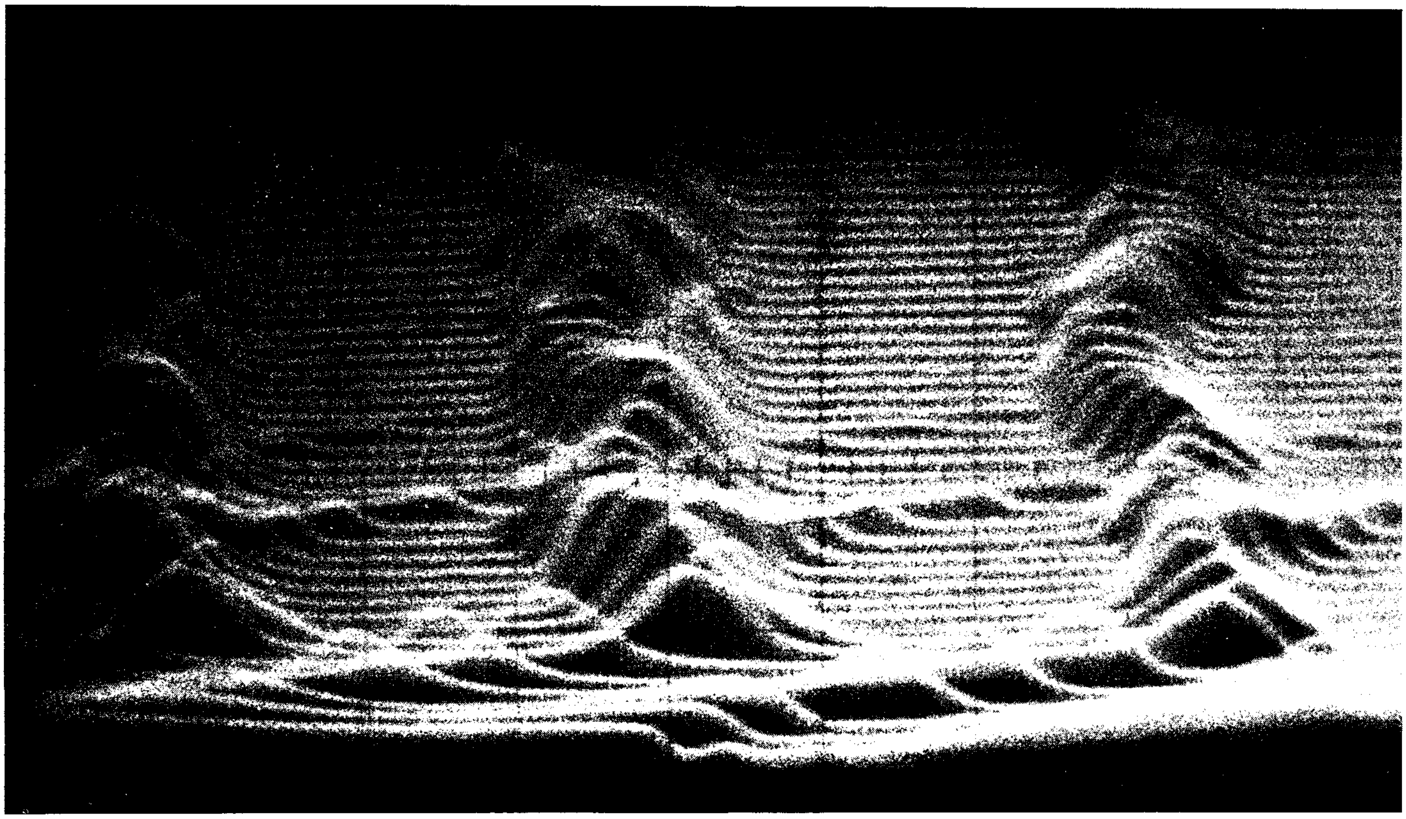
Even so, the requirements to power these magnets fast enough are severe. They must reach their peak field in only 50 ns (50 thousandths of a millionth of a second). To do this, the current fed to the magnet coils must rise from zero to 4000 A in less than

15 ns, allowing 35 ns for the field to establish itself.

The use of spark-gaps to switch on this current was rejected in favour of the more reliable and much more 'jitter free', high voltage deuterium thyratrons. However, thyratrons switch quite slowly (about 50 ns) compared with triggered spark-gaps and something has to be done to increase the speed at which the effect of the thyratrons is felt by the magnet coils. A. Bruckner proposed the use of an ingeneous non-linear pulse-sharpening delay-line between the thyratrons and the coils and this technique has recently been tested successfully.

The idea is to introduce saturable inductances, ferrite cores, along the delay line. As the cores saturate their impedance goes down drastically and the current jumps sharply. Rise-times after such non-linear delay-lines of as low as 10 ns at 30 kV, 1000 to 1500 A, have already been achieved. Several of these delay lines in parallel should meet the needs of the Booster kicker magnets.

A fascinating photograph taken in the control room of the proton synchrotron. It is a display of the behaviour of the beam during its first forty turns in the machine, showing the signals received by an oscilloscope from a 'pick-up station' in the synchrotron ring.
The protons orbiting the ring pass between pick-up electrodes and induce charge on the electrodes. It can be arranged that the signals sent out by the electrodes give information on the intensity of the proton beam or on its position in the vacuum chamber.
In this case, we are looking at the signal which is proportional to intensity. There are about 40 traces (counting vertically) each one representing one turn of the beam round the machine.
If we look first at the bottom trace, we see the beam intensity on the first turn after injection. Notice that it is almost constant since the beam is smeared out evenly filling the whole ring. If we now look at the trace say seventh from the bottom, the radio-frequency system has formed the beam into bunches and, instead of remaining almost constant, the signal (i.e. the intensity) jumps as each bunch passes the electrodes.
The photograph shows the effect of just three of the twenty bunches formed in the machine; the next trace up being the same three bunches on their next turn round. After six turns the 'beam control' is switched on and the bunches no longer 'slip' with respect to the accelerating cavity voltage (to which the oscilloscope trigger is synchronized); hence the steady position of the hills after the first seven turns. The beam control ensures that the accelerating voltage is tuned to the positions of the bunches detected by pick-up electrodes. The CERN synchrotron was the first accelerator to have automatic beam control.
The distance between the hills (horizontally) is a measure of the time between each bunch passing the pick-up station — about 0.3 μs.



A last look at the 2 MeV Van de Graaff which supplied beams to the electron storage ring model, CESAR. CESAR is now being dismantled and the Van de Graaff will go to the University College of Swansea.

Full-aperture kicker

A full-aperture kicker magnet, to be used in a fast-ejection system at the proton synchrotron, operated at full voltage for the first time in February.

The kicker magnet of a fast-ejection system has the job of bending the accelerated protons into a septum magnet which completes the bending of the beam out of the synchrotron into an experimental area. The name 'kicker', given to such a magnet, is an appropriate one because their influence is applied as a sudden jolt, kicking the protons out of their steady orbits in the synchroton ring.

In the CERN machine, the protons circulate in twenty bunches and the experimental programme may call for just a few of these bunches to be sent to the experiments using the fast-ejection beam-line. (At other times it may call for all the bunches to be ejected.) To be able to pick out any particular bunch for ejection, without affecting the other circulating bunches, means being able to switch the kicker magnet on (and off) in the time between consecutive bunches passing through the magnet. At the PS, this time is about 100 ns, and the problem of switching on high magnetic fields in such a short time is evident.

One type of fast-ejection system uses a small kicker magnet which is thrust into the vacuum vessel of the synchrotron towards the end of the acceleration cycle. The reason for this procedure is that the whole vacuum vessel aperture is needed for the beam when the protons are first injected into the ring — no magnets can be left in the way. Then, as the protons are accelerated, the beam shrinks in size because of the focusing forces and a magnet can be introduced around the small beam and be switched-on when ejection is required. In this way, it is necessary to achieve the magnetic field over an aperture only a few square centimetres in cross-section. It does, however, involve using a hydraulic plunging mechanism to move the magnet in and out, which has to operate with great precision.

The possibility of a full-aperture kicker — a large stationary magnet setting-up the necessary field over the full aperture of the vacuum vessel — was put forward by H. Fischer several years ago. The work since then has been led by D. Fiander and the team is now part of the 'Magnet and Ejection Group' under A. Asner, in the Synchrotron Injector Division.

The magnet is a delay-line type with cylindrical inner and outer conductors cross-connected, setting-up a vertical field over the vacuum vessel aperture. (People familiar with this type of magnet will probably be able to decipher the arrangement from the photograph on the cover. The white rectangle in the centre outlines the cross-section of the aperture over which the field is applied. Above and below, the cross-connection between the conductors can be seen.)

The magnet is 2 m long and gives a peak field of 750 G across an aperture 10.5×7 cm^2. It receives a current of 8000 A from two 110 kV lines which are symmetrical with respect to earth. Power is switched to the magnets via two spark-gaps synchronized to 10 ns. (Special low-jitter spark-gaps were developed by D. Fiander and D. Zanaschi.) The rise-time of the field is 90 ns which meets the requirement to power the kicker between the passage of consecutive bunches in the PS.

The tests have shown that the kicker can either eject single bunches (or two or three bunches if required for experiments), or be sustained to eject all twenty bunches. It can also, within an interval of 100 to 150 ms, be powered twice to eject a single bunch (or two or three bunches) each time. Thus, it can pulse twice during the 'flat-top' of one machine cycle and this is a particular advantage for bubble chamber experiments. The CERN 2 m bubble chamber is being adapted to operate twice in one machine cycle, so that photographs can be taken at twice the present rate.

During construction and commissioning of this first full-aperture kicker many difficult problems arose, which could prompt other approaches on any further magnet of this type (such as may be built for ejection of the PS beams to the intersecting storage rings). A second version could, for example, be built in two units to reduce the high voltage of 110 kV to more manageable values like 60 to 80 kV. Also deuterium thyratrons would be considered instead of spark-gaps for switching the power. Some thought is being given to the possibility of employing quadrupoles in the PS ring, to do some additional 'kicking' so that the burden on the kicker magnet proper would be reduced.

The magnet, with its supplies and measuring equipment, has been assembled in the South Experimental Hall extension. A life-test will now go on for a few months to prove the reliability of the various components over several million pulses. If all goes well, the kicker will then be installed in straight section 66 of the PS during the shut-down which begins in May and should further increase the flexibility of the fast-ejection systems.

