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PROGRESS REPORTS OF THE DIVISIONS PRESENTED BY THE DIRECTOR-GENERAL TO COUNCIL

RAPPORTS D'ACTIVITE DES DIVISIONS PRESENTES AU CONSEIL PAR LE DIRECTEUR GENERAL

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INTRODUCTION BY THE DIRECTOR-GENERAL

In the last half year, CERN was able to continue without incident the exploitation of its facilities in collaboration with other European centres of high-energy physics. A number of new and interesting results were obtained and the performance and efficiency of the accelerators were improved. For the first time, the PS was able to obtain a beam intensity of over 10^{12} particles per pulse and to maintain this number as an average for periods of two weeks. With this achievement, CERN unquestionably offers to European physicists the most efficient high-energy accelerator in the world. A new device for separating beams of charged particles was put into operation for the first time: it is an RF separator, developed here at CERN, the first working model of its kind in the world.

Among the scientific achievements obtained during the last half year, we would like to mention our growing participation in the discoveries of new resonances and excited states in nucleonic matter; in particular, CERN and the collaborating European institutions have contributed by discovering a number of new boson resonances and by establishing the quantum properties of many of them.

Let us further mention the discovery that the collision of two protons exhibits even at the highest attainable energies a surprisingly large degree of true elasticity, which expresses itself in form of a so-called "real scattering amplitude".

The evaluation of the neutrino experiment was concluded in the period under review. The specially intense neutrino beam which CERN was able to construct yielded more than 10 000 spark chamber pictures and about 420 bubble chamber pictures of neutrino events. The analysis of these events revealed several interesting results: the much discussed quantum of weak interactions was not found and, if it exists, it must have a mass higher than 1.8 proton masses; the weak interaction form factors for the nucleon were measured for the first time in this experiment.

The theoretical physicists at CERN devoted much of their time to the study and exploration of the new regularities which were found recently in the spectrum of resonances, and which are known under the name of the "SU₃ Group". The collaboration between the theoreticians and experimentalists was further improved and turned out to be of great help in the planning and evaluation of experiments.

One of the most important tasks of CERN is the strengthening of ties with European universities and research institutions. These contacts were broadened considerably in the recent past. Two events are examples of this trend: the large British bubble chamber has started its operation at CERN during the last summer, and a visiting team of physicists from Saclay have carried out a successful experiment at the PS for the measurement of charge exchange scattering of pions with protons, largely with their own equipment and immediate technical support.

At the biennial International Conference on High-Energy Physics last August in Dubna, most of the recent scientific achievements of CERN and its Member States were presented and discussed and could be compared with the results of other laboratories. It is now obvious that the European contributions are on a par with the contributions from USA and USSR. CERN installations have made it possible for the European physicists to contribute essential ideas and results to the field of elementary particle physics.

Much time and effort was spent in the last half year on shaping and formulating the future plans of the Laboratory. The efforts were devoted to three aims: towards the improvement and a more up-to-date exploitation of our present facilities, towards the construction of intersecting storage rings and towards the construction of a new 300 GeV accelerator. All three aims are now much better understood and are formulated in greater detail than before. They represent the logical sequence of a development which has started with the construction of the present CERN facilities and which resulted in the growing scope of high-energy physics in Europe as a whole. Without their realization, Europe will not be able to keep its present position in high-energy physics at a time when all those modern facilities will be in use which are now planned or under construction elsewhere.

I. DIVISION DE LA MACHINE PS

par P. Germain

DIVISION DE LA MACHINE PS

1. Exploitation du synchrotron

a) Temps de machine

Pendant ces six mois, le PS a fonctionné durant 3 670 heures, dont 3 025 pour les expériences, 470 pour les séances d'études de machine, 175 pour les essais spéciaux, plus 245 heures (7%) de pannes.

La moyenne a été de 268 heures par période de deux semaines, dont 222 heures pour les expériences de physique et de chimie nucléaire, 34 heures pour les séances de développement et de mesure, le reste du temps (12 heures) étant partagé entre les mises en route et les essais spéciaux.

b) Intensité

Cette période a vu un nouveau progrès dans l'intensité totale qui a atteint $1,1 \times 10^{12}$ protons lors d'une impulsion, la meilleure moyenne sur une période de deux semaines étant de $9,5 \times 10^{11}$ p/impulsion. Sur l'ensemble des 3 020 heures d'expériences au cours desquelles 3×10^{18} protons ont été accélérés, l'intensité moyenne par impulsion a été de $7,5 \times 10^{11}$ protons.

