CERN COURIER

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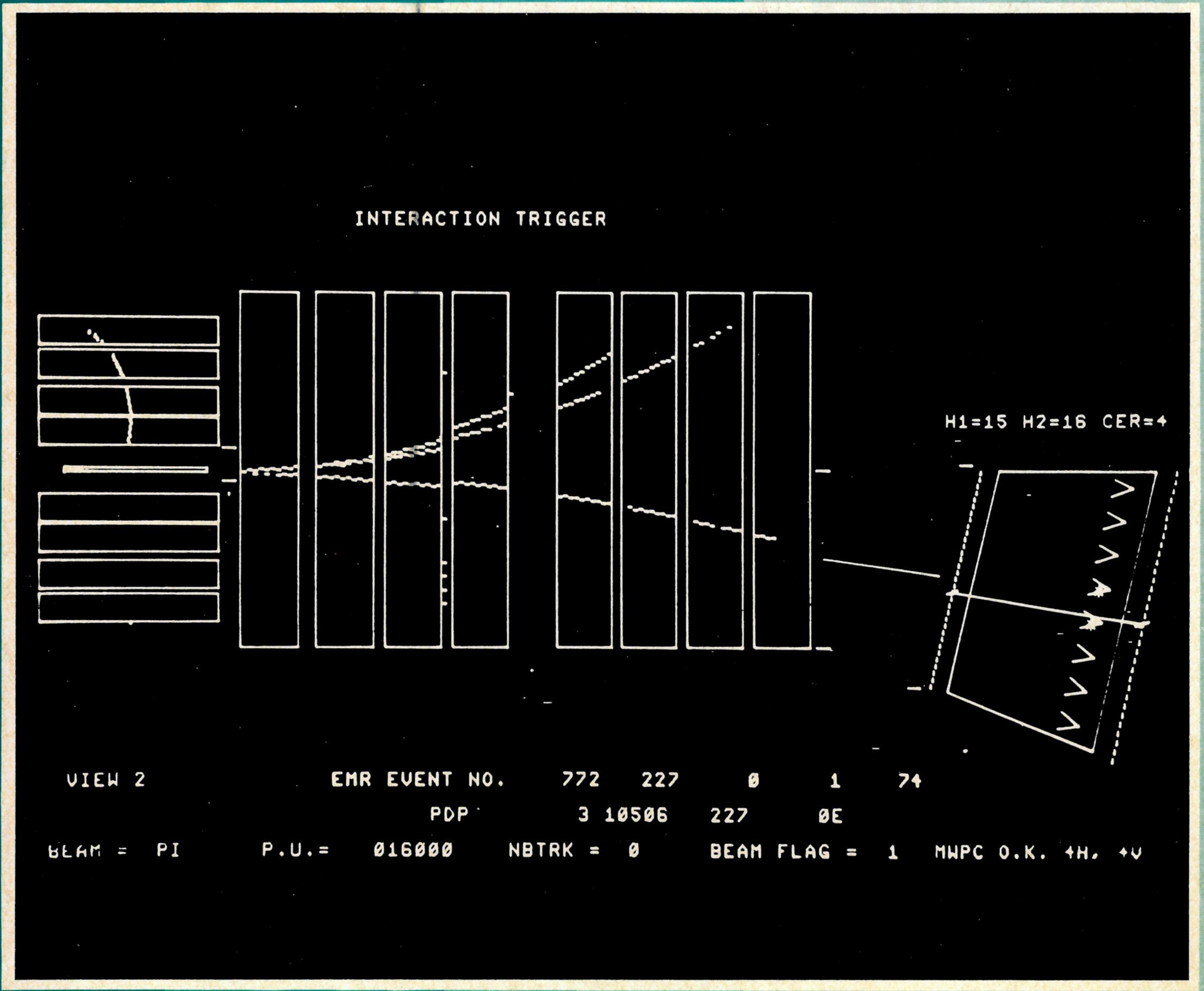

CERN, the European Organization for Nuclear Research, was established in 1954 to '... provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, 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. The Organization has its seat at Meyrin near Geneva in Switzerland. There are two adjoining Laboratories known as CERN Laboratory I and CERN Laboratory II.

CERN Laboratory I has existed since 1954. Its experimental programme is based on the use of two proton accelerators — a 600 MeV synchro-cyclotron (SC) and a 28 GeV synchrotron (PS). Large intersecting storage rings (ISR), are fed with protons from the PS for experiments with colliding beams. Scientists from many European Universities as well as from CERN itself take part in the experiments and it is estimated that some 1500 physicists draw research material from CERN.

The CERN Laboratory I site covers about 80 hectares almost equally divided on either side of the frontier between France and Switzerland. The staff totals about 3100 people and, in addition, there are about 1100 Fellows and Scientific Associates. Twelve European countries contribute, in proportion to their net national income, to the CERN Laboratory I budget, which totals 382.9 million Swiss francs in 1973.

CERN Laboratory II came into being in 1971. It is supported by eleven countries. A 'super proton synchrotron' (SPS), capable of a peak energy of 400 GeV, is being constructed. CERN Laboratory II also spans the Franco-Swiss frontier with 412 hectares in France and 68 hectares in Switzerland. Its budget for 1973 is 188 million Swiss francs and the staff will total about 370 people by the end of the year.

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Around the Laboratories

Cover photograph: Particle interaction photographed in the Omega spectrometer. A positive kaon, with a momentum of 12 GeV/c, arrives from the left and interacts with a proton in the hydrogen target. Omega was operating in an 'untriggered' mode which means that it was ready to record anything when it knew a beam particle had interacted. In this case it caught three positive particles (curving upwards) and a negative pion which was identified by the Cherenkov counter behind the spectrometer. The Cherenkov is set at a low pressure so that it gives its signals when traversed by pions.

CERN: a source of European spirit

L. Kowarski

Great political movements can often be first perceived not as actual events: federations, liberations, revolutions... but in seemingly more relaxed domains such as culture, art, basic science, and even sporting events. It is as if the collective mind had to be prepared in some way before the 'real action' is ready to start in earnest. Thus, if we look at Europe as it emerged from World War 2 in mid-1945 — a continent broken up, devasted and seemingly devoid of means to make its voice heard — we notice that in the minds of political leaders and diplomats, the restoration of Europe's place in the world meant not only the world of politics or economics, but also, perhaps most insistently, the world of culture.

The claim of physics

This conjunction was particularly evident in that post-war summer, when the demonstration was made of the down-to-earth might of a branch of advanced science which, before the war, was considered as one of the most removed from immediate applications. In little more than six years, nuclear physics became the main instrument of power politics. Because of this unexpected identity between cultural achievement and worldly power, it became natural for those dreaming of European restoration through European unity, to choose scientific research as the proper field for a first manifestation of that unity on the cultural plane and, among the domains of research, to choose nuclear physics.

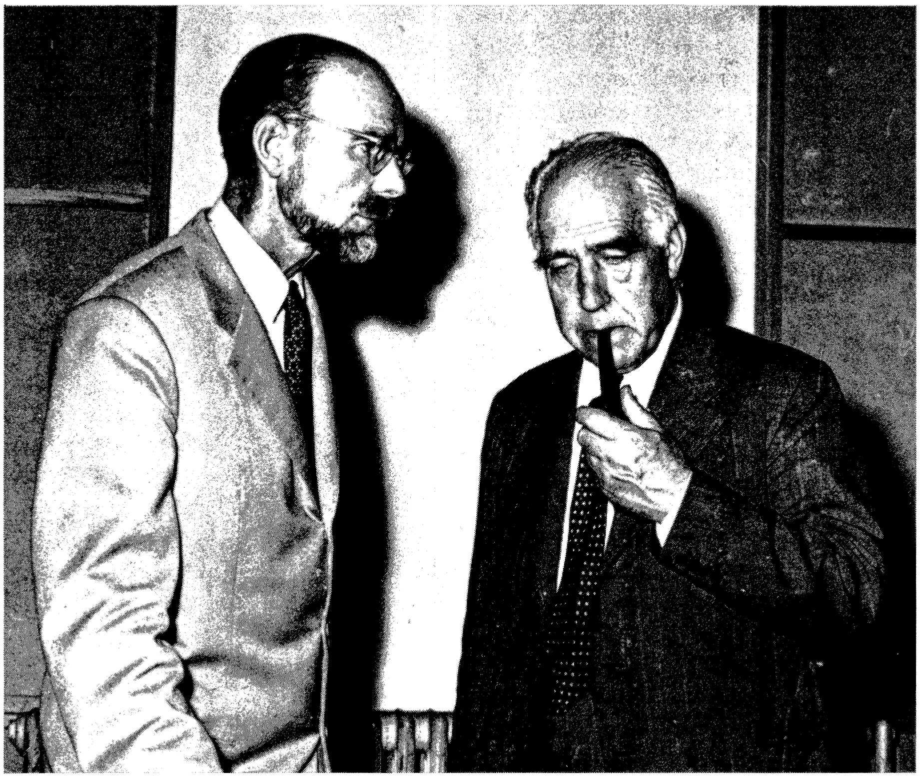
Physicists of Western and Central Europe were not slow to grasp this unique opportunity to unite their efforts and to be sure that governments would listen to them with favour. Their main interest did not lie in the direction of mastering nuclear technology, where the basic physical phenomena were already known, but in the new frontiers of particle physics which looked far more alluring. The example of the United States, rich in insights gained immediately after the war, showed that new kinds of big equipment were very helpful and it was obvious that, at that time, similar equipment could be obtained in Europe only by pooling resources.

Thus it was recognized that to promote the unity of European science involved not only the familiar plane of personnel and information exchanges, but also the much more concrete plane of big machines and a commonly owned piece of land under a wholly new form of common European sovereignty. In this way, subatomic physics showed its unique vocation as a culturally motivated mascot in the search for a politically united Europe. It demonstrated that culture and politics went together and that the specific nature of its requirements pushed the unifying trend towards a most realistic and conspicuous way of expressing itself.

Such a common enterprise in advanced physics could be relied upon to leave its mark not only in physics but also in a much wider context. This promise was quickly grasped by some of the leading protagonists of a united Europe. Two personal opinions which the present writer has heard expressed in private conversations may be quoted as convenient illustrations. Professor W. Heisenberg in the early 1950's considered that, on the way towards Germany's re-integration in the common aspirations of Western Europe, full participation in a common scientific enterprise would be a significant and readily acceptable step. In another and very different region of European politics, a prominent French politician (who, at that time, was against the idea of a restricted Common Market), when hearing in 1954 that Britain was among the signatories of the CERN

An early deliberation, en route to the establishment of the European Organization for Nuclear Research, between two of its most illustrious founders — Pierre Auger (left) and Niels Bohr.

(UNESCO Photograph)



Convention, exclaimed that CERN was worth founding and financing if only to prove that co-operation with the United Kingdom was no less feasible and desirable than that with any Continental nation.

The showpiece of a United Europe

By that time, planning and machine-designing activities of provisional international groups assembled by the incipient CERN were gathering speed and most of the groups were already located in Geneva. In late 1953, the Proton Synchrotron Group of the Provisional CERN organized a world conference (the world, in this context, being limited to Western Europe and the United States) on advanced accelerator design and construction where papers were given by outstanding guest experts as well as by CERN staff. In his summing-up, Sir John Cockcroft remarked that, once decided to embark on a joint effort, Europe found itself quite easily in the forefront of that particular line of advance. Thus the original aim of making Europe's voice heard again on the international scene, showed signs of fulfilment even at this early stage.

A few years later, the synchro-cyclotron came into operation, and almost at once began to yield significant results, on a par with those obtained elsewhere with the most advanced machines of the same kind. In late 1959, when the proton synchrotron reached its full energy, CERN could claim the complete fulfilment of its original objective: Europe *was* in possession of the most advanced and powerful accelerator in the world.

This top-rank glamour was soon recaptured by America, with its slightly bigger machine at Brookhaven but the prestige of the European achievement remained, not only in quantitative terms, but also as a re-assertion of a traditionally European elegance of conception and detailed execution.

Towards a world-wide role

In the prophetic dreams of its first founders, united Europe should aim not at the role of a self-sustained isolated unit, a fortress against the encroaching outsiders, but at becoming a full participant on an equal level in the activities and communications involving the whole planet. In the same spirit, the common enterprise in European physics did not seek to put itself apart from its counterparts in the United States, the Soviet Union and elsewhere but expected to entertain a fruitful dialogue with all these colleagues and competitors.

At the beginning, for political reasons prevailing in the early 1950's, the contact with America was by far the easiest to maintain. Its first manifestation was the friendly rivalry between the physicists of united Europe and those of the united universities on the American East Coast. The latter's common laboratory in Brookhaven was in many ways a prefiguration of what a common European institute might become yet its ambitions as regards big equipment did not run as high as those already entertained in Europe. As soon as it became obvious, that CERN *would* build a very powerful synchrotron, the Brookhaven physicists found themselves in possession of a decisively effective whip to flag up the zeal of their own purse-keepers. Eventually they did obtain the needed resources and, in this way, European influence produced its first direct impact on the conduct of scientific affairs in America.

In the last years of construction and the first years of use of the CERN machines, this fruitful contact was kept up by a constant stream of American visitors and research fellows, whose participation in CERN's life

Symbol of European collaboration — the flags of Austria, Belgium, Denmark, Federal Republic of Germany, France, Greece, Italy, Netherlands, Norway, Sweden, Switzerland and the United Kingdom fly at the CERN site.

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was financed by the Ford Foundation for several years. This tradition remains unbroken to the present day.

The same years coincided with the thaw of the Cold War. The Soviet scientists, for whom the first Atoms-for-Peace Conference held in Geneva in 1955 provided an opportunity to visit CERN, were impressed and paid us the highest compliment — that of following our example. The nuclear institute at Dubna, already in existence for several years, was transformed into an international enterprise, in which every member of the Soviet-led group of nations was invited to take part. Relations between Dubna and CERN were, and remain, unvaryingly cordial. It may be hard to imagine to-day why they ever should have been otherwise, yet if we remember the early date at which they were initiated it becomes obvious that CERN played a forerunner role in the East-West détente, a role to which the then Director General (C.J. Bakker) gave his wholehearted support. A strong Soviet delegation came to the CERN Accelerator Conference in 1956; although some details of its workings were at first reminiscent of older and less confident times, they melted away never to be seen again.

In addition to these two sizable partners, America and East Europe, other scientifically advanced nations — Japan, Israel, India and others — developed a network of contacts which became a significant part of CERN's scientific function. The distinction of possessing the most powerful accelerator in the world was held by CERN for only a few months but that of offering the use of one of the two top-rank machines lasted for several years and was largely responsible for CERN's worldwide appeal. This was reinforced in the late 1960's when CERN once again found itself in possession in a unique facility — the Storage Rings. They make possible a class of physical experiments which cannot be attempted anywhere else — an attraction to which the particle physicists from all parts of the world have eagerly responded and which will retain its effectiveness for many years to come.

On a somewhat more modest plane, CERN's initiatives in the processing of visual data (in particular for the computer-aided analysis of bubble chamber pictures and for the fully automatic analysis of spark-chamber tracks), have spread over the whole world and became the starting-point for other, more recent, devices invented elsewhere.

The new forms of co-operation

The political builders of a united Europe have for many years witnessed the continuing success of CERN; they became accustomed to consider it as an invitation to other initiatives, similar in spirit but applicable to other domains, including those of an economic, industrial or managerial kind. Some of CERN's innovations, expressed in purely organizational terms, proved their relevance in this extended context.

There has been, from the start, a danger that CERN would become just another research institute which happens to be endowed and owned not by one European state, but by several, and for this reason able to afford an unusual wealth of big equipment. If it had stayed in this role, it would still contribute to European unity in general but not to the unity of European physics. This danger was noticed and steps to avoid it were taken even before the synchrotron began to function in 1959. The initial try-out of the new forms of co-operation between CERN and the national institutes took some time to develop and to codify. By mid-1961 this task was largely completed (mainly by J.B. Adams) and the scientific life of CERN (under V.F. Weisskopf's leadership) assumed its character of a research 'commonwealth' centered on the Geneva site but in no real sense confined within its borders.