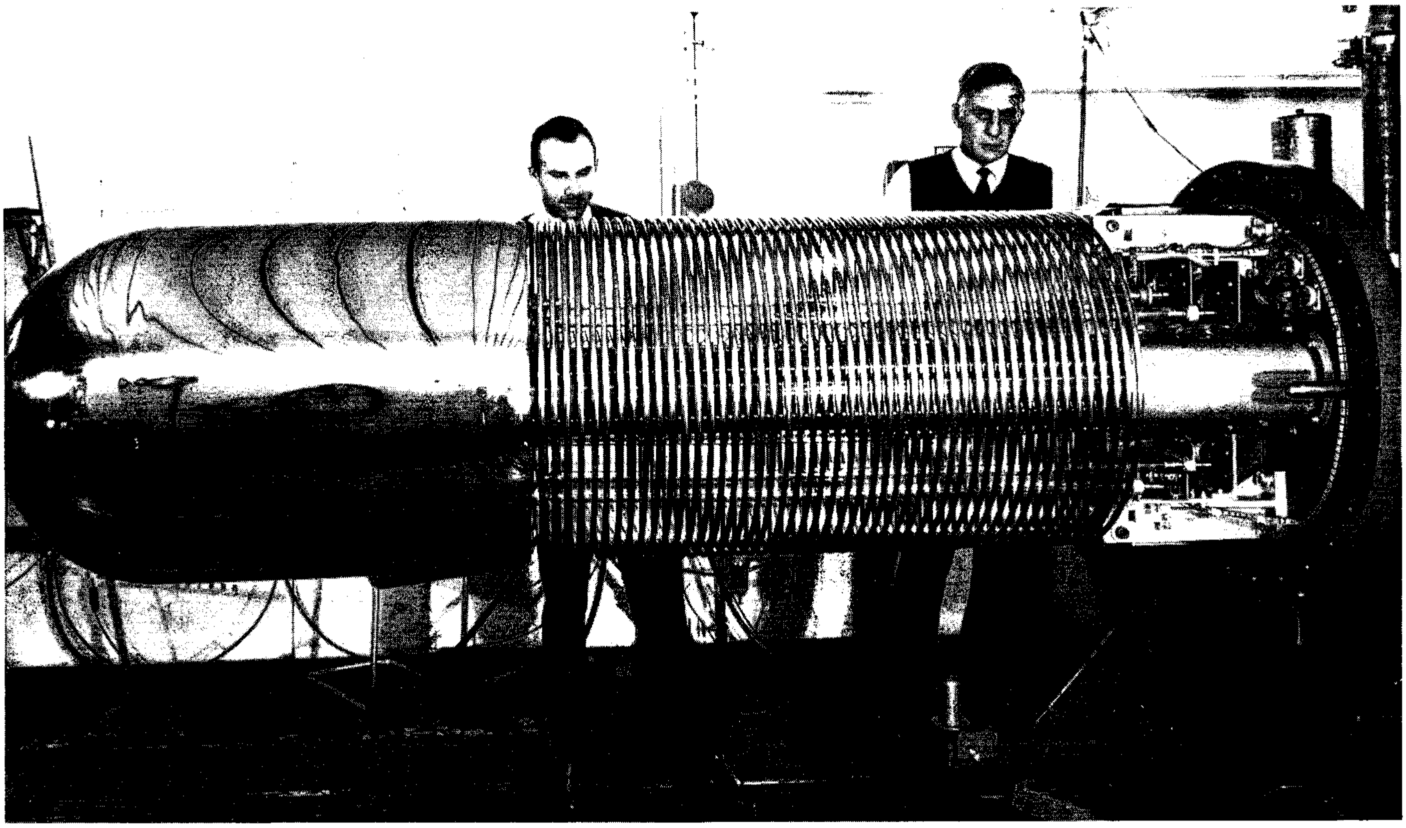
Molecular Biology Conference

A second European Conference on Molecular Biology took place at CERN from 22 - 25 January, under the Chairmanship of Professor Olivier Reverdin. The first Conference was also held at CERN in April 1967, and one of its major decisions was to set up a Working Group to consider the ways in which European co-operation in the field of molecular biology could be best achieved. This Group met in June and September of last year and prepared a draft proposal which was the major subject of the January Conference.

All the thirteen Member States and the three Observer States of CERN were invited to send representatives and there were also observers from international organizations such as UNESCO, WHO and CERN itself.

The outcome of the Conference was an agreement by twelve European States (the CERN Member States with the exception of Belgium) which ensures that the European Molecular Biology Conference will continue to meet at least for the next five years. The main task of these meetings will be to support the work of EMBO — the European Molecular Biology Organization.

EMBO is a private organization set up in 1963 by many leading molecular biologists in Europe. It is registered in Geneva and has been sustained so far mainly by a grant from the Volkswagen Foundation. The support of many European countries will enable the organization to intensify its work — granting study and research fellowships, helping Universities by arrang-



CERN/PI 242.1.68

ing for specialized guest professors, organizing lectures and study meetings.

The standing Conference will also be able to consider other forms of co-operation. In particular, several countries are keenly interested in setting up a European Molecular Biology Laboratory.

The need for such a Laboratory is seen as something rather different from that which initiated CERN. It is not so much to concentrate financial resources in order to provide very expensive equipment, but rather to provide a centre which can bring together an interacting group of differing techniques and talents — each of them only moderately expensive in itself, but in sum beyond most national resources (financial and, especially, human).

The possible structure of such a Laboratory has been worked out in some detail. The total staff would rise to about 560 people, consisting of 150 scientists and engineers as 'permanent' staff, 60 visiting scientists, 40 post-doctoral fellows and 310 technicians and non-technical staff. Considerable emphasis has been put, as at CERN, on not draining many highly-qualified people away from national Universities and research centres. The annual cost of operating the Laboratory has been estimated to rise to about 39 million Swiss Francs.

A research programme has also been considered and has been formulated under five headings : to study —

i) the structure and function of proteins,
ii) viruses,
iii) the chemical basis of immune response,
iv) the functioning of the nervous system,
v) the K12 strain of the bacterium Escherichia coli — a characteristic uni-cellular organism (this study has become known as Project K).

No positive steps towards establishing such a Laboratory have yet been taken by the European governments but it will remain on the agenda of the standing Conference. A special session of the Conference will be called before the end of the year, when the agreement reached in January will be open for signature.

$6^1/_3$ resonance ejection

Slow-ejection using the 6 ⅓ resonance has recently been tested successfully on the proton synchrotron.

The difficulties of slow-ejection were discussed in CERN COURIER vol. 7, page 151 when the achievement of an efficiency of 80% at the PS was announced. A further useful property of the slow-ejection system, which was not mentioned in that report, is the ability to share protons efficiently when an internal target is being used at the same time. It is sometimes very useful if the accelerated beam can be used principally for experiments taking beams from an internal target, while peeling off a small percentage of the beam (say 5 or 10%) to be fed down the slow-ejected beam-line. This gives the experimenters on the slow-ejected beam a few protons to play with to set up and test equipment. The present 'integer resonance' used for slow-ejection is not efficient when sharing in this way.

Ch. Iselin worked through the theory of 6⅓ resonance ejection which seems more appropriate for beam sharing. It has been tested on the PS and 50 % ejection efficiency was achieved. To fit into the machine programme, the tests involved ejection down the beam-line from straight section 58. The system will soon be tested for the straight section 62 beam-line where it will eventually be used for beam-sharing operation of the synchrotron.

CORRECTION: In the January issue (p. 10) we reported that the contract for the pole-face windings of the ISR magnets had been awarded to Brown, Boveri and Co., Switzerland. This should have read Brown, Boveri and Co., Federal Republic of Germany.

Electron Ring Accelerators

A general explanation of the principles underlying a new acceleration technique and a description of the work which has been done at Dubna and which is starting at the Lawrence Radiation Laboratory.

In our report (CERN COURIER vol. 7, page 201) of the Cambridge Accelerator Conference held in September last year, we used the phrase 'the most interesting development in accelerator technology' in mentioning a paper from Dubna called 'Collective Ion Linear Accelerator'. But we could not at that time predict how the interest would spread. In particular, the Lawrence Radiation Laboratory in the USA is already mounting a considerable effort to study this type of accelerator.

From whence it came

Before explaining the ideas involved, we will make the appropriate bows in the direction of the people from whose work the present situation has evolved.

The first known author is W. H. Bennett who, way back in 1934, published an article in Phys. Rev. entitled 'Magnetically self-focusing streams'. (Bennett raised the subject again in the same journal in 1955). H. Alfvén, W. Walkinshaw and J. D. Lawson also worked on similar ideas in the early 1950s.

The first exposition before the accelerator world at large, occured at the CERN Symposium on High Energy Accelerators in 1956, when two Soviet physicists presented independent work on this subject. One was G. I. Budker, well known leader of the storage ring project at Novosibirsk, with a paper entitled 'Relativistic stabilized electron beam'; the other was the late V. I. Veksler with a paper entitled 'Coherent principle of acceleration of charged particles'. Interest bubbled for some time after the symposium but simmered down, because of trouble with plasma instabilities.

It came as a surprise at the Cambridge Conference to learn that, following a new variant of the idea proposed by Veksler, the subject had been re-opened at Dubna and that the Dubna team, led by V. P. Sarantsev had constructed a model to test the principles.

Immediately after the Conference, A. M. Sessler from Berkeley (who has recently spent some time at CERN and contributed significantly to the intersecting storage ring project) fastened onto a study of the theoretical principles involved. Since he has spent a good part of his life investigating other peoples instabilities (beam instabilities that is), he was surprised that, on paper, there is no apparent reason why the scheme should not work. Interest grew around him in the accelerator team at Berkeley and the support of the Lawrence Radiation Laboratory was quickly assured. The Laboratory is fortunate enough to have equipment available which enables them to turn on some experimental effort very quickly. A team led by D. Keefe, in E. J. Lofgren's Accelerator Study Group, is building a model. Sessler remains in charge of the theoretical investigations.

What is it all about ?

Sub-nuclear physics calls, particularly, for intense beams of very high energy protons. Supposing we could form a very intense bunch of electrons and get a much smaller number of protons to sit in that bunch in such a way that the assembly of particles is stable. We could then pull on the electrons with our accelerating fields and, if the bunch was stable enough, the protons could be dragged along with the accelerating electrons.

The energy that the protons would acquire would be greater than that of the electrons in the ratio of the proton mass to the electron mass. (In practice, this figure would not be the ratio of the rest masses, 1836, because the electrons being accelerated would be relativistic, i.e. heavier objects than electrons 'at rest'. They would typically have a mass of the order of 40 times their rest mass, thus the protons would gain say 45 times — 1836 divided by 40 — the electron energy.) A comparatively modest electron accelerator could in this way yield very high energy protons.

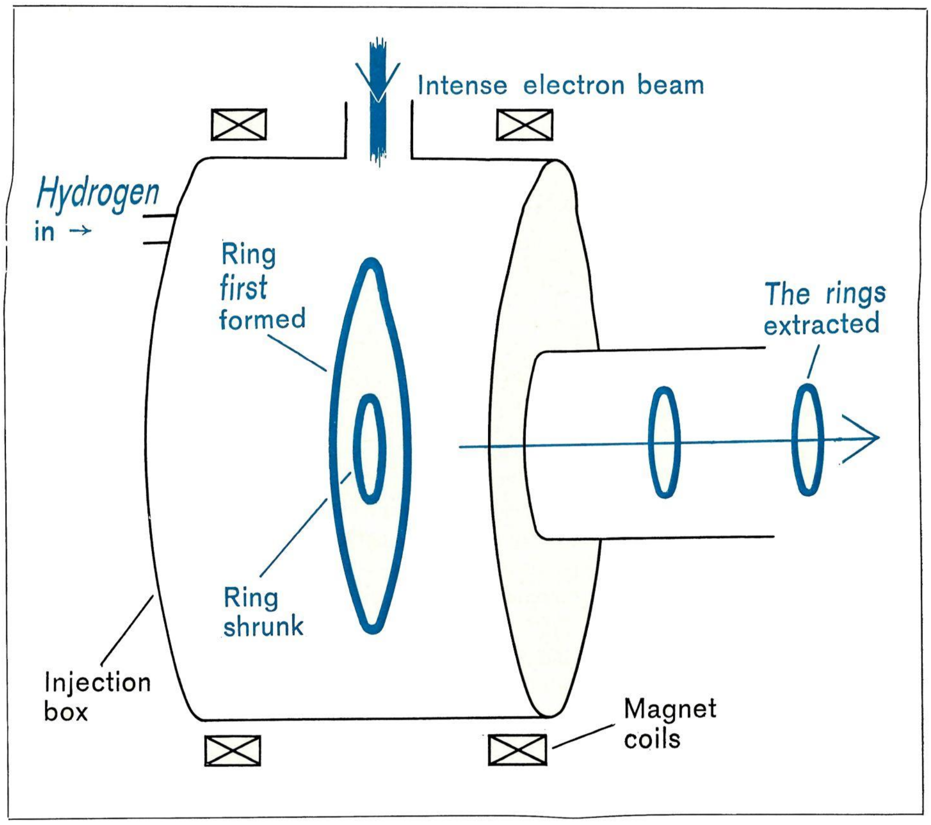
The problem lies in establishing and maintaining the stable bunch. The Dubna work indicates the way in which this may be done, following the proposal of Veksler that a ring formed from high energy electrons containing a much smaller number of protons would be 'self-focusing', i.e. stable.