2. Etudes et améliorations techniques du synchrotron

a) Injection

Le courant du Linac a été souvent supérieur à 65 mA et pendant une séance d'études un courant maximum de 85 mA a été atteint, ce qui est le fruit des améliorations constantes apportées à l'injection. L'étude de la compensation de la charge de faisceau sur les trois cavités à l'aide de boucles et d'alimentation supplémentaires se poursuit. L'émission à 50 MeV est de 3 cm x mrad (pour 95% à 70 mA) et en tenant compte de l'efficacité de capture, 30% de courant Linac injecté pendant les 6 μ s du premier tour est accéléré à pleine énergie. L'émission du faisceau Linac et l'acceptance pendant la première longueur d'onde bé-tatronique ont été mesurées et serviront à l'étude de l'injection sur plusieurs tours. La stabilité générale (particulièrement celle relative aux fluctuations du réseau) est en cours d'amélioration grâce au remplacement des amplificateurs magnétiques des modulateurs RF par des stabilisateurs à thyristors.

La nouvelle source duoplasmatron et ses accessoires sont pratiquement terminés, avec la participation du bureau technique et des ateliers. Le modèle de la nouvelle colonne pré-accélévatrice courte a tenu 500 kV sur 2,5 cm, grâce surtout aux électrodes de titane fabriquées au CERN. La première colonne elle-même est montée et prête pour les essais HT.

Un prototype de nouvelle lentille quadrupolaire d'injection assez réduite pour tenir entre les bobines d'une unité d'aimant et permettant ainsi de libérer les sections droites a été essayé sur la machine avec succès, avec un effet de 2,8 (G x m)/cm. Cinquante lentilles de ce type sont en fabrication au CERN, la moitié ayant déjà été moulées dans l'araldite. Huit alimentations (5 A, 75 V) ont été construites à cet usage.

b) Accélération

La mise au point d'électrodes de détection suffisamment réduites pour être logées dans les boîtes de jonction des pompes afin de libérer aussi les sections droites s'est poursuivie grâce aux essais effectués sur le prototype. Un procédé électronique à l'étude permettra la normalisation directe du signal différentiel des électrodes de détection par rapport à l'intensité du faisceau, afin d'en faciliter l'interprétation. On a pu mettre en évidence une production d'ions par le passage du faisceau à travers le gaz résiduel de la chambre à vide et cette ionisation influence les signaux des électrodes de détection au moment de l'injection.

Le système de mesure du courant par transformateur a été encore amélioré, aussi bien pour le faisceau primaire que pour les faisceaux éjectés.

La chambre à vide a été dégagée de certaines obstructions qui en diminuaient l'ouverture.

3. Utilisation des protons

a) Cibles internes

Le fonctionnement simultané ou consécutif d'un grand nombre de cibles est devenu courant et jusqu'à 4 cibles ont pu être utilisées lors d'une même impulsion du PS. On a ainsi réalisé une impulsion courte sur une ou deux cibles, suivie d'une impulsion longue sur deux ou trois cibles. Pour de telles opérations, le nombre de kickers devenant important, des enroulements de déviation d'orbite ("bump coils") ont parfois dû être utilisés. D'autre part, les éléments de l'éjection rapide ont été programmés et ont fonctionné simultanément ou consécutivement avec des cibles internes. C'est ainsi que par exemple 17, 18 ou 19 paquets étaient éjectés, les paquets restants interagissant avec des cibles internes.

Les cibles 63 ont été mieux blindées contre les effets du champ magnétique. On a simplifié le montage et le démontage des cibles des chimistes. La programmation a été étendue à l'ensemble des appareils utilisés pour le fonctionnement des cibles. D'autres développements sont bien avancés: laboratoire pour le montage et le stockage des cibles radioactives, cibles externes, cibles à mouvement rapide, cible à mouvement asservi, perturbateur plus adapté aux opérations simultanées des cibles, indicateur de pourcentage de partage du faisceau entre diverses cibles.

b) Systèmes d'éjection

Les travaux pour l'éjection dans la zone Est progressent régulièrement. La mise au point des aimants à septum s'est poursuivie (étanchéité, refroidissement, déformation mécanique, champ de fuite qui est de l'ordre de 5 G à 10 kG et de 100 G à 20 kG, etc.). Leur alimentation pulsée 60 V, 16 000 A a été réceptionnée et installée dans son nouveau bâtiment spécial et les jeux de barres 10 000 A ont été mis en place dans le tunnel qui la relie à l'anneau du PS.