CERN's experimental programme is decided by deliberations in which users from all nations, alongside the CERN staff, take an effective part. CERN's equipment has become a resource available to, and directed by, the whole community of particle physics in Europe (and, in certain aspects, also beyond Europe).

This practice offers a working solution for at least two dilemmas which, so far, have plagued other attempts at European unification. Every common enterprise in Europe has to decide whether it is international or supranational. Should it be occupied only with fostering and fortifying relations between activities which take place in its member nations or should it pursue its own activity which, because it is more widely based, would in some way be rated *above* its national counterparts? CERN seems to have somehow succeeded in being both inter- and supranational; moreover, it may be hoped that its Commonwealth shows none of that aloofness (or arrogance) with which supranationality is so often associated.

Once a role other than purely international is recognized as legitimate, another dilemma arises: is the commonly owned institution to become 'super'-national in the sense of — in some way — crowning the sum-total of national activities throughout the whole territory of its membership, or will it be simply 'extra'-national, standing as a sort of separate unit, comparable to the national ones? Some other European enterprises in science and technology have in fact ended up in this walled-off status very unlike the present two-way relationship existing between CERN and its constituents.

The spreading pattern

The closest analogues to the pattern inaugurated by CERN can of course be found in the entreprises which are both international and science-oriented. Some of CERN's originators in fact became, ten or twelve years later, involved in the foundation of ESRO. Although, in the first decade of its existence, ESRO's success was less complete than CERN's, it should also be said that the pattern had not been followed with entire fidelity. Perhaps it would be too much to correlate directly these two divergencies; yet, in the recent proposals for the re-organization of European space research, some of the unCERN-like features of the ESRO idea have been removed and perhaps the new organization will derive some benefit from this partial return to the source.

The European Southern Observatory (ESO) has been less widely publicized but it had close collaboration with CERN from the start and part of its work takes place at CERN's Geneva site. The European Molecular Biology Organization (EMBO) is pursuing very different aims from those of CERN and its development has accordingly proceeded on different lines. Yet, here again, the contacts with CERN in its Geneva setting were lively, cordial and — it is to be hoped — ultimately fruitful.

A parallel and a lesson

The correlation between the consolidation of CERN and the complicated course of the European idea through the 1960's found its reflection in the fluctuating fortunes of the '300 GeV' project, which was finally approved in February 1971. The first plans for a machine of this size were made approximately at the time when the unification of Europe was suffering a set-back connected with the abortive attempt to get Britain into the Common Market (1962-1963). Towards the end of the same decade, the European picture had changed and with it the prospect of building the SPS. The initiation of the procedures to extend the Market and to build the CERN Laboratory II took place in a nearly identical time sequence.

Now that the Common Market covers practically all of Western Europe, the effort which sustained a restricted Europe can give place to the build-up of peaceful and fruitful co-operation between the united Europe and the outside world. In this respect, the enlargement of CERN into an interconnected network of inter-institute collaboration and the concomitant extension of CERN's validity from a regional to a world-wide scene may pre-figure the future role of Europe in the world at large.

CERN's origins, as a new departure both in esoteric pursuit of pure knowledge and in practical politics, are worth some reflection in connection with another eagerly debated topic. One of the most frequently urged features of European unification is the creation of a jointly owned computer industry as a counterpart to the world-wide empire of IBM. It is advisable to remember the lessons of the invisible, and not always logical link between the plane of material events and that of the cultural, we might almost say spiritual, values. IBM is not only a seat of industrial power; it is also the source of an important, scientifically creative intellectual effort. Neither of these two categories of success could have been achieved without the other. The European spirit, as foreshadowed by CERN, first became visible on a plane seemingly remote from all wordly preoccupations. Perhaps this is, after all, the most realistic way to practical achievement.

CERN News

Opening of inter-Laboratory link

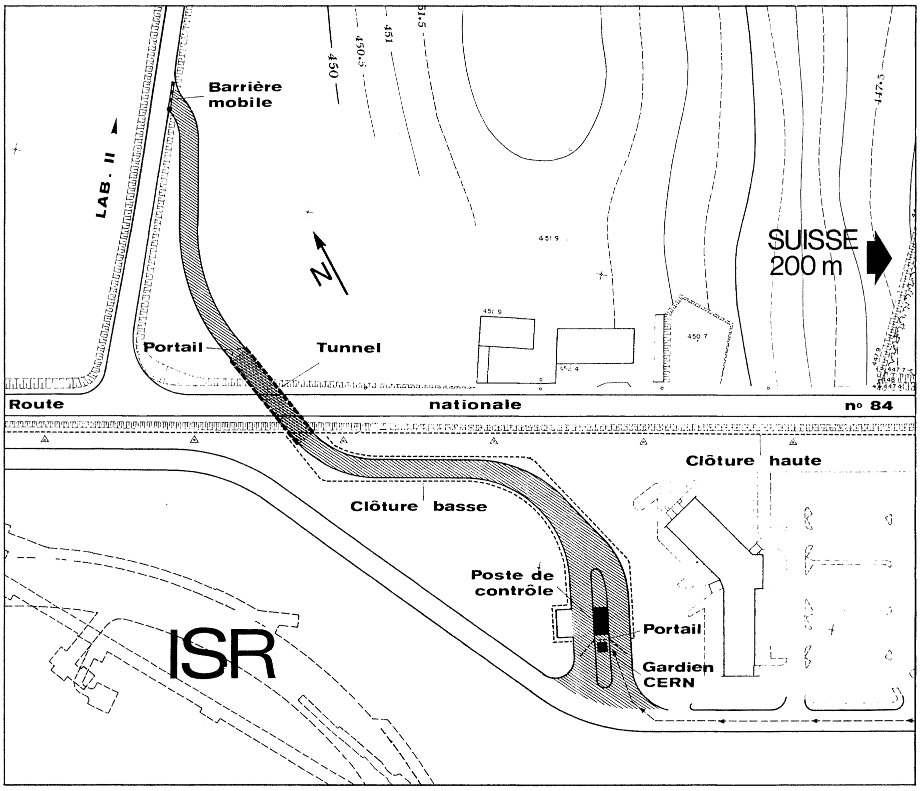
The road and access tunnel between Laboratory I and Laboratory II were opened to internal traffic on 10 September.

When the new site for the construction of the SPS in Laboratory II was made available for the use of CERN, agreement was reached between the host countries (France and Switzerland) and the Organization to open a tunnel passing under the road R.N. 84 in France in order to link the two CERN Laboratories. The discussions of the detailed arrangements were difficult because of the unique problems to be solved taking account of the geographical location of CERN with its installations on both sides of the Franco-Swiss border. Many governmental authorities in both countries were involved (Foreign Affairs Ministries, Customs authorities, Police, etc.), and the number of lawyers and documents that had to be consulted was daunting.

The purpose of the link is to allow personnel and goods to move easily within the Laboratories as is necessary for the smooth functioning of the work of CERN. At the same time, the rights of the host countries to implement the necessary police and customs checks have to be safeguarded. The crux of the discussions was how the principle of the territorial unity of CERN could be reconciled with the sovereign rights of France and Switzerland.

The Laboratory I site is well defined and fenced in. The Laboratory II site, however, is open and (with the exception of the auxiliary buildings, access shafts and office/laboratory area, which are fenced in) the whole site is freely accessible. The roads are public and the farmers, subject to certain conditions, can continue to farm the

The cross-hatched area is the access road between Laboratories I and II which was opened to internal traffic on 10 September. Although this road lies entirely within the French part of the CERN site, the necessary arrangements had to be agreed by both the French and the Swiss authorities since it provides access to the territories of both countries via the western section of the CERN site.



The tunnel under the Route Nationale 84 viewed from the Lab. II side. In the background on the left is the building of the Technical Services and Buildings Division.

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land. In spite of these differences, CERN was concerned to maintain its territorial unity.

Furthermore, it had to be borne in mind that, although the actual road and access tunnel is a link between two areas of French territory (the West Area of Laboratory I, where the ISR etc. have been built, is located on French territory) the Swiss authorities were directly concerned since there are entrances on their territory into Laboratory I not controlled by the normal customs posts. Their interests had therefore to be taken into account but since they coincided with those of the French authorities it was possible to meet them by siting the customs posts together.

Regulations have been laid down to prevent persons not connected with CERN from using the link. They may be summarized as follows:

– the tunnel may be used for official purposes only, and only by CERN vehicles, or specially authorized private vehicles carrying CERN personnel holding a 'carte de légitimation' or an 'attestation de fonction' or régie personnel with a special authorization. Outside the two Laboratory sites and the direct routes between them, personnel must hold the usual documents required under Swiss and French law for crossing the frontier;

– the tunnel may be used only for direct journeys between the two Laboratories and at no time for any other destination in France or Switzerland (e.g. between home and work);

– no private property may be transported and CERN property must be accompanied by the proper documentation;

– the tunnel may not be used by contractors or their employees even if travelling in an authorized vehicle.

A check system has been worked out in line with these regulations. First of all, officials of the CERN Security Service continuously supervise the movement of personnel and goods. All users of the link must follow the instructions of these officials who may turn back persons or vehicles not satisfying the conditions laid down in the regulations. In addition, the French and Swiss police and customs authorities may make spot checks at any time at a post sited near the tunnel or at the CERN entrances on their territory. Persons infringing the regulations will be subject to internal disciplinary measures, quite apart from any steps taken by the customs and police authorities of the host countries.

These arrangements meant that CERN 'lost' part of its grounds, namely the new access road to the tunnel (the hatched area in the illustration). This portion is now accessible to persons who do not belong to CERN, namely the customs and police officials of the host countries, who may proceed to their check post by the following routes:

– (France) crossing the frontier by R.N. 84 and entering the CERN site (Swiss part first, then French), or crossing from North to South by the tunnel under R.N. 84;

– (Switzerland) entering the CERN site and crossing several hundred yards of French territory to reach the check post.

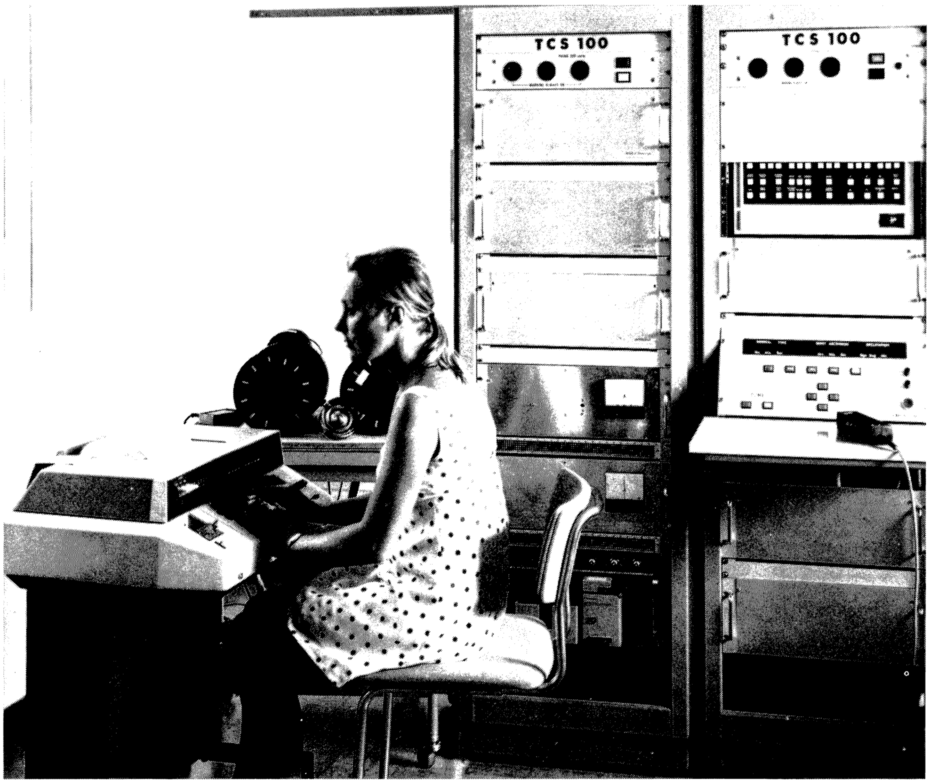
The inter-Laboratory link will be of great importance in helping CERN to operate smoothly and efficiently, thanks to the good will and understanding of the French and Swiss authorities.

The 1 m photometric telescope installed at the European Southern Observatory at La Silla in Chile. This telescope will be the first to receive the computer control system developed by the ESO-CERN collaboration. Equipment left CERN for Chile on 3 September.

(Photo ESO)

Computer goes to Chile

The first concrete result of the CERN-ESO collaboration should by now have arrived on the mountain top at the La Silla Observatory of ESO in Chile.



The control system was thoroughly checked before being sent off and the photograph shows the typing in of a test programme in the ESO laboratory at CERN.

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It is a control system which is to be fitted to the 1 m photometric telescope. The system is believed to be the most advanced so far built and to give the astronomer an ease and precision of control never before achieved.

Designed by people whose background is of computers and machine control, it is not surprising to find that the system differs markedly from tradition. The astronomer has the tendency to think about how to make his controls fit the telescope he has engineered; the control engineer how to adapt the telescope to the control system he sees right for the job.

The particular model being fitted to the 1 m photometric telescope is really an off-shoot of the design for the ESO 3.6 m reflector which is being designed at CERN. So good have the test-bed results been that it has also been decided to fit a similar system to the Schmidt telescope at La Silla at the same time as its mechanical drive problems are sorted out and a third example to the 1.5 m Danish telescope now under construction.

The drive motor employed for each of the telescope axes is a complicated device containing several windings which allow the motor to remain locked in position or rotate over a speed range of a million to one. This motor drives the 1 m directly through a worm gear. For the 3.6 m which will be driven through helical gears, it is proposed to avoid back lash by using two motors set back to back. On the shaft of the motor is a generator and digitiser connected to a standardized interface unit linking the drive with the computer. Reference position for the telescope is preset and the instrument will take up this position on switching on.

Once the correct siderical time has been typed in, the system is ready to go. In the memory are coordinates of stars as quoted in the catalogues or fed in by the astronomer for a series of observations, together with the necessary astronomical corrections for relating these co-ordinates to the stars' actual position. A simple instruction and the dome will open at the optimum place while the telescope swings round to point towards the star indicated, the computer compensating continuously for the earth's rotation. The astronomer can then adjust the setting by hand through the computer's speed control. For major movements of the telescope the instrument is automatically brought up to the safe maximum speed and then decelerated regularly as the telescope nears its target. If the astronomer wants to check on background light he has only to indicate how far the telescope should be off-set and the computer will remember what position to come back to after the measurement.

The system for the 3.6 m will certainly be much more elaborate and it is planned to connect the central computer, in the memory of which will be stored the co-ordinates of a large number of stars, to all other telescopes of the Observatory with computerized control systems.

The telescope is fully protected against computer failure — the nightmare of the chap who doesn't really trust electronics — and the astronomer can override the system at any time. A nice detail is a circuit breaker which operates at a precise angle of tilt and which prevents the telescope from being driven outside its safe limits. It consists essentially of a ball bearing carried in a conical pot. At a certain angle of tilt regardless of the rotational position the ball rolls out disconnecting the circuit — simple but effective.

6600 moves house

In the March issue (page 72) we described the manoeuvres initiated by the Data Handling Division to bring all the central computers into the new computer centre (building 513). These manoeuvres were necessary in order to avoid interruption to the computing service and have recently involved the move of the CDC 6600.

The work in moving the various sections of the 6600 began on 6 September when the peripheral equipment (including magnetic units, card readers and punches, printers, etc.) was disconnected. These units are installed on the CDC 6400 B, which is taking up some of the 6600 part of the CERN SCOPE workload. Subsequently, in the old computer centre (building 510), the dismantling of the four sectors of the 6600 and their transport for reassembly in building 513 in the immediate vicinity of the CDC 7600 computer got underway.

At the end of October, it will be the turn of the CDC 6500 to be dismantled so that its peripheral equipment can be transferred to the 6600, which will become operational in its new home at the beginning of November.

