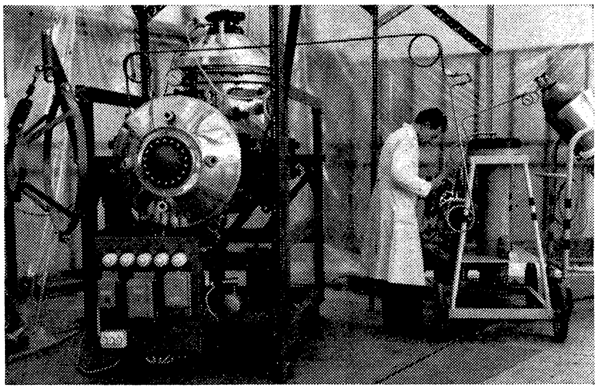
CERN COURIER



No 9
April 1960

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

WHO'S WHO IN CERN

CLAUDE CELARIER

1000 th Staff Member

On Tuesday March 22nd, the growing family of CERN numbered one more member. His arrival could very well have gone by unnoticed but for one circumstance : the Personnel Office discovered Claude Célarier was the thousandth staff member of the Organization.

Who is the fellow staff member all of us at CERN will consider as a symbol of the slow but steady growth of our Organization ?

This alert, bespectacled young Frenchman was born exactly—on April 9th—33 years ago at St. Etienne. Four war years spent at the Ecole Nationale Professionnelle there made him a technical draughtsman. From 1944 on, he worked in the vicinity of his highly industrialized home town, in various branches of the machine-tool industry. He remained in this field until 1950, with only a one-year break for service with the French mountain troops.

Then, the aviation industry. After the war, a large French aviation engine manufacturer installed its research branch at Decize, near Nevers, to develop jet propulsion reactors. Claude Célarier joined the company there. He stayed in this small town of the Nivernais until 1953, when he moved to the firm's test centre at Villeroche, near Paris, to work on compressors and accessories for the jet engines.

Claude Célarier, thousandth CERN staff member, chats with Prof. C. J. Bakker, Director-General, and Mr. R. W. Penney, Personnel Officer (center).

A year ago, Claude heard of CERN for the first time and decided Geneva would not be too bad a place to carry on his trade. He applied for a job at CERN in October 1959, appeared before a selection board on January 6th, and was chosen from among several candidates to fill a vacancy at PS, in Mr. Horisberger's drawing office where he will soon be busy developing beam extraction apparatus.

The day after his arrival, on March 23rd, Claude Célarier was officially welcomed to CERN at a small party organized by the Personnel Section. Three dozen staff members watched him being addressed to by the Director-General and receiving from his hands a scroll commemorating the event and two bottles of Champagne... which soon found their way to the PS drawing office.

Claude Célarier has been married since 1951 and has two children aged 6 and 8. His hobbies are music, the theatre—he acted with an amateur company, back in the Army days—and painting.

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« CERN COURIER »

is published monthly for the staff of the European Organization for Nuclear Research. It is distributed free of charge to members of the Organization, to scientific correspondents and to anyone interested in problems connected with the construction and operation of particle accelerators or in the progress of nuclear physics in general.

Editor

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The cover photograph shows in the foreground the large 25 GeV proton synchrotron ; the **inset picture** shows the large ethylene-filled gas Cerenkov counter used by the Guy von Dardel group to make one of the first nuclear physics measurements with the 25 GeV PS. The counter can select particles with speeds above 95 % of that of light.

First Measurements at PS

The bubble chamber experiment carried out in the week of 21-28 March necessitated 55 hours of continuous operation time of the proton synchrotron, during which 49 000 pictures of particle tracks were taken. Such an unusual event sharply drew the attention on the experimental stage which the PS now reaches. But for all its unconformity and importance, the bubble chamber run was by no means the only work conducted so far or already planned with the large accelerator.

Particle counters have also their word to say, as well as stacks of emulsion plates and, later, the big Wilson chamber and propane bubble chamber.

Early experiments

Altogether some ten preliminary measurements have been, are or will be performed. Perhaps it is a little early to state that real experiments are being carried out. As one of the physicists involved put it, "what has been done up to now should be listed as exploratory measurements to become acquainted with the machine".

Of course, someone has to gather all the particulars of such a programme, to bear also the responsibility of fitting the experiments together, of assuming contacts with the machine operation group : the coordinator chosen for these functions is Professor G. Cocconi, himself one of the team leaders.

In his opinion there are for the time being three remarkable achievements on the experimental side :

- the counters used by the von Dardel group—of which more will be said below—may be regarded as the best in the world at the moment ;
- the electronic circuits built by the Merrison-Fidecaro group to measure the time-of-flight of particles, that is the time they take to travel from one place to another, are accurate to within less than 10^{-9} second, that is to less than one thousandth of a millionth of a second, more exactly 0.9 nanosecond.
- two visiting scientists from Berne University - Drs. Dayton and Winzler - pointed out, while working with W. M. Gibson's emulsion group, a phenomena nobody had proposed using before. On the basis of calculations by G. Plass of PS they predicted and demonstrated by means of emulsion plates that a beam of 25 GeV protons was skirting the magnets at a small angle, leaving the vacuum chamber some 20 m away from the target. This, of course, is not the beam circulating in the machine. It is a secondary beam of protons diffracted by the target No 1 (see the plan on pages 6-7) and kept close to the vacuum chamber

Last Month at CERN

The two highlights of CERN life during March were the re-starting-up of the 600 MeV synchro-cyclotron (SC) and the long run of both the proton synchrotron (PS) and the 32 cm hydrogen bubble chamber.

Shutdown for modification in mid-November, the **synchro-cyclotron** accelerated a new beam of protons on March 9th. At 600 MeV an intensity of 0.15 microampere was obtained. This value is comparable to the one available before the shut-down but, due to changes in the radio frequency system, stability of the beam is much improved.

Following this first step, tests with actual beams up to 600 MeV are being made with the stochastic system designed to increase the output of particles at any given energy. Tests were still being carried on at the time of going to press.

In the future, prior to handing the machine again to experimenters, measurements will have to be made to establish the intensity of the beams coming out of the seven new channels provided to take pi meson beams of different energies into the experimental room.

