# CERN COURIER

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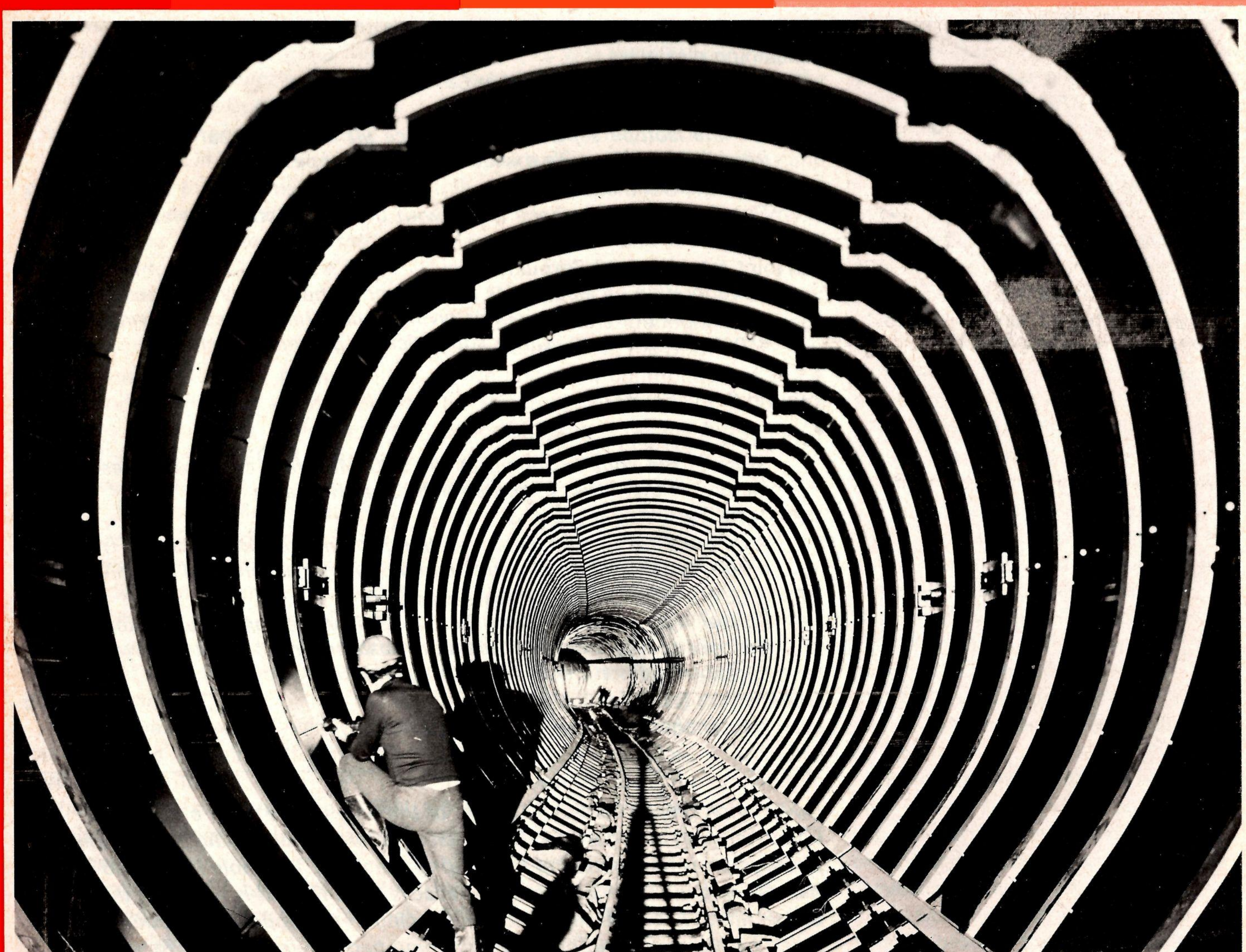

CERN, the European Organization for Nuclear Research, was established in 1954 to '... provide for collaboration among European States in nuclear research of a pure scientific and fundamental character, and in research essentially related thereto'. It acts as a European centre and co-ordinator of research, 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 1000 Fellows and Scientific Associates. Twelve European countries contribute, in proportion to their net national income, to the CERN Laboratory I budget, which totals 391.1 million Swiss francs in 1974.

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 1974 is 227.1 million Swiss francs and the staff totals about 350 plus 10 Scientific Associates.

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# Contents



*Cover photograph: Inside the tunnel of the SPS where work on the final concrete lining is beginning. The metal structure which produces this striking photograph is the shuttering for pouring the vault. The mole had bored around half the ring in December, reaching access shaft PP4. It is here that the tunnel lining is now taking place, advancing in the opposite direction to that taken by the mole — in other words going back towards PP1. The mole itself is continuing its boring way around the ring towards the same PP1. (CERN 48.2.74)*

# ECFA Meeting in February

G. Salvini

*The European Committee for Future Accelerators, ECFA, held a Plenary Meeting at CERN on 22 February. It brought together about thirty scientists from the field of high energy physics, again reflecting the nature of ECFA where representatives of the European Universities, National Laboratories and CERN participate.*

*The meeting was held under the chairmanship of G. Salvini who has been Acting Chairman since 1971 following the sad illness of T.G. Pickavance who had been elected Chairman in succession to E. Amaldi in January of that year. Professor Salvini will now himself be succeeded by W. Paul who was elected as the new Chairman at the February meeting.*

*Professor Salvini presents this report of the meeting together with his aspirations concerning the role of ECFA. He has promoted a revised name of 'European Committee for Future Activities'.*

The Plenary Meeting provided an opportunity to discuss some relevant problems of scientific policy and to review the activity of ECFA during the last three years.

After having recalled what ECFA is, and what it did during 1971-73, I shall report briefly on the discussions and the decisions taken at the meeting and close with some general considerations which I made in my address to ECFA at the end of my mandate as Acting Chairman.

ECFA was created with some specific aims in mind. It has concerned itself with:

- the long-time programmes of CERN (ISR, SPS, other new machines for Europe);
- the collaboration between CERN, European Universities and National Laboratories;
- the National aspects of particle physics and advice to Member States on the weightings to be given to the various fields of activity;
- the cultural impact of high energy physics and the relationship with other sciences.

Its main purpose could be described as collaboration in the best meaning of the word, involving the positive participation of all the parties so as to arrive at the best possible results from European effort in the field of high energy physics.

One of the main activities of ECFA in 1971-72 was the 300 GeV Working Group (more popularly known as the Falk-Vairant Working Group, from the name of its Chairman). Under the fine leadership of P. Falk-Vairant and his collaborators, particularly evident during the fruitful days of the Tirrenia Meetings in 1971 and 1972 (described in CERN COURIER, vol. 12, p. 318), this Committee was the backbone of the preparations throughout Europe for experiments at the SPS.

An important contribution of ECFA to reciprocal understanding is the periodical survey on the high energy physics population in Europe and on the financing of its research. This is known as the Harting Report and I think that the data it contains is the foundation for efficient discussions on European policy in our research.

In May 1972, an important Plenary Meeting of ECFA was dedicated to the activities and future programmes of the National Laboratories in Europe, presented by their Directors. It gave insight into some present problems in a period of delicate equilibrium between the preparation for the experimental programme at the CERN SPS and sustaining a viable high energy programme with national machines. ECFA believes that an understanding of these national problems is an important element in considering the future development of CERN itself.

Part of the ECFA meetings in 1972 were devoted to analyzing the relations between CERN, Universities and National Laboratories. It is recognized that there must be a continuous exchange of physicists and ideas between these three components.

Here is part of the letter of D. Harting and myself, dated 21 December 1972, which remains equally valid today. It was written to summarize some views expressed by ECFA:

'... CERN is an absolutely necessary institution but it is not enough by itself for European development. We know of course that, without CERN, Europe would be nowhere to-day in high energy. But CERN could not exist alone, for we could not justify its solitary existence to our Governments.

... The National Laboratories are necessary, for they develop alternative ways of doing high energy physics, and they guarantee a great capacity and technical know-how in many places in Europe in our field. Otherwise, we would remain in a too passive position to contemplate the beautiful technical achievements of CERN.

... But let us go to the third constituent, the Universities, and similar institutions of high culture in Europe. To say that they are essential is an understatement. They are perhaps the main reason to justify CERN and National Laboratories, and they are the system which must take full benefit of the existence of these two. It is from the Universities that we must really start the transformation of the results of our research into culture for Europe.

If the Universities do not react actively to our scientific results, we are lost, and the interest and development of high energy physics will decay in an irreversible way. This may be considered from another point of view: the Universities are the transmission belt of scientific culture from one generation to the other; if high energy physics

*Professor G. Salvini (left) in conversation with Dr. G.H. Stafford (Director of the Rutherford Laboratory and Vice-President of the CERN Council) during an ECFA Meeting at CERN. Professor Salvini has been Acting Chairman of ECFA since 1971.*

*CERN 15.12.72*

does not enter into the Universities deeply enough, the younger generation will become uninterested in high energy physics and the negative consequences will be felt in one decade or less. . . .

. . . But what are the practical consequences of all this? How can ECFA contribute to these problems, and what suggestions can we give? . . .

. . . CERN must be the heart of Europe in high energy physics. A good heart must guarantee the circulation of the blood. If the blood remains in the heart, a deadly stagnation develops. In other words: European physicists must spend a part of their life at CERN, but not all their life; after a period of work at CERN they should return to their national institutions. Life appointments at CERN must be considered with great care; in fact, being at CERN is a privilege for gifted persons, but this privilege must be continuously circulated among the European physicists. The visitors to CERN are the important thing for both scientific and technical research. . . .'

In order to submit all these points to a careful analysis and to arrive at specific recommendations to the official bodies of CERN and Europe, it was decided to form 'Working Group III'. This Group has been very active during 1973, under the Chairmanship of J.C. Gunn. Its membership is drawn from all three components (CERN, National Laboratories, Universities) and is distributed around the European countries — M. Regler (Austria), J. Géhéniau (Belgium), K. Hansen (Denmark), H. Schopper, H. Faissner (Federal Republic of Germany), D. Morellet, B. Thevenet (France), A. Apostolakis (Greece), C. Mencuccini, G. Morpurgo (Italy), M. Veltman (Netherlands), P. Nyborg (Norway), S. Nillsson (Sweden), P. Extermann (Switzerland), A. Donnachie, G.H. Stafford (UK), Y. Goldschmidt-Clermont, M.G.N. Hine, M. Holder, A. Zichichi (CERN). J. Mulvey, Coordinator of the experimental programme at CERN, also attends meetings as an invited member and the President and Secretary (D. Harting) of ECFA are ex-officio members. J.M. Valentine and D.J. Baugh assure the secretariat.

Let us now turn to the ECFA Meeting on February 22. The first act was the election of the new Chairman (with effect from 23 February 1974). Prof. W. Paul was unanimously elected and we are very happy that the guidance of the work of ECFA will, for the next three years, be in the hands of a physicist who has demonstrated so much concern for the scientific problems of Europe and has brought so much intelligence to bear on them.

D. Harting reported some data on developments in the field of high energy physics in 1972 adding some perspective figures for the following years. M. Hine reported on the present situation concerning computing power available in Europe for high energy physics. European physicists will be informed by their national ECFA members on these topics.

J.C. Gunn made a preliminary report on Working Group III. The Group hopes to complete its work within 1974 and to present a final document with a number of definite recommendations. Among the topics discussed have been: the equilibrium between young physicists entering the high energy field with the hope of a career and the present perspectives of the European 'market' in high energy physics; the balance between visitors to CERN and those in permanent positions; the impact of the results of high energy physics on European scientific culture; the new European enterprises.

Also, as usual at ECFA Plenary Meetings, the Directors General of CERN gave Status Reports on the developments at CERN Laboratory I

# CERN News

and CERN Laboratory II. The recent important discoveries at Lab. I are well known and are a sound basis for confident discussion in ECFA. At Lab. II it is clear that a great effort is being made to avoid the present difficulties in Europe affecting the construction schedule of the 400 GeV machine.

To conclude let me recall a few general points from my address at the end of my mandate as Acting Chairman:

The physicists of Europe outside and inside CERN must be considered equally. CERN must continue to be closely connected with the rest of Europe and the Universities; it is therefore important that exchanges are possible on an equal basis.

We must promote the spread of scientific information. It is becoming possible in high energy physics for results to be talked about at CERN and to be published only later when scientific work has already developed from them. This inflates the urge of young physicists to be at CERN, with the obvious danger that National Laboratories and Universities become 'provincial'. We should make continuous efforts to avoid this.

In the relationship between high energy physicists and physicists working in other fields, we must try to attract their interest and to inform them on what we are doing and why. In trying to explain our problems we shall come to appreciate the deep motivations of our work better ourselves.

One of the next responsibilities of ECFA will be the discussion of a new enterprise of great value — the construction of electron-positron and, maybe, electron-proton storage rings for high energies. Due to the beautiful pioneering work at lower energies in Europe, the Soviet Union and the United States in recent years, we know that this line of research is very valuable. This is a very important positive point on which to end my report.

## Start-up of the PS and ISR

The proton synchrotron and intersecting storage rings were shut down during the first weeks of the year for general maintenance and important modifications as described on page 8 of the January issue. The machines came into action again mid-February.

A main feature of the PS start-up was that, because of the care taken in the preliminary checks, it went more rapidly than in previous years. Whereas it usually takes twenty-four hours to achieve a beam of good enough quality for high energy operation, tests on fast ejection 16 for the ISR at 22 GeV/c and then at 26 GeV/c were made after only fourteen hours of adjustments (injection, passing through transition, etc.).