Les études sur l'aimant de déflexion rapide ("kicker") à pleine ouverture (10,5 x 7 cm²) et à haute tension (± 120 kV) ont continué à l'aide de différentes sections d'essai construites dans la Division et prises comme modèles; parallèlement, les problèmes relatifs aux résistances de terminaison et des éclateurs de précision devant enclencher l'aimant sont en cours d'examen.

Pour les faisceaux éjectés, 12 quadrupoles de 1,2 m et 0,75 m, 11 aimants de déflexion de 1 m et 1,5 m sont en cours de fabrication et les premiers appareils seront livrés vers décembre 1964 ou janvier 1965; on a envoyé un appel d'offres pour une lentille spéciale de 1 m dans la section droite 61, pour laquelle une alimentation pulsée est à l'étude.

Des mesures sur le PS ont permis d'étudier d'une part la procédure d'éjection lente devant aller jusqu'à 27 GeV/c, d'autre part la déformation de l'orbite jusqu'à 7 cm d'amplitude afin d'amener le faisceau vers l'aimant à septum stationnaire, ainsi que les dimensions du faisceau pour de plus grandes intensités.

Les études pour la correction du champ magnétique du PS lors de l'éjection ont permis la construction de prototypes de "shims" magnétiques donnant des résultats satisfaisants. La réalisation des détecteurs retenus a commencé: écrans (ZSn ou plastiques supportant des températures élevées) avec télévision, compteurs Cerenkov, transformateur de courant, chambre à émission secondaire, diodes semi-conductrices avec lesquelles un appareillage électronique permettra la représentation simultanée de trois paramètres sur un oscilloscope. On a pu étudier aussi les problèmes relatifs au partage du faisceau entre les cibles internes et externes ainsi que les incidences sur la programmation du fonctionnement du PS; d'autre part, on a mis au point un système de transmission de plusieurs impulsions de commande distinctes sur un même câble coaxial par une méthode de partage du temps.

Un deuxième passage pour le faisceau éjecté de la section droite 58 est en cours de forage derrière le mur de l'anneau (environ 25 cm de diamètre).

Les études sur l'éjection depuis la section droite 62 ont porté notamment sur l'utilisation du quadrupole spécial de la section droite 61 et sur les méthodes d'accroissement de l'efficacité d'éjection au-delà de 80%.

La lentille quadrupolaire 99 utilisée pour l'éjection actuelle a été améliorée. Les huit nouveaux enroulements destinés à déformer l'orbite ("bump coils"), devant être bobinés autour des culasses des unités d'aimants, ont été étudiés et seront installés lors de l'arrêt de novembre; à cette fin, une alimentation pulsée (650 A, 600 V) est étudiée au CERN.

c) Faisceaux secondaires

Le nombre de faisceaux ou de branches de faisceaux secondaires en service pendant cette période a été de 12, permettant la réalisation de 24 expériences de physique, dont en moyenne 5 avaient lieu simultanément.

4. Contrôle du PS

Les équipements des salles de contrôle ont été constamment améliorés et les installations ont encore été rationalisées, ainsi que les systèmes de contrôle, d'accès, de communication ou de cadencement. Des efforts constants sont faits pour améliorer les méthodes de mesure, d'optimisation et d'automatisation. On a étudié l'agrandissement de la salle de commande principale pour y loger de nouveaux équipements particulièrement pour des systèmes d'éjection, les faisceaux éjectés, les cibles et leurs moniteurs; les travaux seront faits pendant l'arrêt de novembre. La forme des orbites fermées est observée régulièrement afin d'apporter les corrections nécessitées par la présence de champs magnétiques parasites.

5. Zones expérimentales

Plus de 120 appareils de transport de faisceaux (lentilles, aimants, séparateurs, rhéostats, etc.) ont été installés et alignés plusieurs fois dans les trois zones expérimentales toujours bien occupées, nécessitant la pose de 5 km de câbles électriques souples et de 1,2 km de tuyaux d'eau, le blindage pour la protection contre les radiations nécessitant toujours des manutentions de centaines de tonnes d'acier et de béton. Les 63 génératrices tournantes et les 10 redresseurs ont travaillé continuellement, alimentant faisceaux et chambres à bulles.