Extension of the SC generator room and erection of a new wall alongside the road from the gate to the proton synchrotron have begun. The wall will provide an increased protection against radiation, necessary due to the higher beam intensities which the SC will produce. This wall, incidentally, will receive the commemorative plaque recalling the laying of the Organization's first stone, on June 10th, 1955.

Several more construction projects are also being carried out by the **Site and Buildings Division.** Excavation has begun for the erection of two cooling towers which will provide refrigeration water for the PS experimental apparatus. One of the towers will be completed by June 15th, to supply coolant for the French visiting team's propane bubble chamber. Bulldozer and workmen are also digging near the Administration building. There, on the former path of the road leading to the central parking lot and on to the PS, a new fully air-conditioned barrack will be erected to shelter the new electronic computer which will extend CERN's computing facilities.

The Site and Buildings' Power house now receives its third boiler, intended to push the installation's possibilities from 6 to 9 million kilocalorie per hour. Alongside the road leading to the centre of the PS ring, the second bubble chamber test building was handed over to its users.

The old canteen has lost all its former looks ; now a hydrogen bubble chamber workshop, it has been provided with a 5-ton travelling crane.

Speaking of **bubble chambers** the long—55 hours—run of the 32 cm hydrogen one, has provided the proof that both this apparatus and the 25 GeV proton synchrotron can operate practically non-stop for long periods of time. For more on this subject, see the article and photograph below.

Another important item of news has been the obtaining with the **proton synchrotron,** on March 15th, of a current of accelerated particles reaching 10^{11}, which means that one hundred thousand million protons were accelerated at each pulse of the PS.

Ed.

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by the intense magnetic field. It can be said, in this case, that a beam has been "extracted" without any of the apparatus usually employed to that effect. An aperture is now being provided in the shielding wall to carry this beam to the south experimental hall, where any of the interested laboratories may want to make use of it.

Three types of experiments

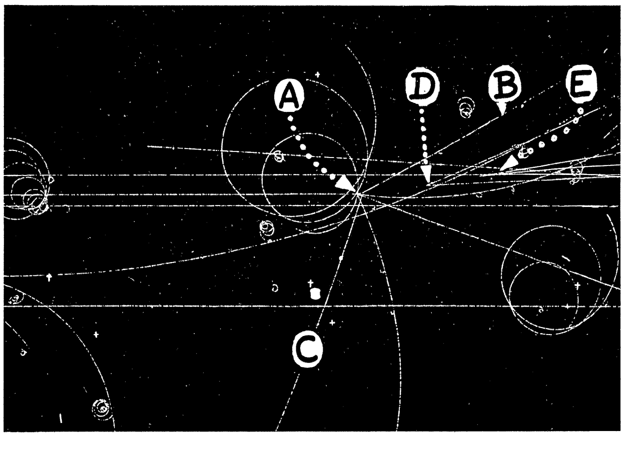
In a recent talk delivered for the benefit of CERN physicists, Guy von Dardel defined three kinds of experiments that can be conducted with the big CERN accelerator.

● First, said he, the high-energy beams might allow to explore the **structure of the elementary particles.** The CERN PS indeed produces particles characterized by shorter wavelengths than the dimension of the particles themselves, dimension which is of the order of 10^{-13} cm, that is a tenth of a millionth of a millionth of a centimetre.

● In a second series of experiments, the high energy beams are used **to produce new particles** and also secondary beams of them (1)

(1) The **primary beam** is the one made of bunches of protons accelerated by the PS in its vacuum chamber ; each pulse of the machine accelerates about 10^{11} particles (one hundred thousand million). In interacting with target nuclei, most of these produce about 7 secondary particles of different kinds, some of which are unstable. The decay of these can in turn produce **tertiary particles.** The three generations of particles can be studied or used by the physicists.

Let us explain this. When they hit protons and neutrons in the atomic nucleus, the tiny nuclear missiles—the protons accelerated to high energies—transform part of their kinetic energy into matter, that is new particles such as antiprotons, antineutrons, mesons and hyperons.



From the analysis of such photographs, nuclear physicists obtain new information on nuclear particles. This picture is one of the 49 000 taken with the 32 cm hydrogen bubble chamber. A beam of negative pi mesons at 16 GeV crosses the chamber from left to right. All particle paths are incurvated by the strong magnetic field (15 000 gauss) inside the chamber. However, particles with lower energies are more deflected. Such is the case for electrons resulting from the interaction of primary particles. Those electrons disappear along spiral tracks, some of which can be seen on the picture. Physicists care little, however, for such events. Much more important is the impact (A), against one of the spirals quite unrelated to the event. A negative pi meson collides with a proton, one of the nuclei in the liquid hydrogen filling the chamber. Four charged particles result from the collision and fly away in all directions.

After a few millimetre, at a spot barely visible on this reproduction, one of the secondary particles also hits another proton ; two tracks (B and C) result from the impact. D and E point to two V tracks resulting from the desintegration in flight of two neutral particles coming from A. Those neutral particles having no electric charge, have left no track between A and D or E.

This "creation" of matter can be explained by the equivalence of energy and mass defined by Einstein's equation ($E = m.c^2$), whereby energy equals the particle's mass multiplied by the square of the velocity of light. To produce new particles, a minimum of energy must be available for transformation into mass. This minimum, the "energy threshold" varies from one particle to another ; for example it is of 4.5 GeV for antiprotons and one machine, Berkeley's Bevatron, was built specifically with the aim of creating those particles.

As for the CERN proton synchrotron the question still subsists: what new particles will be found ?

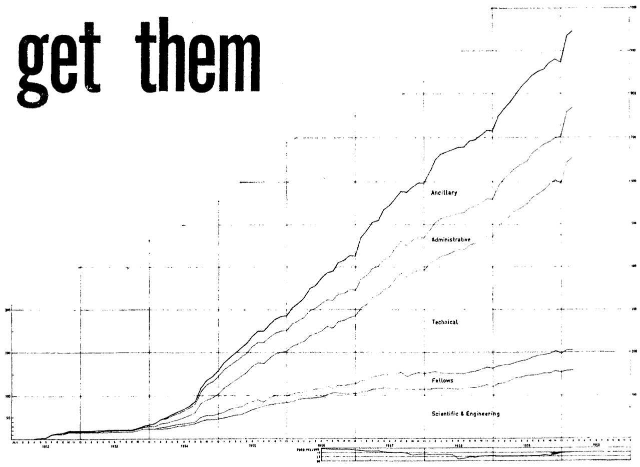
"With the energies of our PS" said G. von Dardel, "it should be possible to produce all the missing antihyperons (2). From the point of

See page 5

(2) see "CERN COURIER" No 4, November 1959. "Fundamental Nuclear Research".