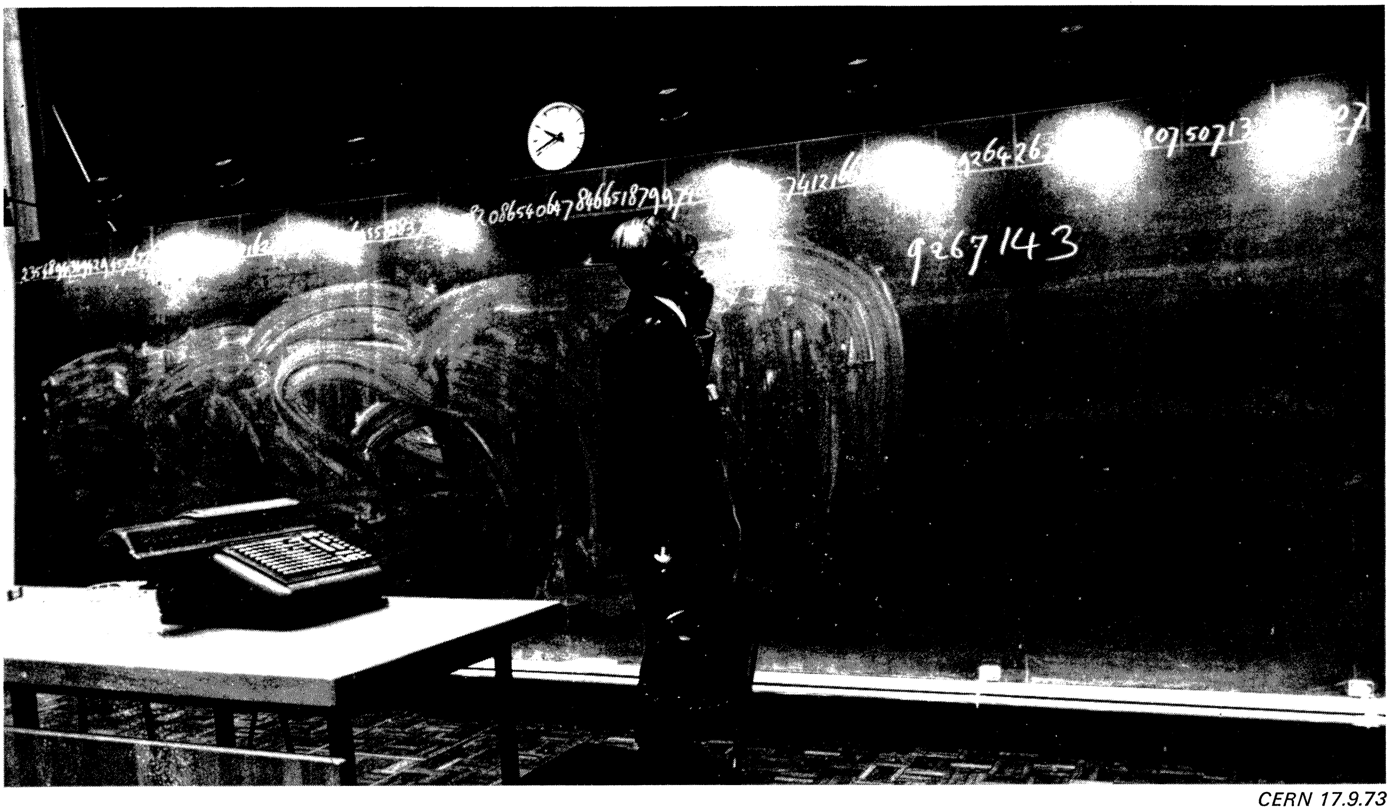
Another related move from the old to the new computer centre is that of 40 000 magnetic tapes, each packed in a tin giving roughly the shape and weight of a cheese. This began in the middle of September.

Human computer in action again

It has become something of a tradition to close the lecture series organized for the Summer Vacation Students with a display of mental arithmetic agility from CERN's human computer — Wim Klein. This year, on 5 September, an additional touch of spice was added to the proceedings by Klein's response to a mathematical challenge.

The challenge, accompanied by a financial inducement, was reported from Mexico where a mathematician had worked out the nineteenth root of a 133 digit number completely in his head in 30 minutes. Klein offered to attempt to beat this in front of his student audience. In fact the audience was supplemented by many other people from CERN so that over 200 assembled to witness the event in the Main Auditorium.

The first step was to compile the 7 digit number which would be the nineteenth root, the first digit necessarily being a '9' so as to ensure that the nineteenth power would have 133 digits. Six 'digit submission forms' were passed into different parts of the audience. One person, witnessed by one other, selected a digit to correspond to the digit place indicated on his form and then typed his choice into a computer terminal specially installed in the Auditorium.



Wim Klein extracted the nineteenth root of a 133 digit number in his head in 8 minutes. He is photographed with his mental wheels turning as he checks his result (below on the right) against the huge number strung out along the top of the blackboard.

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Each form thus carried two signatures and each selected digit was known to only two people. Only the computer knew the full 7 digit number.

In the computer, the nineteenth power was calculated and transmitted to the Auditorium. It took five minutes to write the 133 digits out across the blackboard and to check them and it was at 9.35 h that Klein turned to the blackboard to confront the number for the first time. At 9.40 h he wrote a 7 digit number on the board but asked for it to be considered provisional. At 9.43 h he had completed his mental checks and declared that he believed the nineteenth root that he had written down to be the correct one.

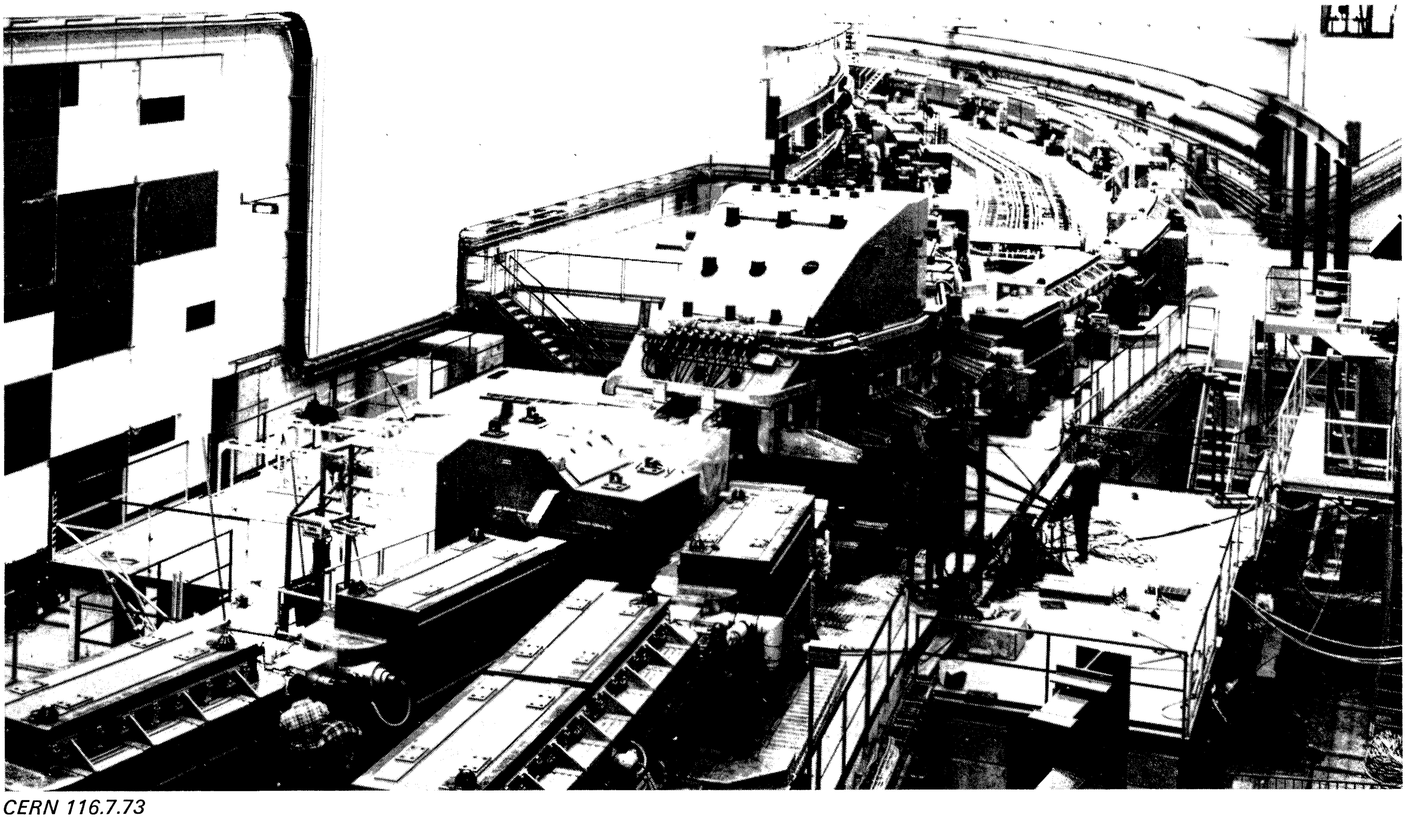
The people from the audience who had selected digits were called upon one by one to call out their choice. The computer also was asked to print out its input. Wim Klein's answer — 9267143 — was correct.

Split Field Magnet operates at the Storage Rings

After its installation in intersection region I-4 of the ISR at the end of May (see vol. 13, page 182), the Split Field Magnet (SFM) was powered on 30 July. When the magnetic fields had been carefully adjusted to the right values for a nominal field of 1 T, protons were injected into the two rings at an energy of 22 GeV and they circulated with no ill effects from the additional fields to which they were subjected. The compensator magnets and magnetic screens, which are designed to correct the perturbations caused by the SFM, performed well.

Further tests took place on 7 and 9 August. At 26 GeV, with beams of 7 A in Ring 1 and 8.6 A in Ring 2, the loss rates were less than 10 ppm/min, which meant that the conditions for physics were very satisfactory. Luminosity measurements have revealed that the losses due to the introduction of the SFM are negligible and the data so far indicate that the teams in the other intersection regions have no need to worry about the Split Field Magnet.

This trouble-free start-up has made it possible to start detector tests straight away. The two forward detectors (using multiwire proportional chambers) have been assembled and thoroughly tested. They are already providing data which are being used to check the analysis programs and will be installed during the mid-October ISR shutdown. Several teams will then be able to begin their experiments. The central detector will be fitted during the long annual shutdown and should be ready for use in 1974.



The Split Field Magnet in position at intersection region I-4 of the ISR. Tests with the magnet powered have revealed no perturbation of the beams orbiting the storage rings and the start of the experimental programme using the SFM is not far away.

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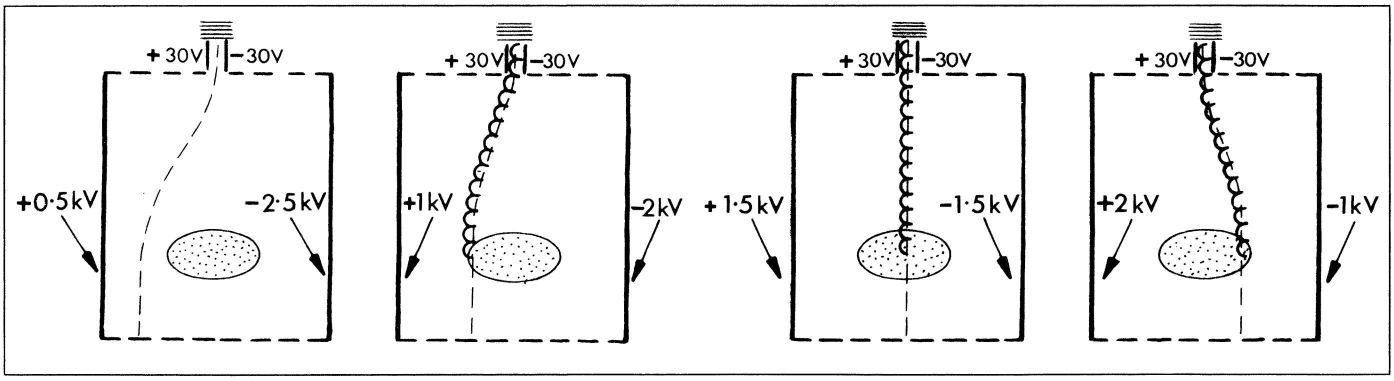


From left to right — four stages of the electrical field configuration set up in an Ionization Beam Scanner (IBS) during a single scan across the aperture of the accelerator. The changing voltages sweep the earth potential from one side to the other.

Looking at a beam with an Ionization Beam Scanner

Ionization Beam Scanners (IBS) have been under development at CERN for several years. They are now in use in the main ring of the 28 GeV proton synchrotron and in the 800 MeV Booster. In the last issue we reproduced photographs of the beam in the 400 GeV NAL accelerator also taken with this type of IBS.

The IBS is a non-destructive beam monitor which measures the transverse density distribution of particles in an accelerated beam with a spatial resolution of better than 1 mm. It makes use of the electrons produced in ionization of the residual gas in the accelerator vacuum chamber by the beam: the number of liberated electrons per unit volume beam is proportional to the density of the proton beam which traversed the volume. Counting these electrons is a convenient way of monitoring the beam.

Similar systems have been used in the Zero Gradient Synchrotron at Argonne where a uniform electric field pulled out the electrons produced by ionization on to an array of detectors. The accuracy was not particularly high since the dimensions of the Argonne beam (several centimeters) did not call for high spatial resolution. The limited accuracy was due partly to the small number of detectors installed and partly to the dependence of the electrons' trajectory on their direction and initial energy.

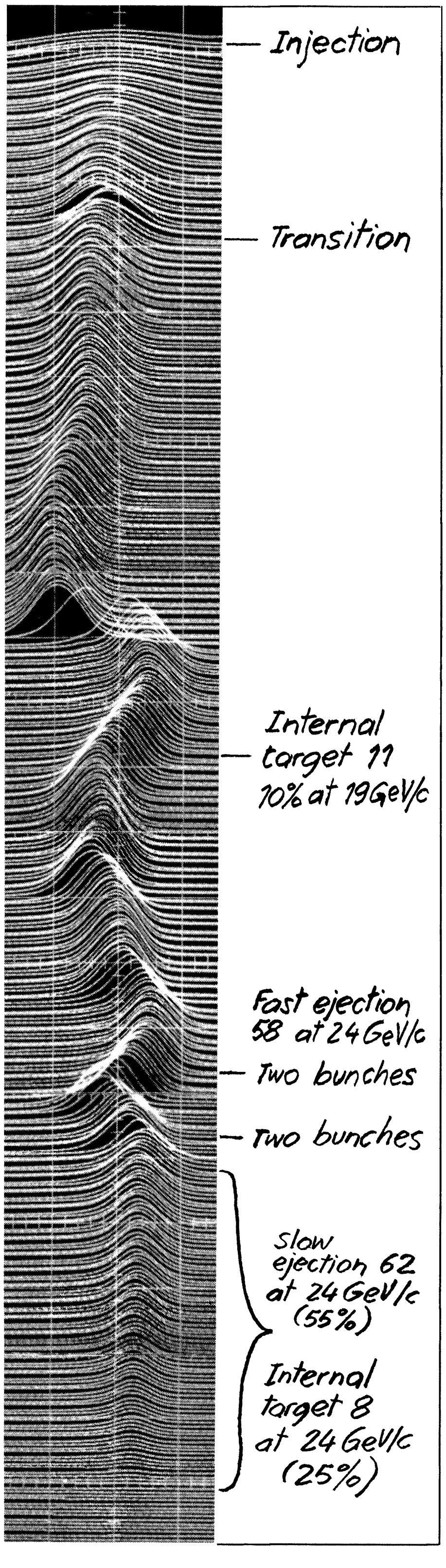
In the case of the CERN PS, such a system would have called for the installation of 40 to 80 detectors in order to achieve a tolerable spatial resolution and the electronics would then have become extremely complex. A system was therefore developed using only one pick-up electrode which scans the beam transversely. The electrons are directed onto the electrode by a combination of magnetic and electric fields. The liberated electrons spiral around the lines of equipotential. The pick-up electrode is linked to the earth potential so that the earth equipotential lines always passes through the electrode. Variations in the electric field produce a lateral shift of the equipotentials and, particularly, of the earth equipotential sweeping it across the beam aperture.

