

which is being investigated at this moment. It is hoped that it will be sorted out satisfactorily before the shut-down.

An exercise in beam gymnastics in the transverse phase plane (beam splitting on a third-order resonance) was successfully performed. This exercise is of interest for accelerators and storage rings in general, and for the booster-injector / PS / ISR / 300 GeV family in particular.

As can be seen from the above summary of the ten main experiments done with CESAR, it has more than fulfilled its purpose. Nevertheless, these represent only a fraction of the research which could be done with the machine, even in, essentially, its present form.

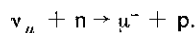
How much effort went into this project? Its financial cost has been mentioned — about 11 million Swiss Francs of which 42% went on salaries. It absorbed 144 man-years over the eight years of its life. But these are only quantitative measures. In the last analysis, it is the quality of people that determines the quality of the work they do, and in a scientific research group, the existence of a good group spirit is often more important than the individual brilliance of its members. From its first beginnings to the end of its life, the CESAR group has had an atmosphere of informality, co-operation and subordination of individual interests to those of the team as a whole, which will be recalled with satisfaction and pleasure by all who have participated in it.

To end on a personal note, I would like to place on record my profound appreciation of the work of all the people who made this group probably the most pleasant to work in, and certainly not the least effective in CERN.

Neutrino Experiments

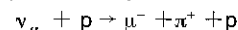
The first series of experiments using the new neutrino beam-line finished in November. The run was extremely successful. In the allotted seven weeks of proton synchrotron time, about 1 125 000 pictures were taken in the heavy liquid bubble chamber and preliminary examination of the photographs indicates that a harvest of about 1 000 neutrino events has been gathered. Possibly about 100 of these will be suitable for analysis as neutrino interactions with a 'free' proton — the first time that such events have been observed.

The previous experiments at CERN in 1963-64 were done with freon in the heavy liquid bubble chamber. They provided valuable information on neutrino interactions (it could be said that at that time any information on the interactions of the elusive neutrino was 'valuable' information) particularly concerning the 'elastic' interaction with a neutron to give a muon and a proton



Inelastic interactions, such as that yielding

a muon a pion and a proton



were much more difficult to investigate. The proton with which the neutrino collided, was bound in a heavy nucleus (carbon, fluorine or bromine) and the pion was likely to be absorbed by the nucleus, making the analysis of the interaction less accurate.

With the new neutrino beam-line, the flux of neutrinos which is fired into the chamber, is much higher and it is possible to fill the chamber with propane while still having a useful number of interactions in this 'thinner' liquid. In propane, there are 'free' protons, the nuclei of the hydrogen atoms (and there are more hydrogen atoms per unit volume than in liquid hydrogen itself). The neutrino interactions with these protons are then unaffected by the presence of other nucleons.

Analysis of the photographs has started and the first results are expected during 1968. The preliminary scanning went on as the experiment proceeded and almost kept pace with the very high rate of taking the photographs. More than 850 000 were



An example of a 'candidate' for a neutrino interaction with a 'free' proton. This interaction was observed for the first time in the recent series of neutrino experiments at CERN. The neutrino entering from the bottom of the photograph interacts with a proton (the nucleus of a hydrogen atom in the propane which filled the heavy liquid chamber) to give a proton (short track to the right) a muon (long upward track) and a positive pion which decayed eventually into a positron (the tight spiral).

The horizontal pipe protruding across the car park connects the 'jet area', where the heavy liquid bubble chamber has been newly positioned, with the neutrino area. It serves as the safety exhaust pipe for the propane in the chamber in case of accidents and is connected with the tall chimney which would release the propane high in the air. It proved cheaper to make this connection rather than build a separate chimney for the jet area. The formidable concrete supports are no doubt necessary because propane is a heavy liquid!

scanned by the time data-taking finished on the synchrotron. The pictures are very good — the heavy liquid bubble chamber excelled itself in this experiment both in its reliability of operation and in the quality of the photographs it produced. The various beam-line components also performed well and of particular importance was the use of a boron-carbide target after testing many possible materials. It gave a more than 20% increase in neutrino flux compared with the previous copper target.

In addition to the main purposes of the experiment, the data is being used to test the 'Adler theory' that the production of pions by neutrinos is equivalent to the production of pions by pions. Several centres are interested in this test (CERN, Ecole Polytechnique, Milan, Orsay and Turin) and the neutrino photographs have been copied and distributed among these centres. Comparison will be made with pion production photographs taken in propane at the 3 GeV accelerator, Saturne at Saclay.

The spark chamber experimenters, who set up their detectors either side of the

bubble chamber in the neutrino beam-line, were also happy with the quality and quantity of their data. Their experiments concern the muon number conservation and measurements of any variation in the neutrino-nucleon interaction cross-sections with the size of the nucleus in which the nucleon is bound.

And there neutrino experiments rest until the arrival of the heavy liquid chamber, Gargamelle, scheduled for 1969. This chamber is being constructed for use at CERN by the French Laboratory at Saclay. The large volume of Gargamelle will further increase the possibilities in observing the intriguing behaviour of the neutrino.