CERN Staff and how we get them

R. W. PENNEY
by Personnel Officer



This chart shows the growth of CERN staff from April 1952 to February 1960 inclusive. From bottom to top, the various curves relate to : scientific and engineering, fellows, technical, administrative and ancillary staff. Supernumeraries are not included. Each vertical division stands for 100 persons.

Once upon a time in a quiet European town, where the supply of apartments almost met the demand, and where pedestrians had an even chance of survival till old age, a handful of scientists started to build the biggest particle accelerator in the world.

The first 1000...

However, this is not a fairy story or even science fiction, although to some of the early pioneers, what has happened since those first Geneva days in 1953 might seem rather fantastic. I wonder whether, as they watched the first bulldozer creep into an empty field at Meyrin in 1954, they realized what they were going to create five years after, not only in the world of science but also in that of human relationships. CERN has built its two accelerators and has fulfilled its first seven years' programme with honour, but it has done more : it has created in itself a new kind of international organization and has demonstrated that given a common and definite aim, people from many countries, of different beliefs and interests, and from all levels, can work and live together constructively and in friendship.

These thoughts have been prompted by the fact that last month CERN passed two milestones in its staffing history : it has reached a total of 1000 staff of all types, and it has received its 20 000th application for employment. The occasion was marked by an informal gathering at which the 1000th staff member, Mr. Claude Célarier of PS Division, was welcomed by the Director-General.

... and how they got here

No doubt most of us in CERN have been at some time on one side or the other of a CERN recruitment board table, but how many of us realize what has gone on behind the scenes to get those 20 000 applications and the more than 3000 candidates who have been interviewed, quite apart from the actual selection, appointment and reception work that inexorably follows.

Before the CERN recruitment programme really got under way, the Director-General and the Council laid down the principle that CERN staff should be selected not primarily on a national quota basis, but above all on the principle of "the best man for the job" and that whenever possible selection should be by competition among available candidates from all Member States. These principles have been kept to this day and have, on the whole worked out so well that the general quality of CERN staff is certainly as good as any to be found in any comparable establishment in the world.

The Personnel and Services Office deals with all matters related with CERN staff, including recruiting.

Where do the applications come from ? Many come from out of the blue, from the increasing number of people who hear about CERN (although one sometimes wonders what they hear about us) and think it would be nice to work in an international organization for what they think are huge international salaries (if any of them ever get to CERN they soon discover their mistake). These make work for the Personnel Office but achieve little else. We do, of course, get some serious and very good applications from these general sources and they are always welcome. A much smaller, but more valuable selection comes as the result of personal contacts made through CERN. Some come through the efforts made by CERN delegates who are informed of each non-local vacancy as it arises. Most of our suitable candidates, however, have to be found through the medium of specific advertisements inserted by CERN in national journals and newspapers. This, of course, costs money but nevertheless our recruitment cost per head for advertisement and travel expenses has only averaged Sw.Frs. 320 per new staff member, considerably less than that paid by most national establishments or companies. It should be emphasized, however, that once an application is received, it gets the same consideration no matter which of these channels it came through.

All applications received are acknowledged, screened, and if at first glance suitable, passed to interested Divisions for a first paper selection. Then follows the familiar board procedure (all too familiar to some of us), the questions, the elimination of the unsuitables, the arguments about the remainder, the satisfaction of finding just the right man, and finally when the board has agreed, the Director-General's approval to accept a new member of the CERN family. It may be of interest to note that, in 1959, for every staff member selected, an average of 3 were interviewed, and 15 applications received. Of our present staff members (not including fellows and supernumeraries) 8 % came from employment with Universities, 22 % from Governmental institutions, 46 % from Industries, 3 % from International organizations and 21 % from other services.

If the Editor finds himself short of copy in the future, perhaps it will be possible to continue this story to the later stages in the career of a new staff member. For the time being, we must leave it with the successful candidate studying his job offer, trying to work out what Sw.Frs. 1000 is worth in kroner, marks, pounds etc. and convincing his family that Geneva looked quite a decent place to live in. He will at least have been warned by this time of one major difficulty : housing. On that sore subject see the next edition of the "COURIER"...

PS Measurements

(Continued from page 3)

view of energy, the most economic process is to bombard protons with secondary beams of pi mesons energetic enough to produce the pairs (3) of hyperons." This is what has been done in the experiment with the 30 cm hydrogen bubble chamber described below.

Hyperons are heavy short-lived particles. But the PS will obviously create lighter particles such as pi and K mesons, maybe even the "dubion", a kind of meson whose probable existence was reported at the last Kiev Conference (4).

Furthermore, tertiary beams of electrons, neutrinos, mu mesons and gamma rays will result from the decay of unstable particles produced in internal targets. These tertiary particles may give rise to interesting experiments such as the ones on high energy neutrinos.

● With the proton synchrotron, it will also be possible to conduct **experiments that lower-energy machines** could also do. The PS can however provide better conditions such as higher intensity beams for example. So far beams of antiprotons have been produced which contain many more antiprotons that were previously obtained with other machines ; so it is obvious that antiproton experiments could be done again with higher accuracy, while new experiments will become feasible.

Nuclear physics with the PS

Emulsion experiments were among the first to be made with the 25 GeV proton synchrotron. With W. M. Gibson as group leader (5), J. C. Combe, W. O. Lock and G. Vanderhaeghe were among those who produced the widely-published first photograph of an atomic nucleus desintegrating after being hit by an artificially produced 25 GeV proton.

The discovery, by Berne University physicists working with the group, of an external proton beam has been mentioned before. Furthermore a device has been designed to allow stacks of emulsion plates to be dropped through the edge of the internal 25 GeV beam for the duration of one pulse.

Still later, the group will search for a type of event predicted by Prof. Ferretti, former director of the Theoretical Studies Division. They will try to observe the production of 2 pi mesons in the field of nuclei brushed by high energy pions.