This is written —

$$N_e > N_p > N_e / \gamma^2$$

where N_e is the number of electrons in the ring, N_p the number of protons in the ring, and γ a measure of the energy of the electrons as they fly round the ring (trans-

A schematic diagram of a 'compressor' where the electron rings are produced and filled with protons.



verse energy) — not the energy given to the electrons by accelerating the ring as a whole (longitudinal energy). A lot of the preliminary studies will be devoted to studying this inequality to find out the ideal ratio of protons to electrons and the ideal electron energy, to give the ring maximum stability.

Now we have to consider how to produce the electron rings, how to fill them with protons and how to accelerate them. We will use particularly the work of Dubna in order to feed some typical parameters into the description.

Forming the rings

An intense beam of electrons is fired into an 'injection box', illustrated schematically in the figure. A magnetic field applied across the box (horizontally in the figure) turns the electrons round so that they travel in a ring, initially with a radius of say 25 cm. The magnetic field is increased rapidly, and the ring shrinks down to a radius of say 5 cm. This increases the transverse energy of the electrons. (It is easier, in practice, to start with fairly low energy electrons and then to shrink the ring to get the transverse electron energy high enough.)

After this, hydrogen gas is fed in and is ionized by the fast moving electrons, liberating the protons at the nuclei of the hydrogen atoms. (Appropriate times are of the order of a few hundred microseconds.) The positive protons are attracted into the deep potential well which the intense ring of negative electrons sets up and join the electrons in the ring. (If we think of what is set up in the injection box as a doughnut, both electrons and protons make up the dough of the doughnut.)

The ring will be stable provided we have achieved a right ratio of protons to electrons and a sufficiently high electron energy. Typical figures are 10^{13} electrons, 10^{11} protons and an electron energy of 15 MeV. Next, by arranging for the magnetic field to fall off in one direction (to the right in the figure), the rings would slide down the field and emerge from the injection box as a stable assembly of electrons and protons which can then be accelerated as a whole.

The whole unit used for forming the rings is often referred to as the 'compressor'.

Acceleration

In accelerating the rings, it is important not to pull so hard that the stability is destroyed — i.e. the electrons pulled away from the protons.

Two methods of acceleration are possible. The first has been called 'expansion acceleration'. It involves setting up a magnetic field which is progressively weaker along the accelerator tube. In travelling through such a field, the radius of the ring grows ; the transverse energy of the electrons falls and reappears as increased longitudinal energy — increased energy of the ring as a whole travelling down the tube. The energy gain is inversely proportional to the square root of the strength of the magnetic field. Thus if the field decreases by a factor of four over some distance the energy of the protons would be doubled as the rings travel that distance.

An electron ring accelerator (ERA) using only expansion acceleration might be suitable for protons up to energies around 1 GeV. Such an ERA could be a fairly compact machine giving this order of energy over a lenght of about 10 m. For energies much in access of this, 'electric acceleration' is needed, using, for example, r.f. cavities. Here electric fields would accelerate the rings, while a magnetic field is continuously applied to keep the ring radius small.

We have to accept that less than a half of the energy fed to the rings in accelerating them would be carried by the protons. Even though the protons gain energy say 45 times faster than their carrier electrons (because of the mass difference) they would be outnumbered by 100 times more electrons. Nevertheless, in terms of efficiency in converting the power fed to the machine into proton energy, there is no reason to think that the ERA would be particularly unfavourable.

Using the accelerated beams

Supposing that everything works — that we can produce stable rings and accelerate them without destroying stability — how could they be used for feeding physics experiments. Having mentioned several times how careful one has to be not to separate the electrons and protons en route to the output end of the machine, it is obvious that once they are there, a good strong pull with a magnet could deflect the electrons away leaving a proton ring.

But the output of an ERA would be very different from anything we deal with at present. Maximum output figures might be 10^{12} protons per pulse (carried by 10^{14} electrons) at a repetition rate of 100 per second. In terms of intensity per second, this looks very healthy but the pulse length would be in the picosecond region (a millionth of a millionth of a second).

Bubble chambers would not grumble about this (though they might grumble at being asked to cycle anything like so fast!) and a few counter experiments could also be happy. But the vast majority of counter experiments need a longer duty cycle, unless there is a major revolution in counting techniques.

One way to meet this need might be to feed the proton pulses into a superconducting storage ring, where they could be 'time stretched' before being used for counter experiments. But this could remove a lot of any possible cost advantage.

We should also mention that other possible features for experimental exploitation are that the ERA could also accelerate heavy ions and polarized protons. These might turn out to be the major applications in the earlier stages of development. Expansion acceleration giving 1 GeV per nucleon would bring a gleam to the eyes of nuclear structure enthusiasts. Even performance figures much lower would be very acceptable for heavy ion acceleration.

The work of Dubna

Let us now turn to what has been done and is being done, describing first the model built and operated at Dubna to test the basic principles. At the Cambridge Accelerator Conference, the Soviet scientists announced that they had achieved stable rings of electrons and protons in the compression stage and that they behaved according to the theory. This is major hurdle number one overcome but extraction has not yet been achieved.

Their model uses an electron induction accelerator feeding beams of 200 A at 1.5 MeV into their injection box where a vacuum of 10^{-8} torr is maintained. The initial ring radius is 25 cm with a field of 200 G across the box. The magnet coils are pulsed to rise to 10 kG in 500 μs. The ring radius shrinks to 5 cm and the transverse electron energy increases to 15 MeV. Hydrogen is fed in after compression of the ring and intensities of 10^{13} electrons and 10^{11} protons are achieved.

The next work at Dubna will be on extraction of the rings and acceleration. They have additional coils which can be pulsed to remove the symmetry of the field in the box so that the rings slide out where the field is weaker gaining energy by expansion acceleration. The rings will then pass through four r.f. cavities each capable of giving 25 MeV energy to the protons. The cavities operate in the E_{010} mode at a frequency of 150 MHz.

In the electric acceleration region, it has been arranged for the magnetic field (which is applied all along the tube) to vary in an important way. In the cavities the field increases to shrink the rings increasing the transverse energy ; between the cavities the field decreases, the rings increase in size and transverse energy is transferred into further acceleration of the rings. In this way the need to restrain the electric fields so that they dont pull the rings apart is partially relaxed in that higher fields in the cavities themselves can be tolerated provided the average field remains within the limit.

After the cavities, expansion acceleration will take place over a distance of 12.5 m with the magnetic field decreasing from 10 kG to a few kG and the proton energy will increase to about 1 GeV.

At LRL

The Lawrence Radiation Laboratory is able to turn on an experimental programme very quickly because there already exists at the Livermore site an excellent injector — the Astron injector, which was built for controlled thermonuclear fusion research. It can produce 4.5 MeV electrons in 0.3 μs pulses of several hundred A at 60 pulses per second. This is more than adequate to study a broad range of parameters for the injection process.

The ERA research is intended to go in two phases. In the first, they will study producing the rings, extracting them from the compressor and accelerating them by expansion acceleration up to about 1 GeV proton energy. (Already, as a guide to the first phase proper, a small compressor is being built from 'off-the-shelf' parts by W. R. Baker. It will use the small 7 MeV linac at Berkeley as its electron source and may provide some useful indications of the problems to be faced, and of the analysis techniques which will be needed when the compressor to be used with Astron comes into use.) They expect to have completed this first phase by September of this year. If everything is successful the device could then be used for medium-energy physics and heavy-ion physics.

The second phase is basically to examine just how useful ERAs could be as very high energy accelerators. It will involve tests of electric acceleration giving an additional energy gain of 1 GeV to the protons. Two possible schemes will be studied to choose the best system for electric acceleration. One involves the use of r.f. accelerating cavities similar to the Dubna approach ; the other, following an idea proposed by E. C. Hartwig and A. Faltens (and independently, previously, by D. Sloan), involves the use of a new 'pulsed-line' type of accelerating column. In the pulsed-line column, a series of conducting plates a few centimetres apart would be powered by a high voltage pulse a few nanoseconds long, obtained by discharging transmission lines via spark-gaps. The spark-gaps fire so that the plates in the neighbourhood of the ring are powered as the ring travels along the column. A lot of work may be needed on achieving synchronization and low jitter with the spark-gaps, but this new scheme is potentially considerably cheaper. Preliminary work on the type of electric acceleration to be used will go on in parallel to the first phase of the Berkeley ERA effort, so that a choice can be made ready for installing this additional section towards the end of this year.

It is after the second phase of the research has investigated the problems of electric acceleration that, if all goes well, serious design studies for machines in the hundreds of GeV region could be made.

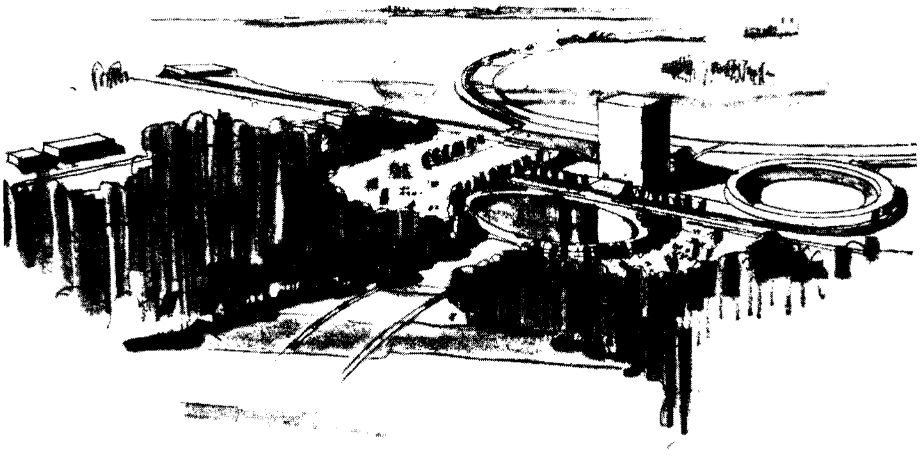
Conference and Symposium

To draw on the knowledge and experience of people from throughout the accelerator and plasma physics world and to keep people informed of their work, Berkeley organized a Conference and Symposium from 29 January to 10 February.

Three days, 5-7 February, were given to the 'Symposium on Collective Field Accelerators' and 75 people attended, including H. G. Hereward, E. Keil and S. Van der Meer from CERN. The 'Working Conference on the Stability of Electron Rings' involved about twenty people including Keil. The CERN representatives were three of a number of accelerator physicists here who have been keeping in touch with the new developments.

After the detailed discussion at the Conference the ideas on the new accelerator technique are still alive. The principle difficulties were tackled and some preliminary answers to most of them were found — it seems that they could be overcome, though it may not be easy in practice. The progress of the experimental work at Dubna and LRL will be watched with great interest.

The Weston Accelerator



On the morning of 9 February, Professor R.R. Wilson, Director of the National Accelerator Laboratory at Weston, Illinois, USA, was at CERN to discuss the American 200-400 GeV accelerator project with ECFA (the European Committee for Future Accelerators). In the afternoon, he gave a talk to a packed Main Auditorium on the design of the Weston machine.
This article is based on Professor Wilson's talk. For the sake of completeness, it repeats much of the information given in October of last year after the Cambridge Accelerator Conference (CERN COURIER vol. 7, page 199).

Design work has been in progress at Oak Brook, which is situated centrally with respect to the Weston site, Argonne National Laboratory and Chicago Airport, since June last year.