Two types of detector have been designed. The first type, which was initially preferred for its simplicity, consists of three plates of which the central one is the pick-up electrode and the two outer ones provide an electric field to collimate electrons passing between them. They also act as a barrier to high energy electrons which are released slightly outside the zero equipotential and would otherwise hit the electrode. The second type makes use of the first dynode of an electron multiplexer in order to increase the device's sensitivity.

The scanning time, which is a function of the device's sensitivity and of the number of electrons in the vacuum chamber, has reached 1 μs in the PS with a beam intensity of 10^{12} particles per pulse at a pressure of 2×10^{-6} torr. This may be reduced still further by improving the sensitivity of the electron multiplexer since the theoretical limit of the scanning time is defined by the time of flight of the electrons, namely 50 to 100 ns.

There are limitations of the IBS due to the beam's space charge which disturbs the electric field configuration and modifies the electron trajectories. It is, therefore, essential to use as high a potential as possible. Although the perturbations can be corrected in the case of the PS and Booster, the IBS cannot be used in the ISR where the intensity of the circulating beam is too high.

Two IBS devices have been installed in each of the four superposed rings of the Booster; they scan the beam in the horizontal and vertical planes respectively. During the commissioning of the Booster, these ionization beam scanners are giving very valuable information, particularly in relation to beam instabilities, and beam profiles are acquired at a much faster rate than with conventional targets.



IBS signals picked up during a pulse of the proton synchrotron at the beginning of September. An internal target, fast ejection and slow ejection affected the beam intensity at different stages of the machine cycle.

Physics with the Omega spectrometer

The Omega spectrometer (which is now operating with both coils in place giving a field of 1.8 T) ran in August after two disappointing periods in April and June when PS breakdowns serenely curtailed the running time. By running parasitically with Gargamelle in July for a few days, using 5 % of the beam (one bunch), the spectrometer and three of the 'triggers' were prepared for the August data taking period.

The Birmingham-Rutherford-Westfield College group, who are studying neutral bosons in the mass range 1-2 GeV/c^2 using a slow neutron trigger, successfully reduced their background triggering rate by building an 80 ton lead collimator inside the magnet. The other two experiments were of the Glasgow-Saclay group with a fast anti-lambda trigger studying strange bosons decaying into baryon-antibaryon pairs and the Bari-Bonn-CERN - Daresbury - Liverpool - Milan group with a slow recoil proton trigger studying charged mesons.

Each group recorded about 1.2 M triggers, roughly 40 % of their expected total data. The average data taking efficiency was 75 % and the spark chambers and Plumbicons performed well with a constant efficiency of more than 80 % for four-pronged events. With 80 spark chamber gaps downstream of the target and 32 gaps on either side this is quite satisfactory.

Included in the August run was a test for the experiment of the CERN-Collège de France-Ecole Polytechnique-Orsay group (using a fast proton trigger to study baryon exchange) which gave promising results. This experiment involves a large high pressure Cherenkov counter and multiwire proportional chambers.

The experiment of the CERN-ETH-Freiburg - Karlsruhe - Saclay group, using a fast lambda trigger did not run in August but took a small amount of data in June and should be completed in October.

On 12 December the large atmospheric pressure Cherenkov counter installed downstream of Omega will be removed to be doubled in size in order to cover the whole of the horizontal aperture of the magnet. By this date it is hoped to complete two more of the experiments and to be ready for a sixth experiment, that of the CERN-ETH group who will trigger on neutral kaons accompanied by charged prongs.

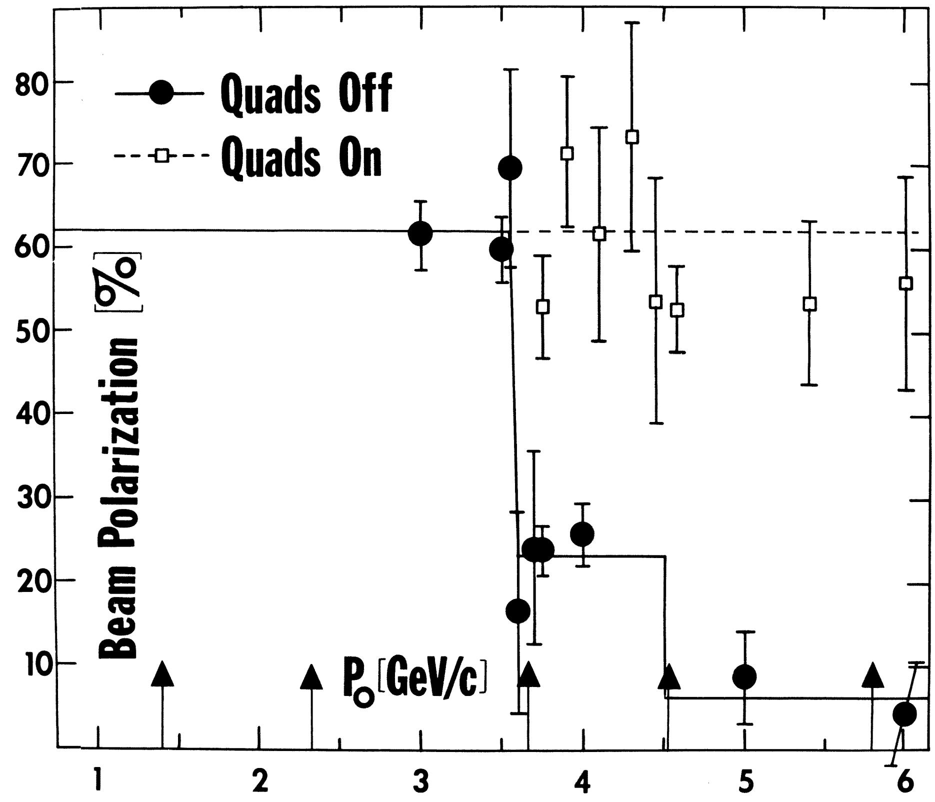
The physicists are working hard to understand the data just taken. Most of the processing of the data will take place outside CERN with only small samples analyzed on the CDC 7600.

Neutral currents

The discovery of neutral currents in the course of neutrino experiments in the heavy liquid bubble chamber, Gargamelle, is regarded as one of the most important results ever achieved at CERN. It has been supported by further evidence of neutral currents in an experiment with very high energy neutrinos at the National Accelerator Laboratory, USA.

A Press Release on the discovery has already been issued and we will be telling the story in the next issue of CERN COURIER as part of the report of the recent Conferences at Bonn and Aix-en-Provence.

Around the Laboratories



Polarization measurements on the accelerated beam in the ZGS at Argonne. When the pulsed quadrupoles are not powered, the depolarizing resonances (which occur at the momenta indicated by arrows along the x-axis) greatly reduce the beam polarization. With the quads on, healthy polarization is achieved up to high momenta.

ARGONNE
Polarized protons

We reported briefly last month that polarized protons have been accelerated in the Zero Gradient Synchrotron at Argonne and we now have more information on this 'first ever' achievement.

The acceleration of polarized protons in the ZGS had been under consideration for several years because the weak focusing, zero gradient characteristics of the ZGS ring magnets make the accelerator uniquely well suited. Two factors led to the decision, two years ago, to pursue the project. First, it became apparent that the Auckland Nuclear Accessory Company Ltd. in New Zealand had the expertise to build a suitable polarized proton source. Second, a strong interest in experiments with high energy polarized beams came from A.D. Krisch and his colleagues at the University of Michigan. This group were willing to give considerable time and effort to the project.

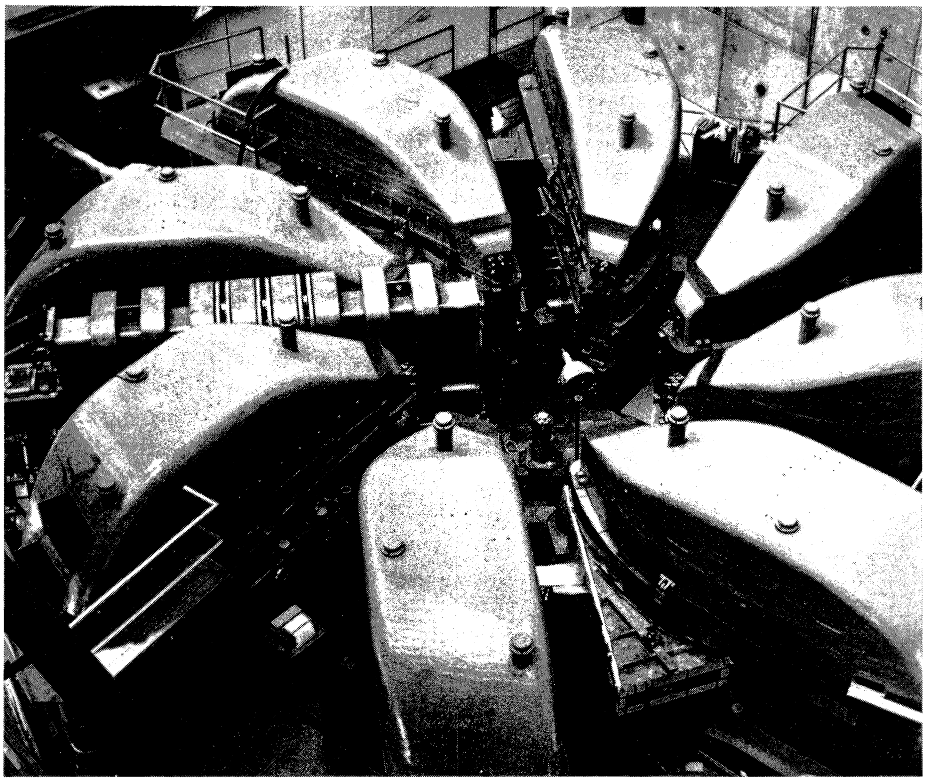
In fiscal year 1972 about $ 225 000 was assigned to bringing a polarized proton source into action at the ZGS. Construction of the source began in 1972 and acceptance tests were completed in Auckland in April 1973. The source was operated for over 50 hours with no failures and, with no adjustments, continually met or exceeded the contract specifications (polarized deuteron output of at least 6 μA with tensor polarization of at least 85 %). The source arrived at Argonne at the beginning of May.

Another development relating to the project was the installation at the ZGS of a second 750 keV preaccelerator in January 1973. It is situated alongside the old preaccelerator and provides beam via two 90° bends to the 50 MeV linac. The two preaccelerators can be alternated on a pulse-to-pulse basis and this mode of operation was used from February to April when a 50 MeV negative hydrogen ion beam was delivered to the booster project while the ZGS operated normally with protons. The polarized source is now permanently installed in the new preaccelerator but it is still possible to deliver negative ions to the booster using the old preaccelerator while polarized protons are accelerated in the ZGS.

There was close cooperation between members of the Accelerator Division led by R. Martin and the Michigan group, plus collaborators from St. Louis University. The university group built a 50 MeV polarimeter that was used in the linac beam and designed the high energy polarimeter which is installed in the Experimental Area.

The Argonne staff also studied the accelerator physics involved in accelerating the polarized protons from 50 MeV to 12 GeV. Various resonances at particular energies, which could depolarize the beam, were identified and their strengths predicted. A system of pulsed quadrupole magnets was constructed to enable the 'tune' of the ZGS to be changed very rapidly twelve times in each cycle to permit the beam to pass quickly through these resonances.

The programme to reach 12 GeV was divided in two stages. The first aimed for 6 GeV in July 1973; the second aims for 12 GeV before the end of this year. A 50 MeV proton beam was obtained from the linac on 29 June with a polarization of 70 %; the current ranged from 3 to 4 μA. Effort moved to the main ring on 5 July and was successfully concluded on 22 July. The goal of 6 GeV was reached with a polarization of (62 ± 15) %. In addition, the experimental team succeeded in making a total cross-section measurement of



The SIN 590 MeV ring cyclotron photographed before the vault was closed with shielding. All eight sector magnets are in place plus one of the four r.f. cavities.

(Photo Villigen)

the scattering of polarized protons from a polarized proton target at 3.5 GeV. During this period the circulating intensity in the accelerator was approximatively 3 × 10^8 protons per pulse and about 10% was extracted and transmitted to the experiment.

Comparing the operating experience with the theoretical calculations indicated that the two strongest depolarizing resonances are at 3.7 and 4.6 GeV and, en route to 6 GeV, these resonances were passed successfully. No substantial problem was encountered in doing this although the timing precision required for pulsing the quadrupoles (0.5 ms) and measuring the resulting polarization of the extracted beam took a long time to sort out. There is considerable optimism that, when the programme resumes later this year, it will be possible to accelerate to 12 GeV with relatively little difficulty despite four more depolarizing resonances lurking between 6 and 12 GeV.

There is a great deal of interest within the ZGS users community in polarized proton physics research. The Argonne-Michigan-St. Louis collaboration will continue their run in the Autumn, taking a comprehensive set of elastic scattering differential cross-section measurements. At the same time, another Argonne group will be using the Effective Mass Spectrometer to study baryon resonance production with a polarized beam. Later there will be a University of Pennsylvania experiment to study asymmetries in inclusive processes and a University of Chicago experiment is scheduled to investigate a question of great interest at Argonne, namely, whether or not a polarized proton beam is a good source of polarized hyperons. If the answer turns out in the affirmative, it should open the way for a number of very interesting weak interaction experiments on hyperon decay at the ZGS.

VILLIGEN
SIN cyclotron nears commissioning

On 30 June the general public was able to see the 'meson factory' at Villigen, Switzerland, prior to the two cyclotron vaults of the 72 MeV injector and the 590 MeV ring cyclotron being covered with shielding roofs. This 'open house' was a big success attracting more than 2500 people showing their interest in this national research facility. After an introductory talk on particle research with accelerators, people toured the accelerator vaults, experimental hall, control room and power supply stations.

Work on the two accelerators has continued vigorously. The status of the project in August was as follows: the injector cyclotron from Philips is being commissioned. To celebrate the Swiss national holiday, the Dutch team working on the injector produced the first internal proton beam on 1 August. A few days later the design energy of 72 MeV was reached with internal currents up to 3 μA, limited only by the available shielding. At low energies, beams of about 50 μA have been obtained. In early September the extraction septum was installed and the first extracted beam is expected a few weeks later. The contract between SIN and Philips calls for an extracted current of 100 μA.

Meanwhile the ring cyclotron is also approaching completion. The 30 m long beam-line between injector and ring is practically ready. All ring components have been tested and the final assembly will be finished in October. The first beam at the design energy of 590 MeV is awaited as a Christmas present. Assembly of beamlines, targets and shielding blocks in the experimental area is in an advanced stage too and the first experiment is expected to start in Spring 1974.