* * *

B. D. Hyams, G. Backenstoss, and P. Marin, are carrying on a **mu meson - electron scattering experiment** suggested by Prof. Bernardini. (see figure 5 along the paths of particles reproduced on the plan, pages 6-7). The purpose of this first experiment planned by the group was to study the mu meson - electron collisions in magnetized iron, making use of highly polarized mu mesons at 10 GeV/c (6), available with a good selection of momentum. It will thus be possible to establish by a "clean experiment" one of the characteristics of the mu mesons, their helicity.

* * *

One of the experiments which reached the most advanced stage is the one conducted by means of a **large Cerenkov gas counter** by G. von Dardel, and his group : R. Mermod, G. Weber and K. Winter. The apparatus used is indicated by the figures 3 along the paths crossing the plan of the PS southern experimental hall, reproduced on pages 6-7. The main apparatus was a large Cerenkov counter filled with ethylene gas.

A coming article in the CERN COURIER will describe the tools of the physicists. However, it may be valuable to define rapidly the Cerenkov counter, so named after the Russian scientist who discovered its principle. When a charged particle crosses a material faster than light would do it in the same material, it generates a sort of shock light wave in which it looses energy and emits light. This light is collected, amplified and allows to measure the mass of particles. In the experiment the secondary beam utilized had a momentum (6) of 6 GeV/c. It came at a 5° angle with respect to the tangent of the circulating beam at the m1 target. The beam was shown to contain far more antiprotons than any other machine had produced before ; the production of antiprotons is thought to be a thousand times that recorded at Berkeley's Bevatron for example.

More than for the pleasure of sheer comparison, this result is interesting because for the first time man has at his disposal such a high flux of antiparticles with which it will be possible to conceive new experiments.

* * *

The A. W. Merrison - G. Fidecaro group, including Mrs. V. Cocconi, T. Fazzini, M. Legros and N. H. Lipman conducted a **"time-of-flight"** experiment (figure 8 on plan). This has nothing to do with aeronautics : its purpose is to study the composition of a PS secondary beam and to distinguish particles of different mass on the basis of their different velocities.

The apparatus used with the contribution of G. Culligan was mounted in the south experimental hall to examine the secondary radiation emerging at 18° from a target at m6. The momentum of particles from 2 to 4 GeV/c was first defined (to about 3 %) in a bending magnet and the velocity of the particles was subsequently measured by timing them between two scintillation counters 21 m apart.

The plan on the central pages (turn page) shows the layout of the different apparatus used for the measurements listed in the accompanying article. The south experimental hall only is shown, no measurements taking place so far in the north hall (not shown) inside the ring of magnets visible on the upper portion of the plan.

The total time-of-flight was 90 nanosecond, for fully relativistic particles (nine parts in one hundredth of a millionth of a second). Preliminary results indicated that this beam contained about 1 % of antiprotons and a similar number of charged K mesons. The precision in timing in this apparatus made it possible to compare the antiproton and proton masses to about 1 part in 200.

* * *

Another important experiment was the one involving Ch. Peyrou's **32 cm hydrogen bubble chamber** group, with G. Amato, T. Ball, J. Bartke, R. Budde, W. Copper, H. Filthuth, D.R.O. Morrison and H. Trembley. Accelerator and chamber ran practically non-stop for 55 hours, starting at 17.00 on Monday March 21 and finishing the work at 00.00 on Thursday 24. Each of the three cameras mounted on the chamber took 49 000 pictures of tracks of particles crossing the liquid hydrogen. The secondary beam (about 1 % of antiprotons, 10 % of mu mesons and 89 % of pi mesons) coming from the accelerator had an energy of 16 GeV sufficient to be able to produce antihyperons. At this writing it is still too early to know of any phenomena which might be recorded on the pictures. A few months will be necessary to analyze and to interpret this maze of photographs. at CERN, at I.N.F.N., the Italian Institute for Nuclear Studies and at the Imperial College, London. The splendid long run of both the accelerator and the bubble chamber are however a source of pride for all involved.

Simultaneously with this work a small freon bubble chamber located directly behind the CERN chamber, was operated by Prof. B. Hahn's team, of Friburg University. Some of the particles crossing the former thus also went through it and provided many interesting photographs.

* * *

The **exploration of a neutral beam** will be made by W. C. Middelkoop and the physicists in his team : Prof. G. Bernardini, G. Gatto, G. Giacomelli, W. Love and T. Yamagata, who are planning experiments with high energy gamma rays, neutrons, nucleons, etc (fig 1 on the plan). The main apparatus used will be a set of 2 Cerenkov counters filled with lead-glass. The purpose of the exploration is, at present, to measure the spectrum of gamma rays produced by the decay of neutral pi mesons at a small angle relative to the beam tangent and simultaneously, to study the associated **neutrons** and **antineutrons.**

* * *

A similar experiment is being made by Prof. G. Cocconi's group. He and A. Diddens, H. Faissner and A. Wetherell are using a small heavy-liquid filled Cerenkov counter to **investigate the production of gamma rays,** produced by the impact of the 25 GeV beam on the m6 target

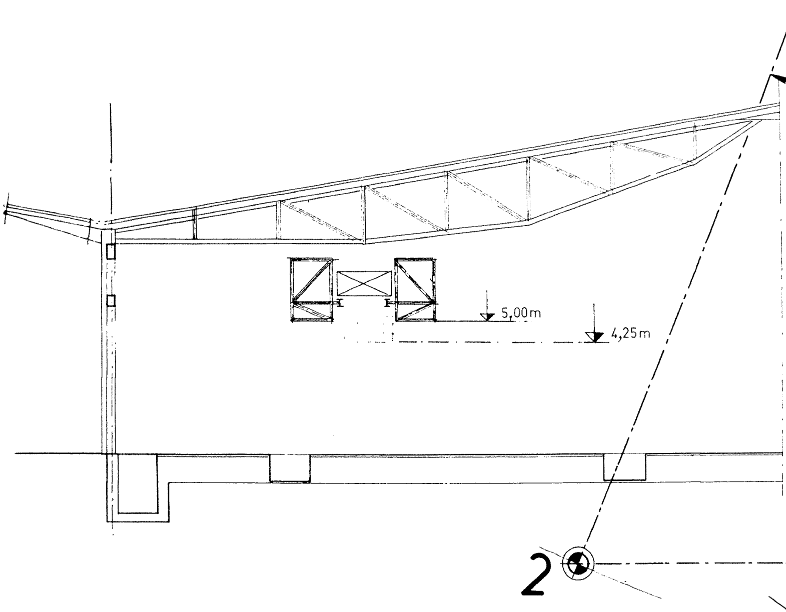
(see page 8)

(3) a pair of particles is the particle itself and its antimatter equivalent.