Jet Set

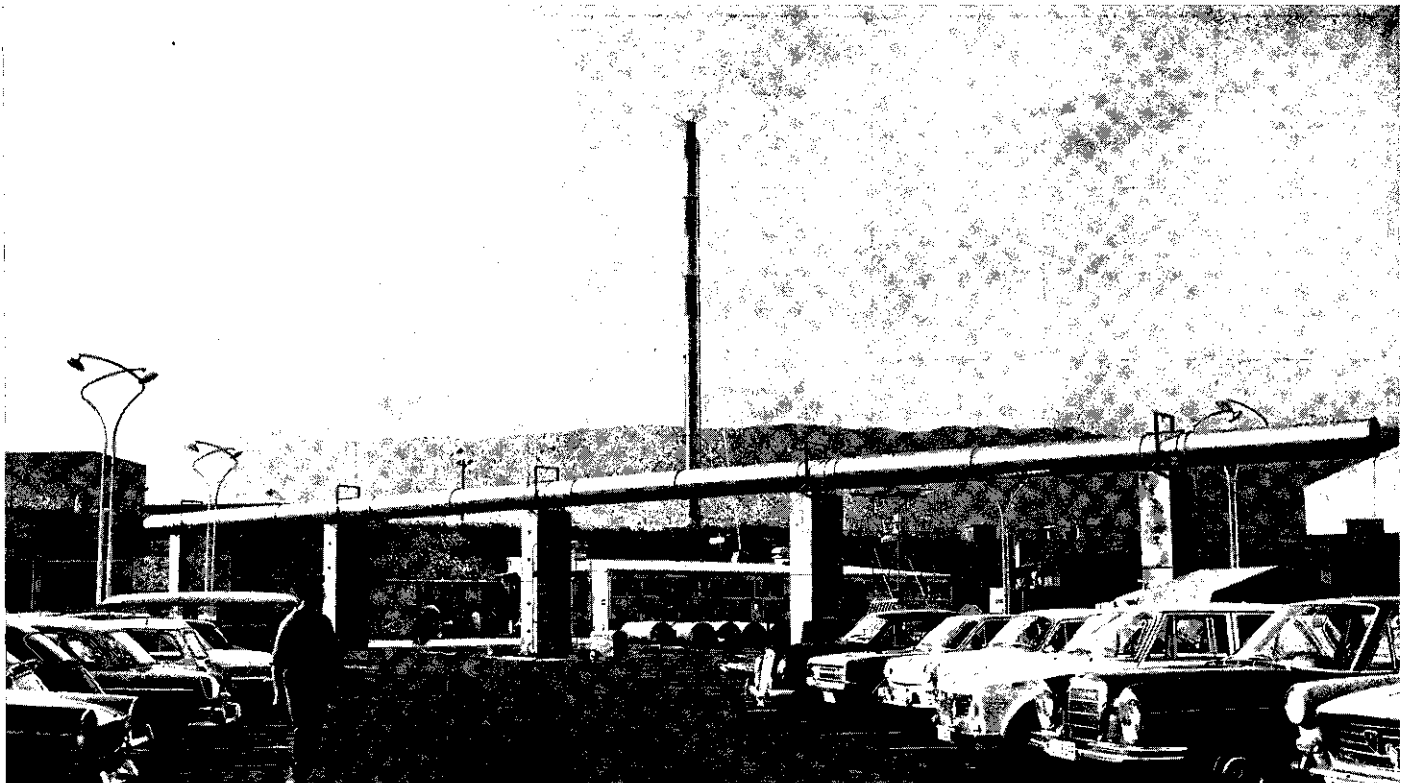
Immediately after the conclusion of the neutrino experiments, the heavy liquid bubble chamber was dismantled and moved to a new position, directly behind the 2 metre hydrogen bubble chamber, in the 'Jet Area'. Here the chamber will be used for the 'jet experiment' scheduled to begin in January.

The experiment is a collaboration of

Berkeley, Ecole Polytechnique, Milan, Orsay and Saclay. It will look at the interactions of high energy kaons with nuclei, carrying out a similar survey to one which has already been done for high energy pions. Both positive and negative kaon beams will be available with momenta up to 10 GeV/c.

Special arrangements have been made so that the heavy liquid will receive the kaons which pass straight through the hydrogen without interacting. A beam exit window has been fitted to the hydrogen chamber and the direction of the incoming kaons has been fixed so that the curvature of the kaon paths as they pass through the magnetic field of the hydrogen chamber still allows them to enter the heavy liquid chamber.

The experiment has become known as the jet experiment because the sort of interaction which is looked for at these high kaon energies, produces a forward spray of particles, giving a bubble chamber photograph similar to the jets seen in nuclear emulsion experiments with cosmic rays. The heavy liquid chamber is being used so



CERN/PI 14.10.67

Arrival of the CDC 3100 at Cointrin airport.
The computer joins the central computer complex
to take care of liaison with on-line experiments,
in the 'FOCUS' development project.

The Distinvar reading head showing the
different elements of this very fast and accurate
method of alignment measurements.

that interactions producing more than one neutral pion can be analysed. This is often not the case with hydrogen since the neutral pions, which leave no track themselves, since they carry no charge, often escape from the chamber before 'materializing' into charged particles. But the distance that the pions travel in heavy liquid (a propane/freon mixture has been chosen for the experiment) before converting into charged particles is shorter.

FOCUS

The latest addition to the central computer complex at CERN is a CDC 3100 to be used in the FOCUS development project. FOCUS is an acronym for 'Facility for On-line Computations and Up-dating Services'. Its main purpose is to serve as the manager of the data-links to the central computers, the CDC 6600 and the CDC 6400, coming from the smaller computers which are being used on-line to electronics experiments (CERN COURIER vol. 7, page 184).