SERPUKHOV Spectrometer with streamer chambers

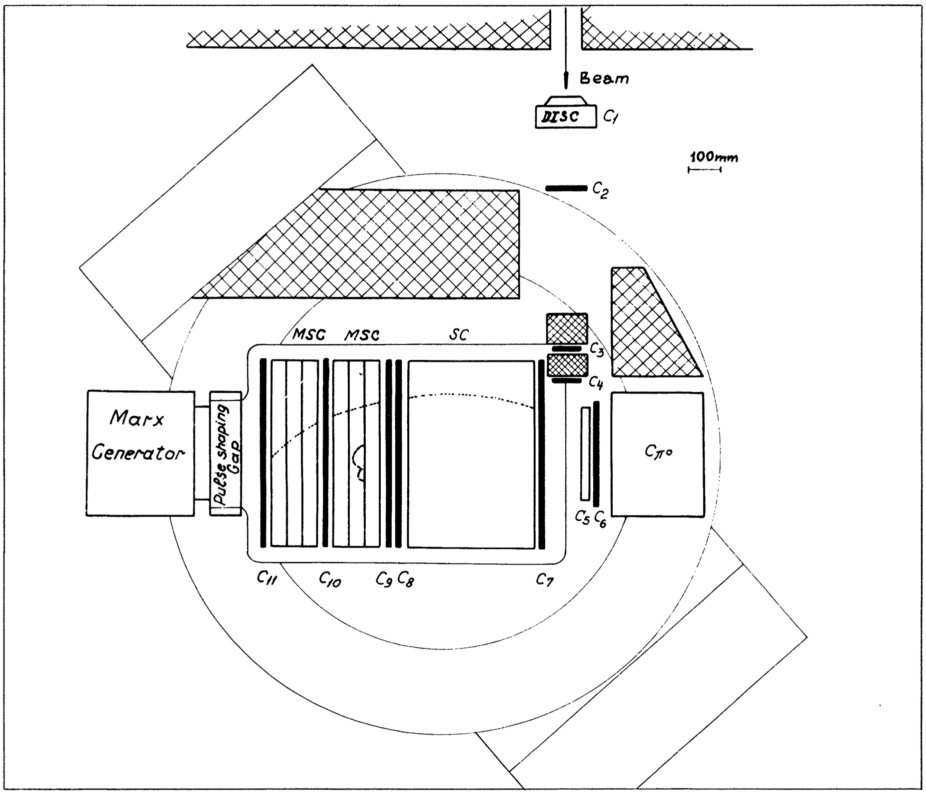
In order to study positive kaon decays, a magnetic spectrometer equipped with streamer chambers has been built at the Institute for High Energy Physics, Serpukhov.

A slow kaon beam is separated from a secondary beam and the kaons are identified by means of a DISC counter and scintillation counters. The charged products of kaon decay are recorded in an array of three streamer chambers, triggered by large scintillation counters. In the first streamer chamber (indicated as SC in the diagram) the momentum of the charged particles produced during the decay can be measured to an accuracy of within 1 %. The following two chambers (MSC) are shower-type streamer chamber, their purpose being to identify the positrons and record the gammas from the decays.

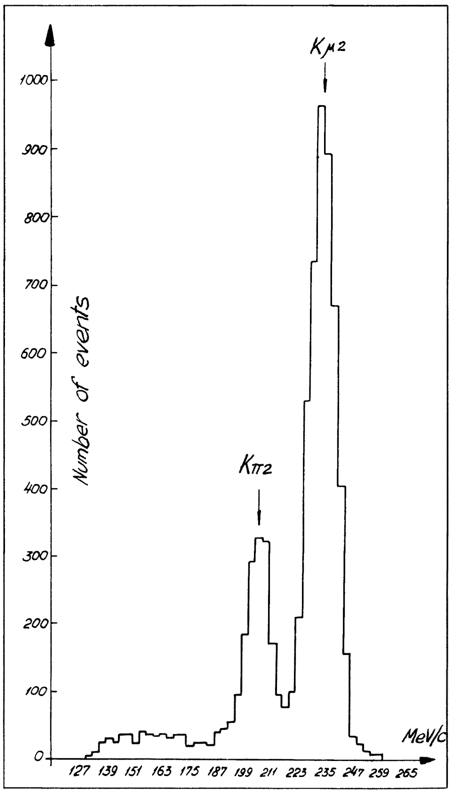
Decays involving the production of neutral pions are analysed using a total absorption Cherenkov counter. Other counters (C_1 to C_{11}) provide various trigger pulses. Over 100 000 photographs of positive kaon decay have been collected and the events are being processed using a bubble chamber programme. So far, the momentum spectrum of 20 000 decays has been measured. It clearly picks out the pion and muon decay channels corresponding to the decay giving two pions $K^+\pi_2$ and that giving two muons $K^+\mu_2$. This then gives the branching ratio of $K^+\pi_2$ compared with $K^+\mu_2$. After small corrections for other decay channels and for pion interaction with nuclei in counters and the targets, the ratio has been measured as 0.329 ± 0.006 which is close to the value of 0.328 obtained by averaging world data.

Work is at present concentrating on processing data on the decay into a muon, a neutrino and a gamma.

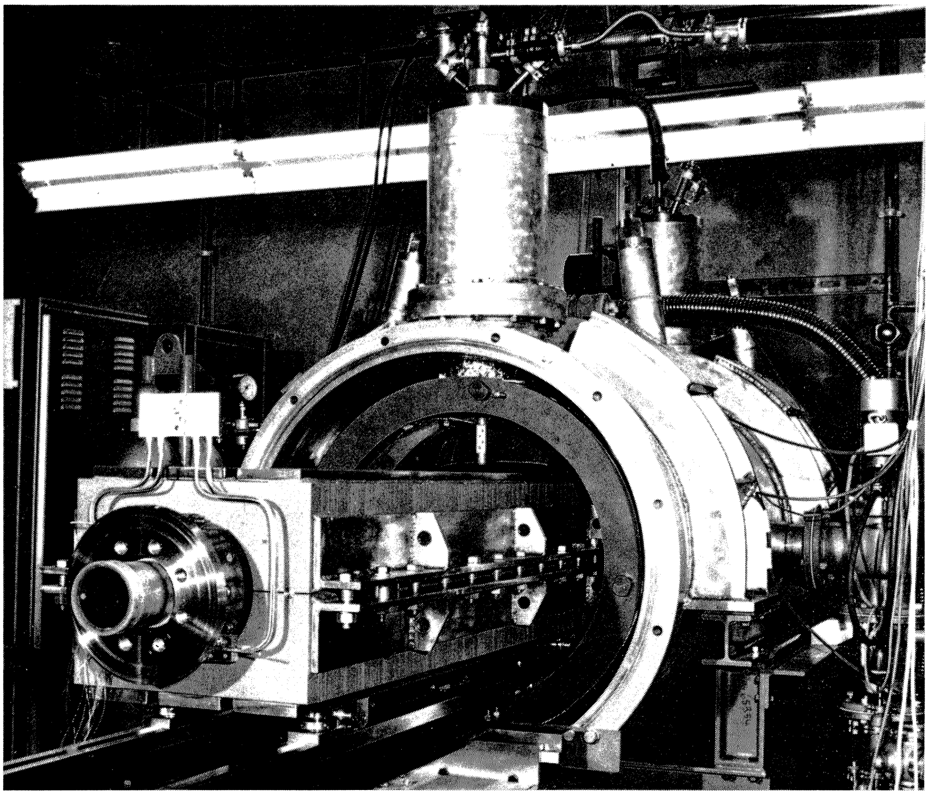
The experimental programme, in general, is in full flight with about twenty experiments under way or setting up. Only 30 % of the programme involves Serpukhov scientists as there is extensive participation from other Laboratories in the Soviet Union (Dubna, ITEP, etc...) and from other European groups via CERN and the collaboration with France (centred particularly on exploitation of the Saclay-built hydrogen bubble chamber, Mirabelle). Mirabelle has taken



Spectrometer for the study of positive kaon decays at Serpukhov. The major detectors are three streamer chambers (SC, MSC, MSC) extending over a total length of almost 9 m. A DISC counter is used in the identification of the incoming kaons and a series of other counters C_1 to C_{11} are used in the triggering system to select the interesting events.



Momentum spectrum of positive kaon decays showing clear peaks for the decays yielding two pions and two muons.



The superconducting dipole, D2a, being assembled in its horizontal cryostat at Karlsruhe. The magnet has reached a field of 4.7 T with good field homogeneity during its tests.

(Photo Karlsruhe)

over 200 000 photographs using the highest energy separated beams currently available in the world (see vol. 12, page 172) and has now been joined by a Dubna-built 2 m chamber, Ludmilla, with which experiments are beginning.

The accelerator operates at an average intensity of 2×10^{12} protons per pulse at a rate of 8 cycles per minute and usually provides beam to about five experiments at a time. One beam-line provides pions, kaons, protons, antiprotons, deuterons and antideuterons in the momentum range 30 to 65 GeV/c. A similar beam-line covers the momentum range 20 to 50 GeV/c. There are channels for neutral particles and muons. An r.f. separated beam takes particles to Mirabelle and the same ejected beam is used to supply particles for Ludmilla. A neutrino beam is being built and is scheduled for first operation at the end of this year as also is the heavy liquid bubble chamber, SKAT.

KARLSRUHE
Good field from magnet D2a

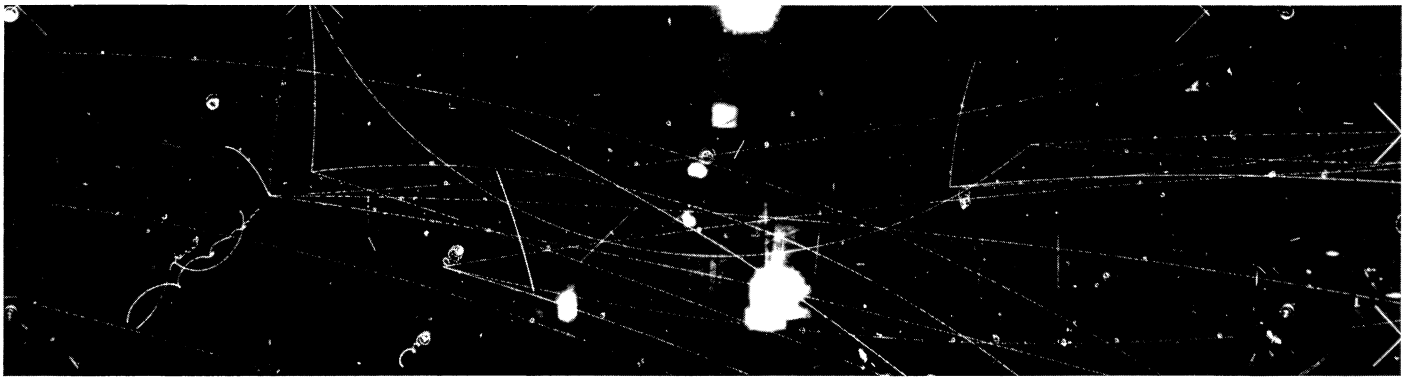
The pulsed superconducting dipole, D2a, was successfully tested in July at the Institut für Experimentelle Kernphysik, Karlsruhe. It reached a maximum field of 4.7 T. This magnet is part of the programme of GESSS, the European collaboration of Rutherford, Saclay and Karlsruhe for the development of pulsed superconducting magnets. In line with the parameters evolved by GESSS as suitable for large synchrotrons, dipole D2a is of full length and is designed to achieve good field quality throughout the cycle.

The main parameters are — length 1.4 m, inner coil aperture 8 cm, peak field 4.5 T. Two iron shells with circular inner bores of 17.2 and 21.6 cm diameter are available to shield the field and to enhance its value within the aperture by about 30%. The smaller shell which saturates at the higher fields was used in the July tests (the other one which was not used remains unsaturated throughout the cycle).

The magnet coil consists of two symmetrical poles each with five semicylindrical double pancakes of cabled conductor. The pancakes are potted in epoxy and spaced radially to provide access for the helium. The cable is made up of twelve strands of niobium titanium multifilamentary superconductor wound around a central strand. It is shaped to a 2.1 by 2.6 mm² cross-section and soldered. Each strand has a diameter of 0.54 mm and contains 1000 filaments of 12 μm diameter in a copper matrix. The design current is 1500 A at 4.5 T.

The field homogeneity across the aperture was measured and the following field coefficients were found at an aperture radius of 30 mm and a dipole field level of 4.5 T: quadrupole 2.5×10^{-3}, sextupole 0.7×10^{-3}, octupole 0.3×10^{-3} and decapole 0.3×10^{-3}. Apart from the quadrupole term, which can be readily corrected, these values are within the tolerances required for magnets such as could be used in a 1000 GeV machine as studied by the GESSS Machine Design Committee. Significant dependence on the field level was observed only for the sextupole component which rose from 0.4 to 0.7×10^{-3} at low fields. Losses, due to eddy currents in the soldered cable, reached about 50 W for a peak field of 4.5 T and a rise time of 5 s. This is within the expected range for the type of conductor and cable used.

Training (an increase in the maximum field obtained in successive quenches) was observed. About



Photograph taken in the 1 metre bubble chamber at Dubna recording neutron-proton interactions. A 5 GeV neutron beam was fed to the chamber, produced by accelerating deuterons in the synchrophasotron.

100 quenches were required for D2a to climb from 2.5 to 4.7 T. Training will be carefully watched after further cool-downs to look for hints as to the causes of quenching. It is believed that they are due to spontaneous releases of energy from small movements of the conductor or of sections of the support structure (since there are many sections in D2a, training had been expected).

The suitability of the coil configuration chosen in D2a for reaching the required field levels and homogeneities has been demonstrated and the design of its successor concentrates on improving the training characteristics and on reducing losses, for example by selecting an unsoldered cable. D2b is in the design phase and is scheduled to operate in the second half of 1974.

DUBNA Recent results

A few topics from the research programme at the Joint Institute for Nuclear Research, Dubna:

About 200 000 bubble chamber pictures have been taken in the 1 metre hydrogen chamber with a beam of almost monochromatic neutrons. The beam was obtained by stripping deuterons which were accelerated in the synchrophasotron. The experiment took place during the first three months of this year. Eight neutron energy levels were used, ranging from 1 to 5 GeV, and the expected neutron energy spread was about 5 %. Over a million events were recorded on the photographs.

The programme of work on meson chemistry has continued and new results have been obtained. In recent years research at various centres throughout the world has established that the probability of the nuclear capture of negatively charged mesons depends on the chemical composition of the target material. Theoreticians at Dubna have developed a model of a large mesic molecule to explain this phenomenon. It is hoped that the present work by experimenters and theoreticians will establish the quantitative dependences between the probability of nuclear capture of the meson and the nature of the atomic bonds in the target. With this in view, experiments have been carried out at Dubna on the nuclear capture of stopped negative pions by hydrogen in various organic and inorganic compounds.

In saturated hydrocarbons, the conditions of capture proved virtually independent both of the length of the carbon chain (from C_5 to C_{17}) and of its spatial structure (C_6H_{14} and C_6H_{12}). However, in the case of compounds in the aromatic series, there is an almost two-fold reduction in the capture probability. This seems to be linked with the change in the type of orbital hybridization (switch from Sp^3 to Sp^2 hybridization).

When the compounds have inorganic bases $M(OH)_q$, the probability of pion capture by hydrogen proved to be q times less than the value forecast by the theoretical model for all the samples investigated. No such reduction was observed in other compounds of similar symmetry such as salts or organic derivatives.

In the methane derivatives CH_3X, where X is the electron-seeking substitute, the probability of capture is also reduced (to varying degrees depending on X). This is probably due to the negative induction effect of the substitute. There is a linear correlation between the fall of the capture probability and the substitute's induction constant. This confirms the assumption that the main cause of the reduction in capture probability is the shift of the electron cloud away from the hydrogen atoms under the influence of the electron-seeking substitute.

There is no such linear correlation in the case of C_6H_5X benzene derivatives. This is probably because the induction effect is masked by the hyperconjugation effects normally associated with unsaturated systems.

After many years of development, a new particle detector has been brought into operation which uses a working medium consisting of either crystalline argon or xenon. The design of such a detector with a dense working medium is one of the concerns of experimenters for neutrino physics and particle physics at very high energies. Several attempts have been made, particularly at Berkeley, to use liquid monatomic substances for this purpose, but all the problems have not yet been overcome.

The Dubna technique uses a pure monatomic medium frozen to a precise temperature. It was found that the electrons liberated by the passage of charged particles in the crystal volume were quickly collected at the wire and multiplied to give a healthy signal with a gain of about 150. The detector has a wide plateau and good operational stability. If the crystals are perfect, the detector is not saturated by space charge during operation and can be used in an intense particle flux.

Research with crystal wire detectors has paved the way for the development of large multiwire proportional chambers, in which the wires can be firmly fixed in space by freezing them into the crystal. Owing to the high ionization produced by charged particles in crystals, the wires may be arranged close together and thus give good time and spatial resolution.

For further development of crystal wire detectors, solid single-crystal hydrogen and crystalline helium offer interesting possibilities. It would also be extremely useful to find crystalline substances which could be used in such detectors at room temperature.