(4) see "CERN COURIER" No 2, September 1959.

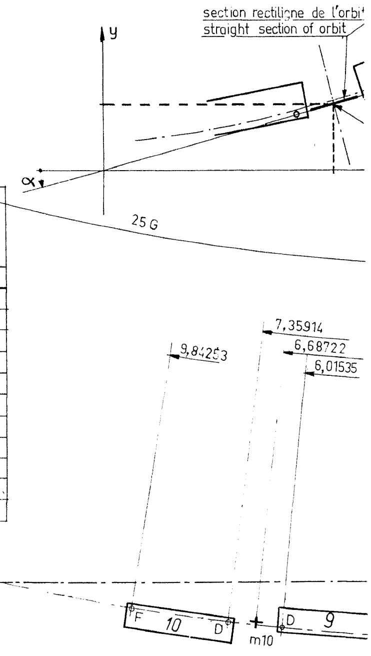
(5) Names quoted in the article are listed alphabetically after the group leader. In this connection here is the definition of a group leader according to a senior physicist : "A group leader is, in the world of scientists, at the same level as others in his group but, due to his experience, he has definite responsibilities in the management of the group's business. Of course, he is also very often a teacher to the young fellows in his group but, as in all good teaching the teacher learns quite often from his students."

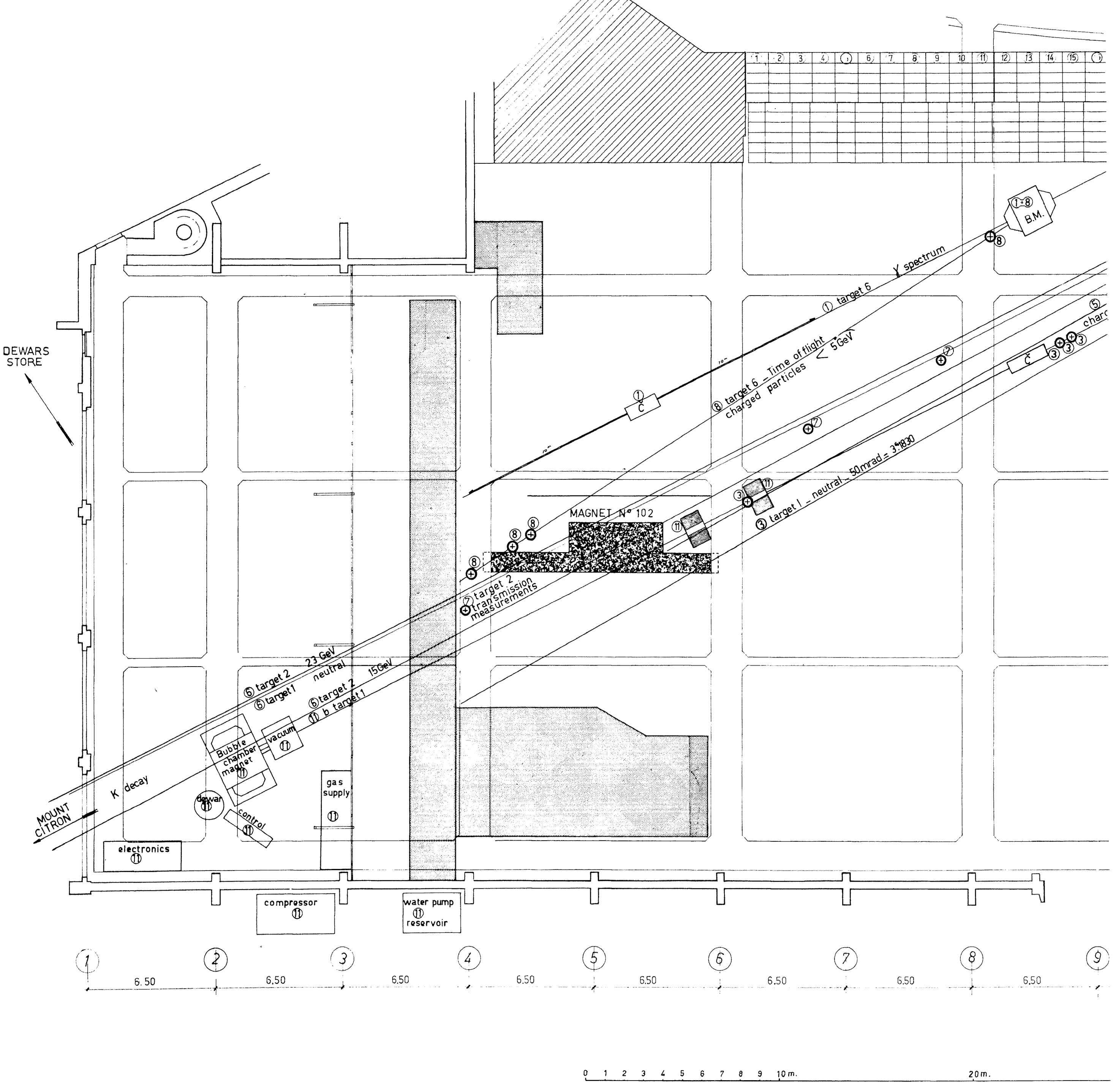
(6) the momentum is the quantity of motion defined by GeV/c, c being the speed of light.