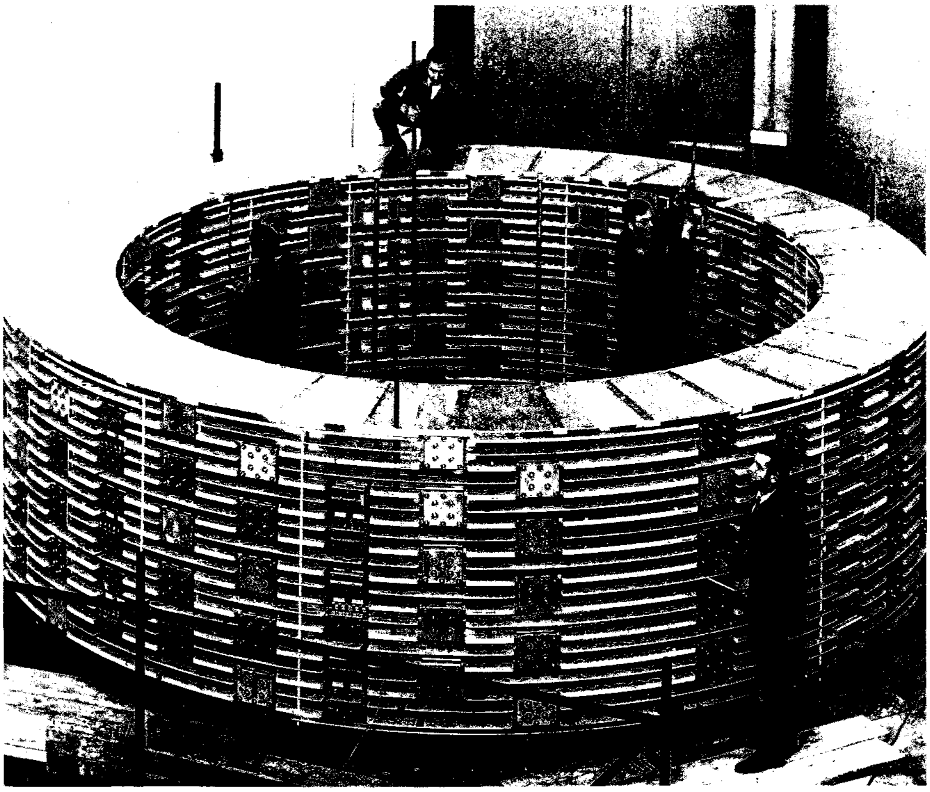
It was then possible to test the various operations listed in the machine schedule: internal target 1 at 18 GeV/c for counter experiments, fast ejection at 26 GeV/c for the 2 m bubble chamber, slow ejection and internal target 8 beam sharing for counter experiments. Well before the scheduled time it was clear that the high energy programme could be carried out. It was of particular importance to be ready on time because the work of boring out the injection beam-line to the SPS, which is carried out during the periods when the ISR are not being filled, makes it essential to adhere rigidly to the time-table.

After two weeks of operation, the PS intensity had not reached the previous record levels and remained just below $2 \times 10^{12}$ protons per pulse. The current supplied by the Linac was of rather low intensity (30 to 35 mA instead of 40 to 45 mA within an energy spread of $\pm$ 150 keV) and it was not as stable as during the previous record performances. These shortcomings are probably due to a considerable asymmetry in the field distribution of the compensation cavity of tank I which has caused the repeated failure of an insulator. This can give the abrupt phase change which has been detected. The breakdown rate after a fortnight's operation is about 5 %, better than the annual average for 1973 (8 %).

The Booster is gradually being brought into action again. It is required for neutrino experiments with Gargamelle in April when the highest possible proton beam intensity can be used. The ISR will then be filled using every other pulse. During the pulse for the Gargamelle experiment, attempts will be made to eject a single bunch to the 2 m chamber and, after eighteen bunches have been ejected for Gargamelle, to eject the last bunch slowly for tests with the Omega spectrometer. Obviously, this method of operation must be tried in advance, and the first trials are scheduled for 8 March.

The ISR started up on 14 February. A first check, without any beam in the rings, verified that all the machine components were connected up and operating correctly. The next day, beams from the PS were stored without any special problems and, on 16 February, physicists could re-start their experiments. The only significant incident during this start-up period was a leak in the vacuum tank of a beam profile monitor, which was quickly repaired.

During the first week after the machine start-up, the beams in the two rings were accelerated to 31 GeV for a period of experiments with the Split Field Magnet at intersection I-4. The circulating currents in the two rings were then 4 A and the luminosity reached a figure of $0.34 \times 10^{30}$ cm$^{-2}$s$^{-1}$. On 23 February, beams were stored in the ISR for forty-one hours. The intensity of each beam was 10 A at an energy of 26 GeV and the luminosity



CERN 1.11.70

*One of the coils of the superconducting magnet of the 3.7 m European bubble chamber, BEBC, during its assembly in 1970. The coil has twenty pancakes, stacked vertically one above the other, each with 87 turns of superconductor — altogether one of the largest superconducting magnets ever built. Faults on a coil connection necessitate a major dismantling of the bubble chamber which will be out of action until early next year.*

reached $3.7 \times 10^{30}$ $cm^{-2}s^{-1}$. This long period of operation showed that the beams were particularly stable since the decay rate of the circulating current was only 4.6 ppm/min during the forty-one hours, as against 60 ppm/min in the same conditions last year.

This improvement has been achieved mainly because of the new working lines now used in the ISR. The betatronic frequency fluctuations brought about by space charge forces caused the working lines in the $Q_V$, $Q_H$ stability plot to curve inwards during stacking and to cross the fifth and third-order resonance lines. The working lines used this year, referred to as 8C, prevent this and eliminate these resonances in the stored beam. The result is impressive — the beam stability is greatly improved and makes it possible to sustain longer experimental periods with beams of which the luminosity decreases only slowly.

## Problems with the BEBC magnet

In the December issue (pages 370-371), we described the promising results in the commissioning of the 3.7 m European bubble chamber, BEBC. The superconducting magnet had by then reached its design field of 3.5 T in the chamber volume. We also mentioned that an intermittent fault had been encountered when the magnet was powered and that this fault had disappeared during a series of systematic tests. It was not possible at that time to study the problem in more detail.

When the magnet was warmed up in January the fault reappeared. Measurements confirmed that a short circuit was occurring not in the superconducting coil itself but in an auxiliary circuit.

It was still possible to operate the magnet though only at a limited rate of charge and discharge. At the peak field of 3.5 T the stored energy is 730 MJ and operation then became too difficult and even hazardous, since the short circuit could have caused other, more serious faults. It was therefore decided to tackle the repair immediately.

The auxiliary circuits concerned connect the double pancakes to the terminals on the cryostat cover. They are inside the cryostats and cannot be reached from outside or via the few apertures in the cryostats. In order to remedy the fault, the upper pole piece, the magnetic shielding and a major portion of the vacuum tank has to be dismantled. The cryostats then have to be removed and opened in order to give access to the coil and the defective wiring. When the magnet has been dismantled, it will be possible to take a close look at the breakdown since it is impossible to establish all the details until such a direct examination has been made.

The dismantling operation will take about two months. The repair itself can be quickly carried out but the opportunity will be taken to improve the measuring circuits and the pipework of the cryostats. Six weeks' work is scheduled. Reassembly will take several months because of the large number of tests which will have to be made at each stage. Over-all testing should be possible once more in November. A programme of improvements will also be carried out on the chamber and its installations — especially the expansion system, the optics and the cooling system — in parallel to the work on the magnet.

Operation of BEBC for physics should be possible again at the beginning of 1975 after the annual PS shutdown.

## Conference on underground survey techniques

A conference on underground survey techniques was held at CERN on 5-6 March under the Chairmanship of J. Gervaise, Leader of the CERN Laboratory II Survey Group. It was organized by CERN in collaboration with the National Institute of Applied Sciences (INSA) of Lyon and attracted some seventy participants mainly from France, Belgium and Switzerland.

In his opening address, J.B. Adams, Director General of CERN Laboratory II, recalled the problems facing the surveyors in 1954, in the building of the 28 GeV proton synchrotron, and then, in 1966, the Intersecting Storage Rings. Ground movements can adversely affect the magnetic field configuration in the machines and the first task was to measure the stability of the

*The muon storage ring under construction. The ring requires extremely careful assembly since it will be used in an experiment to measure the 'g-2' value of the muon to very high accuracy. We will return to this experiment when the ring is tested in the summer.*

*The detection system built up of multiwire proportional chambers in place in the large aperture of the Split Field Magnet at the Intersecting Storage Rings. This system, linked directly to large computers, is able to devour data on the high energy proton-proton collisions at unprecedented rates.*

ground to allow the civil engineers to provide as rigid a foundation as possible. Errors in alignment also upset the required fields and it was essential for the hundred magnets of the PS, for example, to be no more than a few tenths of a millimetre from their theoretical positions.

The PS tunnel was built almost at ground level and the concrete beams carrying the magnets were supported on the molasse via eighty pillars. At that time, therefore, there were no underground surveying problems to deal with. The same applied at the ISR. Although they were sunk more deeply into the ground, the width of the tunnel and the experimental halls made it possible to use traditional techniques.

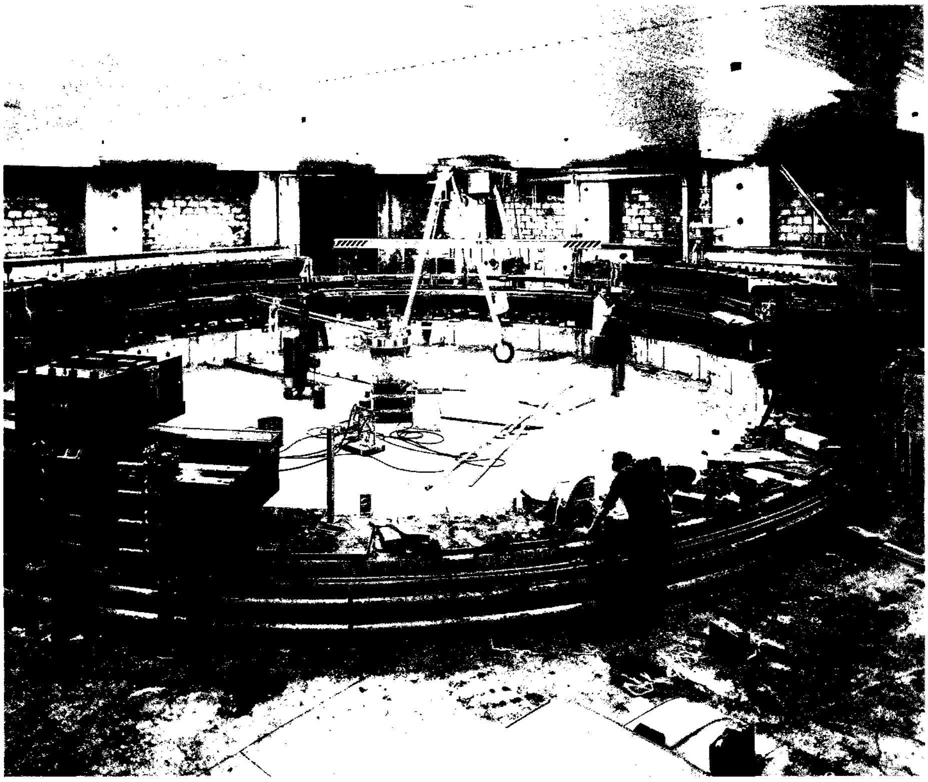
A geological survey carried out for the SPS showed that the molasse bed adjoining Laboratory I could accommodate an accelerator 2.2 km in diameter, the machine being buried deep in the ground. The Survey Group had thus to ensure all the stringent alignment requirements underground.

Half the circumference of the main tunnel, the injection tunnel and the ejection tunnels to the West and North experimental areas have been bored. The results are very satisfactory. At none of the shafts is the tunnel axis more than two centimetres away from the reference points based on the surface network.

J. Gervaise gave a detailed report on the successive stages of the survey made for the SPS and made three particular points.

The first relates to the constant development of survey equipment, which could well become obsolete within a year. None of the techniques and systems used for the PS between 1954 and 1959 are applicable today and seem completely old-fashioned.

A second point concerns the cost of underground work. The CERN site is centred on a fold in the molasse of the



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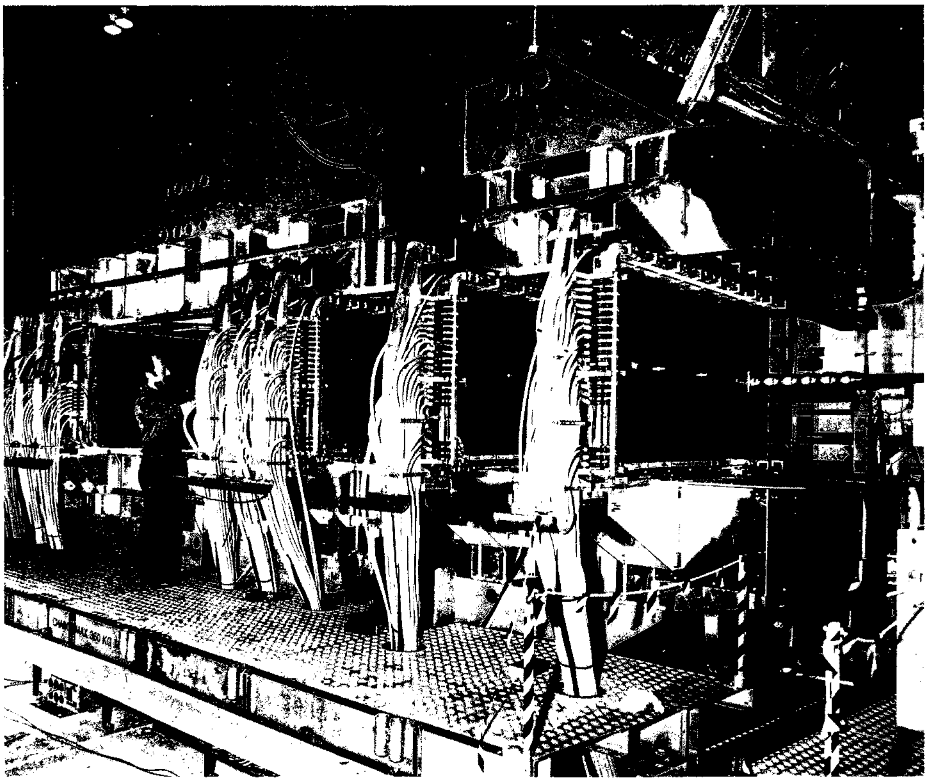

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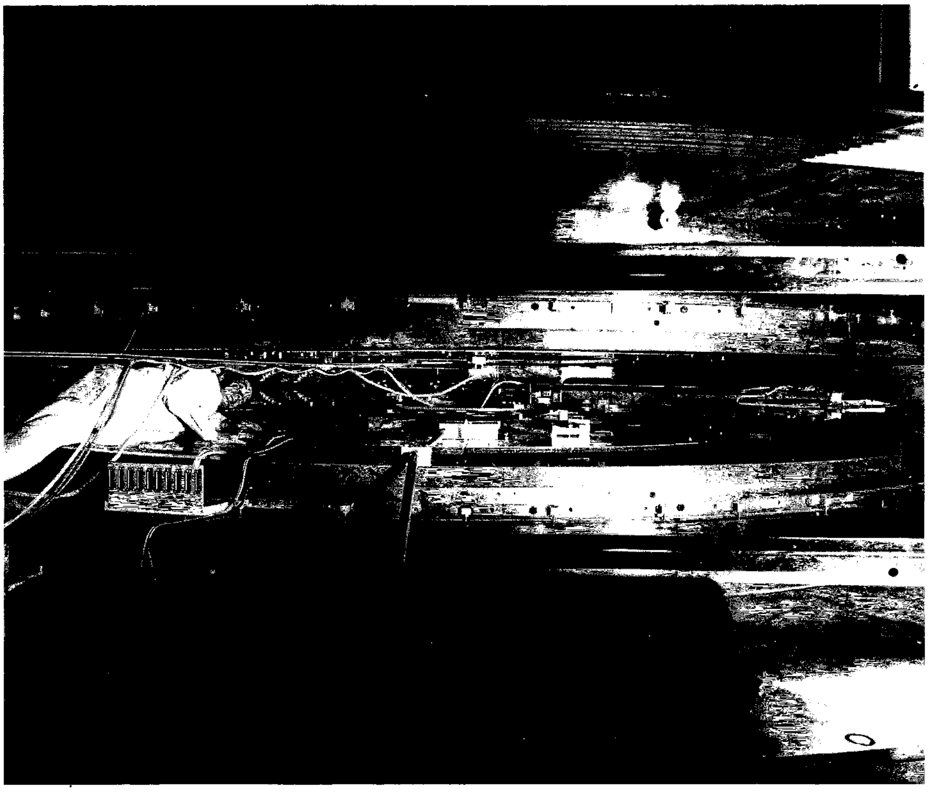


*Measurement of the field in the magnet of the 600 MeV synchro-cyclotron. In the course of the improvement programme at the machine, the magnet has received a number of modifications including the cutting of a 21 cm diameter hole in the centre of the yoke for the new type of ion source. A new map of its field, which is about 2 T, is therefore needed. A bar 3.5 m long carries a hundred Hall plates linked to a computer. The plates are mounted with a 3 cm spacing and give field valves to the required precision of about 2 × $10^{-4}$. 36 000 readings are taken in about 40 minutes.*

CERN 6.2.74

Geneva basin and, with an accelerator 2.2 km in diameter, there is a difference in level at the surface of about 50 m between the highest and lowest points on the circumference. Conventional 'cut and fill' methods would have been extremely expensive. Also, with the wish to protect the environment as much as possible and to retain productive land, it was essential to build the synchrotron underground.