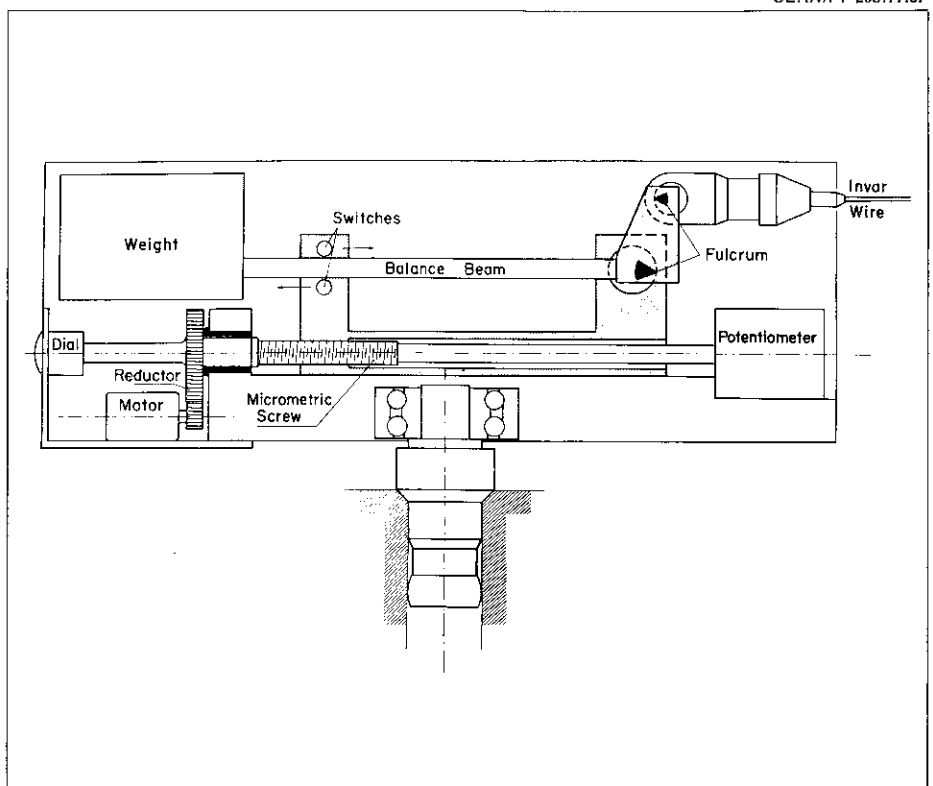
To carry out the full, detailed calculations on the information gathered in these experiments almost always requires the resources of the central computers. The small on-line computers carry out preliminary checks and then record the data on magnetic tape for processing later on the central machines. Some of them, up to now, have been connected with the central computer, via separate data-links, so that they could call for this processing directly. Unfortunately, this method of operation is inefficient in the use it makes of the memory of the central computer and the demand for such data-links would soon overload the memory of the 6600 and 6400.

The solution is to use the 3100 as an intermediary to accumulate the data. It receives all the data-links from the on-line computers and 'manages' their access to the central computers via one data-link.

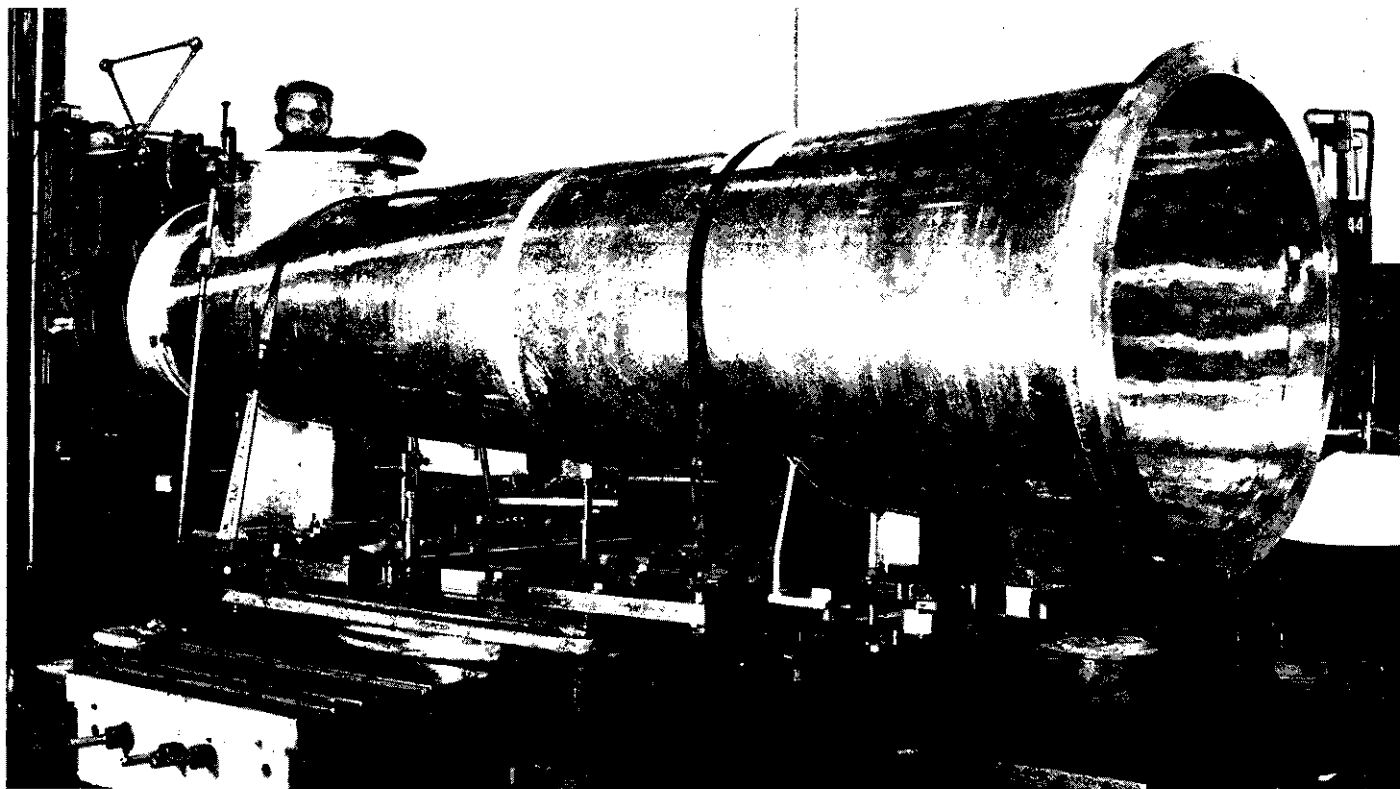
Another advantage from the use of this additional computer is gained by the fact that it makes it possible to add a type-writer console at each on-line computer. By using these consoles, the physicists will be able to select and modify their programs which are in the central computers, again with the 3100 as intermediary, and to receive their results printed out by the consoles.