Coordonnées et angles des sections rectilignes de l'orbite
Coordinates and angle of straight section of orbit

Points	X	Y	α
m 100	49.967 553	11.181 694	33.04467
m 1	44.037 053	8.061 212	29.04467
m 2	37.940 441	5.279 205	25.04467
m 3	32.327 706	3.153 827	21.04467
m4	26.592 583	1.385 066	17.04467
m5	20.757 725	-0.020 087	13.04467
m6	14.153 202	-1.155 218	9.04467
m 7	7.495 293	-1.917 109	5.04467
m8	1.500 486	-2.204 032	1.04467
m9	-4.500 518	-2.113 973	-2.95533
m10	-10.484 013	-1.647 286	-6.95533





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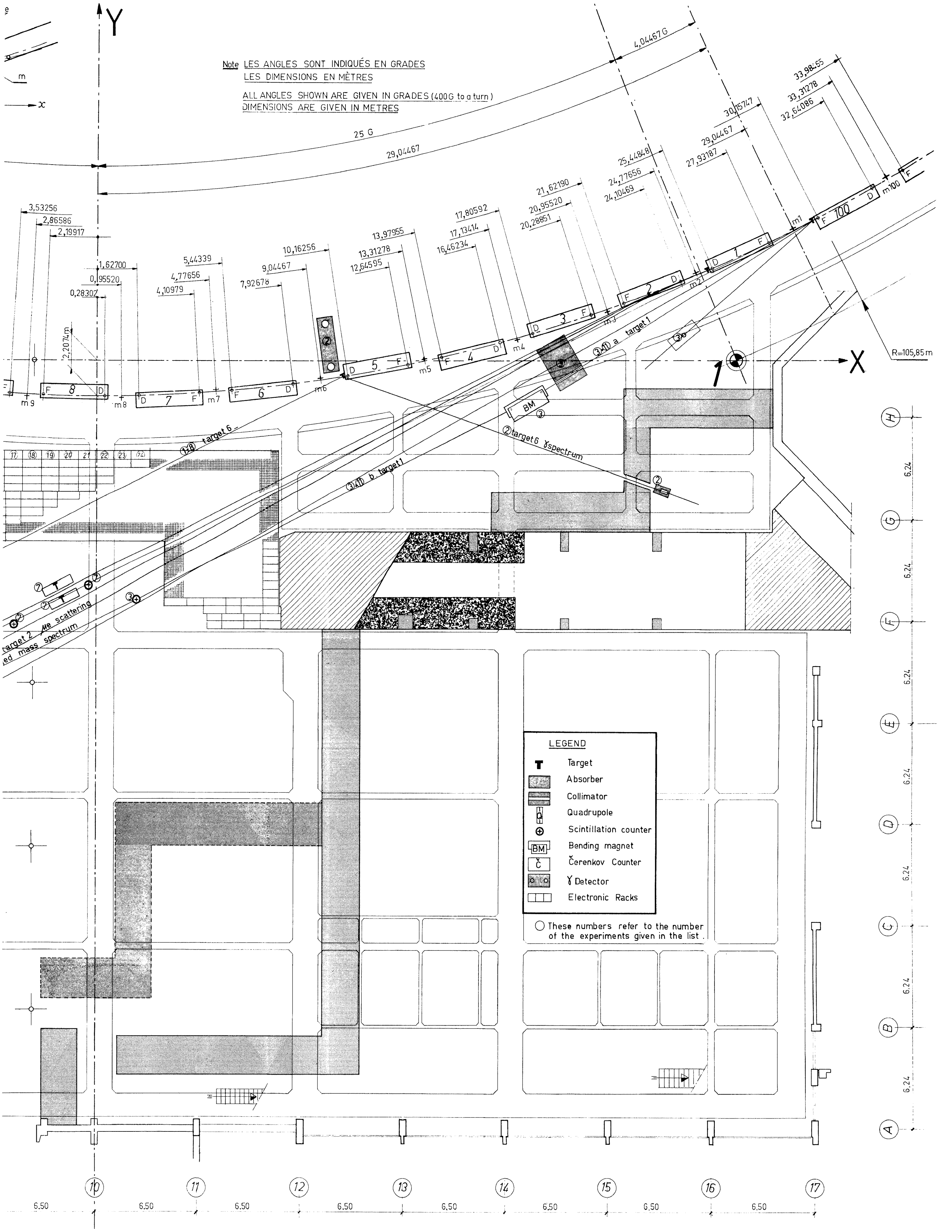


BEAM AND EXPERIMENT LAY OUT

as from JANUARY 1960

7 JANUARY 1960

The PS

Five targets were available in the proton synchrotron for the first long experimental run, starting on 21 March. They produced secondary beams of a duration as short as a few hundred microsecond for bubble chamber work or as long as almost 50 millisecond for experiments using counters. What has this stage of target development involved and what are the plans for the future?

How to use the beam

For the nuclear experiments the accelerated protons may be used in a number of ways. Some experiments can be made directly with the circulating beam, others with a beam of secondary particles created by this beam; finally one can also eject the protons from the machine and let them fall on a target placed at a convenient distance; this target may be a bubble chamber, for instance.

In the first two cases the protons are made to hit a target brought into the ring vacuum chamber in such a way that the acceleration is not disturbed earlier on in the cycle. The present targets are of this type.

Depending on the kind of experiment, the target has to yield a short or long burst of secondary particles or of scattered protons, containing just a few or many particles.

To reach this aim one must select the correct target dimensions, taking into account the nature of the physical processes occuring in the target when the accelerated protons impinge on it.

The three processes of main interest for target operation occur when a proton hits a target nucleus, misses it very closely or passes by somewhat further away.

In the first case the energy of the hitting proton is partly used to create particles like mesons, antinucleons, hyperons and antihyperons (*).

In the second case the proton experiences an "elastic scattering" due to the nuclear forces which keep the nucleus together. The mean angle of the resulting deviation of the proton orbit is of the order of 1°, independently of the target material.

In the third case, the electric charge of the proton is acted upon by the electric field of the target nucleus. The resulting deviation of the proton orbit depends on the strength of the electric field, which increases with the atomic number as well as with the closeness of approach. Thus the " Coulomb scattering" is much stronger in a gold target than in a hydrogen one, even if both targets are made to contain the same number of nuclei.

Though not directly interesting for beam production, a further process has sometimes to be taken into account: the ionisation of the target atoms by the circulating protons, which causes a loss of their kinetic energy.