Un nouveau système centralisé de mesure des courants et de contrôle à distance des génératrices, groupé par faisceau, a permis de diminuer les temps de mise en route des expériences. Les performances des séparateurs électrostatiques ont été améliorées autant pour la tenue des hautes tensions que pour la résistance aux claquages.

Les 5 aimants en C "Alsthom", type "fenêtre", ont été livrés et essayés, et les mesures magnétiques ont indiqué une excellente uniformité relative de $\pm 0,7 \times 10^{-4}$ à 16,6 kG. La première lentille mince "Rade Končar" de 0,75 m à profil en "huit" a été livrée et l'ensemble des 6 le sera cette année. La linéarité de champ jusqu'à 1 000 G/cm est très satisfaisante. Quatre aimants standards de 2 m ont été commandés. Des alimentations à redresseurs 950 A, 185 V ont été étudiées et 8 sont commandées. Des commandes pour des génératrices et des redresseurs supplémentaires standards sont toujours en cours. Des études ont aussi porté sur des alimentations pulsées spéciales et sur des alimentations mobiles pour chambres à bulles de 3 MW (5 000 A, 600 V) ainsi que sur des unités de refroidissement mobiles de 3 MW pour lesquelles des offres ont été reçues. D'autres études portant sur l'amélioration générale des systèmes de refroidissement se poursuivent en permettant une utilisation accrue des zones expérimentales.

De nouvelles unités de ventilation et d'échappement pour les gaz explosifs ont été commandées pour les halls d'expériences. Une cible à deutérium liquide ayant fonctionné pour une expérience a été construite par la Division. Le bureau technique et l'atelier ont continué à participer en tout ou partie à l'étude et à la fabrication de certaines pièces telles que tubes à vide, chambres à vide articulées, tanks spéciaux pour le PS, appareils de manutention, etc.

6. Etudes de faisceaux

La Division a continué ses travaux de liaison et de collaboration avec les groupes de physique pour la préparation des expériences et leur programmation, ainsi que l'étude de l'utilisation des cibles externes et de leur blindage.

7. Projets d'améliorations du PS

La Division a commencé l'étude de projets relatifs à une amélioration éventuelle du PS, tels que l'augmentation du taux de répétition, une nouvelle injection à 200 MeV (avec la Division AR), une extension du hall Est et un grand hall expérimental pour faisceaux éjectés.

II. SC MACHINE DIVISION

by G. Brianti

SC MACHINE DIVISION

The period under consideration has been marked by an intense utilization of the SC for physics experimentation. In fact, 3 713 hours amounting to 85% of the total time have been devoted to the experiments. Of this time, less than 4% has been lost through faults and unscheduled repairs. The ageing of various installations, however, required the revision of important machine parts and a considerable preparatory work for its continuation during the January shut-down.

The studies and the constructional work for improving the SC and its utilization have continued along many lines, principally:

- (a) Better facilities for experiments. The main points are the construction of the new 100 kW beam stretching system and of the first section of the new extraction magnetic channel.
- (b) Machine studies. The biggest effort has been concentrated around the testing and installations of the cyclotron model for studying the phenomena occurring in the central region of a synchro-cyclotron. Collaboration with other laboratories (especially Rutherford) for the utilization of the model has been established.
- (c) Meson beam studies. A programme of measuring pion production cross-sections by 600 MeV protons on various nuclei and at different emission angles has been started in order to improve understanding of the present pion beams and to evaluate possible improvements.
- (d) Improved radiation safety, both with the machine on and off. For the first condition, local shielding of the roof has been reinforced and a number of baryte beams have been constructed to be used for covering the external proton beam so as to extend its allowed utilization time. The construction of a suitable irradiation cave to complete the installation for the external proton beam has been decided for next year. For the work with the machine off, the design and realization of remote control and handling of various fixtures in and around the machine are actively pursued with a view to reducing the doses absorbed by maintenance crew. The theoretical and experimental studies of machine activation have led to a definite proposal which is being examined. All this work has been carried out in close co-operation with the Health Physics Group.

In addition, preparatory work for the extension of our d.c. supplies and cooling water has started, to meet the increased demand caused by the new experimental installations and the cyclotron model. Preliminary studies on a possible arrangement for the on-line isotope separator and the connected facilities have been undertaken, especially in view of its compatibility with other uses of the external proton beam.