A change in the 'philosophy' of the underground survey for the accelerator is a third important point. Although the synchrotron geometry is three-dimensional, there are only two spatial parameters affecting the protons — the variation in machine radius and the vertical variation in the mean plane chosen of the closed orbit. Any deviation in the longitudinal closure, which is normally the most important parameter in tunnelling, is here of secondary importance. Anyway, to avoid any longitudinal deviation, the length measurements were made with geodetic equipment, and not with field survey instruments; the distinvar is used for the geodetic traverse and a MA 100 tellurometer is used for the goniometric traverse.

For transverse deviations it was planned to use gyroscopic compasses for locating the underground network to guiding the boring machine. Specialists carried out geotheodolite tests and looked for ways of making quicker automatic readings. It took two years to become fully familiar with the instrument and its operation, after which the desired results were achieved.

The first day of the meeting was taken up by lectures not directly related to CERN, such as: Instruments and methods of underground surveying (N. Lenoble); Examination of the problems involved in boring road tunnels (G. Tarlet); Precision tunnelling and the transfer of directional measurements (M. Dauge); Traversing in tunnels to determine dam distortion (H. Chablais); The geodetics and field surveying of the Parisian Regional Express Network (R. Collin).

The second day began with a summary by E. Menant of the underground surveying problems at CERN. D. Bois, E. Menant and J. Olsfors described the automation of the gyroscope and the concluding talk by J. Gervaise dealt with the detailed results obtained with the underground survey for the SPS. Finally the participants were able to see what it was all about during a visit to the SPS tunnels.

## Machining plexiglass

A new type of milling head operating on air bearings has been developed in the West workshop. It is driven by an air turbine and the speed of rotation can be controlled electronically to maintain a steady preselected speed within a range from 1000 to 22 000 rpm. Machining times with this milling head are substantially reduced.

So far, industry has been unable to supply a self-propelling head with a sufficiently rigid spindle for the range of speeds and• dimensions required. The dimensional tolerances which are needed led to the development of this new machine, which is the brainchild of Ch. Brégy. At the moment it is used with very satisfactory results in the machining of components intended for light-guides and scintillators. However the principle will later be extended to a vertical-shaft centrifuge for machining epoxy resin for parabolic mirrors. This will produce a better surface finish and more accurate reproduction.

This development is in line with one of the objects of the CERN workshops — to design prototypes to meet the very special requirements which arise is carrying out fundamental research.

## The ISOLDE improvement programme

In the context of the improvement programme of the 600 MeV synchrocyclotron (described, for example, in vol. 13, page 333) the isotope separator on-line, ISOLDE, is also undergoing a series of major modifications.

The separator was brought into operation in 1967 and is designed to study the short-lived nuclides far from stability. The radioactive nuclides, produced by exposing a selected target to the 600 MeV proton beam from the SC, emerge from an ion source. An ion beam, usually of one element, is formed and passed through an analyzing magnet. From there, isotopically pure ion beams are trans-

*Diagrams of the on-line isotope separator which is being improved during the long shutdown of the 600 MeV synchro-cyclotron. The new version, ISOLDE-2, consists of*
*a) target and ion source,*
*b) electrostatic lens for ion extraction and ion beam focusing,*
*c) analysing magnet,*
*d) 'switchyard' with four pairs of deflectors,*
*e) electrostatic focusing lenses*

ported by means of an electrostatic beam handling system to the measuring equipment.

The ISOLDE improvement programme began in June 1973 and will continue until May/June, when the synchro-cyclotron is due to start running again. Two divisions (Nuclear Physics and Synchro-cyclotron) are involved in this programme in which the CERN-ISOLDE group is collaborating with scientists from the Denmark, Federal Republic of Germany, France, Norway and Sweden.

The ISOLDE group is rebuilding the separator. The new target and ion source unit will make it possible to produce radioactive isotopes of about 35 elements (the previously number was about 10) and to have ion currents with an intensity up to several nA ($10^{10}$ ions per second) which is a very high figure for radioactive particle beams.

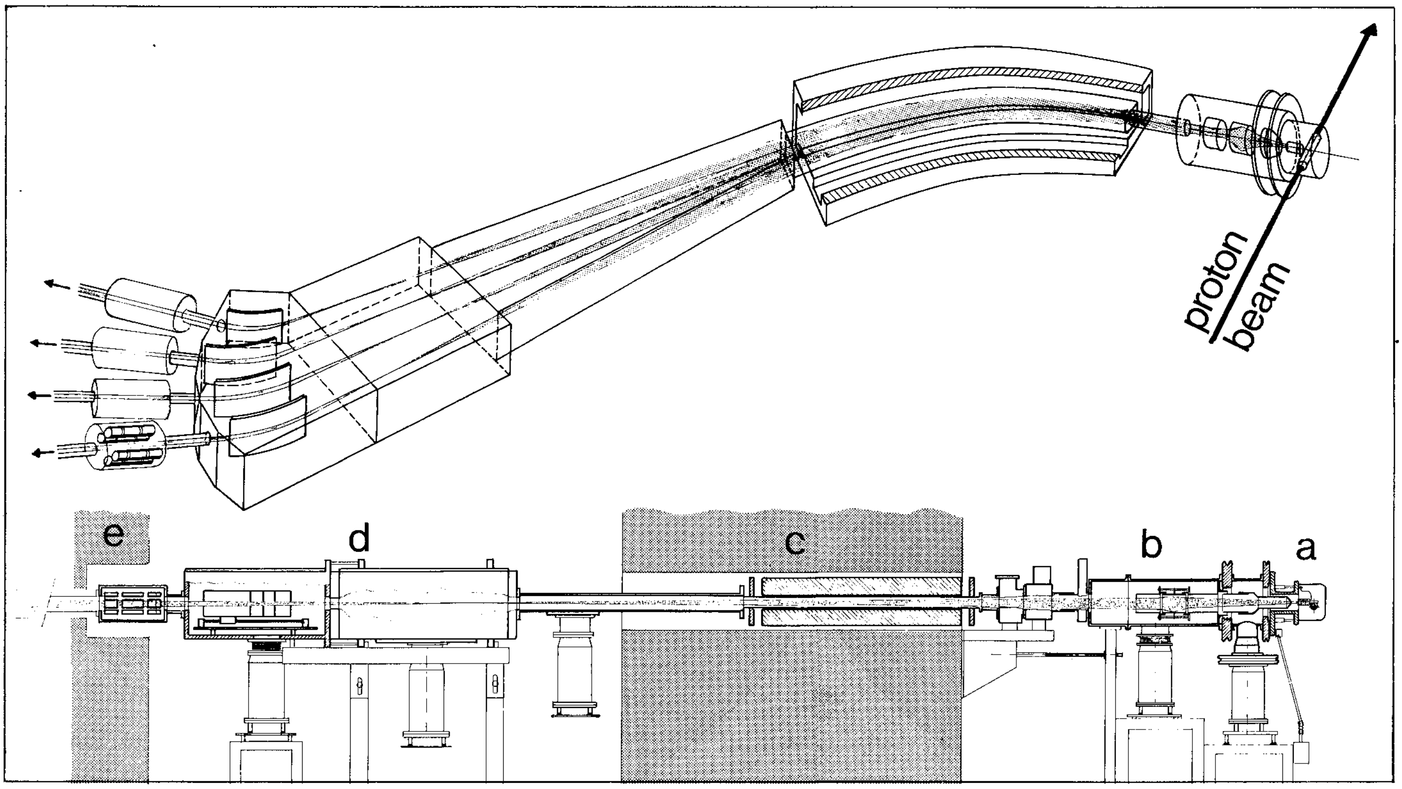
Another new development is the system for transporting the beams to the measuring equipment situated in the experimental hall. The new switchyard has four electrostatic deflectors installed at the output from the separator and can guide, simultaneously, four different isotope beams selected from a wide range of masses towards the experiments.

The ion-optical system will transport low energy (about 60 keV) beams of heavy isotopes focusing them on a 1 $mm^2$ spot at a distance of 15 m. This requires a dozen electrostatic quadrupole lenses distributed in the four beam-lines. The experimental hall is now to be used only for measurements connected with the four beam-lines which emerge through the shielding wall.

In view of the planned increase in the intensity of the proton beam to the ISOLDE target (from 0.05 $\mu$A to 5 $\mu$A), a new shielding wall has been built with heavy concrete and iron blocks. This wall, 3 m thick, has been placed parallel to the former wall, 2.5 m thick, leaving a space in which the mass separator has been installed. The new wall also incorporates the mass-analyzing magnet.

The proton beam transport line from the synchro-cyclotron is about 60 m long and has been completely rebuilt in order to achieve a better vacuum in spite of the expected increase in radiation damage. The ventilation system in the target room has been improved to reduce the radioactivity of the irradiated air to a permissible level before it is returned to the outside atmosphere. For evacuation of the air a chimney 20 m high has been built.

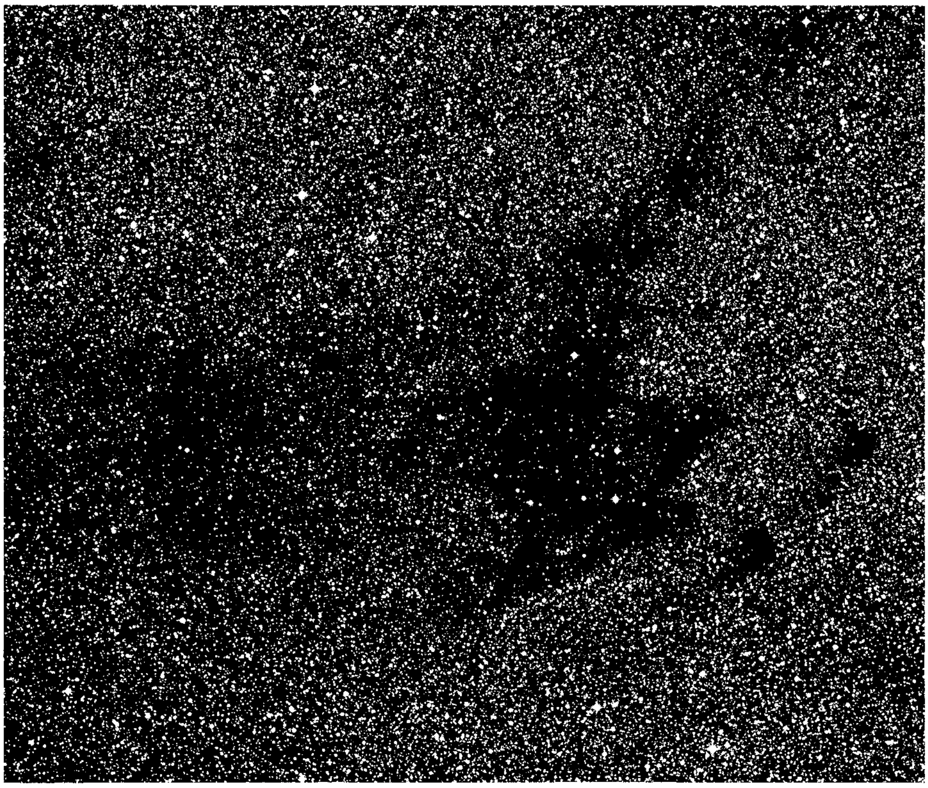
It will soon be possible to install new experiments at ISOLDE-2 to take advantage of the availability of a wider range of isotopes and higher beam intensities in the continuing study of the nucleus.



# Photos of Southern Sky

The 40 inch Schmidt telescope came into regular operation at the European Southern Observatory in Chile last year. The first task is to complete a survey of the Southern sky from −20° to −90° on Kodak IIa-0 plates. It is known as the ESO (B) Survey or the Quick Blue Survey. It will be followed by a southern equivalent of the famous Palomar Sky Survey which mapped the Northern sky. This will be carried out in a joint programme by the European Southern Observatory at Chile and the UK Science Research Council Observatory in Australia. It is known as the ESO/SRC Survey of the Southern Sky. The ESO Schmidt telescope will take the red plates (098-04+RG 630) and the SRC 48 inch Schmidt telescope will take the blue plates (IIIa-J + GG395).

Here are shown, for the first time, two spectacular photographs recorded during the Quick Blue Survey. The original plates were taken by ESO astronomer H.E. Schuster and copies were made in the ESO Sky Atlas Laboratory at CERN by B. Dumoulin, B. Pillet and R.M. West.