A major policy decision affecting the design should be underlined before going into any detail. A budget figure of \$ 250 million has been fixed for the construction of the machine itself. (Experimental equipment, development and 'pre-operating' costs during the construction period will add about \$ 100 million.) Within this budget, Wilson was determined to build 'the most accelerator possible'. Therefore, in working on the machine design, given the parameters which have to be met (an energy of 200 GeV and an intensity of 10^{13} protons per second), everything has been done to ensure that a move to substantially higher energy (at least 400 GeV) at a later date could be easily accomplished given further financial support.

The site

The site is roughly a five kilometre square. Towards one corner, the main ring has been located (see Figure 1) in a position where it passes a cluster of trees and a slight rise (nick-named 'Mount Ramsey') which break the otherwise flat stretch of corn-field. It was decided to take advantage of this pleasing spot for the Laboratory buildings and not to make use of the full diagonal of the site for an ejected proton beam, which would mean pushing the ring as far into the corner as it would go. This decision was taken reasoning that by the time the ejected beam is ready for full exploitation, techniques, such as the use of superconducting magnets, should be available to reduce the necessary beam length below what would seem the optimum with conventional techniques.

Another general decision on the machine, which affects the site layout considerably, is to concentrate as many of the major components as possible into one region. Thus ejection and injection are in adjacent straight-sections, and the next straight-section along contains all the r.f. accelerating cavities. These are the components most likely to need fairly regular attention and it is an obvious advantage to have them clustered together.

It is at this busy point that the Laboratory buildings will be centred. It would almost be correct to say 'the Laboratory building', since there will be a 'high-rise' building of perhaps twenty floors to provide the offices and laboratories for the big majority of the eventual 2000 staff. Wilson is determined to make Weston an attractive site. He hopes that this central tower can be beautifully designed and that it will be possible to avoid the usual sprawl of buildings. In the basement of the tower will be the machine control rooms within

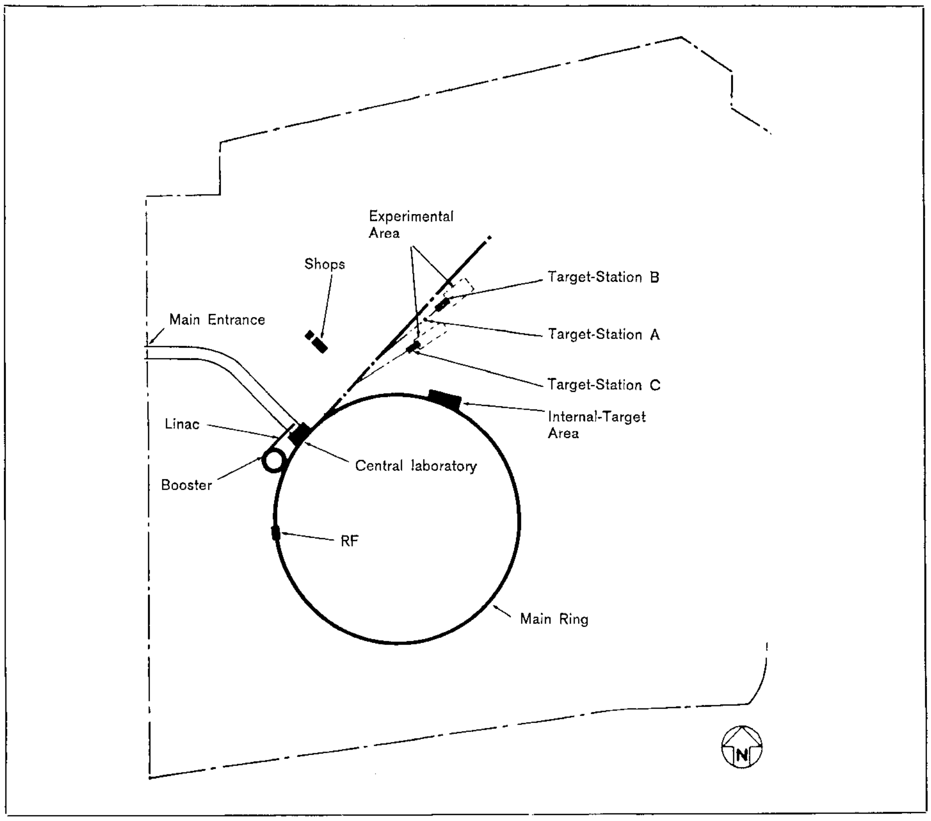


Figure 1

Figure 2: A diagram of the end of one of the bending magnets. Note the 'window frame' construction with the vacuum vessel passing through the centre of the magnet, and the three jacks for the magnet alignment.

Figure 3: A photograph of the model of the ring building with the magnet set close to the wall. The configuration and positioning of the magnet coil can be seen clearly on this photograph. (All the illustrations for this article are by courtesy of the National Accelerator Laboratory, Weston.)

easy walking distance (and short cable distance) of the main machine components.

Another feature of the site may be a lake dug out in the centre of the ring, with an island around a clump of trees, where a conference centre could be built.

Main ring

The main ring is 2 km in diameter and the magnet structure is 'separated-function'. This means that the jobs of bending the protons round their orbit and of keeping the beam focused are done by different magnets. One set does the bending, another set (quadrupoles) does the focusing.

The ring is packed with magnet so that to achieve an energy of 200 GeV a field of only 9 kG will be needed in the bending magnets. (The corresponding gradient in the quadrupoles is 175 kG/m.) To take the energy to 400 GeV will then require more magnet power supply (together with more r.f. accelerating power and more cooling) to achieve a field of 18 kG. Beyond this, the magnet designers are confident of climbing to 21 kG while still retaining good field and hope to be able to push it as high as 22.5 kG, equivalent to an energy of 500 GeV.

A drawing of the end of a bending magnet can be seen in Figure 2. They are 'H', or 'window-frame' magnets with the vacuum tube running through the centre and they will be constructed in such a way that they remain light and compact. This involves positioning the copper coils which power the magnets on the 'median plane' (the same horizontal plane as that on which the beam travels) which is traditionally avoided in constructing accelerator magnets to avoid the radiation problems arising if lost protons plough into the copper of the coils. It has been accepted in the Weston design because — one, they plan not to lose many protons (see the paragraphs on Ejection below) ; two, sophisticated beam stops will be placed in the straight-sections to absorb stray protons aiming for the coils; three, it is hoped to use ceramic and no epoxy resins in insulating the coils.

Each bending magnet will be built as a unit 6.3 m long welded on the outside, with the welded frame forming the only support. No nuts and bolts are around and any faulty magnet would be taken out and