Co-operation with NASA has been continued. One of our engineers is going to the USA for the commissioning of the cyclotron magnet, whereas another member of the Division will go to Eindhoven to assist in the final testing of the RF equipment constructed by Philips.

From the organizational point of view, it has been decided to reinforce the direction of the Operation Group by the appointment of two qualified engineers.

The details of the work can be summarized as follows:

1. Operation

(a) Machine time distribution (in hours) 1.5.64 - 31.10.64
184 days = 4 416 hours

Nuclear physics	3 573 (+2 330 parasites) (81%)
Technical development	141
Maintenance and setting up of experimental equipment	474
Faults and repairs	140
Holidays	0
Shut-down	88
	<hr/>
	4 416
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(b) Machine and general installations

In addition to the routine work, the effort was concentrated mainly on the following points:

- (i) Reduction of radiation doses to staff during installation in and around the machine, by redesigning the target, probe-target and ion-source mechanisms and the lens platform.
- (ii) Improvements of the safety system for controlling the access to radiation areas, required by the increasing complexity of the utilization of the machine.

- (iii) Reinforcement of shielding for the machine and the experiments, mainly required by the new Swiss law on radiation dangers. Obviously the manipulation of this additional shielding puts an increased load on the installation crew.
- (iv) Complete overhaul of the two 1 MW motor generator sets, performed in the factory, and subsequent testing and recommissioning on our premises.
- (v) Design of the new 18 kV local sub-station, required by the increasing short-circuit power of the CERN network and the rising SC consumption.
- (vi) Considerable help to the experimental teams concerning vacuum installations, especially for the polarized target and the external proton beam.

2. Studies and developments

- (a) A considerable effort has been devoted to prepare the test and the installation of the new 100 kW beam stretching system, which will take place during the January shut-down.

By means of model measurements, studies were started of possible arrangements of RF broad-band accelerating structures for the SC.

Studies of suitable forms of balanced line beam probes for non-destructive internal beam measurements were made on a model. Investigations concerning the design of a beam monitor for the external proton beam have also been put in hand.

- (b) The work around the polarized proton source has been continued, but recent developments in other laboratories and the future utilization of the machine made it necessary to initiate an exhaustive enquiry on our project, on both technical and financial grounds. It is anticipated that a decision on the future of the project could be reached by the end of the year.

3. New projects

- (a) Cyclotron central region model

The magnet has been accepted. Its pole tips are under construction after preliminary field measurements, whereas the vacuum tank has arrived and acceptance tests are in progress.

The RF system is near completion with all parameters frozen, and the low-energy tests have been performed in the vacuum tank. The method for RF alignment has been devised and the low-level electronics is almost finished. The control system is designed and under construction.

The building which will house the model is in progress and will be completed by the spring of 1965.

(b) Extraction channel

The first of the seven 50 cm sections is being mounted and will be measured in the near future. The new arrangement of the kicker condenser bank has been mounted for testing.

(c) Magnet measurements

The MSC magnet measuring team have devoted approximately 60% of their time to some other divisions. A scheme for fully automatic field measurements and data recording and handling has been adopted and is in progress.

(d) Induced radioactivity

A proposal for reducing the induced activity in the SC machine based on the positioning of low-activity absorbers inside the tank has been worked out. The studies of long-time irradiation have been continued both on the SC and PS machines.

(e) Beam design

A systematic study of various beams used in experiments at the SC is being made with the help of computer programmes. A number of beams were designed and tested.

Programmes are being established for the use of pion production data and for the optimization of external pion production targets.

4. Engineering

As in the past, the Group has continued to devote its efforts to producing equipment for the MSC Division and experimental apparatus for the NP Division.

(a) Work for the MSC Division included:

- a vacuum vessel and pumping system for the model cyclotron, together with handling equipment and various parts of the RF system;

- various items associated with the polarized proton source;
- a number of magnets and supports;
- the revision of targets;
- the redesigning of the ion source and probe target.

(b) Work for the NP Division included:

- counter arrangements;
- beam transport lines and special magnets and lenses;
- spark chambers;
- Cerenkov counter;
- experimental layouts.