CERN/PI 203.11.67



We all live in a yellow submarine... The biggest Cherenkov counter ever to be built at CERN was photographed in the main workshop where the inside walls of the counter were being polished.



CERN/PI 125.10.67

Better than one part in a million

An automatic measuring device, called the Distinvar, has been developed at CERN for rapid and accurate measurements of distances up to 55 metres. It was tested in one of the proton synchrotron tunnels for a thousand measurements over a distance of 50 metres and gave a relative accuracy of better than one part in a million. The total time involved in each measurement is three minutes of which the reading itself is only a matter of seconds. It is also possible to carry out the measurements by remote control.

Considerable attention has been given at CERN to the problems of metrology. This is because of the immediate requirement for the alignment of the intersecting storage rings and the future requirement of the alignment of the 300 GeV machine. Compared with the 28 GeV proton synchrotron, which itself posed quite severe alignment problems at the time of its construction, the 300 GeV is ten times the diameter with smaller magnet

apertures which reduce the alignment tolerances still further.

Five devices have been produced (some still in the prototype stage) — a laser device for alignment in air up to 50 m; a 'Mekometer Type III' (developed together with the National Physical Laboratory at Teddington, UK) which gives optical measurements in air with automatic compensation for changes in atmospheric conditions; an interference fringe method using a helium-neon laser; an automatic liquid level for level measurements; and the Distinvar. All the devices make use of automation and can be coupled to computers.

The Distinvar uses a calibrated invar wire attached to a special reading head which reads off the difference between the calibrated length and the actual distance between the measured points.

In the head, a 'balance beam' oscillates between two electrical contacts fixed to a carriage. The contacts achieve balance by causing the carriage to move along a precision micrometer screw until the tension in the wire is balanced by a weight (see

the diagram). The position of the carriage (and hence the distance to be measured) is then transferred via a potentiometer to be read off directly at the recording station or passed to a computer.

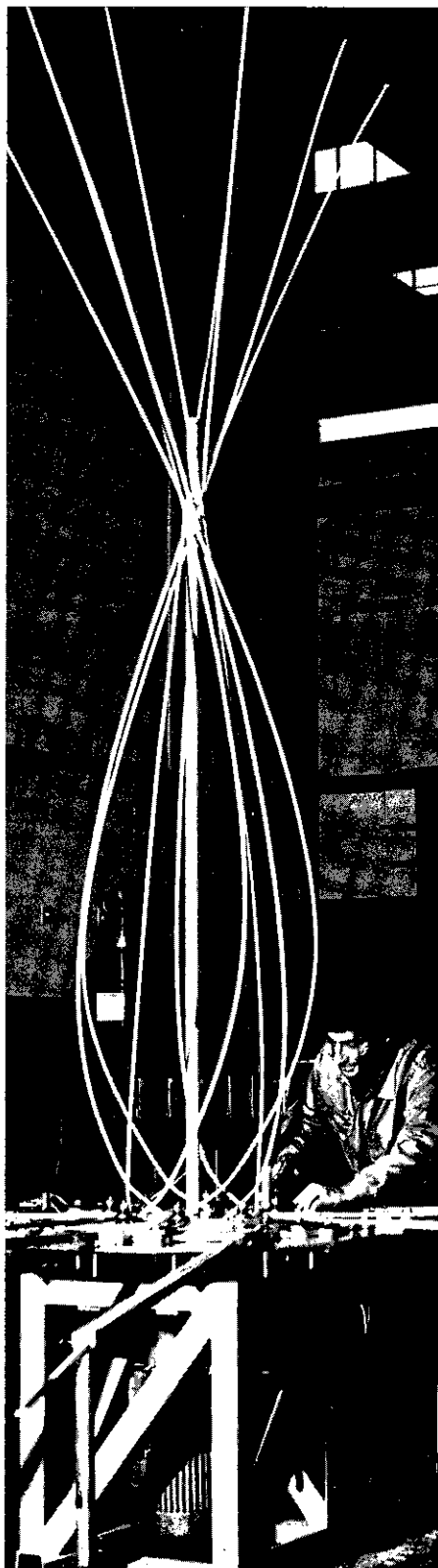
The relative precision between different measurements has been tested to be better than one part in a million. The absolute precision is obtained by calibrating the invar wire before and after a measurement against an invar rule, 4 m long, calibrated by the International Bureau of Weights and Measures, (Sèvres).

The whole measurement procedure is entirely automatic and could, for example, be performed by robot in radio-active areas. The Distinvar will be used in the alignment of the ISR magnets and a significant comment on its performance is that, because of the speed and reliability of the instrument, it has not been necessary to allocate any time for alignment in the construction programme.

(A detailed description of the Distinvar will appear in a paper by J. Gervaise in the Proceedings of the 6th International Conference on High Energy Accelerators.)