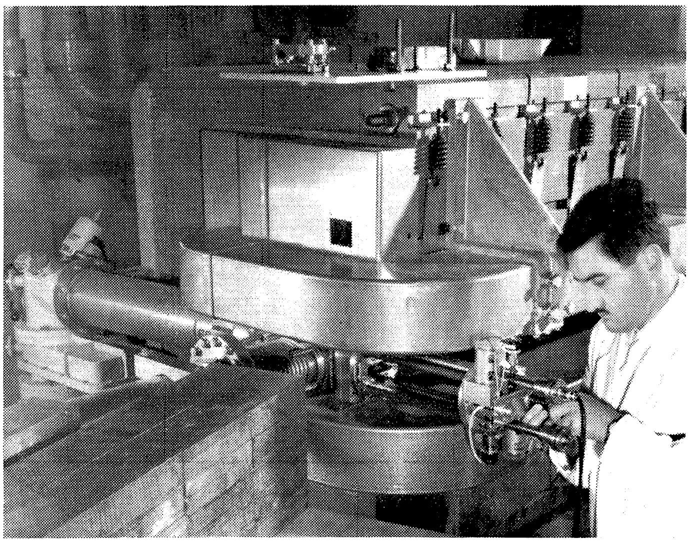
What is the effect of these processes in normal target operation? As the accelerated protons move with a high speed, most of the newly created particles come out of the machine in the forward direction, the most energetic ones in a cone of a few degrees half angle and the ones with lower energies in a cone of about 60° half angle.

A large fraction of the elastically scattered protons will also leave the ring vacuum chamber, through still smaller angles.

It depends on the target material whether many protons are scattered out of the chamber by multiple Coulomb scattering or whether they keep being trapped inside the chamber by the magnetic focusing field. According to calculations by M.G.N. Hine and J. Geibel, the former behaviour is expected for heavy targets, made from stainless steel or copper, the latter for lighter ones like aluminium or beryllium targets.

The energy loss in the target causes a shift of the proton orbits towards the ring centre, due to the strong focusing properties of the CERN proton synchrotron. This shift is so small however, that the protons will normally stay inside the vacuum chamber until the beam has been lost due to the processes listed above. In contrast to what happens in weak focusing machines like the Cosmotron, the Bevatron (USA), or Saturne (France), the protons therefore go on traversing the PS targets again and again until they have either been scattered out or made a nuclear interaction.

As the interaction in the target is a statistical process, a given proton may interact immediately after target and beam have come together or only after most of the beam has been lost already. There is a good chance that most protons have interacted i. e., hit a target nucleus after the beam has traversed about 100 gram of target material per cm^2 surface, at right angles to the beam.



P. Collet is one of those responsible for the mounting of targets in the PS vacuum chamber. Here, he is adjusting the drive for the radial positioning of the apparatus. In the left foreground is a lead wall, at an 18° angle from the vacuum chamber, intended to collimate a secondary beam of particles from the target.

The choice of targets

The following recipes for the choice of the target heads will now become understandable.

For an intense secondary beam of short duration one takes a thick head of a material with a low atomic number, like aluminium. A large head of 1 gm/cm^2 (4 mm thick) will give a burst of about 200 microsecond duration.

For obtaining particles at small angles to the circulating beam — a requirement which is important for steering the beam into some

(*) See "CERN COURIER" No 4, November 1959 - and, in this issue, the article on PS Measurements.

PS Measurements

(Continued from page 5)

and flying in a backward direction (figure 2 on plan). The number of gamma rays and their energy distribution will give information about the production of neutral pi mesons by the 25 GeV protons hitting the nuclei of the target.

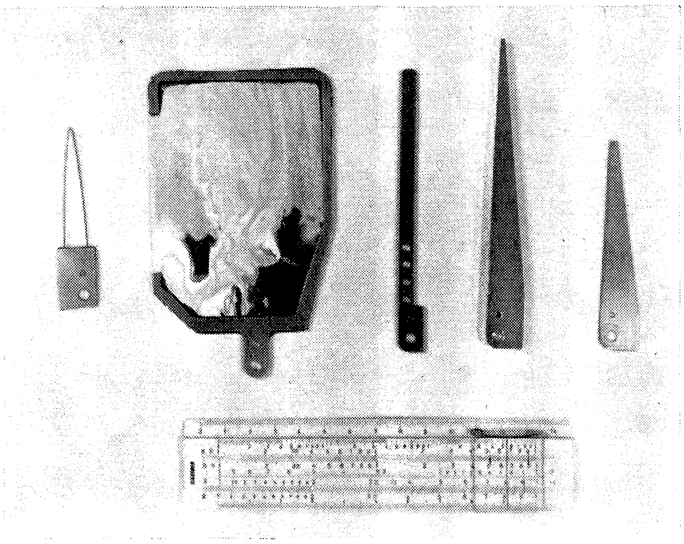
* * *

The so-called Mount Citron is the earth mound looming between the PS south experimental hall and the French border. Its thickness at the base is about 52 metre in the general direction followed by the beams from the machine. Arne Lundby and his group - L. Gilly, B. Leontic, R. Meunier and J. P. Stroot—will, in collaboration with Prof. Peters of Copenhagen, conduct there one of the two experiments they intend to make around the PS (fig 6 on the plan). Twenty holes are being drilled vertically into Mount Citron down to the level of the beams coming out of the accelerator. Counters lowered into the holes will **measure** the number of **muons (mu mesons) entering the hill** and how far they go at energies from 10 to 23 GeV.

It has been calculated that all particles from the neutral beam but the muons from the decay of neutral K_2 mesons (K^0_2), will have been filtered out. The counters sunk in the hill beyond that region, will thus act as detectors of K^0_2 entirely unaffected by other particles. It will thus become possible to measure accurately the properties of high-energy neutral K mesons, about which little is known. Charged K mesons will also be studied through this device.

targets

K. H. REICH
by PS Machine Group



A set of target heads showing, from left to right : a 0.5 mm stainless steel wire and a 0.04 mm aluminium foil ; the other targets are made 2 mm copper, 3 mm aluminium and 1 mm stainless steel.

types of ejection apparatus or when making certain emulsion plate exposures—one selects the target on the basis of its scattering properties.

If in need of a long burst of particles, one uses a very thin target. A large aluminium foil of 10 milligram per cm^2 (about 0.04 mm thick) will give a burst of roughly 20 millisecond duration, while a foil of 1 mgr/cm^2 (about 0.004 mm thick) will produce a burst of about 200 millisecond.