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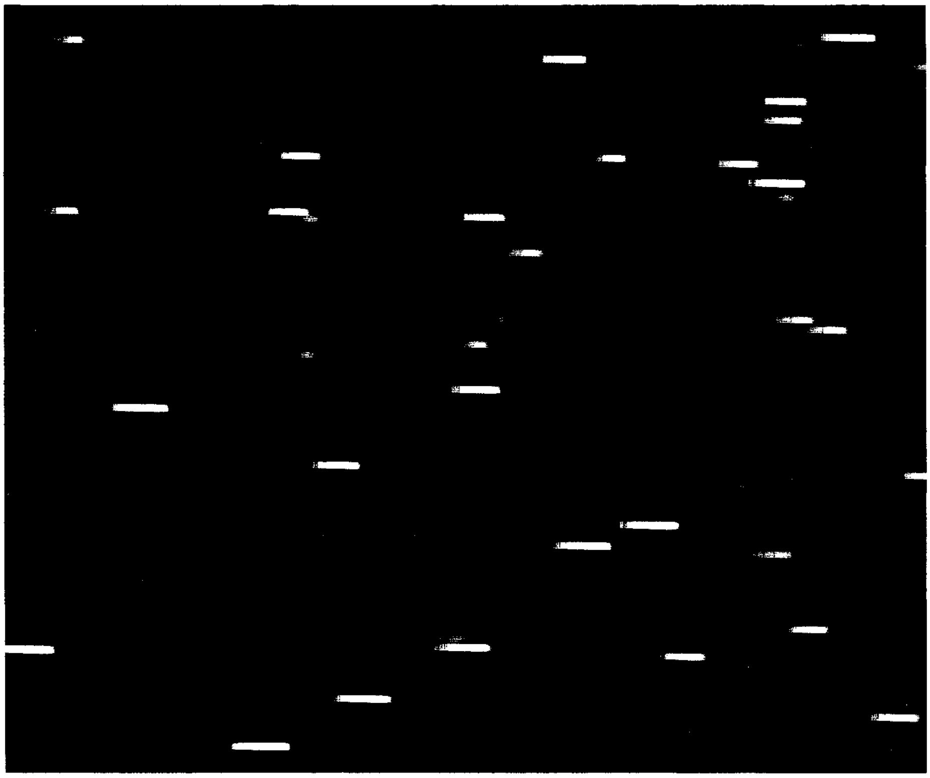


2.

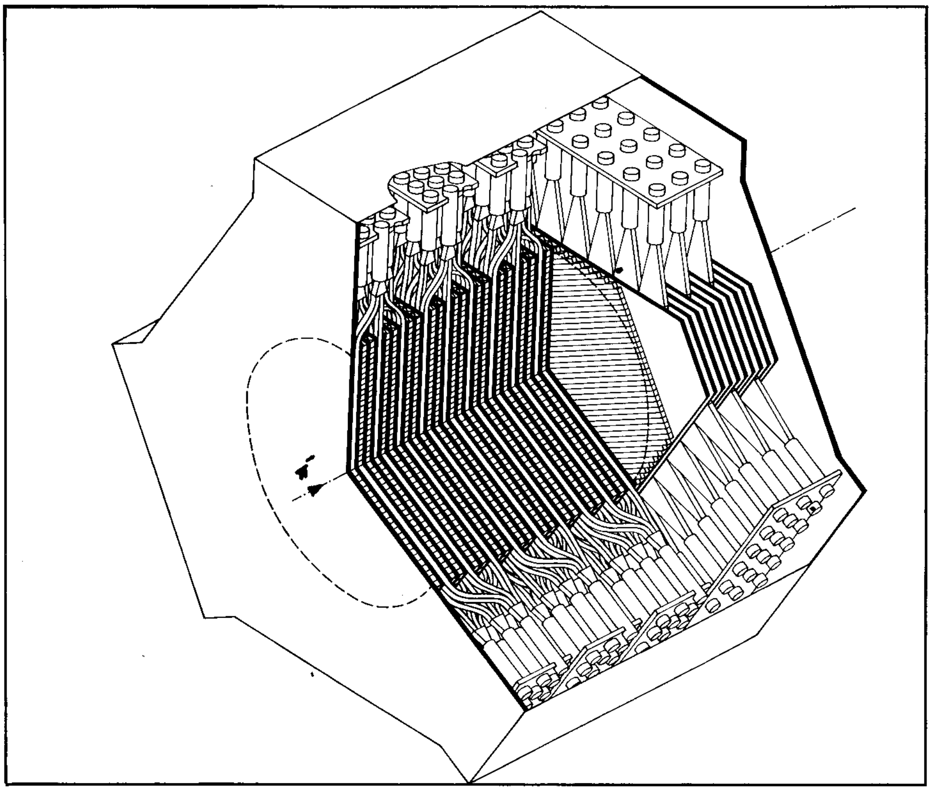
1. A dark nebula observed in the milky way. It consists of opaque interstellar material which shrouds the light of the stars behind.

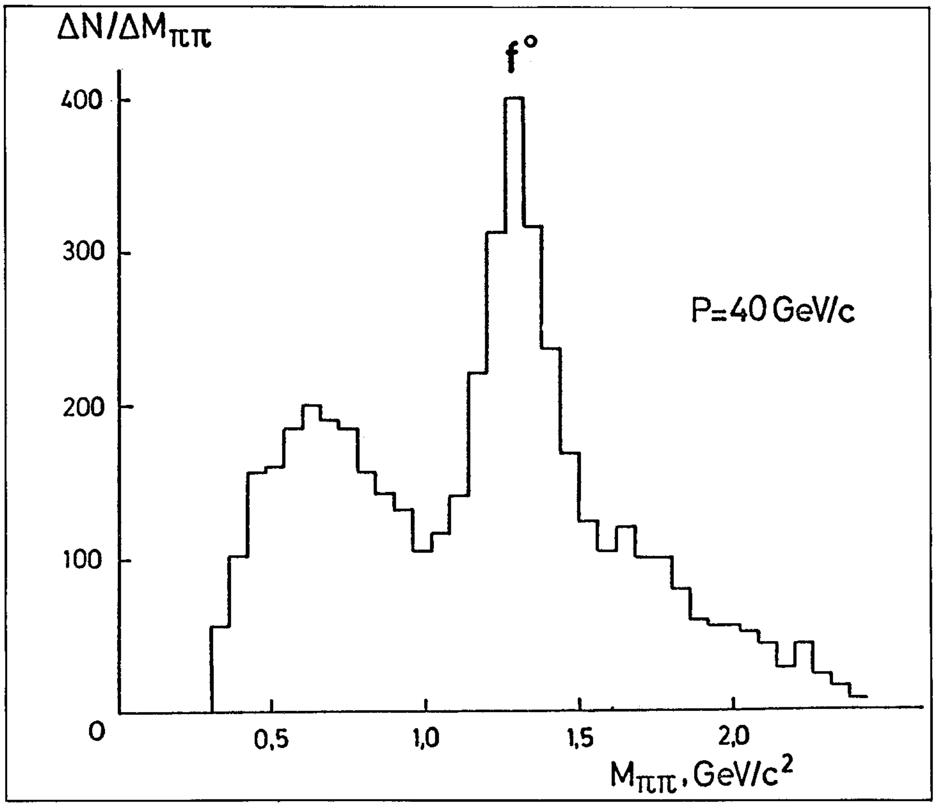
2. A small part of a 30 × 30 cm² blue plate on which the light from the stars has been passed through a prism. The wavelengths which are covered go from 3900 to 4900 Angstroms, the ultraviolet part is cut off by a filter. The Schmidt telescope is equipped with one of the world's largest objective prisms made of ultraviolet transparent UBK 7 glass. It has a diameter of just over 1 m and its thickness varies from 40 to 113 mm.

# 4th joint experiment at Serpukhov

*Diagram of the gamma detector showing how it is built up of alternate sheets of stainless steel and scintillator. The photomultiplier tubes are arranged around the outside.*

*The decay of the f° particle into two pions clearly picked out from the experimental data after only 10 hours of data-taking despite its very low cross-section.*






The 4th electronics experiment to be carried out under the terms of the Agreement between CERN and the Institute for High Energy Physics at Serpukhov has been installed in the experimental hall of the IHEP 76 GeV proton synchrotron since October 1972. It has now gathered a large amount of data and analysis of these data has started.

The experiment involves physicists from Karlsruhe, Pisa, Serpukhov and Vienna (the European centres being partly supported by CERN). It is studying the interaction between negative pions and protons in which charge exchange takes place giving a neutron and neutral mesons as final state:

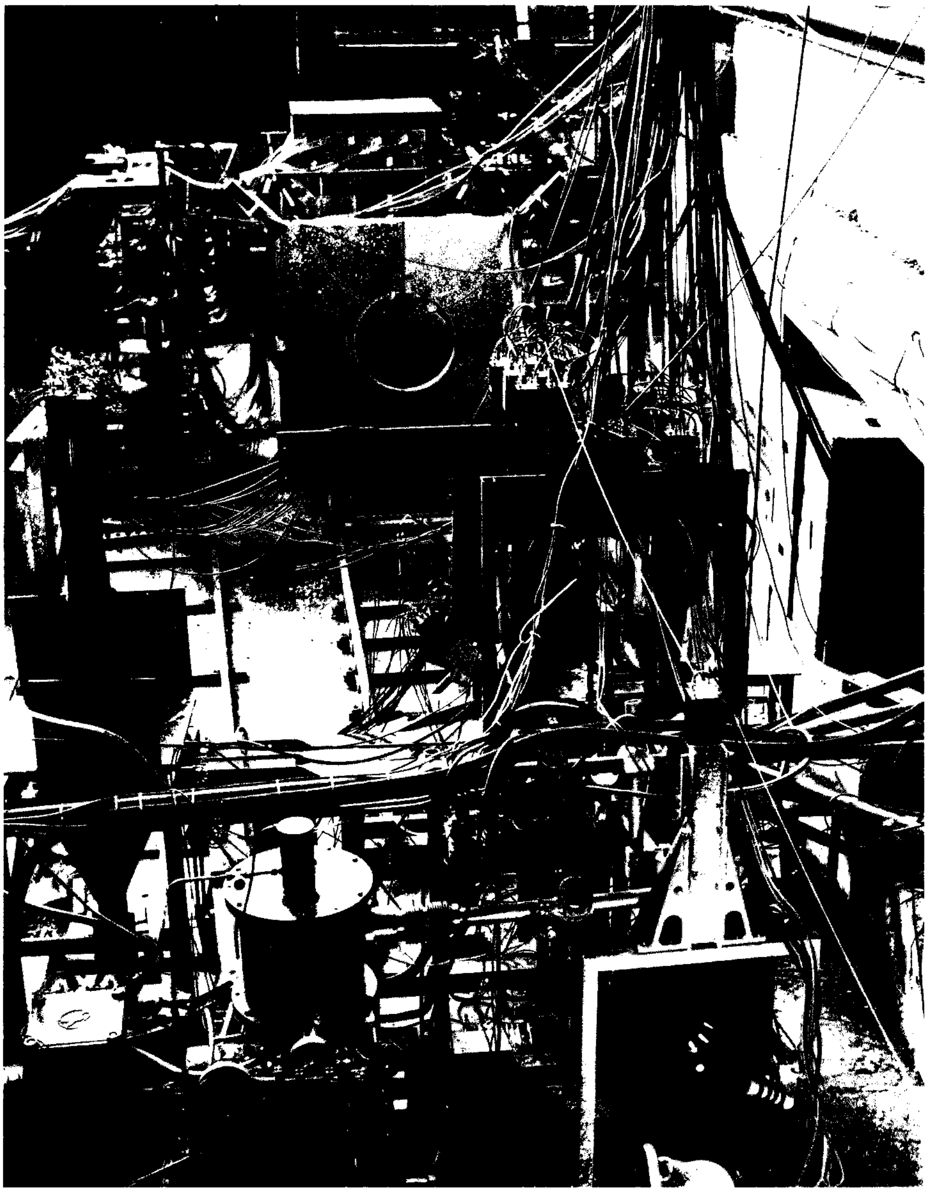
$$\pi^- + p \rightarrow n + \text{neutrals}$$

The Karlsruhe and Pisa groups had already examined this interaction at the CERN PS energies detecting $\gamma$-rays and neutron in coincidence. They took data at 3.8, 6, 8 and 12 GeV/c and looked at the production and decay properties of mesons, in particular for those giving 2, 3 or 4 gammas ($\pi^0$, $\eta$, $\omega$, $X^0$ and $\pi^0\pi^0$ with mass up to 1.7 GeV). They were interested in carrying the study through to higher energies extending at the same time the mass range available for $\pi^0\pi^0$ and searching for higher mass resonances.

A Serpukhov group (led by Yu. D. Prokoshkin), having completed an optical spark chamber experiment, was interested in gathering higher statistics on the interaction giving a neutron and a single neutral pion (or $\eta$, $X^0$ mesons)

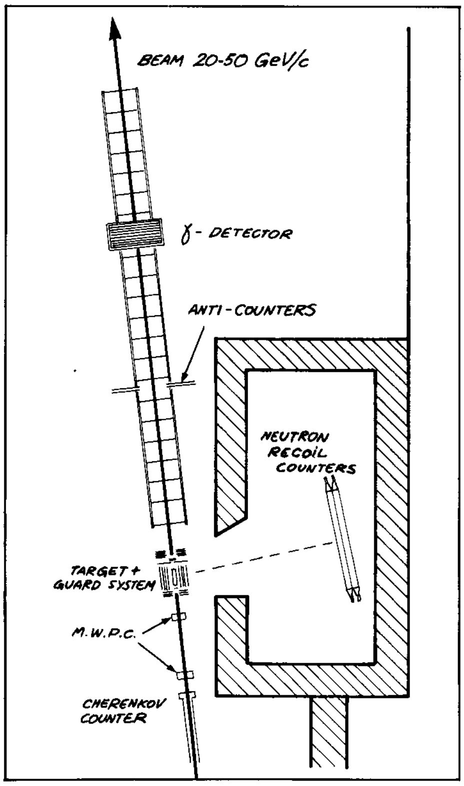
$$\pi^- + p \rightarrow n + \pi^0 \ (\eta, X^0).$$

On the assumption of charge independence for the pion-nucleon interaction, the amplitude for charge exchange is determined by the difference between the amplitudes for elastic $\pi^+p$ and $\pi^-p$ scattering. The charge exchange reaction is also considered the most suitable for testing the Regge picture of high energy interactions, which is central to many recent theoretical models. From both points



The experimental apparatus of the Karlsruhe/Pisa/Serpukhov/Vienna experiment being carried out at Serpukhov. In the foreground, surrounded by counters and cables, is the hydrogen target which is bombarded by a negative pion beam. Hidden in the concrete blocks on the right is the neutron detector. In the rear is the on-line gamma detector.