Folk art at CERN. This basket-work was photographed in the synchro-cyclotron workshop during the winding of a new magnet coil.

Opposite page: an aerial photograph of the cake made of the site of the intersecting storage rings where the major excavation work is now complete.



Separators for Serpukhov

As part of the collaboration between the Serpukhov Institute for High Energy Physics and the European Organization for Nuclear Research, CERN is busy studying a radio-frequency particle separator system and a fast-ejection system to be used on the 70 GeV proton synchrotron which came into operation at Serpukhov in October. The design of both schemes is now at an advanced stage and it has been found that only minor extensions of the techniques developed for use on the CERN synchrotron are necessary to meet the requirements of the higher energy machine. The spirit of collaboration is excellent and the practical aspects of implementing such an extensive collaboration between two high-energy physics Laboratories are working well.

The purpose of a particle separator is to sift out a particular type of particle at a particular momentum from the spray of many particles with a wide momentum range coming from a target bombarded by the accelerated proton beam. (The operating principle of a two-cavity radio-frequency separator was described in CERN COURIER vol. 7, page 125.)

The proposed design for Serpukhov is based on a new three-cavity system which completed a very successful test run at CERN in June of this year. Ideas on using three cavities were first put forward by W. Schnell and the two-cavity system, brought into operation at CERN in 1965 by a group led by B.W. Montague, was designed for possible extension to three cavities. This was realized by P. Bernard, P. Lazeyras, H. Lengeler and V. Vaghin in the u4 beam to the 2 metre hydrogen bubble chamber.

They succeeded in separating anti-protons with a momentum of 12 GeV/c, which is about twice as high as previously achieved. It is also about the highest momentum which can be reached with the CERN proton synchrotron if a useful number of anti-protons is to be separated (the separator itself could handle higher momenta). 104 000 pictures of anti-proton events were taken in the chamber. There were two anti-protons per picture on

average and the pion and kaon contamination was below 5%; this involves the separator rejecting about 100 000 negative pions for each anti-proton it feeds to the chamber. The low anti-proton intensity was due to the fact that the fast-ejection system of the proton synchrotron operated with protons of comparatively low momentum (20.6 GeV/c) which is far from ideal for the production of anti-protons.

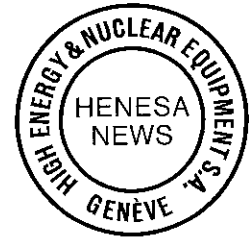
With three cavities it is possible to overcome a limitation of the two-cavity system namely that the separation of one type of particle from two other types is only possible for very narrow momentum regions. The only possibility for anti-protons with the previous CERN system was a momentum of 7.3 GeV/c. With the new separator, pure pion beams, kaon beams or anti-proton beams over a nearly continuous momentum region from 7 to 16 GeV/c are possible.

The design of the separator for Serpukhov covers a momentum region from 17 to 36 GeV/c. Most of the technical details have been examined and some preliminary work, such as low-power measurements on the r.f. structures and brazing of the structures, has been done. The construction programme has been discussed at several of the meetings, which are held once every three months between the scientists from Serpukhov and CERN, and has been agreed. The group at CERN have benefited from the help of V. Vaghin from Serpukhov who has been at CERN for the past 18 months. Serpukhov, whose job it is to build the beam in which the separators will operate (this is the beam to the large hydrogen bubble chamber 'Mirabelle' which is being provided by France) has benefited from the advice of P. Lazeyras from CERN and A. Samoilov has come to work for some time in the beams group.

All the way round

The bulk excavation of the circle, 300 metres in diameter, for the intersecting storage rings was completed in October. It has involved digging out over a million cubic metres of earth and rock (molasse), most of which has been moved off the site; about a third is retained to be used as shielding over the top of the ring tunnel when it is built.

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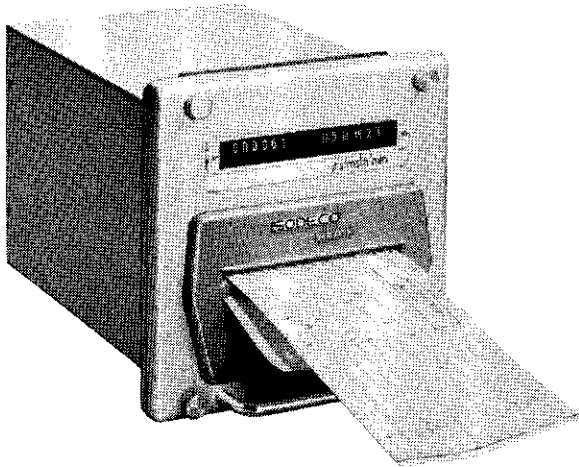
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The civil engineering work on the ISR site is being done by the contractor Sogene with Albanese as excavation sub-contractor, both firms from Italy. They began the excavation in November 1966 and this particular item of the construction programme has been achieved about six months ahead of schedule. Detailed excavation of the foundations of the ring and concrete work are under way. About 100 000 cubic metres of concrete will be poured during the construction.

The foundations of the large West Experimental Hall have also been completed and assembly of the steel frame of the building began this month. This is an important item in the construction programme since it is intended to have the hall ready in July 1968 to receive components for the storage rings as they arrive on the site. The hall will be used as a laboratory to assemble and test equipment, such as the magnets, before they are placed in position in the tunnel.