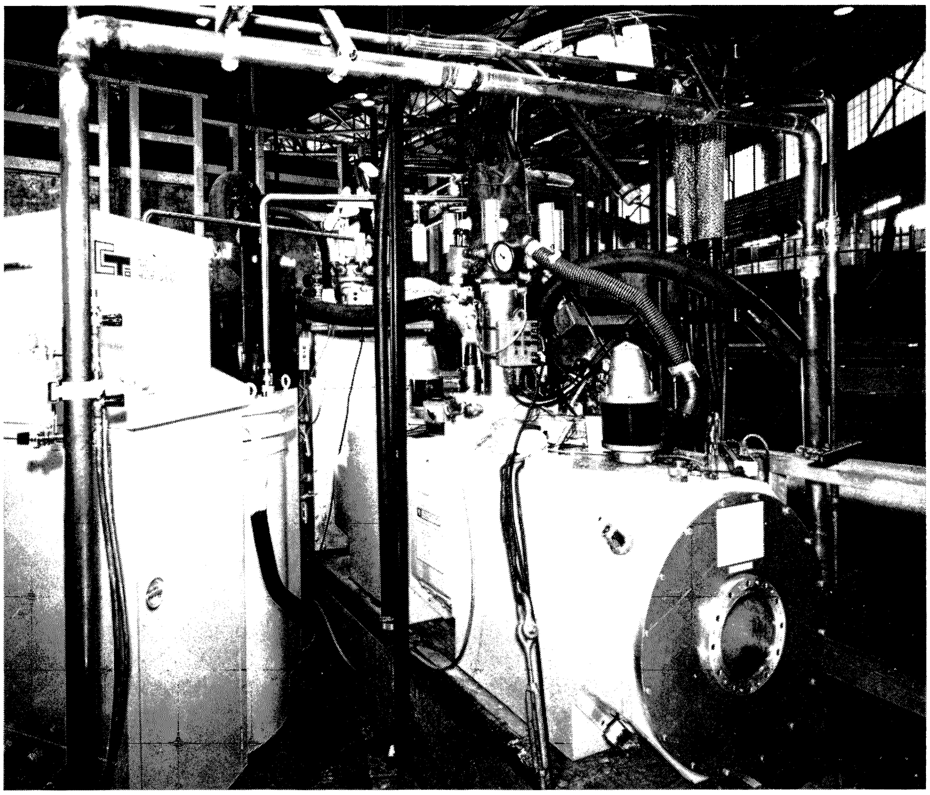
LOS ALAMOS
Pions in experimental area

On 27 August pion beams were produced at the 800 MeV proton linear accelerator, LAMPF, in Beam Area A. Preparatory work in the Area was completed a few days previously and the first proton beam (at 447 MeV) was fired in.

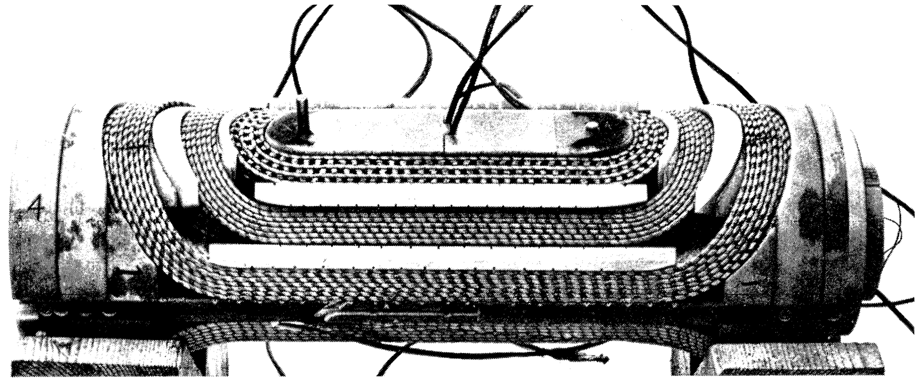
The first experiments using pion beams are scheduled to start in a few months' time. A long programme of basic nuclear physics research and of research into the potential medical applications of pions is already lined up.

BERKELEY
Progress with superconducting magnets

An experiment is beginning at the Berkeley Bevatron using a beam-line which incorporates a superconducting bending magnet and a superconducting focusing quadrupole doublet. The



Superconducting magnets in action on a beam-line at the Bevatron accelerator. Nearest to the camera on the right is a superconducting quadrupole doublet with a superconducting bending magnet behind. Their helium liquefier and refrigerator is on the left. After successful tests the beam-line is being used in a physics experiment.



Number 9 of a series of superconducting dipoles which have been built to study pulsed operation. Numbers 9 and 10 are 'identical' and will be used to help determine how reproducibly pulsed superconducting magnets can be constructed. Measurements are expected to be completed in October.

(Photos LBL)

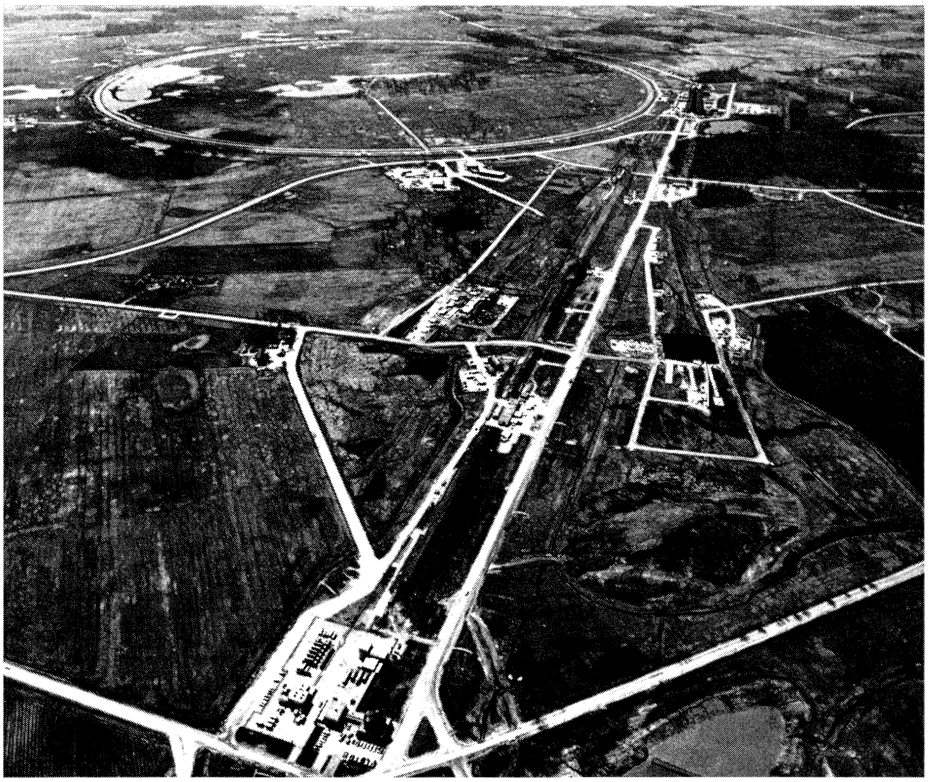
Aerial photographs from the site of the National Accelerator Laboratory, Batavia.

1. Looking from the experimental areas — bottom centre is the location of the ex-Argonne 30 inch chamber, which is in operation, and of the 15 foot chamber, which is nearing completion; the other two experimental areas are to the right and left of the beam-line to the bubble chambers half way back to the main ring which can be picked out at the top of the photograph.

2. The elegant Central Laboratory Building with the crown-shaped auditorium in front of it.

We hope to include news of the experimental programme at NAL in the next issue.

(Photos NAL)



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magnets have performed reliably over a 900 hour run during the Summer and are now being used to handle a negative pion beam of 2 to 4 GeV. Running periods of 3000 hours d.c. operation are foreseen (limited by the need for compressor maintenance). The high fields and large apertures of these magnets will be particularly useful later for experiments with beams of heavy ions.

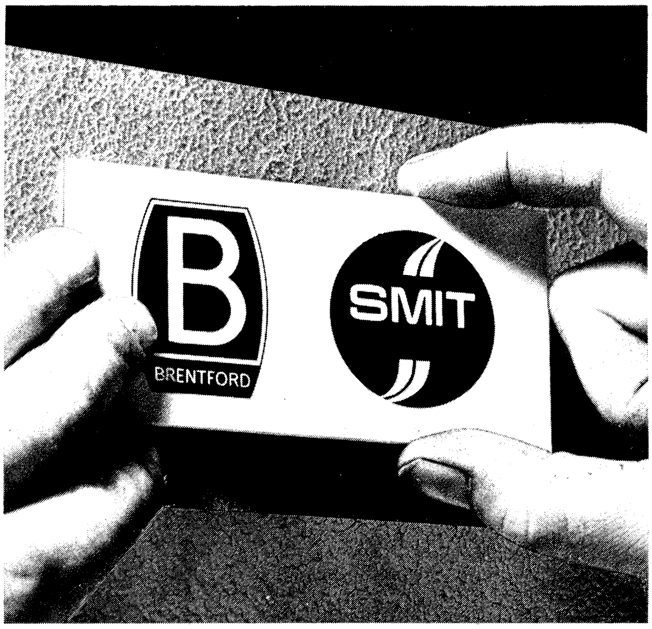
The dipole has a 20 cm bore and an effective length of 83 cm. The peak field is 4 T and was reached after three quenches showing considerable training. Field quality is good — only sextupole and 14 pole components exceed 0.1 %. The quadrupole doublet has the same 20 cm bore, an effective magnetic length of 2×63 cm and produces a field gradient of 0.24 T per cm. The two focusing magnets are essentially identical and their field quality is within acceptable limits.

After several months of tests and adjustments there was a long run with the magnets in the beam-line which ended on 26 July after 48 days. The three magnets were on for 99 % of this time and operation seems to pose no special problems. At the beginning of August, following compressor maintenance, they were again cooled down in readiness for use in their first experiments.

There is a parallel development programme on pulsed superconducting magnets which has reached the stage of studying magnet reproducibility. Two dipoles (models number 9 and 10) have been built to identical specifications. They are each 40 cm long, 7.5 cm bore and are reaching central fields of over 4.5 T.

An idea of the construction technique can be obtained from the photograph. The superconductor is compacted into braid and there are three coil blocks wound from this braid in each half of a magnet. The coils are potted in epoxy and surrounded by an iron yoke. There are superconducting sextupole correction windings also incorporated.

The first tests indicate that the multipole components in the fields of the two magnets are identical to better than one part in 10^3. A thorough programme of measurements began in August and it is hoped to list detailed comparisons by the end of October.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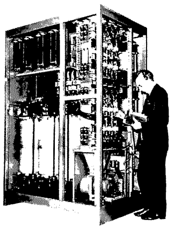
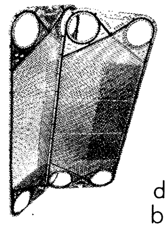


la nouvelle génération d'échangeurs à plaques existe Alfa-Laval la nomme Alfa-Flex

LA SÉRIE ALFA-FLEX : UNE RÉVOLUTION DANS LA TECHNOLOGIE DES ÉCHANGEURS THERMIQUES



ALFA-FLEX = FLEXIBILITÉ

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- **Possibilité de faire varier en continu le NUT** en réalisant l'assemblage dans le même paquet de plaques d'un nombre de canaux de circulation possédant chacun des valeurs différentes de θ* et d'en réaliser le mixage de façon à obtenir le nombre d'unités de transfert thermique désiré compris entre les valeurs minima et maxima du θ de la plaque.

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- **Augmentation des pressions de service :** des pressions de service de 25 bars ont été rendues possibles pour les appareils de taille normale.

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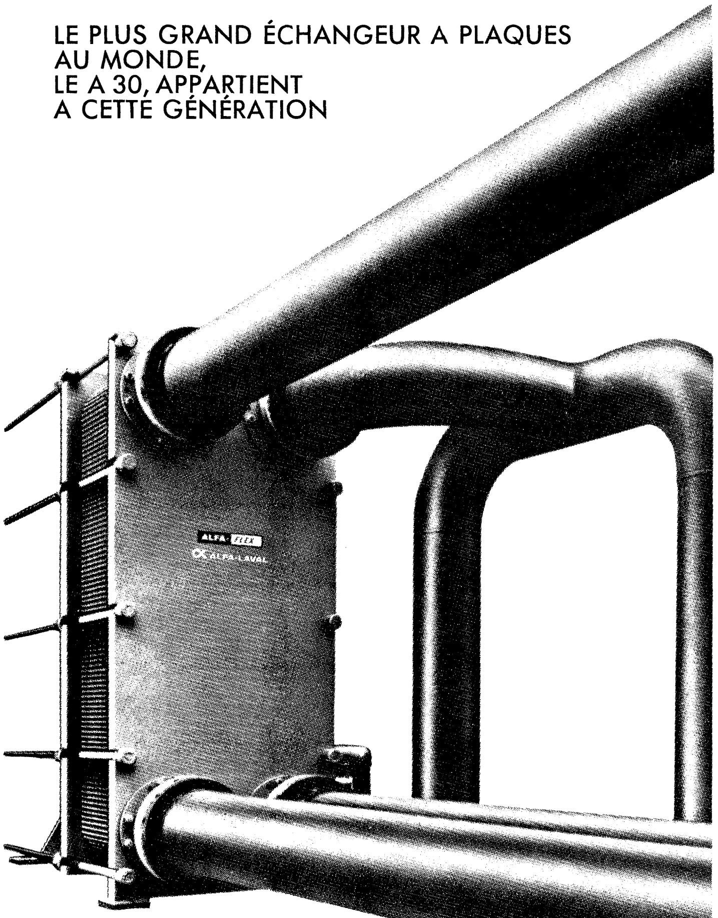

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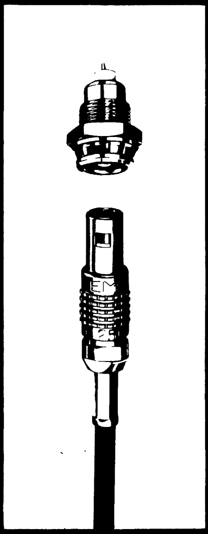

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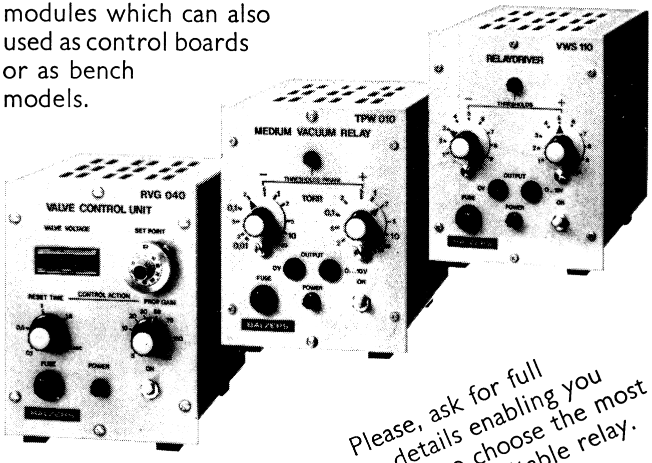
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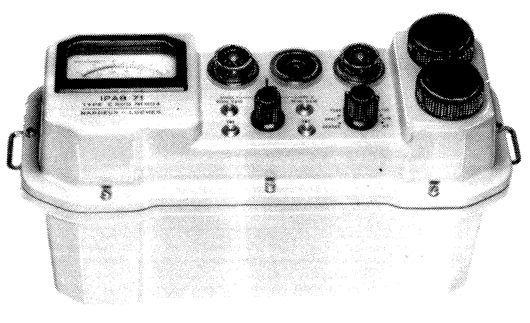