For various reasons targets have often to be smaller than the cross-section of the vacuum chamber and then the rules of thumb given above no longer fully apply, since the protons will miss the target every so often. Again, the influence of the target operation on the radio frequency acceleration system has not been considered so far, though it may be of great importance.

Work on the present targets started late last summer under the direction of G.L. Munday. The target mechanisms were designed by H. Horisberger's drawing office and manufactured at the Main Workshop. Each mechanism contains two heads, which can be flipped into the beam by means of an electro-magnet. The transistorised controls allow one to chose the moment of flipping up and to vary the stay up time between 10 and 300 millisecond : the actual flipping takes only about 20 millisecond. Furthermore the final radial position of the target (or the vertical position if it is built in vertically) can be controlled from the main control room where the position of the head is also indicated.

From a great number of conceivable methods, two are mainly used now for bringing beam and flipped up target together : kicking the beam onto the target by means of the magnetic radio frequency deflector designed by M. Geiger, or letting the beam spiral onto the target under the action of the main magnetic field.

The first method is used for bursts of short duration, as it is easier to create and to control a rapidly increasing magnetic field than to create and control a correspondingly fast motion of a target weighing, say, 100 gram, the speed of which may reach several hundred km per hour.

The spiralling method is used for counter work, where it is important to remove the radio frequency from the beam. To this effect one takes away the action of the radio frequency system at the end of the accelerating cycle and then lets the debunched beam spiral onto a suitably placed target of aluminium about 0.01 mm thick. Incidentally, the best heads have been made so far of a foil previously used for wrapping up cigarette packages.

Another method designed to provide a burst of constant counting rate, is at present under study. It consists in bringing the beam onto the target by means of a servo-system acting on the control of the radial beam position which is steered from a counter telescope. Ch. Schmelzer and W. Schnell have already obtained interesting results from these and other beam gymnastics.

Besides the construction of faster and heavier targets the target programme foresees a detailed study of the effects of target dimensions and materials on the properties of the secondary beams, the elaboration of more refined methods for beam sharing, and production of bursts of constant intensity by means of radio frequency adjustments.

Future developments

Another line of development is the programming of the target controls. It is hoped to produce in the future not only several still shorter or still longer bursts from one pulse, but also to obtain them almost automatically in a prearranged order.

Looking further ahead one sees the ejection schemes come into operation. They are at present being worked on in C.A. Ramm's group by F. Krienen, B. Kuiper and G. Plass. In the not too distant future the Machine Group is expecting to see the main magnet power supply modified. It will then allow production of particle bursts of constant energy of several hundred millisecond duration. This will be of great interest to counter people.

Finally it must be said that the target work has already greatly benefitted from the active co-operation of the physicists and with further joint efforts the CERN proton synchrotron will certainly be exploited more and more effectively.

Transmission measurements of negative mesons and antiprotons with energy above 15 GeV through hydrogen and deuterium targets is also prepared by the same group, independently from the Mount Citron affair. A target will be placed between magnets 1 and 2 (see plan) Measurements performed in the south experimental hall will be done mainly with a gas Cerenkov counter similar to the one used by the von Dardel group.

* * *

Simultaneously with some of the preceeding experiments G. Rudstam, E. Bruninx, P. Estrup and K. Goebel have made **irradiation experiments,** getting copper and aluminium targets irradiated and determining the yield of the different isotopes formed in them.

* * *

The large **150 cm cloud chamber** now being built, will later be used by another group of SC experimenters : Prof. Preiswerk, P. Astbury, R. Fortune, A. de Marco, L. Solinas, and C. Verkerk. Similarly C.A. Ramm and his group (J.J. Bleeker, P. Innocenti, G. Muratori, B. de Raad, L. Resegotti, R. Salmeron and R. G. Voss), will use the **1 m propane bubble chamber** now being assembled near the PS workshop.

Except for the last two, all the groups mentioned have already done some work with the machine either on duly allocated nuclear physics time of the machine, or "parasiting" each other or on machine running-in time, i.e. making use of the beam produced while the Machine operation Group conducts further tests of its accelerator ●

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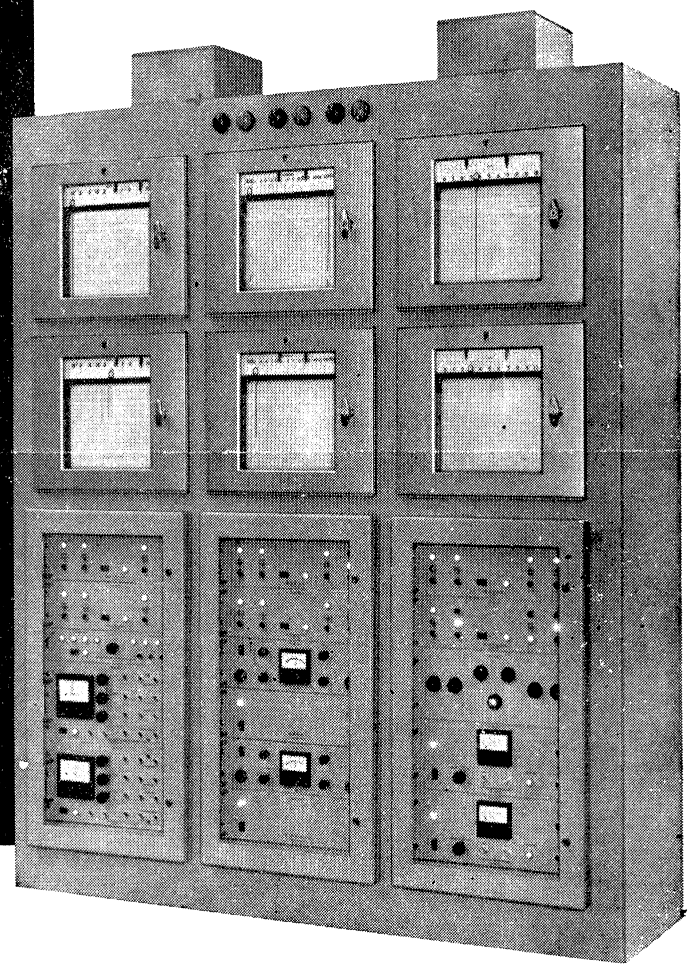

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