CERN/PI 245.11.67



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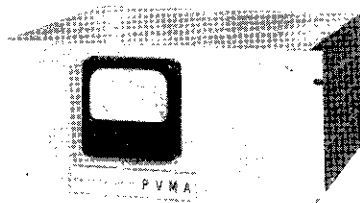
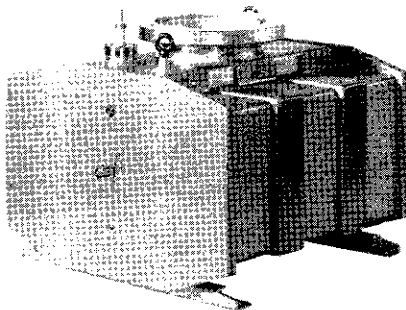
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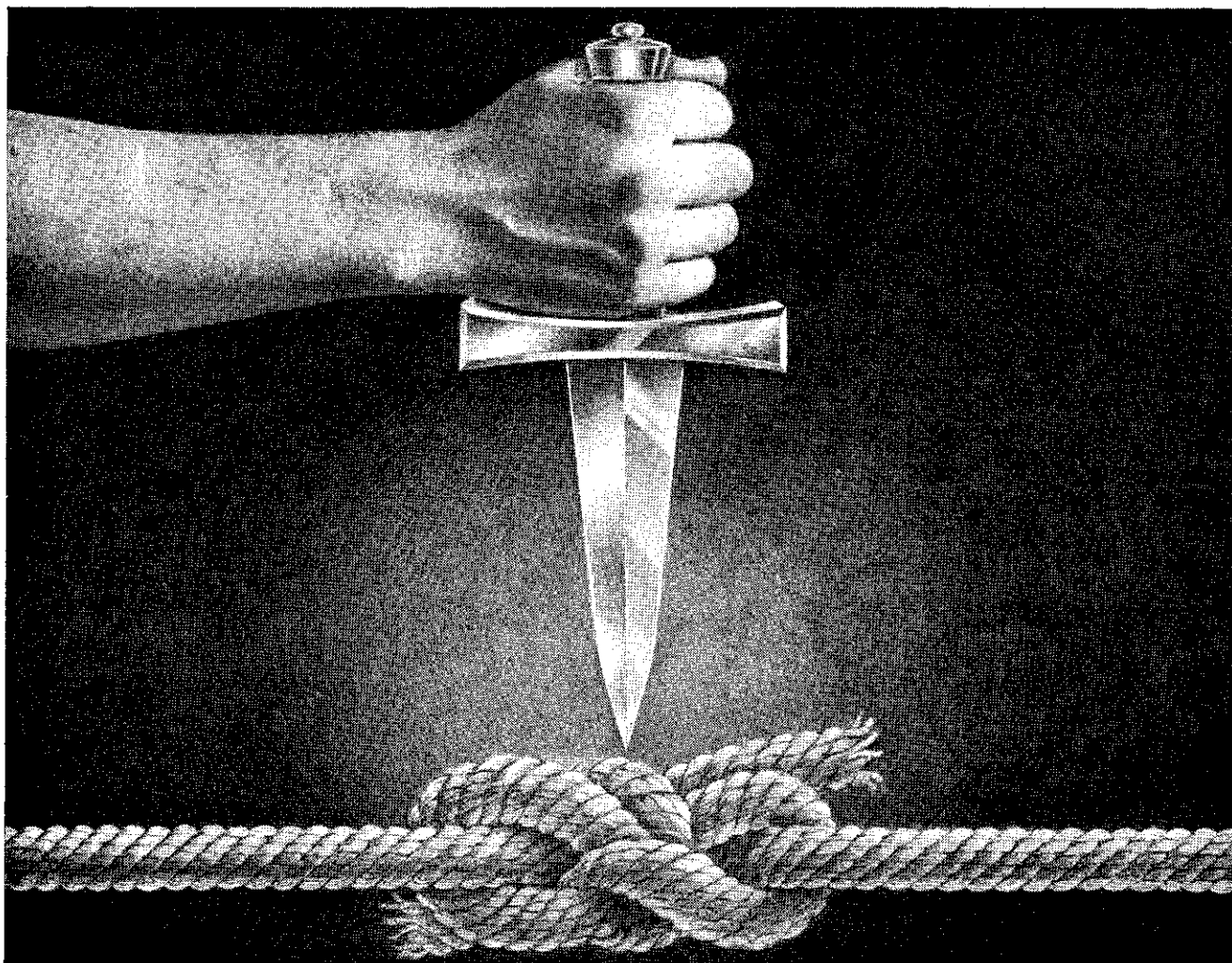
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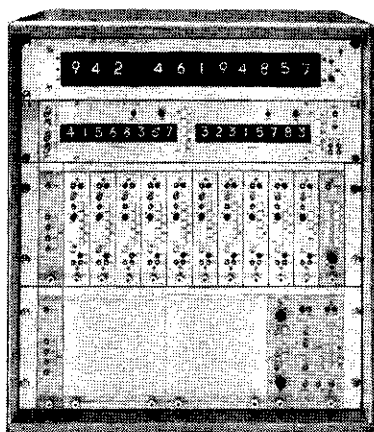
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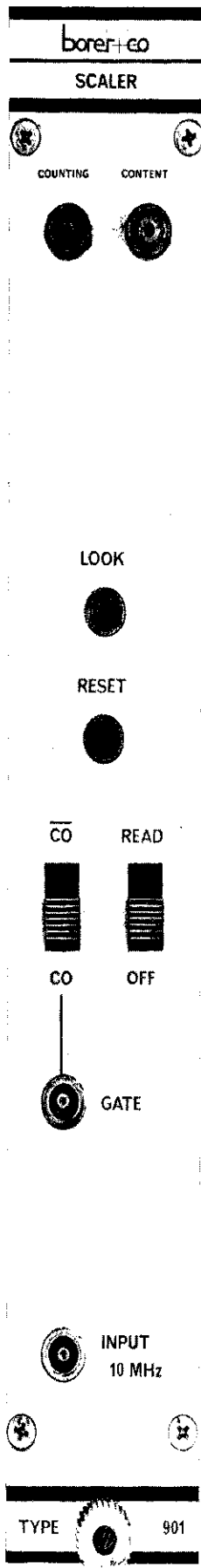
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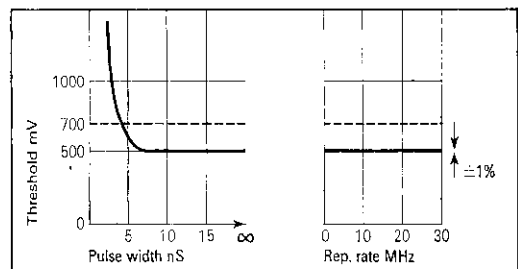