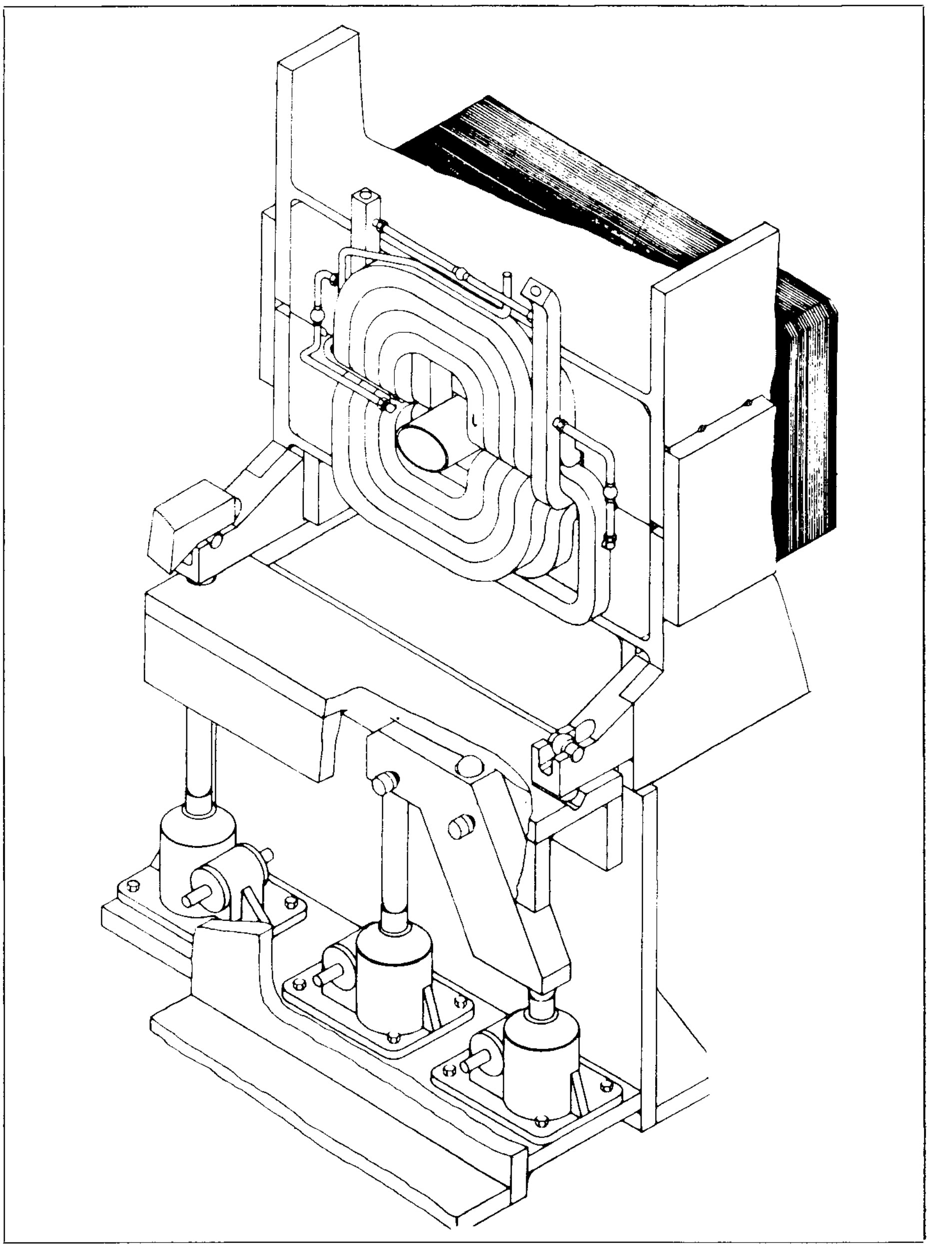


Figure 2

Figure 3

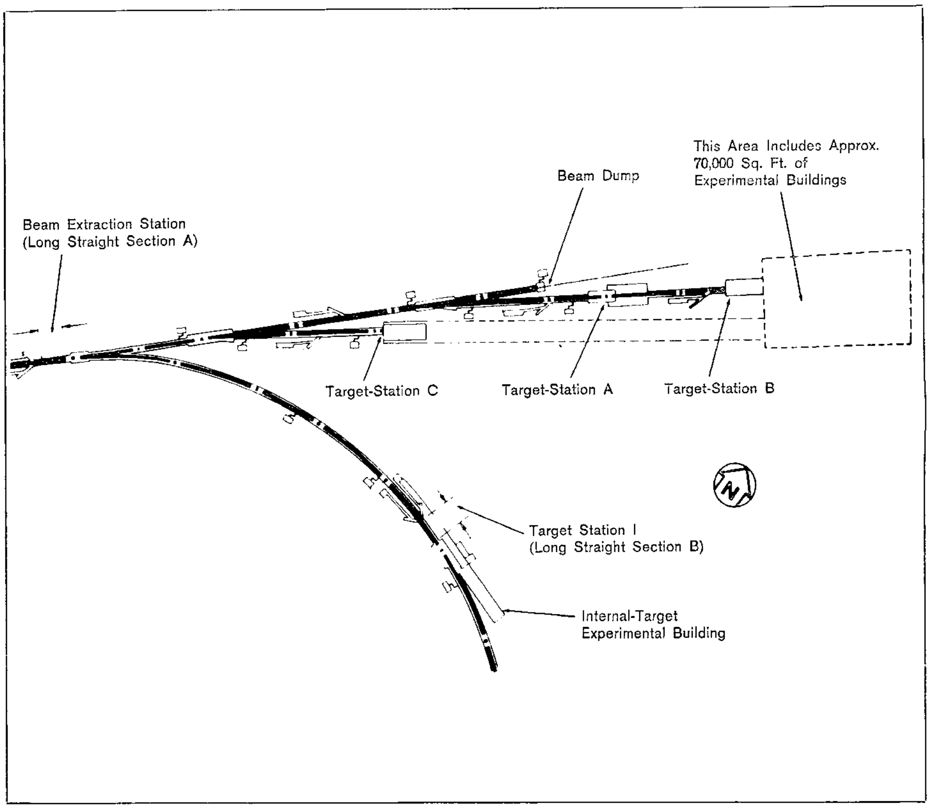


Figure 4

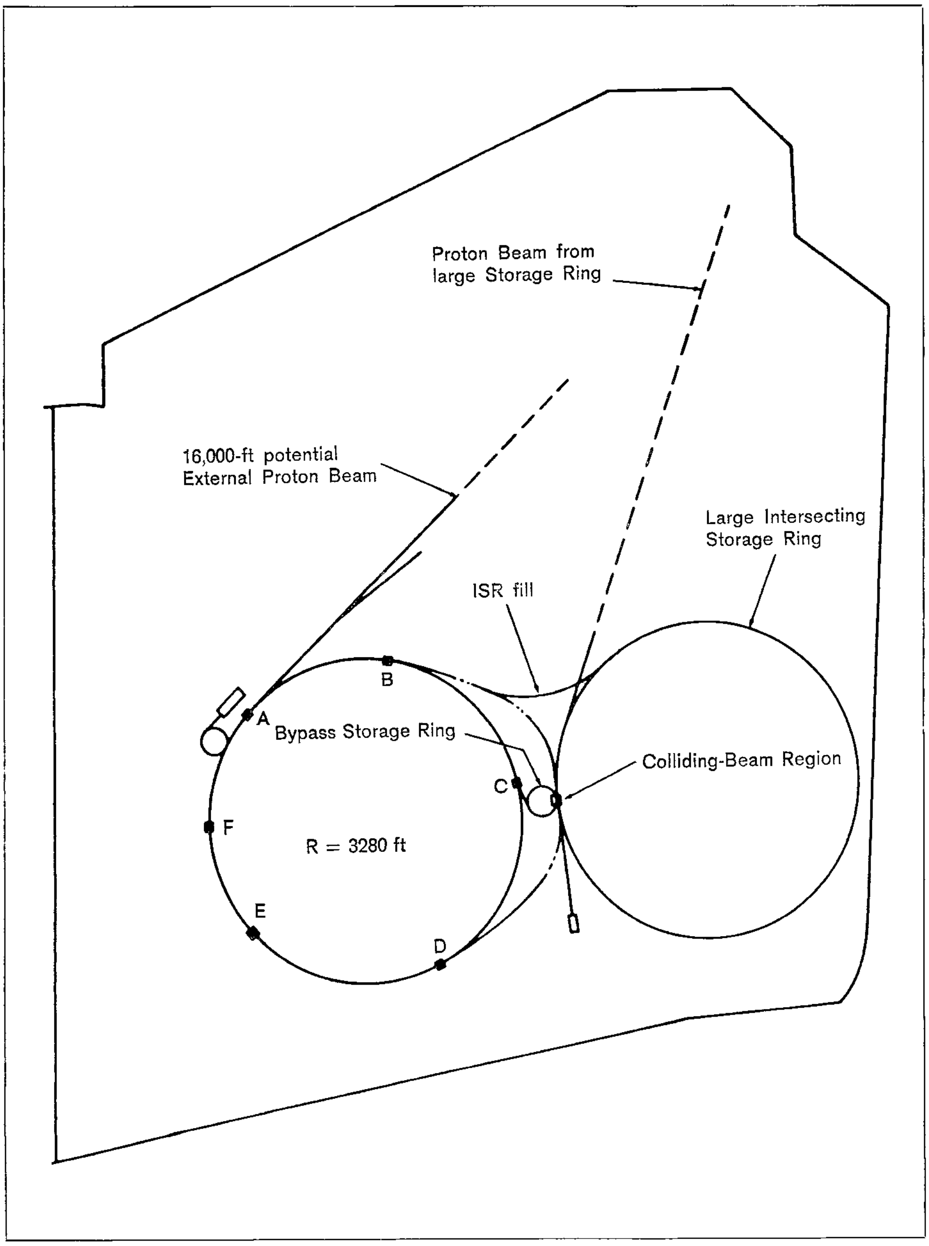


Figure 5

Figure 4: The ejected proton beam and its branches to feed experiments.

Figure 5: Projected future developments of the Weston site showing some possible layouts of a by-pass and storage rings which could be added at a later date.

another sloted in, by remote handling equipment if necessary. The magnets sit on a three jack system (see Figure 2 again) which can manœuvre the magnets in any direction. Alignment will be done by means of wires strung from quadrupole to quadrupole, a distance of about 60 m, with electric pick-up to indicate position. It will be possible to 'send a machine round' to adjust the jacks accordingly. There will be no foundations for the ring building and any realignment following settling of the ground will be dealt with via the jack system. Alignment is not considered a serious problem, as perhaps can be realized from the proposal to dig a lake in the middle of the ring !

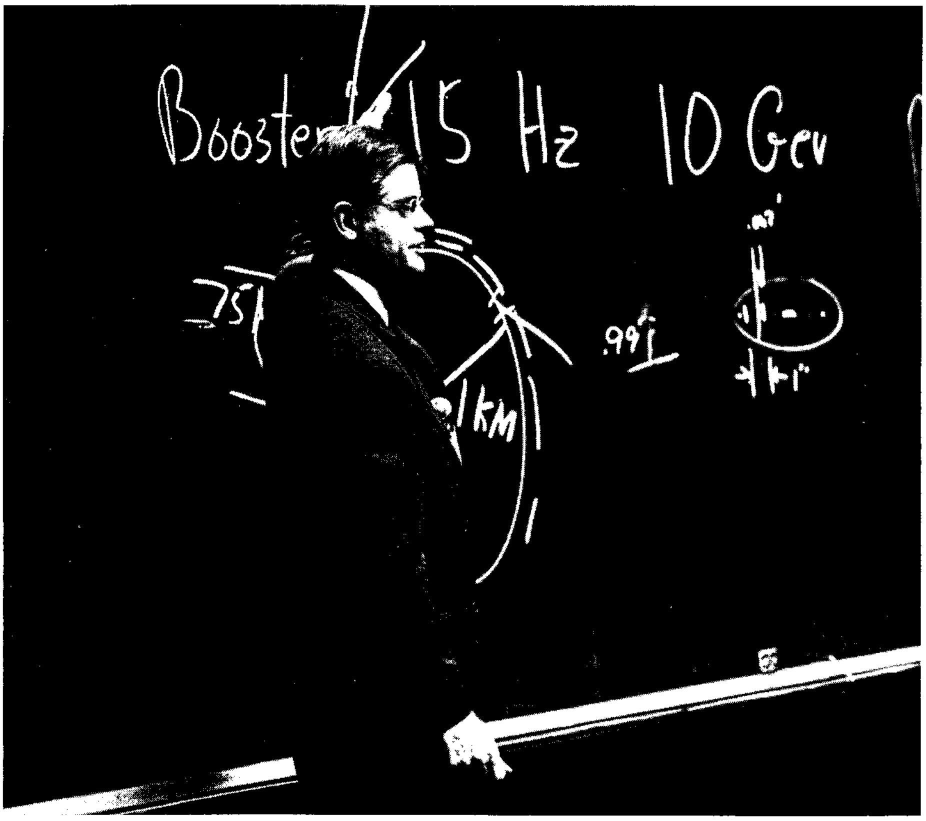
There are six long straight-sections (54 m) and six medium straight-sections (29 m) with 'mini-straights' dotted around in the lattice. The lattice reads — quadrupole focusing magnet, set of four bending magnets, mini-straight, quadrupole defocusing magnet, set of four bending magnets, mini-straight, quadrupole focusing magnet.

The vacuum vessel aperture is 5 × 10 cm and 3.8 ×12.5 cm following the beam contour dictated by the focusing magnets. The pressure will be 10^{-8} to 10^{-7} torr.

The magnets will probably be powered directly from the electricity grid, dispensing with rotating machinery and the magnet cycle for the 200 GeV is — 0.8 s filling time (at about 500 G), 1.6 s rise time, 0 to 1 s flat top, 0.6 s fall time. With an intensity per pulse of 5×10^{13}, this gives an average intensity of about 1.5×10^{13} protons/s.

To complete the story of the main ring, Figure 3 shows a model of a section of the ring building which has been constructed at Oak Brook. The ring will be excavated, and not tunnelled, and the building constructed of prefabricated concrete. By pushing the magnet close to one wall, a comparatively modest building (about 3 m diameter) has been made to look spacious. The inside area will be kept free, 'so that we can drive a jeep round if necessary'. It has been decided to have no train or overhead crane around most of the ring. There will however be cranes in the straight sections where the building will be wider. This also gives people somewhere to run to when the jeep is coming round !

Professor R. R. Wilson, Director of the National Accelerator Laboratory, giving his talk on the design of the Weston accelerator at CERN on 9 February.



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Injection

Injection into the main ring will be via a 200 MeV linear accelerator and a 10 GeV booster. The linac will be virtually a straight copy of the one being built as part of the improvements programme on the Brookhaven synchrotron. The booster is fast-cycling, 15 Hz, with a radius of 75 m. (A slow-cycling booster is not yet ruled out, however, if a good design can be developed.) The main ring will be filled with 13 pulses from the booster which just about fills the circumference in one turn. For future 400 GeV operation, two-turn injection would be used which would increase the filling time but still give, despite the lower overall repetition rate, about the same intensity per second.

The booster will be a combined-function machine. Attempts to push a separated-function design on the booster, to bring it into line with the main ring, were rejected because of higher cost. Wilson summed up the situation as follows, 'If you only need a low peak field in the magnets combined-function will probably win, but if, with a fixed radius, you want to get maximum energy (involving the highest field possible) separated-function wins because you can push the magnets to saturation while retaining good field across the magnet aperture'. The configuration of the poles in combined-function magnets makes them run into saturation problems faster.

Nevertheless, pursuing the mass production approach, the magnets, vacuum chamber, tunnel etc... will be virtually the same size as in the main ring.

Ejection

Here we come to another crucial aspect of the Weston design. It has been decided to concentrate initially on just one ejected proton beam and to aim for an ejection efficiency of 99 %. For slow-ejection, this seems a very high figure. CERN has recently pushed slow-ejection efficiency at the PS up to 80 %. Brookhaven, with a newly installed system on the AGS, are currently testing with the hope of reaching 90 %. However, at Weston, they are building the system into the machine rather than adding it later, and many of the design decisions (such as the choice of a larger vacuum vessel aperture than would otherwise be necessary) have been taken with an eye to high ejection efficiency. Wilson also maintains that, especially if they are not successful in achieving 99% efficiency, it is better to concentrate the radiation problems which will then arise, in one area of the machine.

As can be seen from Figure 4, beams will be drawn off to the right of the ejected beam-line. The use of beam-splitters and target stations will, of course, allow many experiments in different experimental areas to be fed at the same time. On the left of the beam-line will be a road, services and service buildings. No definite plans for experimental area lay-outs have been decided as yet but the schematic representation in Figure 4 has an experimental hall of almost 7 000 m². The experimental halls will be at ground level.