Below is a diagram showing the layout of the detection system.




of view the high statistical and systematic accuracy expected in the new experiment is essential.

The experimental programmes and the efforts of both groups could usefully be combined and a unique apparatus could be used (in particular the gamma detector which is an advanced and expensive instrument), simply by choosing for each interaction and energy the appropriate target-detector distance and electronic recording conditions.

The experimental equipment, which has been set up, can handle a very intense beam ($2 \times 10^6$ particles per second) of incoming negative pions giving a high data taking rate, limited in some cases by the speed of the on-line computers. For example, in previous experiments at CERN and Serpukhov, the decay into 2γ-rays of the $X^0$ meson produced in the negative pion-proton interaction, had only been seen about a hundred times by the groups involved (about 50 times at CERN and about 50 at IHEP). Now such events are collected at the rate of 100 per day. Similarly the production of a high mass meson decaying into two neutral pions, which is another event of very small cross-section at high energies, can be seen at the rate of 5 events per nanobarn per day.

The negative pions (up to now with momenta of 25 and 40 GeV/c) are incident on protons in a liquid hydrogen target 40 cm long, cooled by pressurized helium, where the point of interaction is determined by the amount of Cherenkov light collected by a photomultiplier. Surrounding the target is a set of veto counters which stop an event being recorded if they detect a charged particle. There is also a set of lead-scintillator sandwiches which guard against gammas emerging at large angles and missing the gamma detector in the forward direction. A fraction of the recoil neutrons can also interact in the guard counters but, by recording the individual pulse heights, it is possible to distinguish low energy neutrons from gammas in most cases.

A neutron detector, built up of sixteen plastic scintillators $240 \times 16 \times 16$ cm$^3$ mounted in two layers of eight elements, is used to give time of flight and position measurements on neutrons coming from interactions in the target. It covers, however, a small solid angle and has low detection efficiency so it is not incorporated into the trigger system. Thus only a fraction of the data is giving information on emerging neutrons. This is an extended and improved version of the detector already provided by the Karlsruhe group for the CERN experiment.

The prima donna of the experimental equipment is the gamma detector. It is the first of its kind giving on-line information on the positions (to about 2 mm) and energies (to a few percent) of the gammas. The detector is built up, along the beam direction, of alternate 1 cm thick layers of steel and plastic scintillator. It consists of four blocks of scintillation counter hodoscopes, 648 counters in all, each made by 3 scintillators ($1.5 \times 1.0$ cm$^2$ in cross-section) viewed by a single photomultiplier. Altogether there is 36 cm of steel (about 20 radiation lengths) which makes the detector suitable for measuring gammas of very high energy. Gammas of 100 GeV would lose 98 % of their energy in the detector and even gammas of 1000 GeV would lose more than 90 %.

The pulse height detected by each photomultiplier is recorded and used to determine the energy and position of the gamma (the 'centre of gravity' of the resulting electron-positron shower is assumed as a good approximation for the position). The electronics for this system was built by Serpukhov (analogue to digital converters) and Pisa ($8 \times 12$ bit single module CAMAC scalers).

There will be a further addition to the detection system later this year in order to look also at the negative kaon-proton charge exchange interaction. Multiwire proportional chambers from the Vienna group and wire spark chambers from the Serpukhov group will then be introduced to see the charged pions coming from neutral kaon decay.

Data taking is likely to continue until the Summer of 1975 but some results will be available before then. Meanwhile the 5th collaborative CERN-Serpukhov experiment involving physicists from Bologna, Dubna, Milan, Trieste and Warsaw will be installed at Serpukhov. They will be studying the extraordinary phenomenon where many-pion systems are able to travel through a nucleus just as easily as a single pion.

## VILLIGEN
## First pions at SIN

As reported briefly in the February issue, protons were accelerated to full energy in the ring cyclotron of the Swiss Institute for Nuclear Research, SIN, for the first time on 18 January. A 590 MeV beam has been extracted and pions have been detected from the first target. Development of the project was last described in vol. 13, page 43. We will now fill in the story in some detail through to the successful commissioning of the machine.

Briefly recalling the main features of the accelerator — It consists of two cyclotrons. An injector cyclotron, built by Philips, is designed to provide 100 μA of protons at 72 MeV to a ring cyclotron and also to provide a variety of ions and polarized beams at variable energy for an experimental programme at low energies. The ring cyclotron continues the acceleration up to a peak energy of 590 MeV. It receives particles on an internal radius of 2.05 m and accelerates them via four r.f. cavities to a radius of 4.5 m. Since the central region has effectively been lifted out by having an injector cyclotron, high accelerating voltages can be applied in the cavities leading to considerable separation between the turns at extraction energy. This greatly simplifies the extraction problem and should eventually result in very high extraction efficiency (95 % is aimed for).

Vacuum was achieved in the ring cyclotron for the first time on 21 September 1973 and the beam transport system and essential parts of the control system were ready for testing by October. In the injector cyclotron, the first internal beam was accelerated to 72 MeV on 1 August using 3rd harmonic acceleration (reported in vol. 13, page 263). Assembly of the extraction system followed and, with only the electrostatic section available (the magnetic section was still being manufactured and tested), the cyclotron gave an external beam of 20 MeV protons or 33 MeV deuterons in the 1st harmonic mode (8.45 MHz). In preliminary test runs in November the beams were used successfully to test the beam transport system between injector and ring cyclotrons and to test the basic functions of the injection system of the ring cyclotron.

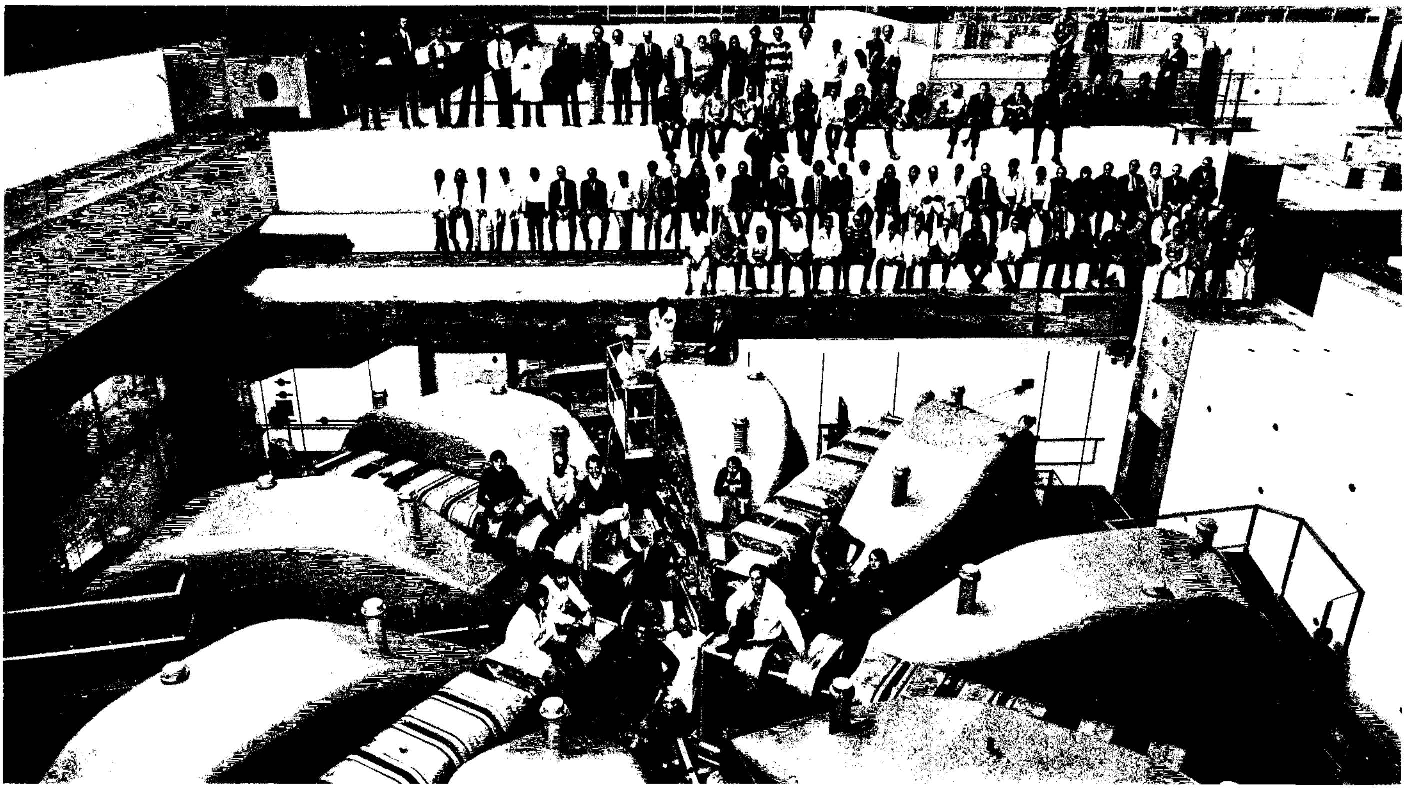
After these tests the shorting bar for 50 MHz operation and the magnetic channel of the extraction system were installed in the injector cyclotron by Philips. The latter is a rather complicated 'septum coil' which is mounted immediately after the electrostatic deflector. On 31 December a 72 MeV proton beam was deflected for the first time, reaching the target at the exit of the injector cyclotron while operating in the 'injector mode' (acceleration on the 3rd harmonic at 50 MHz).

On 12 January 1974 this beam was used for proton injection into the ring cyclotron. After crude empirical adjustments of the sensitive parameters, a few beam revolutions were recorded. The following night, acceleration from injection radius out to 2.4 m (equivalent to approximately 92 MeV) was obtained.

A long test run was scheduled for 17/18 January. During tune-up of the ring, the ceramic insulator of the r.f. feedthrough in one cavity developed a leak. The faulty element was removed and replaced with a blind cover plate since spare elements were not then available. With relatively poor vacuum conditions for stable high voltage operation of the cavities, the tests had to be performed using three cavities instead of four. Fortunately, the beam dynamics group was ready for such a case — after all a normal table can stand also on three legs if properly loaded! Beam was injected into the ring on the morning of 18 January and

*The team of the Swiss Institute for Nuclear Research, SIN, line up around the ring cyclotron which they have brought so smoothly into action.*

*(Photo SIN)*



in half an hour could be accelerated from 100 MeV to 540 MeV setting a new world record for isochronous cyclotrons. (The previous record was 100 MeV protons at the Maryland cyclotron.)

To manœuvre the beam to extraction radius at 590 MeV took more effort. Different trim-coil settings were tried but a drastic loss of protons, starting a few centimeters before extraction radius, proved difficult to be overcome. Finally, late in the evening (and shortly before the filament of the ion source burnt out!) 4 nA of protons succeeded in avoiding all obstacles and were extracted. This was the first time that any accelerator produced protons of relativistic energies with a 100 % macroscopic duty cycle.

For the whole run the injector, still under the responsibility of Phillips, produced a stable beam with very few interruptions for over 30 hours. All experiments were carried out with beams of 1 to 1.5 μA from the injector and 0.6-0.8 μA measured on the first revolutions in the ring.

The reason for the loss of protons at the outer radius was found a few days later when the ring was opened for inspection. A vertical clipping of the beam had occurred due to a faulty mount of a support plate for pole face windings. The support plate was almost reaching the magnetic mid-plane at a point close to the extraction radius. The fault was easily repaired. Inserting the spare unit of an r.f. feed-through in cavity 3 plus readjustments of beam collimators made the ring fully operational again.

In the following tests on 7/8 February, all four cavities were operating under very stable conditions. The beam could be injected, well centred and brought to extraction radius without any severe intensity loss. All the extraction elements worked according to specifications. More than 80 % of the beam was extracted and measured on the temporary beam dump in the cyclotron vault. Towards the end of this run the intensity climbed to 0.5 μA at the beam stop.

On 14/15 February there was a closer investigation of injection beam matching and vertical beam behaviour. Vertical oscillations near injection were found to be due to supports of alignment references on the last injection magnet. These had been manufactured accidentally from steel instead of stainless steel and when they were removed the unwanted oscillations disappeared.

Summarizing events on the accelerator side, everybody was surprised how fast and smooth the commissioning of the ring cyclotron progressed. The planned three to six months for tuning up this novel accelerator were cut to about five beam shifts!

The 'big run' dedicated to the production of pions from the first external target was scheduled to start on Friday, 22 February. The extracted proton beam-line and the pion channel ($\pi$M3) from a thin target were ready. A temporary beam dump was set up a few metres downstream from the target, which consisted of a simple 5 mm thick graphite plate.

The run started with trouble in the injector cyclotron requiring the exchange of an insulator, for the extraction septum. A further difficulty was a short in the r.f. power amplifier of one of the main cavities which again limited operation to three cavities for the rest of the run.

Beam tests started in earnest in the early afternoon of 23 February and soon difficulties with beam centring at injection were encountered. Analysis of the beam probe data revealed that this was largely due to a magnetic field distortion caused by the removal of the above mentioned steel supports. Powering some pole face windings cleared the trouble and beam was accelerated to extraction radius with an intensity of 0.1 to 0.2 $\mu$A by 11.20 p.m. The expected beam losses near extraction due to the 'Walkinshaw coupling resonance' were observed and eliminated by improving the horizontal beam centring at injection. This made the machine physicists very happy. The only job remaining on the ring cyclotron was the optimization of the extraction and this was carried out amid mounting excitement on the part of the experimental physicists who were waiting for their first pions.

The highlight of the night occurred at 0.27 a.m. on 24 February when the first extracted protons were observed as a bright spot on a scintillator screen at the thin target. A few minutes later the first pions were detected in the $\pi$M3 channel which was set for positive particles of momentum $300 \pm 3$ MeV/c.

The pulse heights from pions passing through a thin plastic scintillator could be clearly distinguished from the pulses due to secondary beam protons and a polaroid oscilloscope picture was quickly transmitted to the control room. After slight adjustment of the second bending magnet in the $\pi$M3 beam, the pion rate reached the expected intensity of $3 \times 10^3$ positive pions per second with a proton intensity at the target of 30 nA. More precise measurements of the pion beam were made with a lucite Cherenkov counter and a long scintillation counter, from which it was estimated that the proton to pion ratio was roughly one to one in a cross-section of 10 cm$^2$ across the beam. The transmission of the proton channel from extraction to the thin target was improved to 50 % and then left unaltered so as to provide stable conditions for the experimenters. Later, the proton beam intensity from the injector was increased and resulted in a maximum proton current of 300 nA being recorded at the pion production target.