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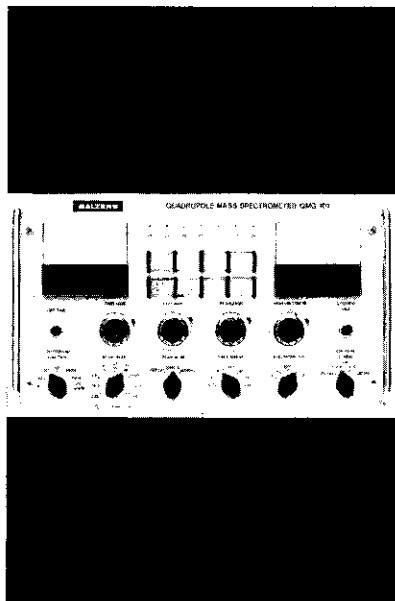
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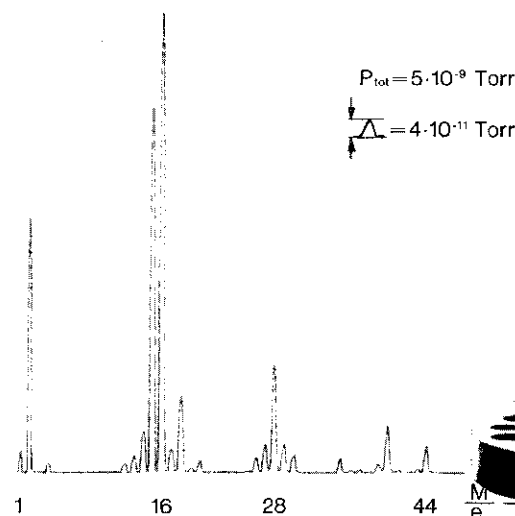
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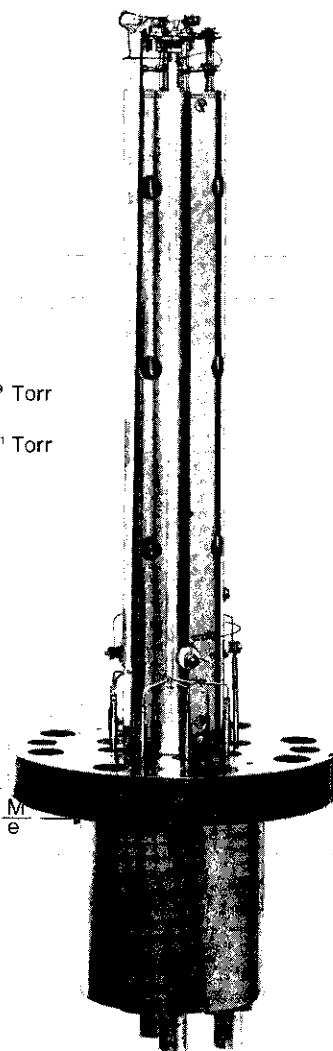
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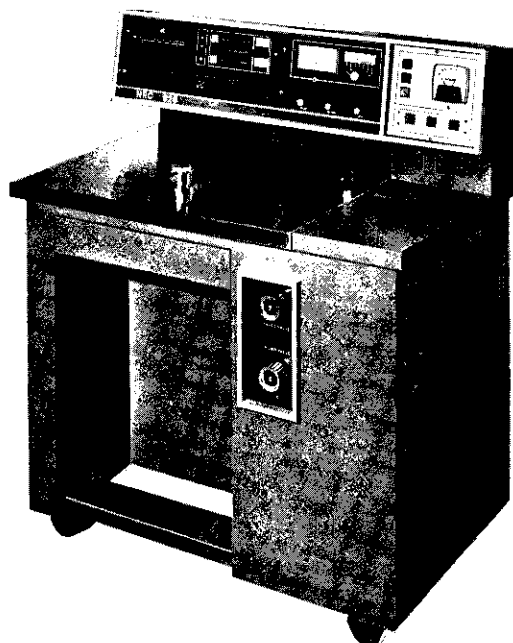
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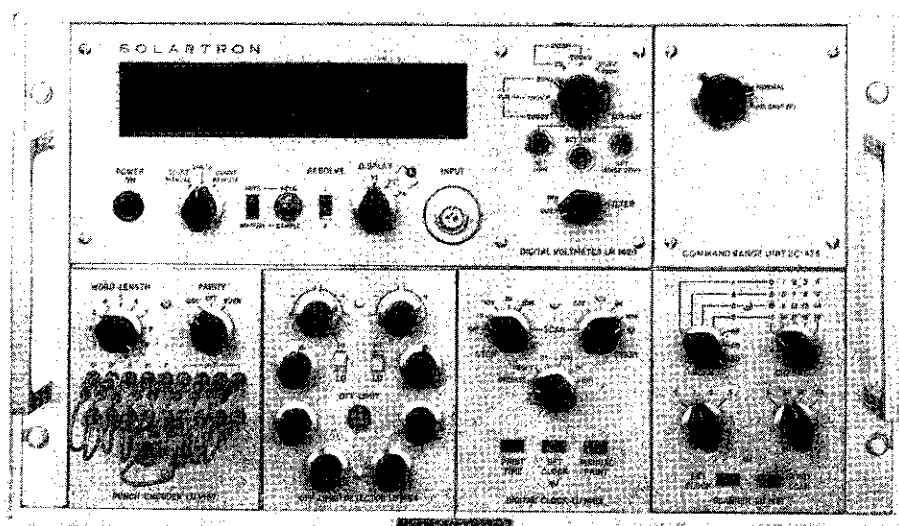
Sensitivity:
 1.5×10^{-11} torr l/s Clean-up time : 2 sec.
 Direct Reading Double filament Ion source
 Modular design