The ejected beam-line will be treated as part of the machine, using, as far as possible, the same tunnel size and the same magnets as in the main ring. By this mass-production approach, Wilson expects to have his magnets built in nine months.

As can be seen on Figure 1, some provision is being made for experiments which want to draw their beams from an internal target, but it is intended to keep use of this facility to a minimum, again to avoid radiation problems. It is from the straight-section where the internal target will sit, that a second ejected proton beam could be taken at some future date. The very first experiments will probably use the internal target at low intensity.

Figure 5 shows the result of some speculation about future developments at the site. It includes a by-pass, a low energy storage ring, a full energy storage ring and other positions for ejected beam lines. At this stage, there is little point in saying more about these developments, other than that they could be accommodated by the existing site and by the present design.

Professor Wilson concluded with some remarks on cost and timescale. Comparisons have been made between the European 300 GeV project and the Weston project which do not take into account the as to what costs really cover and what different definitions in the two cases completion dates really mean. For the two machines and their associated equipment to reach the same capability for experiments will costs about the same amount of money and involve about the same amount of time.

They plan at Weston to produce their first full energy beam by 1 July 1972. From then on, physics can begin at the machine, initially on a small scale. Professor Wilson is however encountering delaying tactics from his Deputy Director, E. Goldwasser, who is on record as considering that first operation should be held back until 4 July.

European Physical Society

On 30 January, forty physicists representing most countries in Europe and all fields of modern physics, met at the Battelle Institute in Geneva under the Chairmanship of Dr. H. Thiemann. CERN was represented by Professor P. Preiswerk and Professor J. Prentki. Their purpose was to continue the work to set up a European Physical Society.
Preparation of the constitution of the Society is almost complete and it is hoped that only one more meeting of the 'Steering Committee', which will be held in Prague, will be necessary before the first General Assembly of the Society can meet in Florence in the Autumn of this year.
This article consists of extracts from a talk given by Professor G. Bernardini at the Ecole de Physique, Université de Genève on 29 January. The title of this talk was 'First steps towards the creation of a European Physical Society'.
Professor Bernardini, from the Scuola Normale Superiore at Pisa, has played a leading role in preparing the ground for a European Physical Society. He initiated a meeting at Pisa on 'European Collaboration in Physics' where the idea of a European Physical Society was first seriously discussed. As a former President of the Italian Physical Society and Managing Director of the Journal 'Il Nuovo Cimento', he has first-hand knowledge of the value and the difficulties of Physical Societies.
Professor Bernardini is well known at CERN. He was appointed Director of Research in 1956 to take charge of the planning of the first experiments at the 600 MeV synchro-cyclotron and continued to guide the research programmes until he returned to University in 1963. He remains directly involved in CERN affairs as a member of the Scientific Policy Committee.

National Physical Societies exist in many European countries and some of them are very active and effective. Also, some of the most glorious European Academies maintain their leading positions in respect to the growth of science and its increasing influence on economic, social and political life.

However, for several reasons, varying from one country to another, the existing bodies show a great variety in their peculiar features and in the influence they exert on the present status and foreseeable future of physics. Some of them are mainly associations of physics teachers, particularly concerned about the almost insoluble problem of how to teach physics quickly, extensively and well ; others, aiming to defend the cultural value of science, organize debates, meetings and lectures ; still others, acting more specifically as Physical Societies and often with thousands of members, extend their activities to the production of Bulletins and the organization of international conferences and schools. Some of these Societies, besides issuing publications concerning the life of the association, act also as editors of one or other of the many European journals of physics. Of course, the journals published by Physical Societies, try to deal with all branches of physics equivalently.

At the same time, scientific research and the number of people interested and working in physics is growing. This makes more and more difficult the allocation of limited resources and qualified manpower, among an increasing number of specializations. As a consequence of specialization and of the new rise of cultural unity in Europe the national limits have been happily surpassed in several fields and some very effective and powerful organizations have been established on the broad basis of a European collaboration.

This has happened in space research nuclear physics, high-energy physics, and so on. For instance, I feel that CERN can be considered one of the best examples ; one in which the necessary budgets of hundreds of millions of francs are automatically bound to the governmental support of all the Member States. Another good example, where the budgets are in thousands and not in millions of francs, is a free association born from the initiative and good will of a few scientists — the 'Groupement Ampère'. Created around 1952, it now involves more than 500 physicists interested in electromagnetic waves, optics and electrodynamics.

However, if one looks at the progress made in the last decade, not all organizations have been as successful as CERN on one side or the Groupement Ampère on the other. Not all give the impression of a well-orientated scientific community making the best use, for the benefit of Europe and all mankind, of an undeniably great intrinsic potential. The impression is different. It is that of some general confusion which slows down the scientific and technical evolution so badly needed on our continent in the race for primacy in the civilized world.

This confusion originates partly from our historical inheritance ; partly from major economical and political facts with which, at present, European scientists have, and probably should have, very little to do ; but mainly, at least in my opinion, from unavoidable conflicts between controversial views and interests with which, on the contrary, European physicists have a lot to do. This confusion is negative in all respects — not only for a balanced development of modern physics, not only for the rise of those cultural values which are the noblest aspects of our history, but also for the present, urgent problems that Europe has to solve in order to become in a possibly remote, but certain future, a single highly civilized nation.

Of the forty people meeting in Geneva about half are the voluntary members of a Steering Committee for the promotion of a new association — the European Physical Society. The others represent almost all European national Societies and Academies who have kindly accepted the invitation of the Steering Committee to attend a discussion upon what may be done to establish a European Physical Society in the near future and if so, according to what principles and rules.

The movement to create a European Physical Society, started in Bologna in November 1965 during the Annual Conference of the Italian Physical Society. During this conference, taking advantage of the presence of a number of very distinguished European scientists repre-

Professor Bernardini, photographed while working at CERN, where he led the planning of the experimental programme during the first years of operation of the two accelerators.

senting most of the modern lines of research, the idea of a European Physical Society was openly discussed around the tables of a dinner-party. This happened particularly in connection with the future of 'Il Nuovo Cimento' and other European journals, and also with reference to the idea to build a 'super-CERN' for a new proton accelerator in the range of hundreds of GeV. These and other questions, at that time as now rather controversial and not equally welcome to the new generation of European physicists, were discussed in Bologna.

This discussion created the strong feeling that such a Society could be the ideal forum where problems of this kind could be examined and evaluated in the most objective and sensible manner. So at the end of the dinner, it was decided to have a new meeting with a larger number of participants to examine in more detail and in concrete terms the proposed institution of this new association.

A meeting was held in Pisa at the Scuola Normale Superiore, sponsored by the President of the Italian Republic and organized by the Scuola and the Societa Italiana di Fisica. The agenda included a few specific points such as the situation of the European journals, and co-operation around the high-energy Laboratories. But, as had been foreseen, the main point was, 'Should a European Physical Society be created in the next few years?' The discussion, initiated particularly by a speech of Professor S.R. De Groot, was extremely lively and the clash of ideas quite evident. However, the 100 physicists from all parts of Europe unanimously approved the following resolution at the end of the Meeting :

'The Meeting was strongly of the opinion that steps should be taken to found a European Physical Society.

Its function would be :

a) to provide a forum for the discussion of subjects of common interest to all European physicists, and

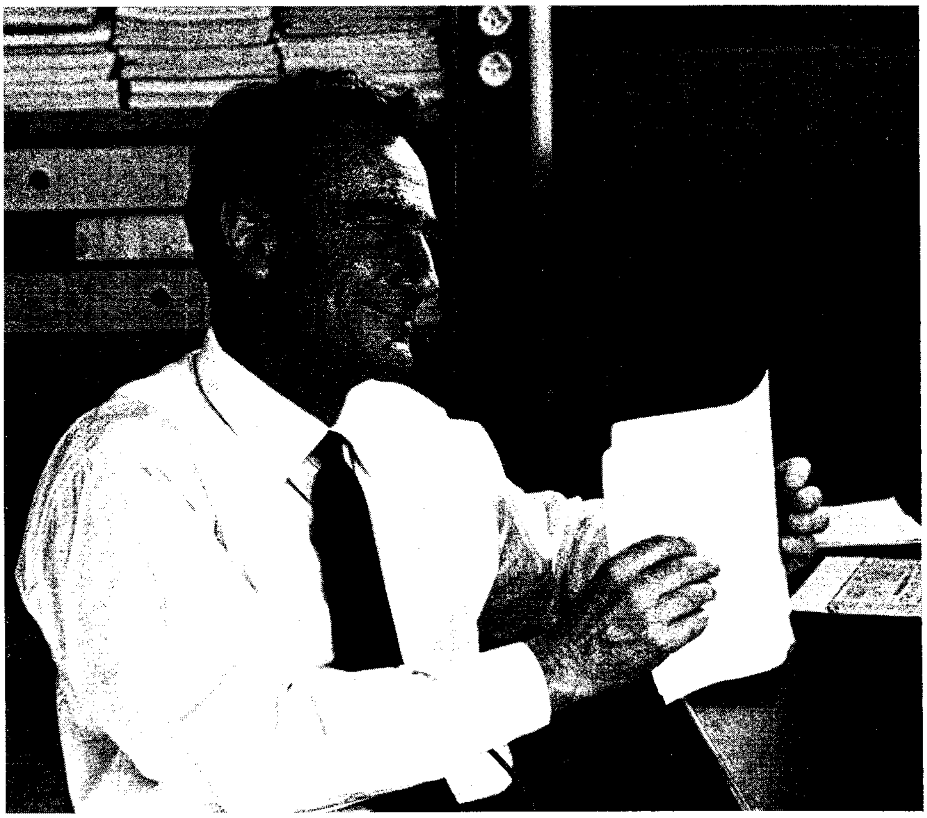
b) to provide means whereby action can be taken on those matters which cannot conveniently be handled by national bodies...'

The resolution recommended approaching the existing European bodies and the immediate constitution of a 'Working group for further action'. This is the Steering Committee to whose activity is due all the progress since then. They organized a meeting at CERN on 25 November 1966 under the chairmanship of Professor B. Gregory, Director-General of CERN ; a second meeting in May 1967 at The Institute of Physics and the Physical Society in London under the chairmanship of Sir James Taylor, President of the Institute, and a third meeting at the Battelle Institute, under the chairmanship of Professor H. Thiemann.

The CERN Meeting was the first contact of the Steering Committee with some Presidents and Secretaries of national Societies. The possible structure of a European Physical Society was discussed on the basis of a paper presented by Professor Béné, President of the Groupement Ampère. This paper, remarkable for its clarity, completeness and objectivity had a determining role on the suggestions and conclusions formulated by the two working groups at the CERN meeting. They concentrated on defining the fields of activity of a European Society and on the minimum conditions required to make it a living body. Already at this meeting the discussions, which were taken up in a wider forum and with renewed vivacity at the London meeting, were focused upon two possible types of organization — a completely new Society based on individual membership or a federation of the existing national bodies.

In London, two papers beside that of Béné lead the debates — one by Professor Ch. Peyrou, the other prepared by the Société française de Physique. This Society was present for the first time but since then it has made a substantial contribution to the movement towards a European Physical Society. The structure now proposed is a well-balanced compromise between the two extremes. It is a synthesis made in London, by a working group led by Professor Abragam, President of the French Physical Society, of the propositions presented by Béné, Peyrou and the French Society.

The compromise ensures that a future European Physical Society cannot have any negative influence on the national Societies. On the contrary, its effectivness will depend on co-operation with the national



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Societies and on a sensible sharing of tasks, initiatives and responsibilities. Its members may be associated to it directly and individually, or through their association to the national Societies.