During the coming two months, another pion beam will be installed and three experiments around the first target will be made ready. By mid-summer, the area around the second target will become operational together with two more pion beams and with the neutron time of flight path. Muons from a superconducting solenoid are expected later in the Summer and polarized protons by the Autumn. The start of the full experimental programme is determined by the final commissioning date of the injector cyclotron, which is seriously delayed.

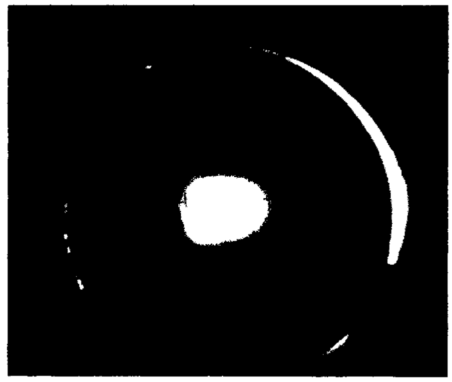
Research groups mainly from Swiss and German research centres have proposed about 48 experiments (for more details see vol. 13, page 45) and are now preparing equipment for their first runs.

*Pictures from the February tests of the SIN cyclotron:*

*1. The 590 MeV proton beam spot detected at the position of the first target by a glass scintillator. The beam size is about 1 cm diameter and the intensity is about 30 nA.*

*2. Proton beam profiles at the exit of the extraction channel measured using 1 mm wide metallic fingers sweeping through the beam. The intensity is about 500 nA.*

*3. Pulse height spectrum from a lucite Cherenkov counter (45 cm long, 10 cm diameter) located at the end of the 300 MeV/c pion channel. From left to right the peaks record pions, muons and electrons.*



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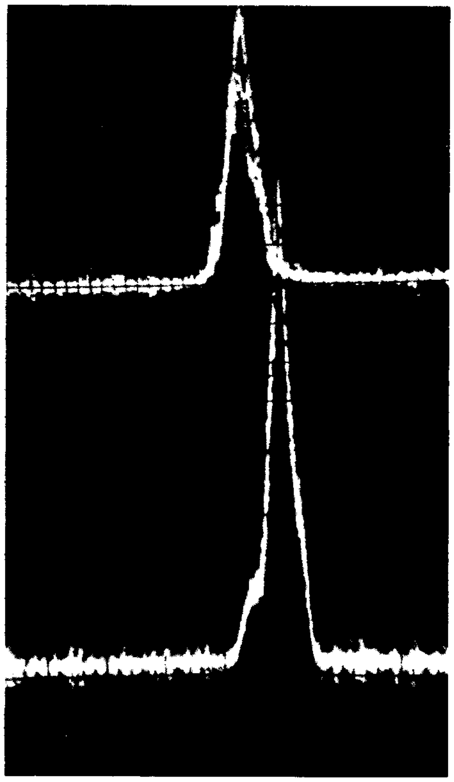

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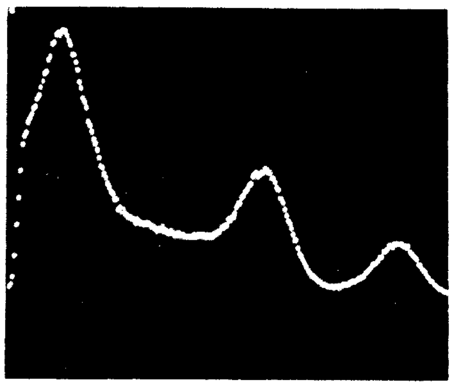

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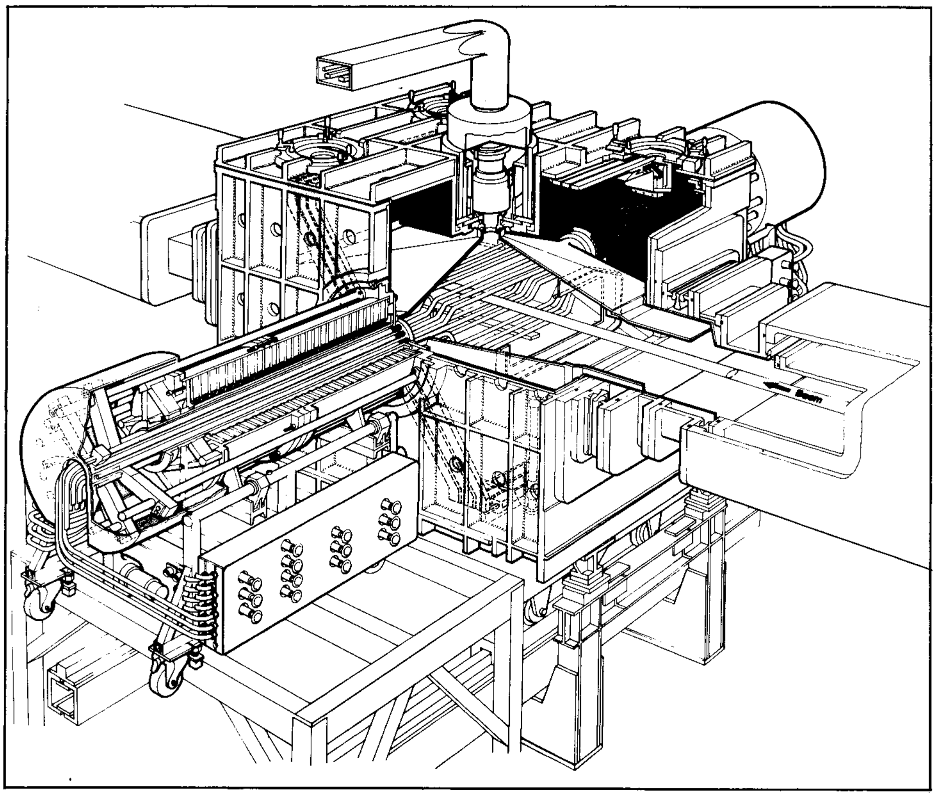
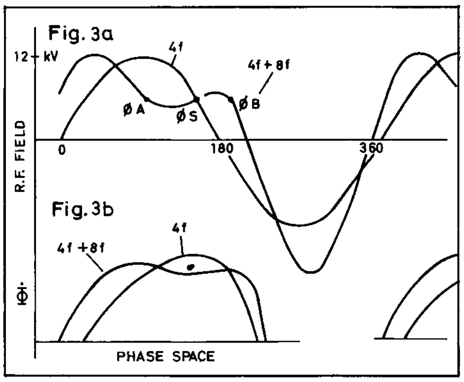


*Diagram of the r.f. structure which adds a second harmonic to the accelerating fields in the Nimrod synchrotron. This results in better bunch configurations and makes it possible to accelerate higher intensity beams.*

*Below, for the specialists, is shown the effects on r.f. fields and phase.*




We congratulate Professor W. Blaser and his team on their fine achievement in bringing their accelerator so smoothly into action. With this 'meson factory' they have added a very important facility to Europe's armory for nuclear physics research. We wish them many fruitful years of physics with their new machine.

## RUTHERFORD Better bunches in Nimrod

The 7 GeV proton synchrotron, Nimrod, at the Rutherford Laboratory has reached new record intensities following the bringing into operation of a further r.f. accelerating system. The new system adds the 2nd harmonic to the r.f. fields seen by the proton beam. This gives the same synchronous energy gain per turn but there are now two stable phase angles which increases the phase acceptance and reduces the maximum amplitude.

The effect of the additional r.f. system is to modify the shapes of the bunches in which the protons orbit the ring. The space charge forces within the bunches are reduced and higher intensity beams can thus be accelerated. With the second harmonic in action, Nimrod intensity has been carried to $4.2 \times 10^{12}$ protons per pulse and the average intensity is around $4 \times 10^{12}$. This is an increase of 40 % compared with previous figures.

Work on the system began three years ago with model studies of a tuned drift tube structure capable of increasing the normal accelerating fields by 60 % at the 2nd harmonic of the normal field. There were challenging problems to be overcome, such as the exacting specification for the large volume of ferrite needed to tune the drift tube, the wide frequency range to be covered (2.8 to 16 MHz), and the phase locking to the main r.f. field and to the bunches.

The final design consists of a copper clad steel drift tube with a reinforcing outer skin. Ferrite from Philips (similar in quality to that used in the new CERN PS r.f. cavities) is moulded in rings and mounted in two large cylindrical resonators on either side of the box containing the drift tube, serving as tuning stubs. Bias conductors pass through the central stems and drift tube, returning along the inside walls of the box under r.f. screens. The box lid carries at 50 kW power valve (4 CX 35000) driven remotely by a 1 kW drive chain supplied by Marconi Ltd.

Problems were encountered with vacuum leaks into the box and all internal joints had to be rewelded. First attempts at operation in the ring were promising in that the combined r.f. fields held higher intensity beams but, after several milliseconds, oscillations in phase and bunch width caused severe losses. Careful studies showed that oscillations in bunch width can occur independently of phase motion and can be damped out by feeding back a signal, derived from a bunch width monitor, into the phase control system for the r.f. fields. When this was achieved, the combined r.f. systems carried the beam happily to full energy giving the 40 % increase in intensity which was anticipated in the design.

This use of higher harmonic r.f. fields in accelerators was first suggested by N.M. Blackman as long ago as 1949. The idea has, however, only been used at the late lamented Princeton 3 GeV synchrotron and at the ITEP 7 GeV synchrotron in Moscow. In both cases, the higher harmonic systems were applied over short periods after injection. Nimrod is the first accelerator to have a high power system which can operate throughout the acceleration cycle.

## BERKELEY/STANFORD PEP Agreement

With effect from 25 February, a 'Cooperative Basic Agreement' exists between the Universities of California and Stanford concerning the PEP project.

The Lawrence Berkeley Laboratory, operated by the University of California, and the Stanford Linear Accelerator Centre, operated by Stanford University, have been collaborating on the development of a large colliding beam project since 1971. It is known as PEP for Proton-Electron-Positron since its complex of accelerator/storage rings would make possible the study of high energy collisions between these three types of particle.

Realization of the project is now envisaged in stages, the first being the construction of an electron-positron ring of 300 m radius to hold beams of energy up to 15 GeV. Further stages could add a 200 GeV proton ring using superconducting magnets and another electron ring. It has been decided that PEP would be located at Stanford and be fed with electrons and positrons by the existing 20 GeV linear accelerator.

The Agreement spells out the form of the continuing collaboration between the two Laboratories in the evolution of the project, with the aim of beginning construction of the first stage in fiscal year 1976. The electron-positron ring is estimated to cost between $ 50 million and $ 60 million spread over the five years 1976 to 1980. The project would be staffed by scientists and technicians drawn in a balanced way from the two Laboratories. After completion of construction PEP would be operated as a national physics facility. The actual management of the accelerator operation would be a Stanford responsibility and both Laboratories would participate in the experimental programme in a similar way to other Laboratories and Universities.

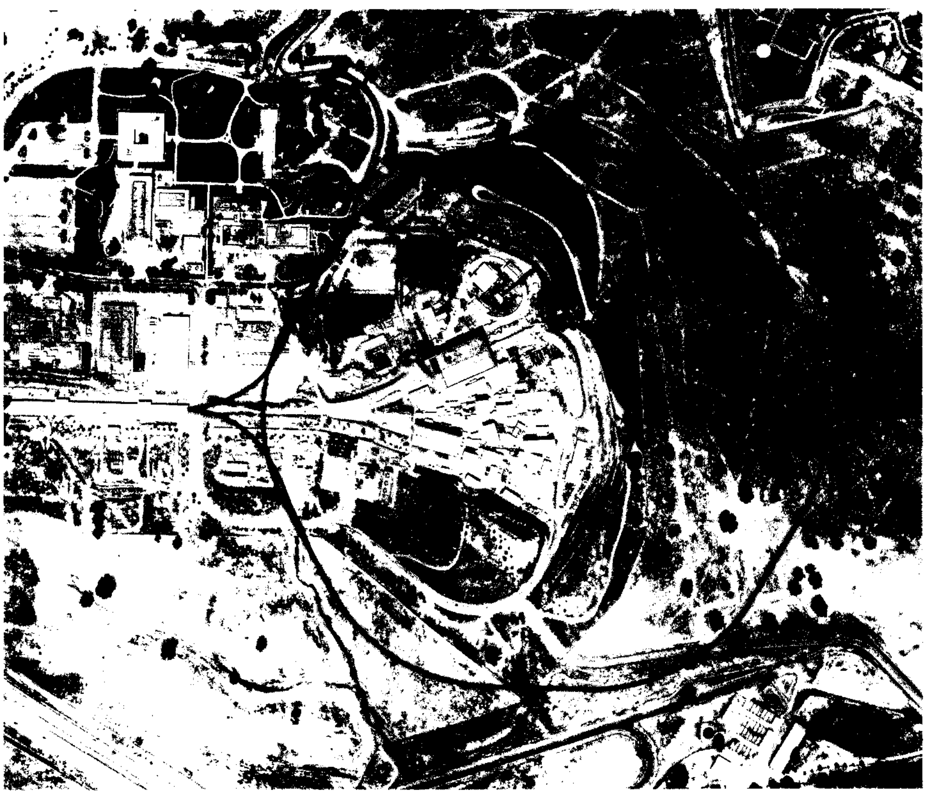
This formal Agreement presents the decision makers with a much clearer picture of how the PEP project could be managed.

In order to pull the high energy physics community into the discussions, particularly concerning the experimental facilities, a summer study will be held at Berkeley from 5-30 August. A steering committee for the study has been set up (B. Barish, M.L. Goldberger, D. Cline, J. Kadyk, R. Lander, B. Richter and K. Strauch — Chairman). They plan to have a week of 'workshops' on topics such as QED experiments, Hadron experiments, Weak interaction experiments, Searches for new particles, Spectrometers, etc. . . The following weeks will be given to working out detailed recommendations.

Meanwhile, the electron-positron storage ring SPEAR at Stanford is operating with beams in the energy range 1.5 to 2.6 GeV. SPEAR was designed to be capable of holding particles up to 4.5 GeV but, initially, the radio-frequency system and the magnet power systems were built for lower energy operation.

After the ring came into action, work began on the design of components required for 4.5 GeV. The additional magnet power supplies and increased cooling are straightforward but the increase in r.f. power and voltage is substantial since the radiation loss from the stored beams increases as the fourth power of the energy. Thus, the voltage required to compensate for radiation loss and to maintain an adequate lifetime increases from 500 kV at 2.6 GeV to 7 MV at 4.5 GeV. Both the shunt impedance per unit length of the existing r.f. cavity and the available straight section length make it entirely impractical to achieve these voltages at the frequency of 50 MHz which is used at present.