Geneva Office:
 Route de Cointrin 81
 Tél. 33 11 80

Plant and Service Center:
 Saint-Julien (Haute-Savoie)
 France (12 km from CERN)

data logging



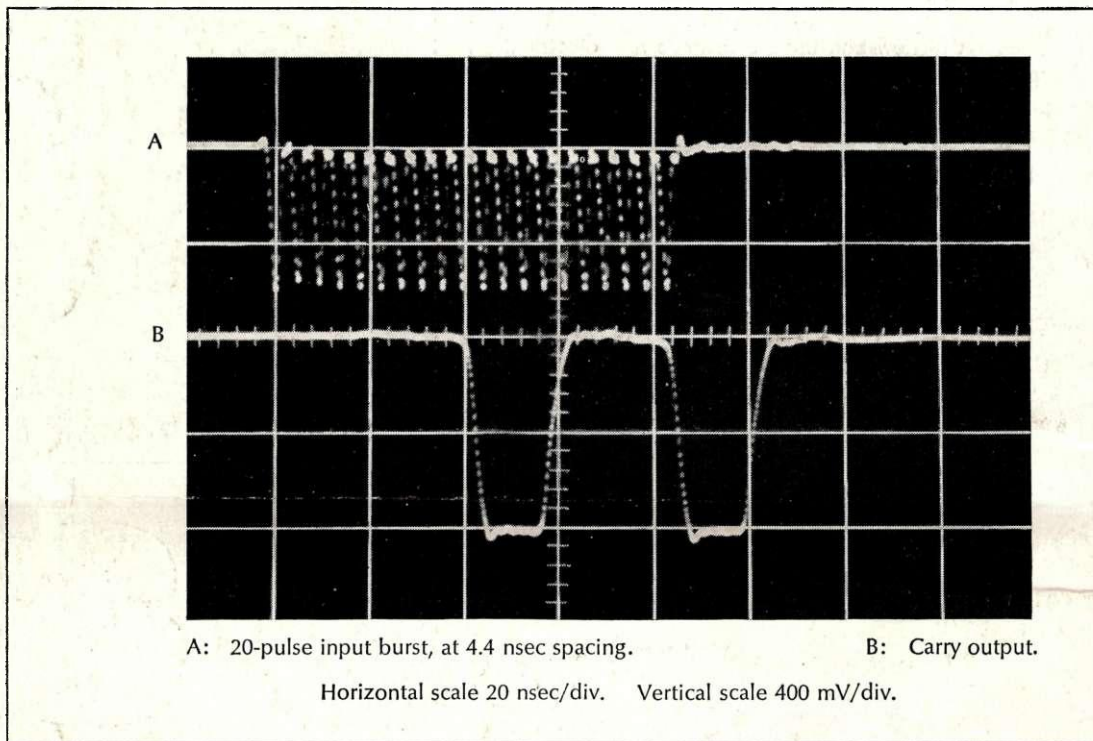
- 20,50 or 100 channels
- sensitivity 10 μ V
- accuracy 0,05 %
- printed or punched output
- modular concept for expansion
 - linearisation
 - off-limit detection
 - digital clock
- max speed 10 channels/sec.

SCHLUMBERGER
 INSTRUMENTATION S.A.

GENÈVE
ZÜRICH

8, av. de Frontenex
 1211 Genève 6
 Tél. (022) 35 99 50

Now you can buy a decade scaler with 4 nanosecond resolution. You also get a protected input discriminator, gated BCD outputs, and front panel visual readout. You don't get any exotic, selected, adjustable or otherwise critical components.



Our new S110/N DECADE SCALER Module is capable of correctly scaling in excess of 200 MHz CW, or resolving pulse pairs spaced less than 4 nsec apart.

The input accepts NIM-standard fast logic signals. However, even less than minimum-amplitude NIM signals can be scaled. The input is protected by a limiter which provides good termination and fast recovery, so the input may accept raw phototube signals. A stable, -400 mV discriminator follows the limiter to drive the scaler. The circuitry is, of course, direct-coupled.

The unique design of the direct-coupled scaling circuitry obviates the need for selected components, trimming adjustments, etc. This allows us to deliver to you a field-servicable instrument at low cost.

The S110/N is adaptable to system use, since it provides gated NIM-standard slow logic signal outputs. The coding is 1248 BCD, which may be changed to 122'4 if desired. Provision is made for diode isolation at the outputs, to permit "wired-OR" bussing.

The carry output is a NIM-standard fast logic signal of nominal 20 nsec width. The "universal" reset/inhibit input accepts either positive or negative signals, and an internal driver assures that reset action is always completed.

The S110/N is packaged in a single-width NIM-standard module, and 12 modules may be put in our new NIM bin. Even though compact, user convenience features such as visual readout and reset mode selection have not been omitted.