Other relevant decisions and initiatives at the London Meeting, which were further elaborated by the Steering Committee were as follows :

First, the residence of the Steering Committee was fixed in Geneva at the Institute of Physics with a branch-office in London under Dr. Cohen (Secretary of the Institute of Physics and the Physical Society) ;

Second, a bank account was opened to give the Society a practical start and contributions have been received from the Italian Physical Society, Professor Weisskopf, the Weizmann Institute, the Swiss Physical Society and CERN ;

Third, the proposed official language of the Society was chosen as English ;

Fourth, the Steering Committee was asked to prepare a constitution for the Society — its rules; its official residence; the structure of the governing bodies ; the tasks assigned to the secretariat and the first budgets.

It is hoped that a final discussion and approbation can take place in Prague next May. This is intended to be the last meeting of the Steering Committee, where it is hoped to announce officially the constitution of the European Physical Society.

Then in Florence at the end of September or early October, the first General Assembly of the Society could take place. This may consist of one day devoted to an Inaugural Ceremony of the Society, to plenary discussions of its activities for the subsequent two years, and to the appointment of the people to govern the Society during this two-year period. Two other days could be devoted to an up-to-date presentation of the most relevant achievements in several fields of physics, pointing out in particular the contribution of European physicists. It has been proposed that a few outstanding scientists could be invited to prepare review talks of general interest. To make complete and interesting surveys possible, similar to the procedure followed at the Solvay Conference though on a smaller scale, one day would be spent in open discussion of the papers prepared by the lecturers. People who are actively working in the particular field to which the lectures refer, would be invited to these discussions.

To conclude, I would like to make a short review of the motivation for the institution of the European Physical Society. It may be considered useful for the following tasks :

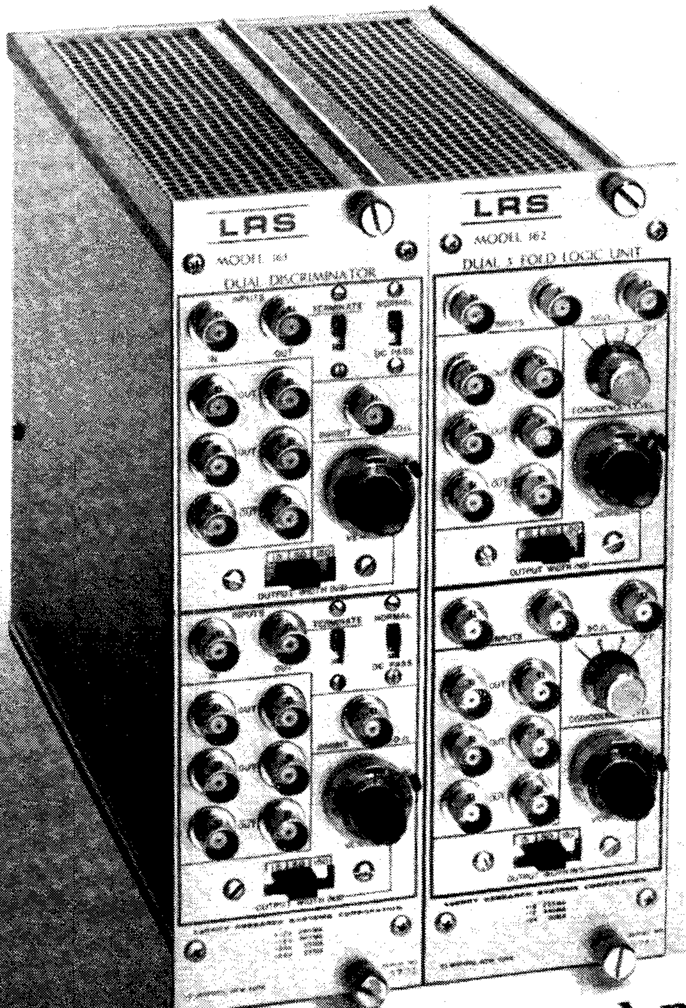
1) the coordination of meetings and conferences, particularly in those fields where the number of interested people in each European nation is not very relevant
2) the coordination, initially, and then the editorial responsibility for European physical journals. It seems very desirable to have one day, one European journal for high-energy physics, one for nuclear physics, one for plasma physics, one for solid state physics, one for cosmology and so on.
   The Society may provide the boards of editors and a well balanced panel of referees to achieve an even, high standard in all published papers.
3) the coordination and in some cases, if necessary, the regular publication of review articles to reduce the dangers of specialization
4) the publication of a regular bulletin giving information concerning the national society activities, an agenda of conferences, news of major projects, etc...
5) the organization and control of the many so-called 'Summer Schools' whose proliferation it is quite urgent to limit
6) the exchange of experience and information on problems related to teaching physics at all levels
7) the preparation of plans for the exchange of students and young physicists between Laboratories and Institutions.

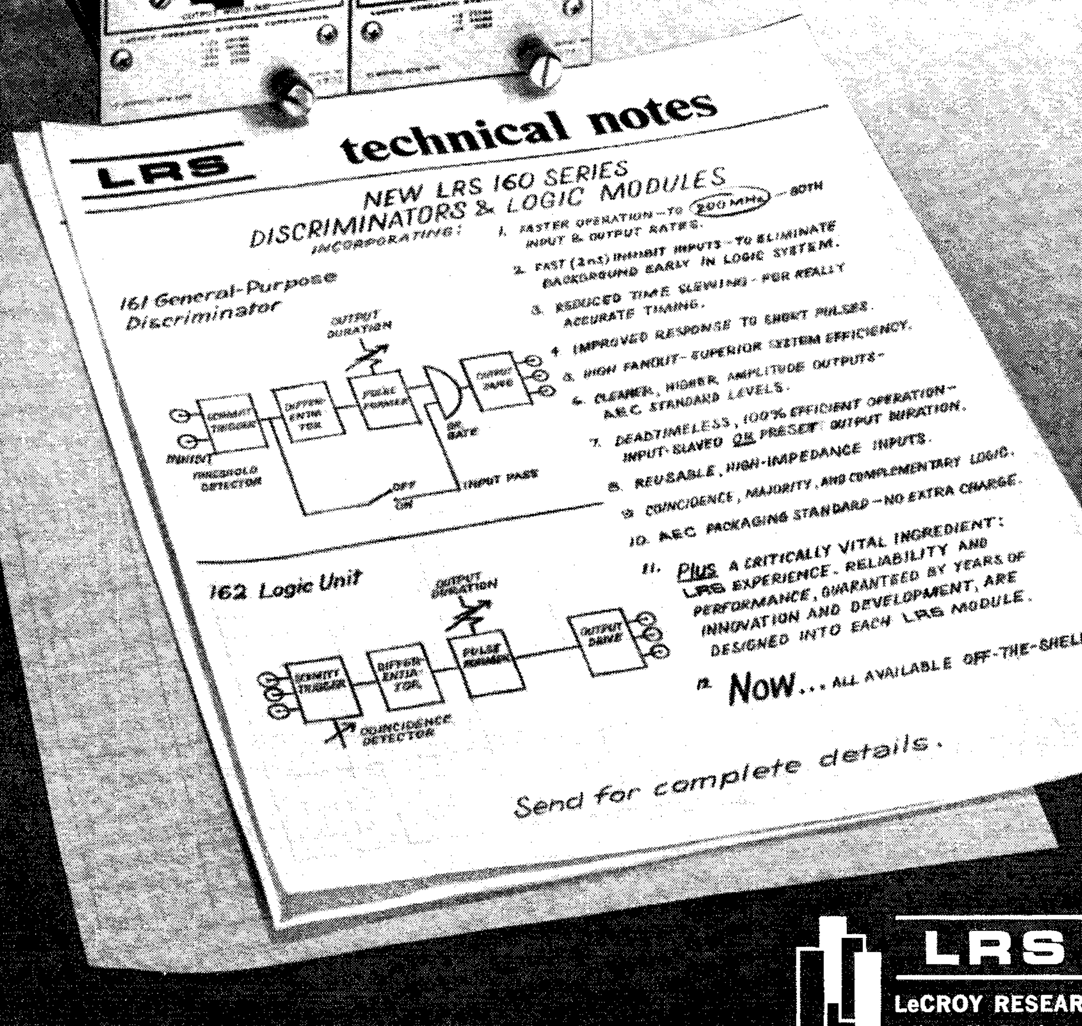
These are the more obvious tasks at present. It would not be sensible to try to say more at this stage. We hope that the European Physical Society will very soon be born but we cannot expect to see it in full flight immediately after.

THE INNOVATOR LINE

FAST LOGIC...
logically designed

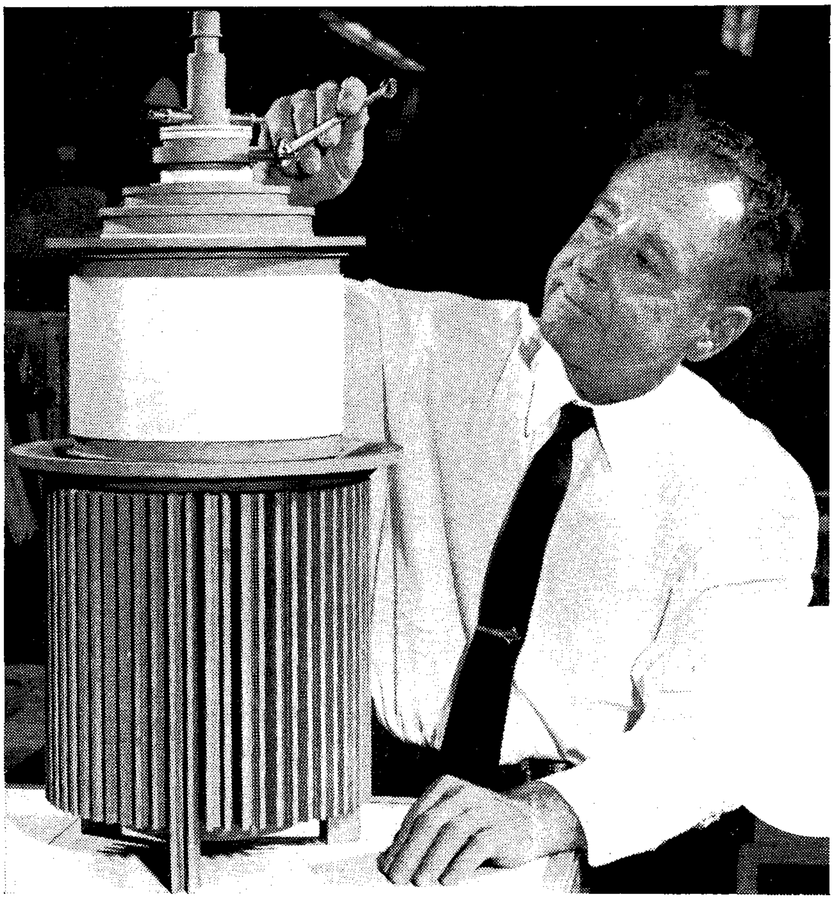
When we first introduced the *LRS Innovator Line* a few years back, it was a new and untried design. It incorporated many *firsts.* Deadtimeless operation. Full-system direct coupling. Continuously variable output duration. Well-protected inputs. High fanout. No multiple pulsing. . . . We incorporated new features we felt were important. □ Experimenters must have thought so, too. They tested the new instruments. They did experiments with them. They suggested further refinements. □ We listened. We made changes. We kept on making improvements that were important to the experimenter. And we're still listening. □ The result is the newest generation of LRS fast logic – our new 160 Series Discriminators and Logic Modules. All still logically designed – by experiment.