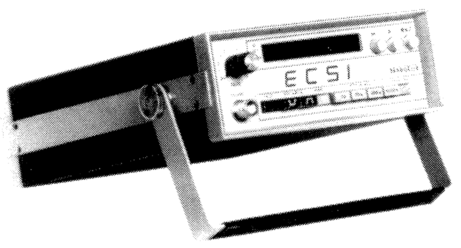
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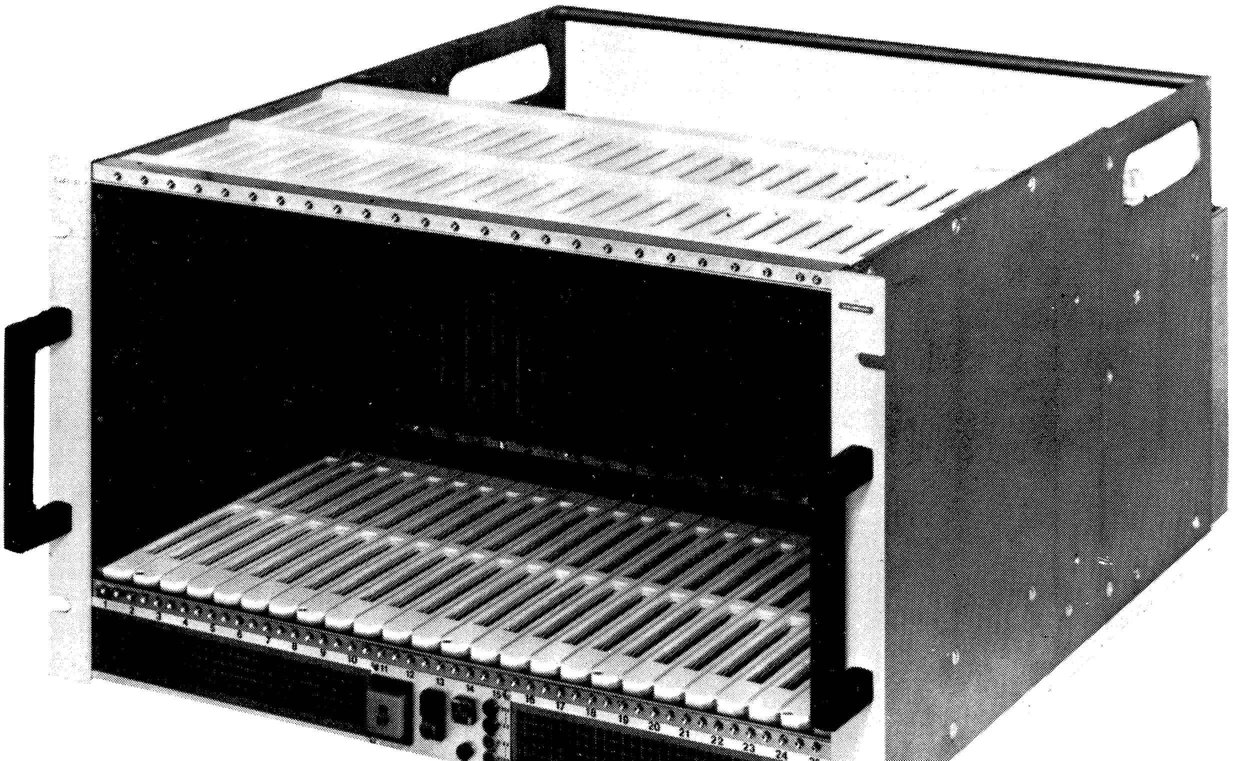


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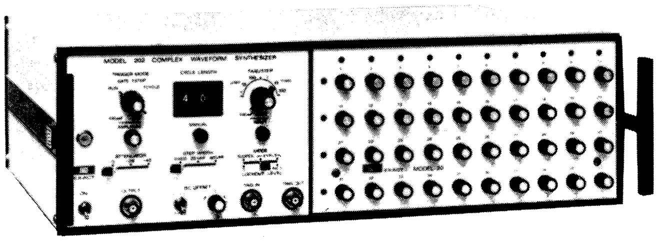
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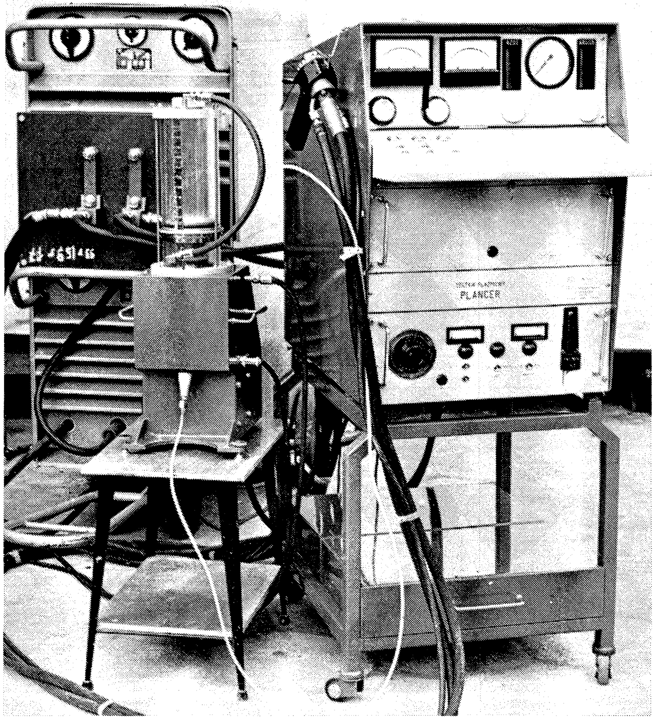

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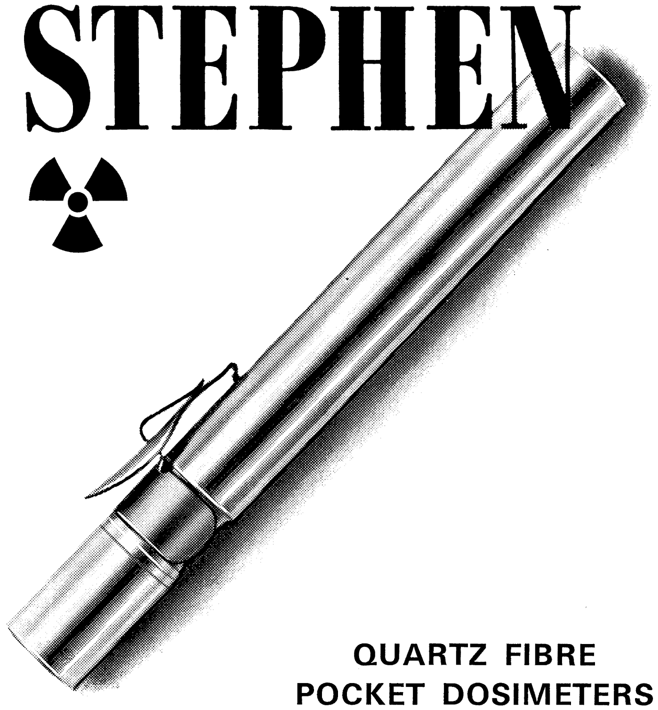

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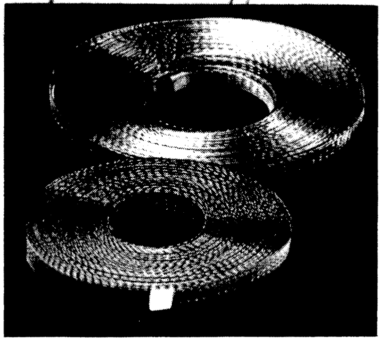

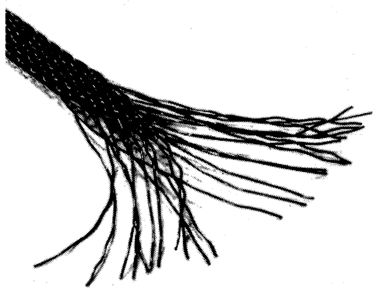

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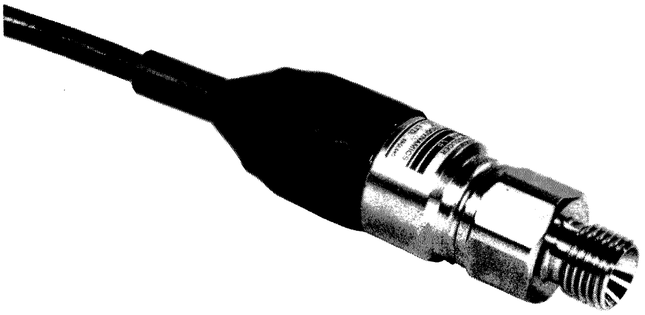

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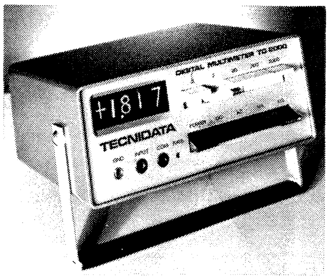

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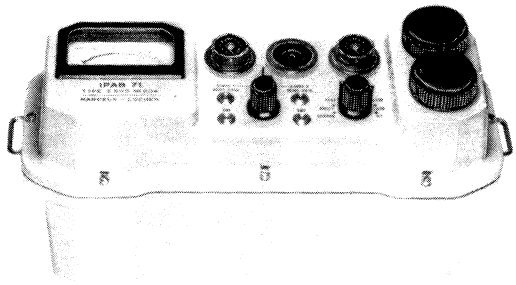

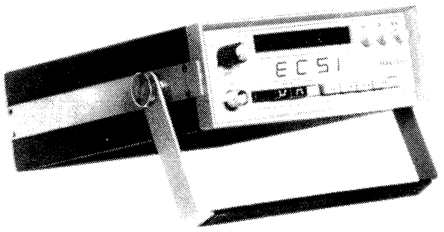

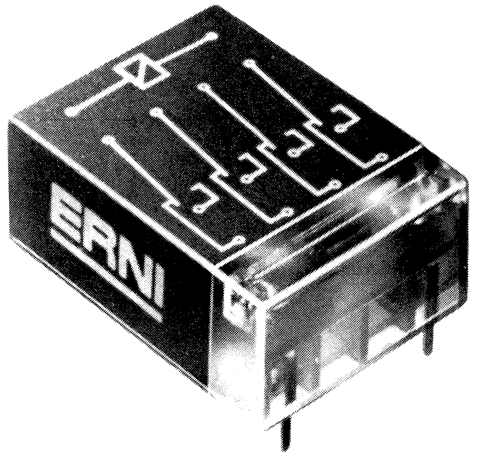
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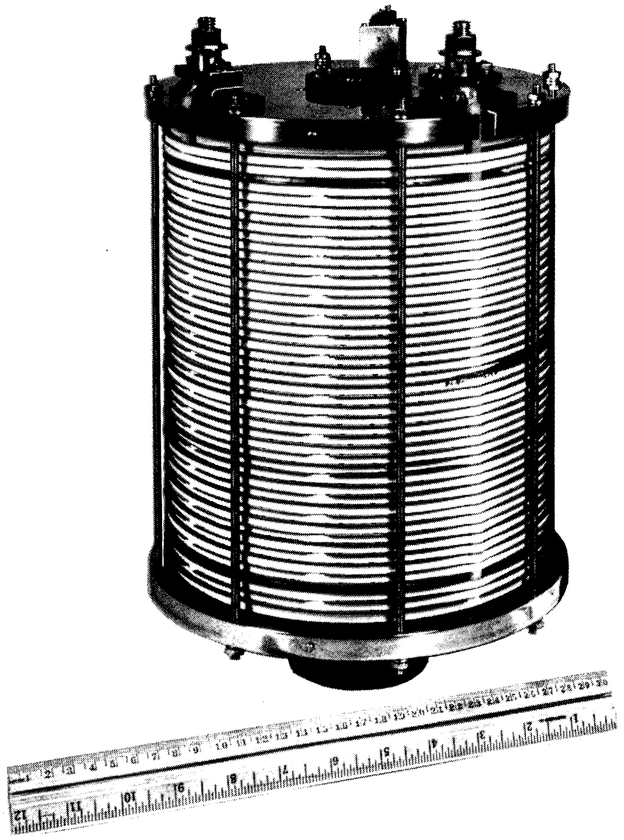
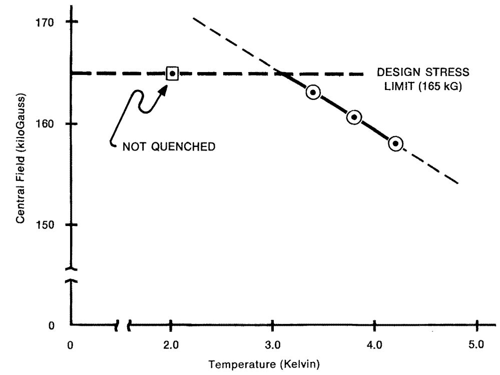


New IGC magnet breaks the 150 kG barrier



CENTRAL FIELD AT "QUENCH' VERSUS MAGNET TEMPERATURE

An IGC superconductive magnet has decisively penetrated the long-standing 150 kG barrier for commercial superconducting solenoids. Built for the Mullard Cryogenic Laboratory of the Clarendon Laboratory, Oxford, England, the new magnet produces 158 kG at 4.2 K and 165 kG at 3.0 K. This record performance was made possible by IGC's modular approach to magnet design, combined with the superior properties of IGC's stabilized Nb$_3$Sn conductor.

Unique in its characteristics, the new magnet has an outer diameter of only 231 mm and weighs only 66 kilograms. It is also extremely stable, performing to 150 kG in less than 30 minutes on its first run, and in less than 10 minutes on subsequent runs.

From a mechanical stress standpoint, the new magnet was designed to perform to 165 kG. As the inset graph shows, however, the results suggest that IGC Nb$_3$Sn magnets may be capable of fields in the range of 170 kG at temperatures near the helium λ point (2.18 K).

Superconductive magnet performance to fields above 180 kG at 4.2 K may also be made possible by this major advance. Such magnets will use V$_3$Ga superconductor (now available through IGC) in the regions of the winding space where the field is greater than 150 kG.