A study of how the cost varies with frequency for a system which will fit into the available straight section length indicated a broad optimum around 300 MHz. A frequency of



*Aerial view of the site at Stanford where it is proposed to locate the PEP accelerator/storage rings. The ring drawn in is about 700 m in diameter. The output end of the existing electron linear accelerator, which would feed electrons and positrons to PEP, can be seen on the left. Also discernible (near the centre of the picture) is the electron-positron storage ring SPEAR. The PEP rings would be installed in tunnels bored about ten metres below ground with just the experimental halls in the long straight sections appearing as surface buildings.*

358 MHz, the 280th harmonic of the circumferential frequency, was selected. A cavity built up of four groups of five coupled high shunt impedance cavities was designed and is now being constructed. Each group of five cavities will be installed in a SPEAR straight section. The first group is assembled and has undergone low-power tests; the remaining three are in production and will be completed and tested in July. Each will be powered by a 135 kW klystron, which is also designed and being built at SLAC. The first klystron is under test with very satisfactory results so far.

The complete r.f. system — power supplies, klystrons, and cavities — will be installed in SPEAR during the Summer and power supplies for the ring magnets will then be added. These additions will allow operation up to 4.2 GeV per beam to begin with and, after some operating experience, it is later hoped to push the maximum energy to 4.5 GeV.

One result of the seven-fold increase in the operating frequency of the r.f. system is that the electron and positron bunches will be shortened in the same ratio, resulting in smaller interaction lengths. The shorter bunches also mean that, to maintain the same injection rates, the linear accelerator must deliver the same charge per pulse in a shorter burst. A new electron gun for the input end of the accelerator has been developed for this purpose.

As we reported in the last issue (page 39), results from experiments with SPEAR have been amongst the most fascinating of recent years. There is therefore great interest in seeing what happens when the interaction energy is increased to 9 GeV.

## GLASGOW
## Over a million

The Glasgow Film Analysis Group recently celebrated two events — the measurement of the millionth event on their SMP system and the installation of a new computer.

For analysing bubble chamber film, the Glasgow University team has used a set of three SMPs on-line to an IBM 7040 computer. SMP is the abbreviation for Scanning and Measuring Projector — a type of elaborate scanning table with a measuring system built into the top which was promoted by L. Alvarez at Berkeley. The Glasgow system has been in action about 100 hours per week since 1966. It has measured film from a series of experiments mainly using the 2 m bubble chamber at CERN. It has also measured film from the streamer chamber at DESY.

The new computer is an IBM 370/145 which has 384 kbites of memory and is particularly well adapted to a multiuser environment. It can be used for batch processing and also controls a POLLY measuring machine (the type developed at Argonne) which is at present being adapted ready to receive film from the 3.7 m European bubble chamber, BEBC. A second POLLY is under construction and will also be controlled by the IBM. Linked to the computer in addition are display terminals, used for the reconstruction of events recorded in the Omega spectrometer at CERN, and a line to the large IBM 360/195 at the Rutherford Laboratory.

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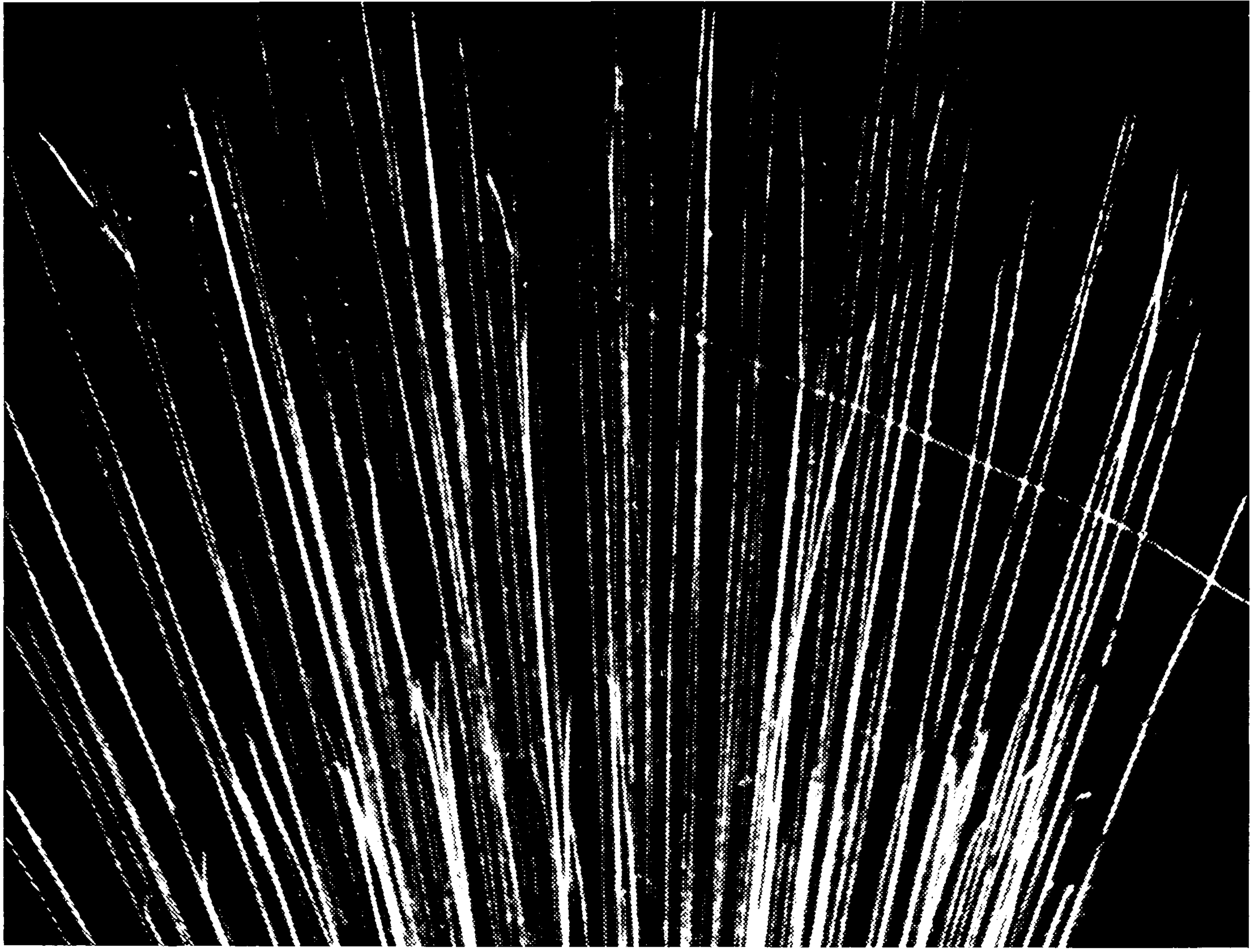
SERIES RCB preservation container for cryobiological purposes, capacities 4, 12, 21, 41 up to 1000 litres
SERIES T and EF closed tanks for liquid supply at low and medium pressure, capacities 160, 170, 600 litres

## L'AIR LIQUIDE

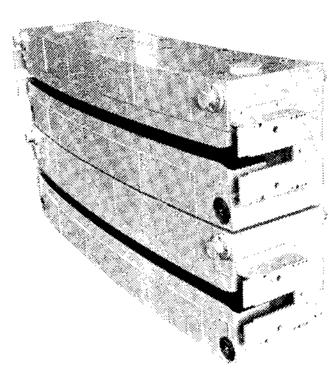
**division matériel cryogénique**

57, av carnot 94500 champigny/m.
tél. 883 97 40 télex 23884 champal champ



Nuclear transmutation

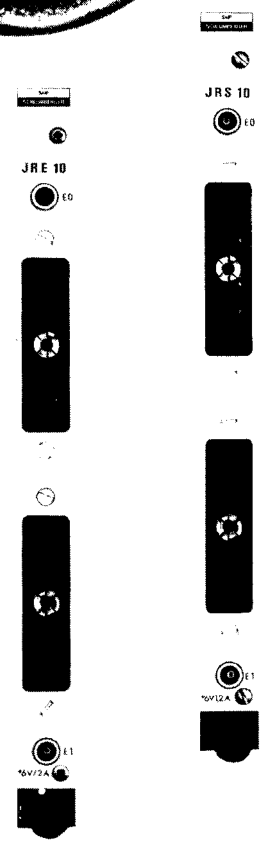




Double bending magnet for beam transport made of KRUPP STEEL

# camac

## parallel input and output registers




**JRE 10 : parallel input register**
allows to send onto the dataway 24 bit words, from two peripherals

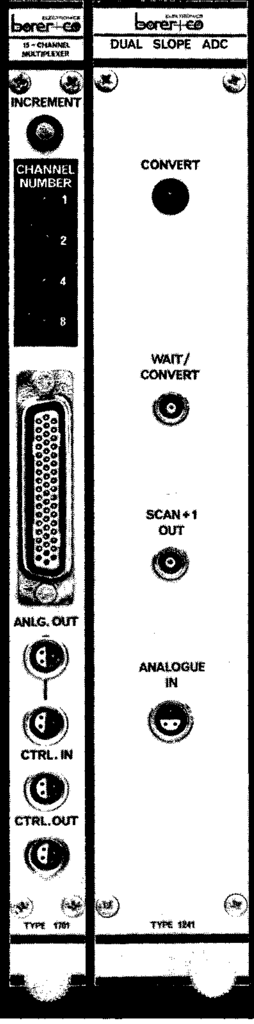
**JRS 10 : parallel output register**
allows to send to two peripherals 24 bit words from the dataway.

Common features :
- Each register contains **two independent 24 bit registers**
- The **peripheral can operate as master or slave** in regards to CAMAC system
- **transfers with «shake hand» signals**

FOR MORE INFORMATION PLEASE CONTACT :
SAIP/SCHLUMBERGER : BP 47 - 92222 Bagneux (France)
Tel. : (1) 655.22.11 Telex : SAIPEX 25 075 F

SAIP
**Schlumberger**

# Application-minded A-to-D Conversion




*Two Camac modules designed to combine for optimum system capability at minimum cost*

**ADC Type 1241** + **MULTIPLEXER Type 1701**

- Floating, Camac-independent differential inputs
- Integrating (dual slope) operation
- 11-bit and sign readout
- 7 programmable ranges between ±20mV and ±10V
- Programmable input filter
- Synchronized automatic scan-through or random-access address modes for up to 20 Multiplexers, i. e. 300 analogue channels per ADC

**borer**

4500 SOLOTHURN 2, SWITZERLAND
tel: 065/4 88 21 telex: 34228

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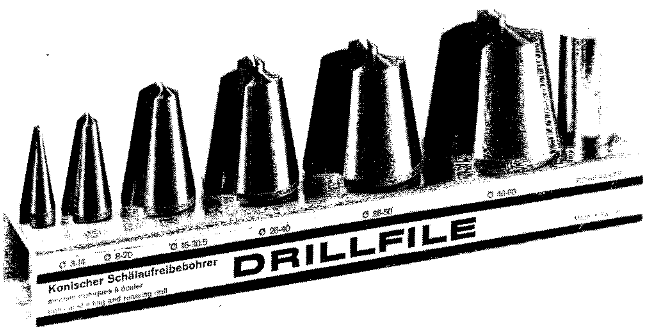
The tapered slabbing and reaming drill is economical and very useful

# DRILLFILE

**special drill**




for the economical mounting of car aerials and car radios, car calling units as well as telecommunication devices **DRILLFILE** is recommended by leading firms all over the world. In its measurements **DRILLFILE** accommodates all requirements.

## TIPSWITOOL

**1564 DOMDIDIER/Switzerland**

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# LASER CHRONOLITE UND HOLOGRAPHIE-LASER

ein im Q-switch-Betrieb arbeitender Rubin-Impulslaser, der zwei in kurzen Zeitabständen aufeinanderfolgende Laser-Lichtimpulse abgibt. Der Zeitabstand ist im Bereich von 1 ms bis 10 µs stufenlos variabel und kann auf Wunsch nach oben und nach unten erweitert werden.

Die Halbwertsbreite des Laserimpulses liegt bei 20 ns. Wellenlänge 694 nm. Kohärenzlängen von mehr als 1 m sind erreichbar. Die Impulsenergie von 50 mWs reicht aus, um in Reflektionsholographie eine 13×18 cm Photoplatte zu belichten und Objekte von 10 bis 20 cm Durchmesser auszuleuchten.

Bitte fordern Sie Unterlagen an bei

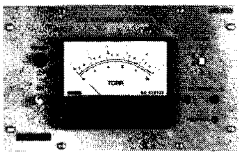
**IMPULSPHYSIK GmbH**

**2 Hamburg 56 (Rissen) Sülldorfer Landstr. 400**
**Tel. (040) 81 21 51 / FS 02 189 514 ffid**

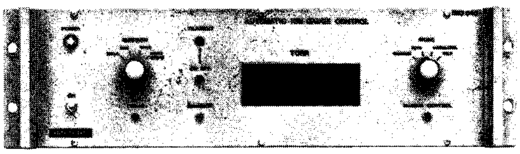
# The novel features of these components...

## ...are also incorporated in the new BALZERS ionization vacuum gauges!

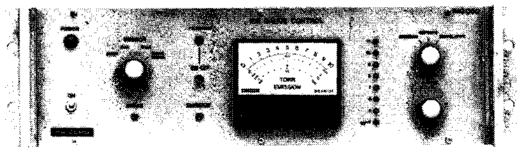
The novel features of these components and the newly conceived circuit design, combined with the dependable principle of the hot cathode ionization, are the primary requirements for advanced designs in the field of vacuum measuring instruments. The vacuum user is mainly interested in the benefits he gets from advanced designs. The most outstanding are enumerated below. In addition, comprehensive documentation will be gladly submitted to you upon request.



Measuring range: total $10^{-1}$ to $10^{-8}$ Torr – Measuring systems: HiFi and BA gauge heads. Accurate pressure read-out on strictly log. display. Output signal 10 V 1/2-19 rack panel. Adjustment and control of zero and emission current not required. Automatic monitoring of cathode current.



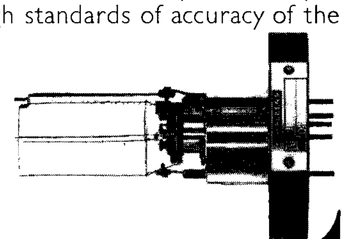
Measuring range: $2 \cdot 10^{-3}$ to $10^{-12}$ Torr. Measuring system: BA gauge heads. Digital read-out and automatic range selection. Analog and digital signal outputs for process control and computer connection. 1/1-19 rack panel.



Measuring range: $10^{-3}$ to $10^{-12}$ Torr. Measuring system: BA gauge heads. Analog read-out and manual range selection with LED range read-out. Signal output 10V/5mA per decade. 1/1-19" rack panel.