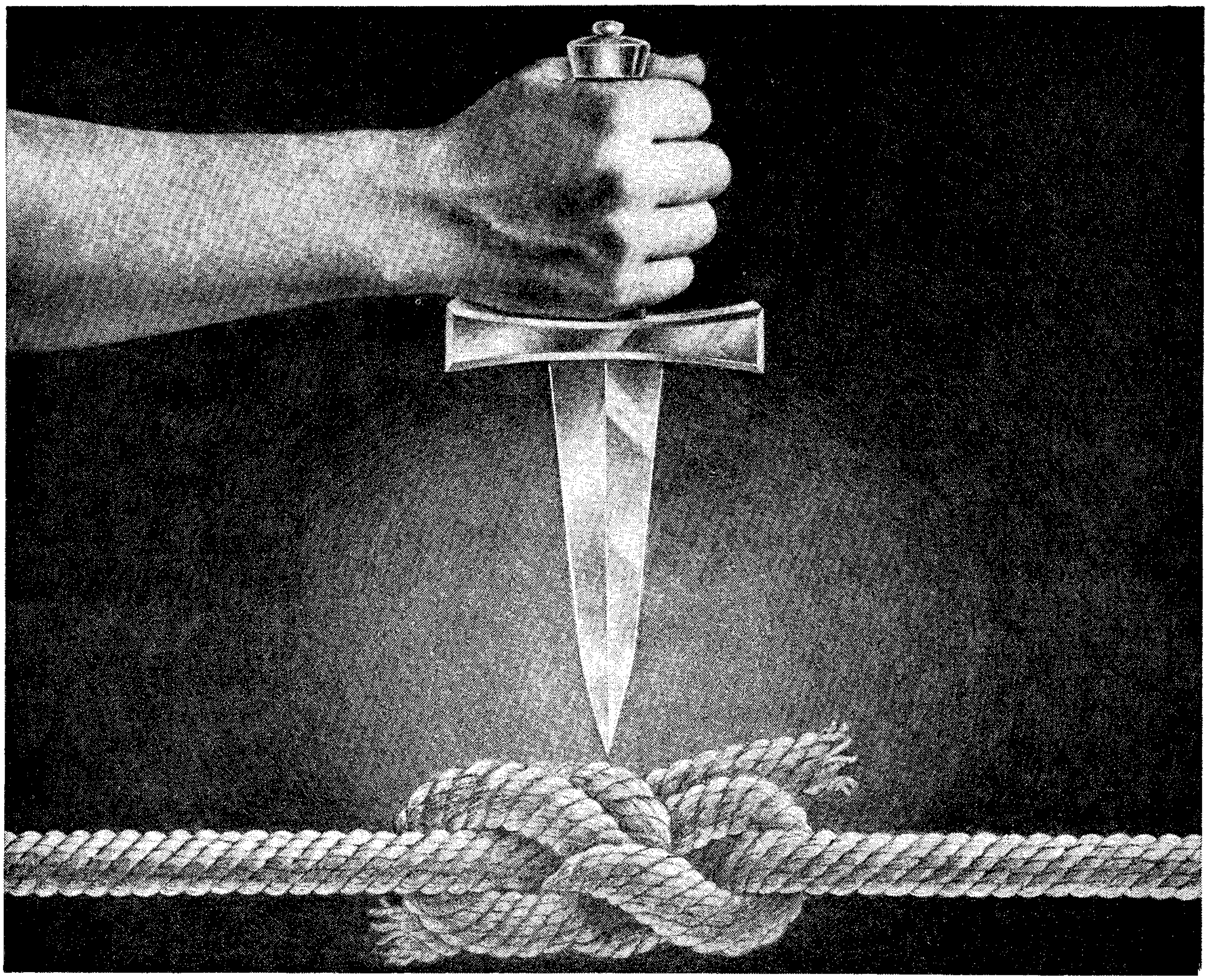


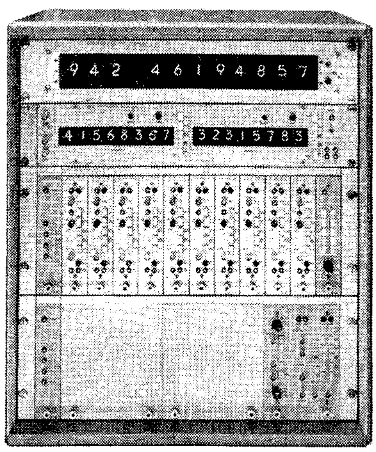


LRS

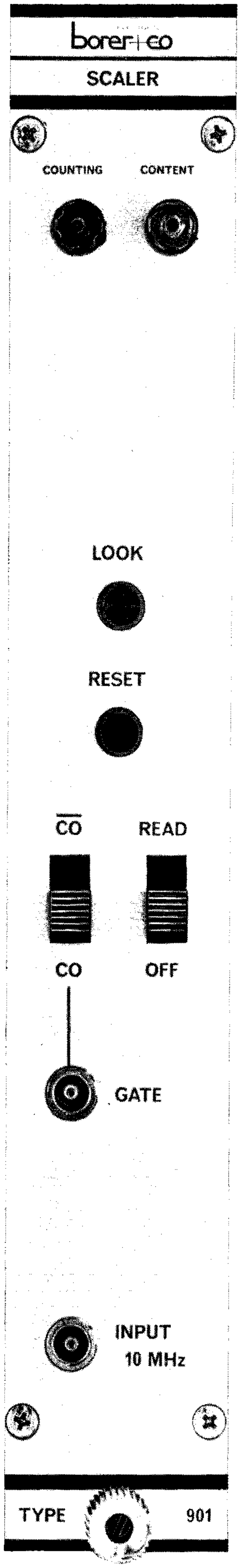
LeCROY RESEARCH SYSTEMS CORP.
1 Hayes St., Elmsford, N. Y. 10523 • (914) 592-5010
Innovators In Instrumentation





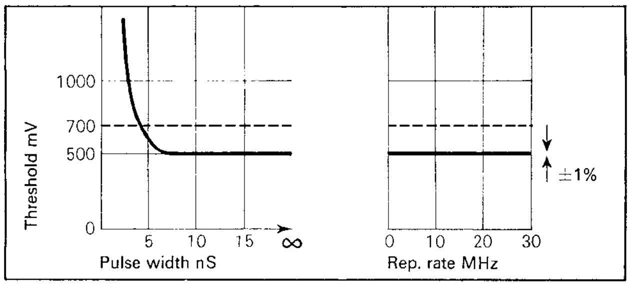


If you want to be certain of your scaler counting accuracy ■ ■ ■ ■ ■ ■ ■ read on



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 10^6 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
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

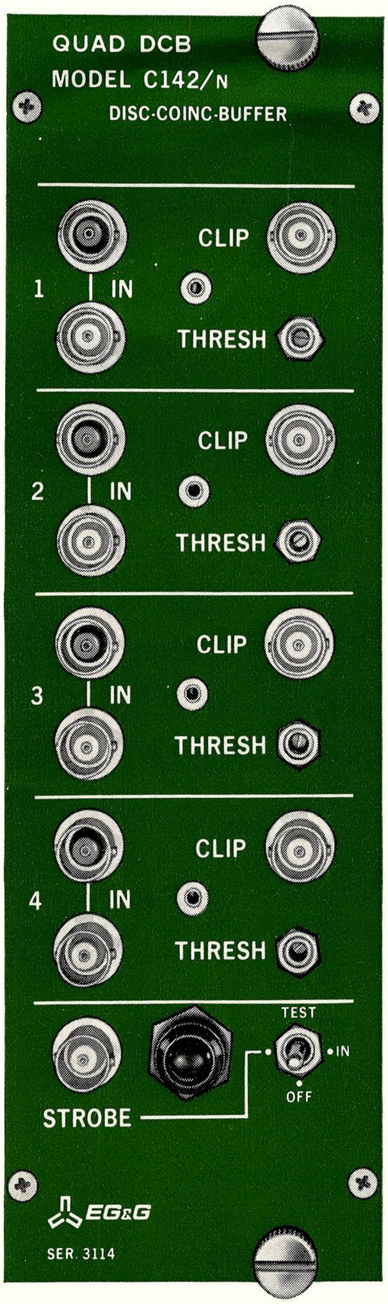
Germany: Verkaufsbüro München, Kaiserstrasse 10, D-8000 München 23
Telephone 34 80 16

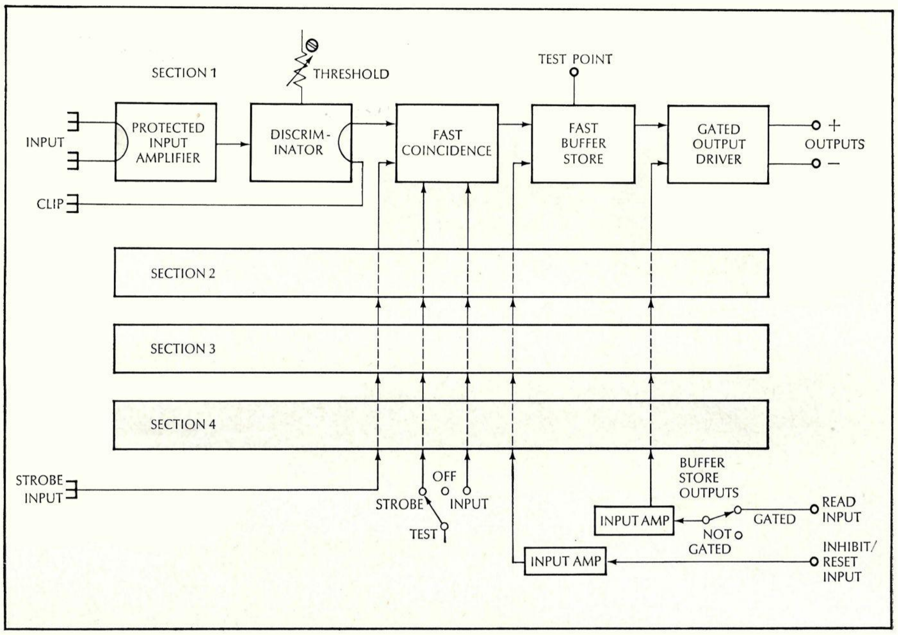
France: Sorelia Electronique, 150 rue de Chatou, 92 Colombes
Telephone 782.16.39-782.32.79

Italy: Boris G. F. Nardi, Via Capranica 16, Milano
Telephone 2362924-2361394

How much can you put in a module? Four discriminators . . . four coincidence circuits . . . a fast four-bit buffer store . . . versatile output and control circuitry . . . almost a bin full of 200 MHz instrumentation is in the new C142/N QUAD DCB . . . to save you space and money.

EG&G
NUCLEAR INSTRUMENTATION





How did we do it? We arranged nearly 600 components in four complete data channels, shown above.

"Bridging" inputs to the discriminators are protected to ±200V overloads, and allow detector signals to be reused or conveniently monitored. Each discriminator has a multiturn threshold control, −100 mV to at least −500 mV, and each discriminator will operate in excess of 200 MHz. The "biased amplifier" discriminators have no dead-time, and output signal width is equal to input width above threshold. The CLIP connector allows discriminator output signals to be clipped with a shorted stub, without multiple pulsing, to as short as 2.0 nsec.

The STROBE input accepts NIM-standard fast logic signals, and each of the four direct-coupled coincidence circuits is capable of 200 MHz operation.

Each coincidence circuit drives a fast buffer store (tunnel diode flip-flop) which is reset and inhibited from the rear-panel interface connector. A rear-panel locking toggle switch allows the buffer store content to be read out upon computer command, or allows the buffer store content to read out directly at all times. The buffer store may be monitored from the front-panel test point.

Independent positive and negative polarity outputs are provided at the interface connector and the read and inhibit/reset lines accept either positive or negative signals, to make the C142/N easy to interface to any computer or slow logic system.

There's a lot more to be said about the C142/N . . . ask us.

For detailed specifications, write or call: EG&G, Inc., Nuclear Instrumentation Division, 40 Congress Street, Salem, Massachusetts 01970. Tel: (617) 745-3200. Cables: EGGINC-SALEM. Field offices: Chicago, Illinois; San Ramon, California; Alexandria, Virginia, Representatives in foreign countries.