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TABLE OF PERFORMANCE SPECIFICATIONS

Quench Field at 4.2K	158 kiloGauss
Quench Field at 3.0K	165 kiloGauss
Clear Bore Diameter	25.7 mm
Outer Diameter	231 mm
Length	262 mm
Operating Current at 150 kG	126 Amperes
Field Homogeneity at 150 kG	3 x 10^{-4} in a 5 mm DSV
Time to 150 kG (Virgin Run)	Under 30 minutes
Time to 150 kG (Subsequent Run)	Under 10 minutes
Weight	66 kilograms
Average Current Density in Winding Space at 165 kG	15,500 A/cm^2

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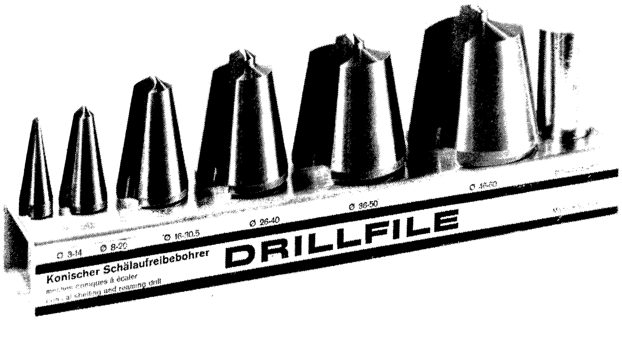

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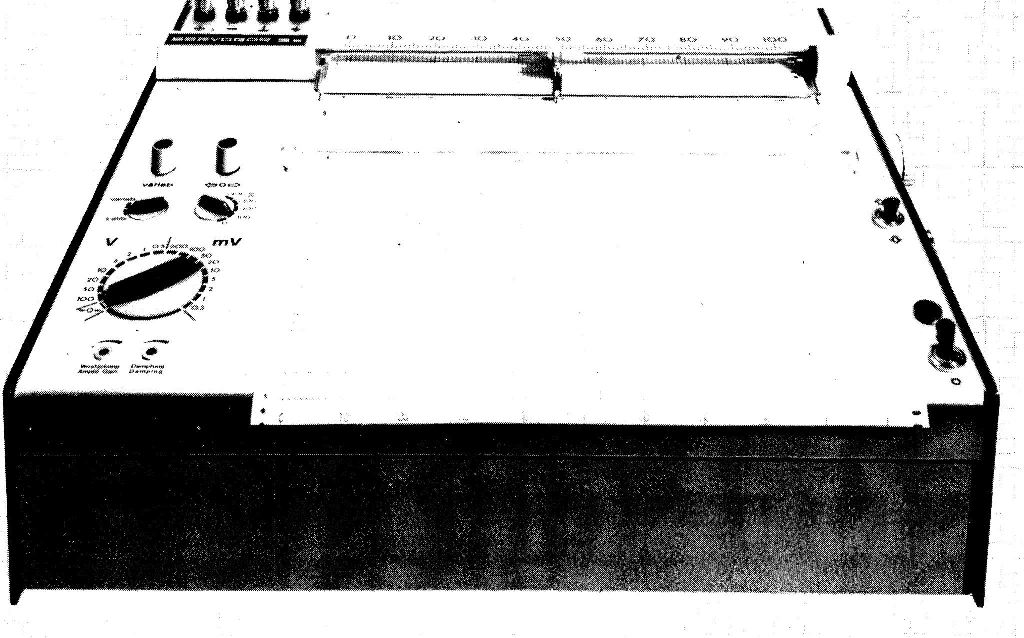

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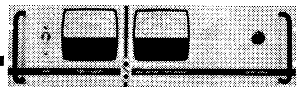

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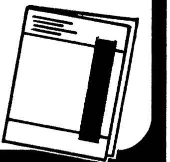

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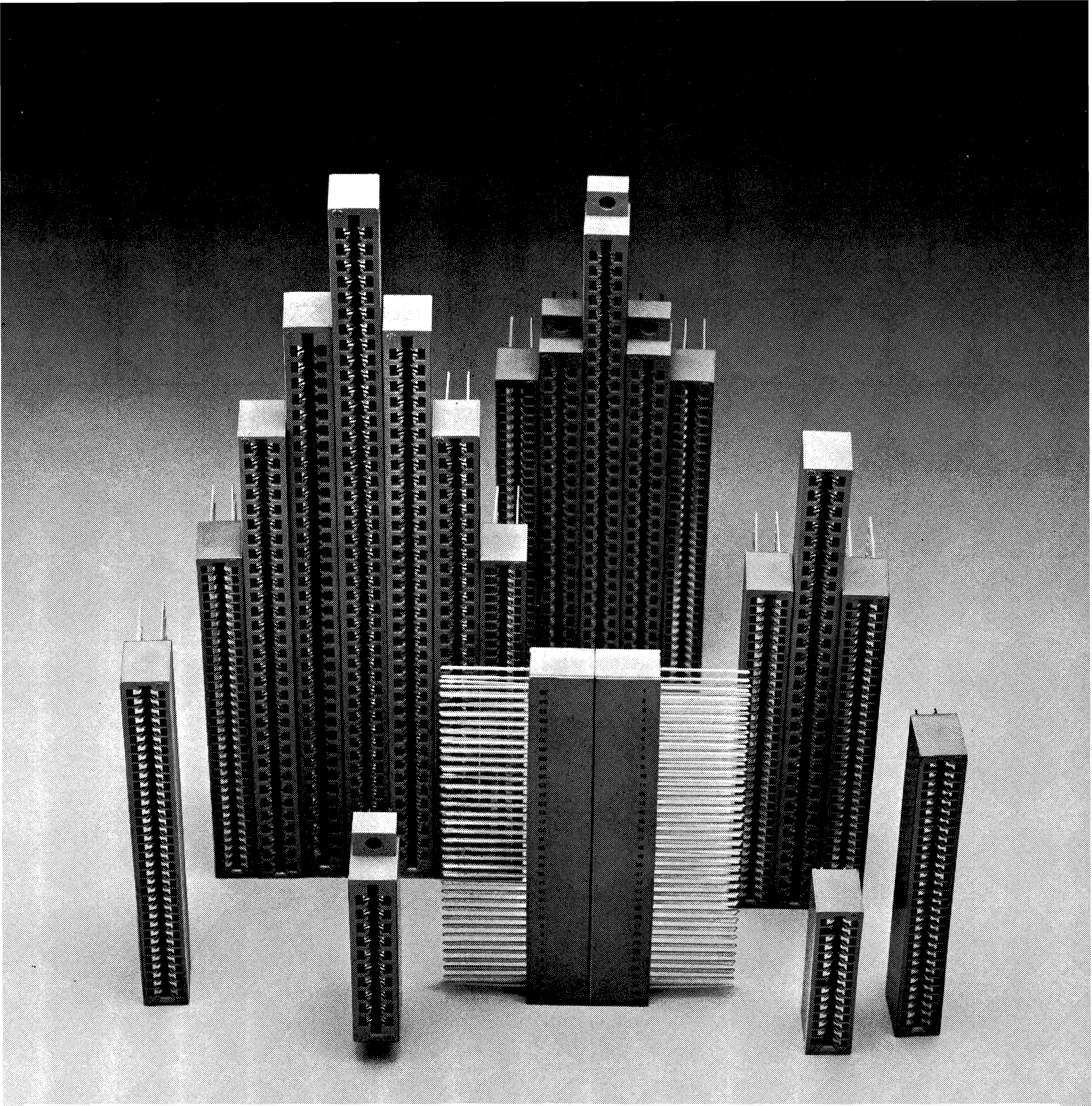

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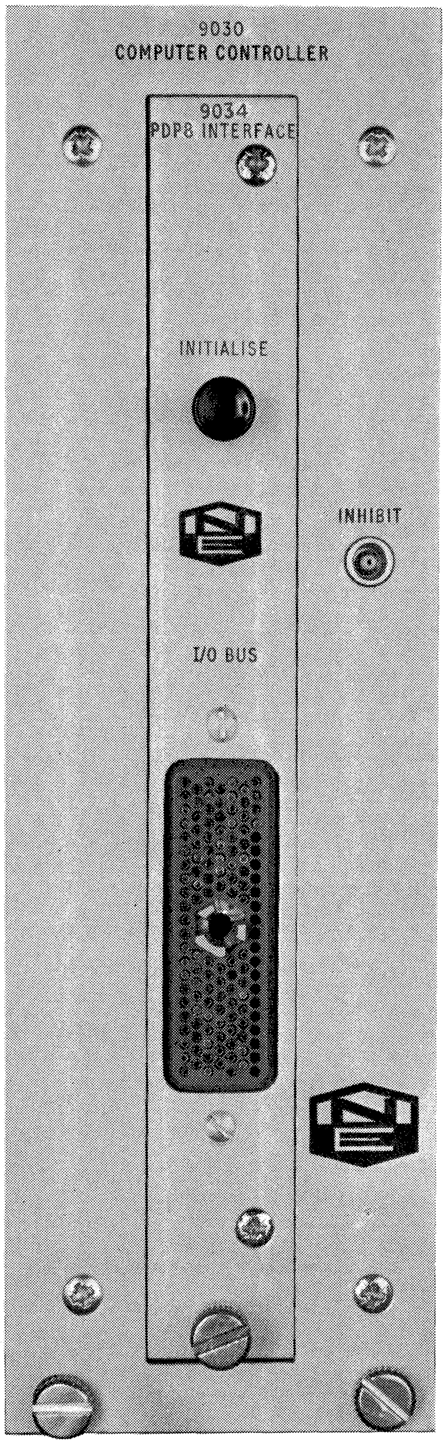

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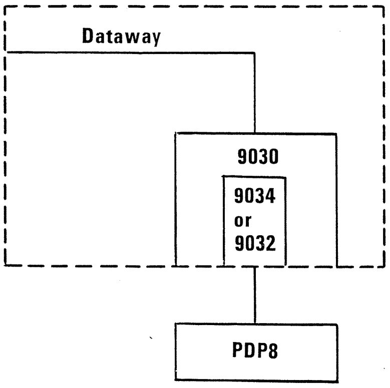
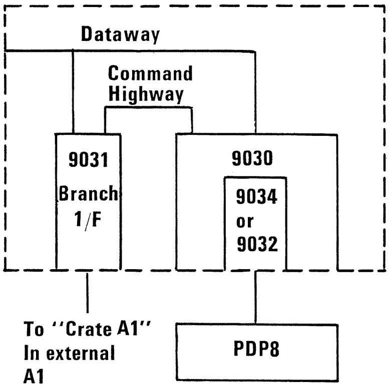


Single Crate Operation



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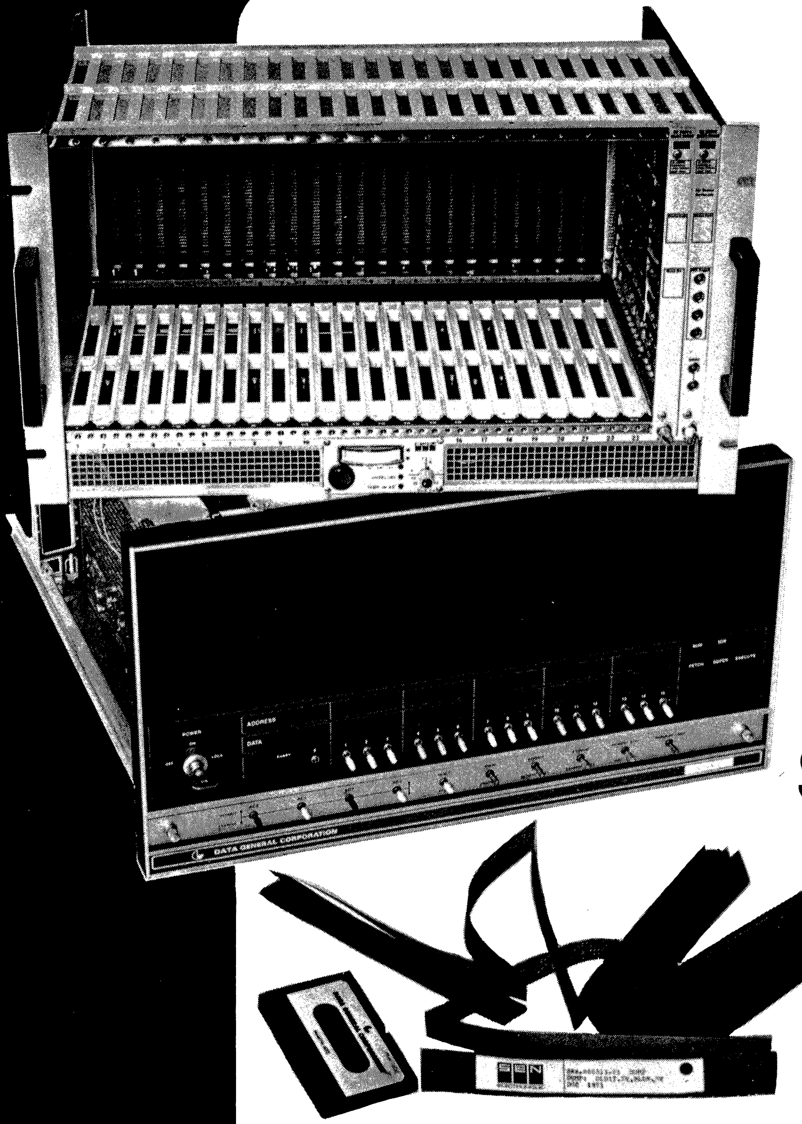
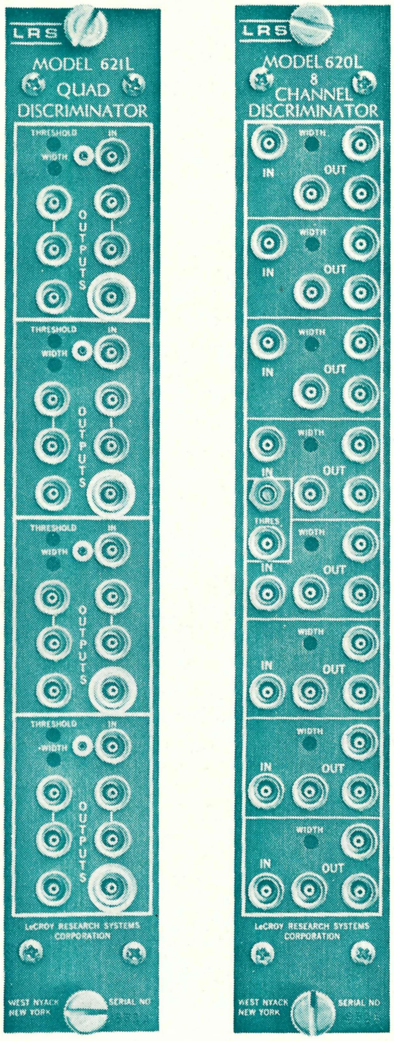
Associate Companies: Germany: Nuclear Enterprises GmbH, Schwanthalerstrasse 74, 8 Munchen 2, Germany. Telephone: 53-62-23 Telex: 529938
U.S.A.: Nuclear Enterprises Inc, 935 Terminal Way, San Carlos, California 94070 Telephone: 415-593-1455 Telex: 348371.



The new standards in discriminators

Model 621L Quad Variable Threshold Discriminator is an extremely versatile instrument with performance characteristics especially chosen for large-scale general-purpose use.

- **Continuously variable threshold** from −30 mV to −600 mV. Low minimum threshold permits proper back-termination of phototubes or allows use of small photomultipliers without the necessity for a separate amplifier.
- **Fiddle-free threshold and width controls** are screwdriver-adjustable. Recessed behind the front panel, they cannot be changed inadvertently during the course of an experiment.
- **Continuously variable output width controls** from 5 ns to 1 μs is the widest continuous range offered by any discriminator in its class.
- **100 MHz operation:** The double-pulse resolution of 8 ns provides ample speed for most large-scale general-purpose applications.
- **High fan-out:** Each channel offers six NIM outputs (5 normal; 1 complement).
- **No multiple-pulsing:** One, and only one, output pulse is produced regardless of input duration or amplitude.
- **Low time slewing:** <1 ns.
- **Deadtimeless operation** updates the output pulse to reflect the most recent input signal.
- **Front-panel monitor point** allows direct calibration of threshold without removing input cables.
- **746 Sw Fr per channel** in unit quantities.



Model 620L 8-Channel Discriminator contains eight identical pulse amplitude discriminators designed for use with hodoscope and similar large-scale applications where only moderate flexibility is required.

- **Low input threshold** of −30 mV provides compatibility with lower gain hodoscope counters or with signals which may have been degraded by long cable delays.
- **Excellent threshold stability** of <50 μV/°C preserves threshold value over varying operating environment.
- **Common threshold control** adjusts all thresholds simultaneously from −30 mV to −1 volt.
- **High fan-out** of three −800 mV signals
- **Output width is variable** from 5 to 30 ns and is independent of input duration, amplitude, and rate; *no need for width cables.*
- **Low time slewing** provides accurate timing signals regardless of the distribution of input amplitudes.
- **Short 8 ns input-output delay** minimizes need for long compensating delay cables and provides prompt system outputs.
- **Front-panel monitor point** allows direct calibration of threshold without removing input cables.
- **472 Sw Fr per channel** in unit quantities.

If you have designed fast logic systems, you have seen optimum system designs scrapped because of inadequate discriminator fan-out. Either you've had to compromise the over-all logic design to accommodate the fan-out limitations, or you have had to increase and unbalance the logic delays through insertion of fan-out modules in the system.

We do not think this is how it should be . . . and we have done something about it. Two new LRS discriminators attack the fan-out problem directly. The Model 620L, the most compact and economical discriminator available, offers three independent outputs per channel. The new Model 621L, based upon the proven design of the world's most widely used discriminator, the LRS Model 321B/50, provides six outputs per channel, 2 dual bridged NIM outputs, one 16 mA normal, and one 16 mA complement. This rather phenomenal fan-out capability of LRS discriminators is achieved through a simple new output stage design which minimizes module power dissipation.

With the Model 620L for your hodoscope counters and the Model 621L for fast trigger logic and general-purpose use, you will enjoy:

- **Lower system cost**
- **Smaller system size**
- **Shorter, uniform delays**
- **Simpler system design and setup**
- **Higher reliability from low-dissipation circuits that run cool.**

For further information, call or write *Raymond Chevalley*, Technical Director, LeCroy Research Systems SA, or your local LRS Sales Office.

LRS

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