Extended emission current range. Degas and modulator device. Multiple protection for electronic system and gauge cathodes. Remote control for cathode. Excellent and very stable amplifiers for measurements and emission current control insure high standards of accuracy of the measuring data.

In addition to the equally new UHV gauge head, type IMR 132 (flange NW 35 CF), most commercially available BA gauges can be used.



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BALZERS-owned Sales Companies in:
Zürich (CH), Frankfurt/M (D), Wien (A), Kungsbacka (S), Berkhamsted (GB), Santa Ana (USA), Meudon (F), Milano (I)

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für Hochvakuumtechnik und Dünne Schichten
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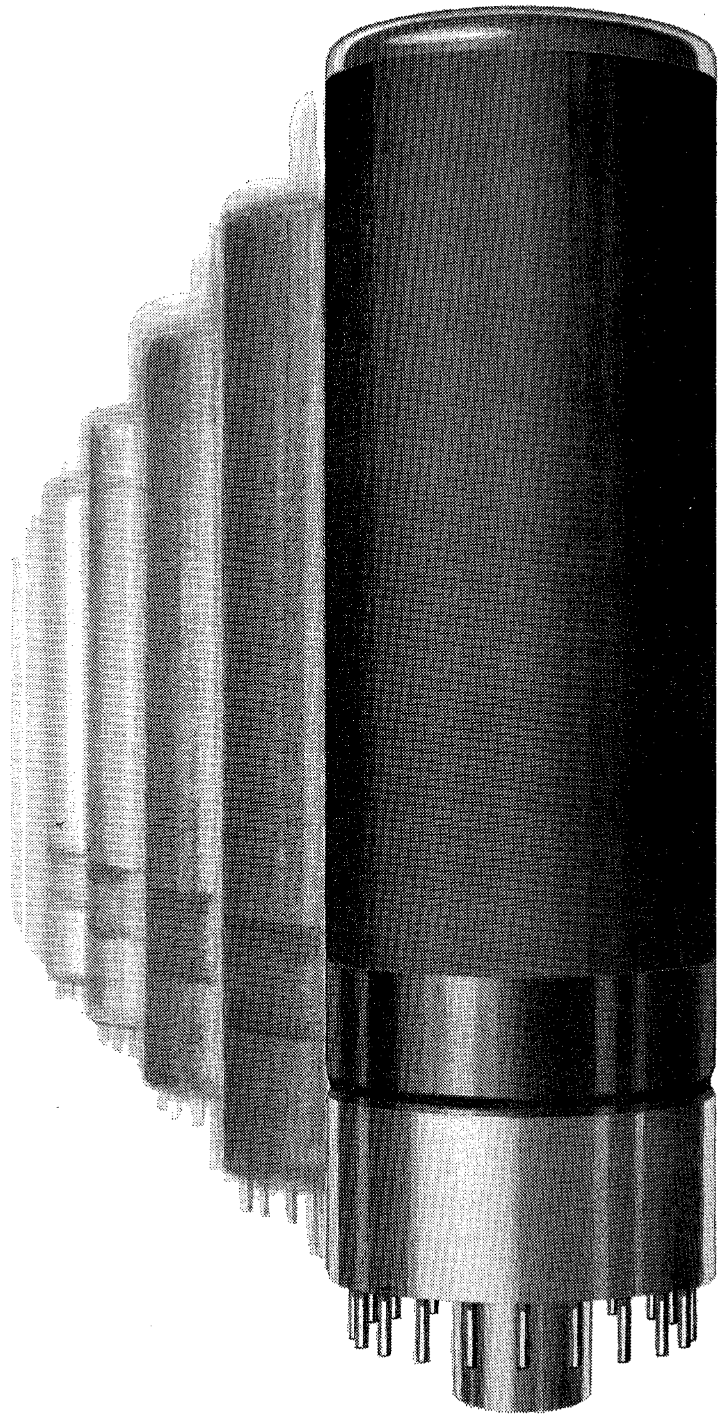


# FAST, FASTER, FASTEST

**0,3 ns transit time fluctuation is the new standard in photomultipliers.**

The new XP 2020 sets the state-of-the-art for high speed photomultipliers. A transit time fluctuation of only 0,3 ns and a 1.5 ns rise time makes it ideal for fast coincidence techniques or Cerenkov detections. Moreover it is competitive on price with slower equivalents.

Almost as fast is the new PM 2203, a 12-stage linear-focused tube with a bi-alkali photocathode. It is ideal for applications having low luminous fluxes, such as single photon counting, as well as for time measurements.

The table below gives the main specs. Data sheets and samples for evaluation are available on request.

| | XP 2020 | PM 2203 |
|---|---|---|
| Spectral response | type D | type D |
| Useful cathode diameter | 42 mm | 45 mm |
| Quantum efficiency at 400 µm | 25 % | 30 % |
| Cathode sensitivity at 400 µm | 85 mA/W | 100 mA/W |
| Rise time | 1,5 µs | 1,6 ns |
| Transit time fluctuation | 0,3 ns | 0,35 ns |
| Gain at 2,6 KV | $10^8$ | $10^8$ |

Type PM 2203 is a direct replacement for type 8575 and a near equal to the 9814B.

For more information on these new tubes plus an updated product survey of the extensive Philips range write to :

Philips Industries, Electronic Components and Materials Division, Eindhoven - The Netherlands

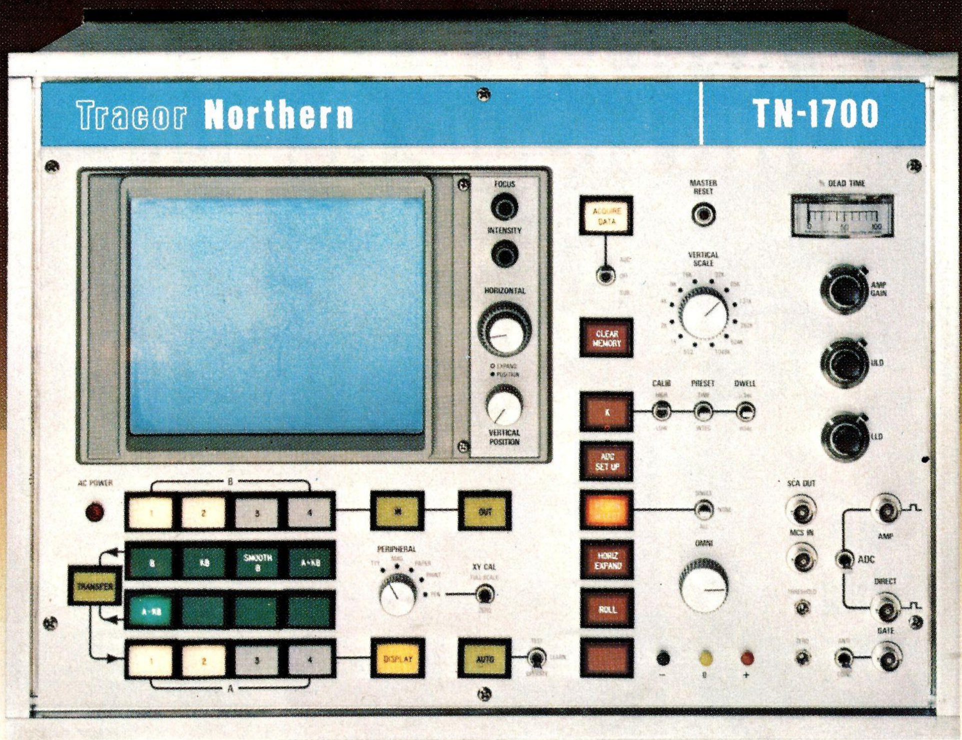
Distributed and sold in the U.S.A. by : Amperex Electronic Corporation 230 Duffy Avenue, Hicksville N.Y. 11802

In Canada : Philips Electron Devices 116 Vanderhoof Avenue Toronto 17 - Ontario

PHILIPS Electronic Components and Materials

**PHILIPS**

# ANNOUNCING TN-1700.
## The pacesetter for the next generation of pulse height analyzers from Tracor Northern




### The UNEXCELLED TN-1700 includes these standard features:

**Acquisition Features**
- New State of the Art ADC
- Digital Conversion Gain Control
- "Zero-deadtime" MCS

**Display**
- Large 6.5" CRT
- Live, flicker-free display
- Full alphanumerics for results and labels

**Region of Interest Versatility**
- Unrestricted Setup (including overlapping limits)
- Dynamic Integration
- Selected-region I/O

**Set-Up Convenience**
- Learn and Test Modes
- Arbitrary Energy-Scale Calibration
- Interactive Controls

**Dynamic Data Processing**
- Smoothing
- Stripping/Summing
- Normalization

**I/O Functions**
- Plotter (with alphanumeric labels)
- Teletype
- Parallel or Line Printer

*Tomorrow's Electronic Instrumentation Today* **Tracor Northern**

TRACOR EUROPA B.V. - SCHIPHOL-AIRPORT-AMSTERDAM, Building 112A (The Netherlands) - Tel.: 020-15 16 02

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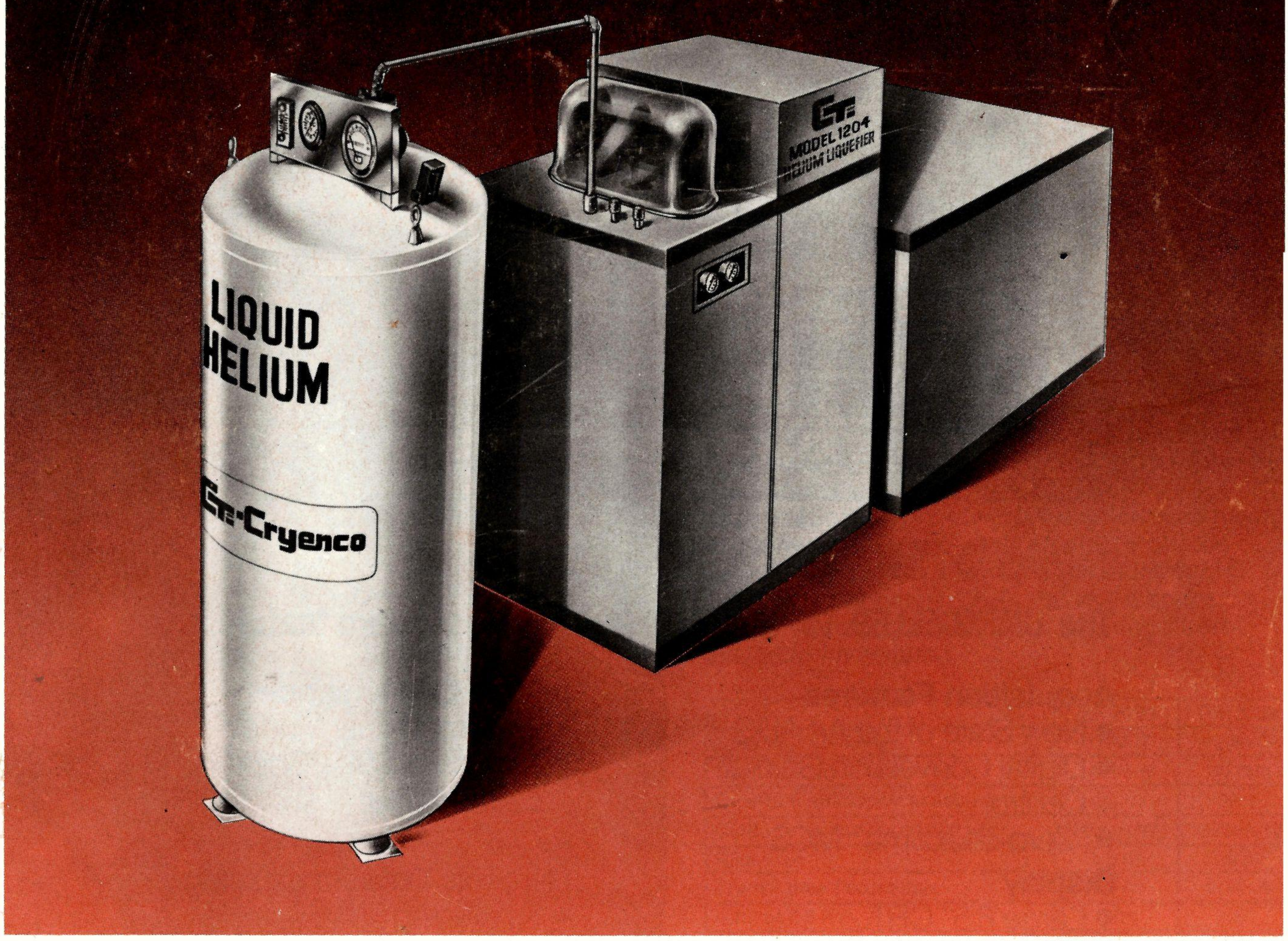
# NOW ANY LABORATORY CAN AFFORD TO MAKE ITS OWN LIQUID HELIUM




CTi's new Model 1204 Helium Liquefier/Refrigerator was designed especially for the laboratory with a growing requirement for liquid helium or continuous cooling of superconducting magnets. It answers the need of research centers that have always wanted a reliable in-house supply of liquid helium, but felt that helium liquefiers were too expensive.

The Model 1204 is a "compact" version of the CTi Model 1400 Helium Liquefier/Refrigerator, widely used throughout the world in university, industrial and government laboratories. It is a reliable and inexpensive system that can provide up to 5 liters per hour of liquid helium or 15 watts of refrigeration at 4.5°K *without liquid nitrogen precooling.* Its optional, integral purifier and gas collection system allows reuse of helium gas recovered from experiments. The Model 1204 is capable of both intermittent service and continuous, around-the-clock duty without operator attendance.

And . . . its cost is low (less than many scientific instruments commonly found in the laboratory).

## FEATURES

☐ Hands-off, semiautomatic operation ☐ No foundation required (The Model 1204 can be moved easily) ☐ Simple to install and operate ☐ Proven design, standard components ☐ Quiet, vibration-free ☐ Liquefies directly into any storage or experimental dewar ☐ Simple, preventive maintenance twice a year (The user can do it) ☐ Parts and service available worldwide ☐ Built and guaranteed by the world's leading manufacturer of helium liquefiers

A companion system, the new Model 1220 Helium Refrigerator, is available to provide 75 watts of continuous-duty, closed-cycle cooling at 20°K for hydrogen recondensing, target cooling, and cryopumping application.

Write or call CTi today for complete technical and price data on the new economical helium liquefier/refrigerator that *any* laboratory can afford. And ask about CTi's complete line of closed-cycle refrigerators, liquid nitrogen generators, dewars, and other cryogenic accessories.

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