III. NUCLEAR PHYSICS DIVISION

by P. Preiswerk

NUCLEAR PHYSICS DIVISION

1. Experiments at the proton synchrotron

During most of the time this year there were 10 experiments in the setting-up, testing or running stage on the floor of the experimental halls at the PS. The policy followed by the Electronic Experiments Committee to have two users per main beam increased the efficiency. Loss of machine time due to beam blocking during the setting-up and running-in period of a given experiment could be reduced. Moreover, the improved beam-sharing facilities increased the possibilities of parallel running of several experiments.

In the last report we drew the attention to the present rapid development of electronics techniques. Filmless spark chambers with computer on-line have now successfully been operated in two experiments. An experiment to determine the parity of the Σ particle uses a polarized proton target. The first high-intensity counter beam with separation of antiprotons and kaons was put into operation and is extensively used. The automatic measuring devices, the HPD and Luciole devices of the DD Division, have also become essential for the measuring of spark chamber pictures.

Among the contributions made by NP groups at this year's International Conference on High-Energy Physics at Dubna, we would like to mention: the complete analysis of the results of the 1963/1964 neutrino spark chamber experiments, results on small-angle proton-proton scattering revealing a real part of the scattering amplitude, results on π -p and K-p charge exchange processes, the study of the Λ - β decay, the observation of the annihilation of the proton-antiproton system into muon pairs and the determination of the magnetic moment of the Λ particle by the Emulsion Group in collaboration with groups in Bristol, Lausanne and Munich.

A series of measuring of proton-proton scattering in the Coulomb-interference region at 10, 19 and 26 GeV/c have been performed in June-August. Sonic spark chambers, with a data read-out onto magnetic tape, were used. Angular distributions over an angular range of $\approx 2 - 20$ mrad and total cross-sections were obtained. A real part of the elastic scattering amplitude of about 30-40% of the imaginary part was found over this energy range. The same system was used in September to measure elastic proton scattering at 19.3 GeV/c on D, Li⁶, Li⁷, Be⁹, Cu and Pb.

Since September, the SDS 920 computer has been connected on-line to the experiment and used for checking the incoming data. Using this facility and the possibility to record the data at a rate 5 times that of the previous system, two days of running time have yielded about 10^5 scattering events.

An experimental equipment to measure π^- -p scattering with large momentum transfer has been mounted in the 3.5 GeV/c beam in the North hall. The experiment uses two magnets, one for the scattered and one for the recoil particles. Nine spark chambers viewed by a single fast cycling camera give the trajectories of the three particles involved.

A visiting team from Saclay has finished a run to study the π^- -p charge exchange process with 6, 10, 13 and 18 GeV/c pions and also the production of π^0 and η mesons between 2.5 and 5.8 GeV/c pion momentum. The analysis of the pictures taken is proceeding.

The analysis of spark chamber pictures taken early in the year by a CERN group on the peripheral production of γ in π -p collisions also continues.

The CERN/ETH Group is analysing the pictures taken with the large magnetic spark chamber. Results on the charge exchange process $K^- + p \rightarrow \bar{K}^0 + n$ at 9.5 GeV/c were obtained and also on the process $\pi^- + p \rightarrow K_1^0 + K_1^0 + n$.

After the discovery of apparent CP violation in the K_0^2 decay by the Princeton Group at Brookhaven, an experiment was set up to measure the energy dependence of this effect as it may reveal the existence of a new field.

The "maximum angle missing-mass spectrometer" for the investigation of the mass spectrum of unstable bosons has been completed and put into operation. Known resonances, such as the ρ^- , A_1 and A_2 mesons have been obtained in the first run. The method, not used before, has been shown to work, and a systematic investigation of the mass spectrum of charged mesons in the mass range from 0.7 to 2.25 GeV has begun. The work is done in collaboration with the DD Division Mercury Computer Group; the system uses the Mercury on-line.

The decay mode $\rho \rightarrow \pi + \gamma$ has not yet been directly observed. One expects the branching ratio of $\rho^- \rightarrow \pi^- + \gamma$ to the normal decay mode $\rho^- \rightarrow \pi^- + \pi^0$ to be of the order of less than 1%. An experiment with spark chambers has been set up to study the decay of the ρ and is running.

The final data-taking run of the Λ - β decay was completed at the beginning of March. About 200 000 pictures were fully analysed. The preliminary result, based on a sample of 67 $\Lambda^0 \rightarrow p + \bar{e} + \nu$ decays, indicates the V-A nature of the interaction. A more refined analysis is almost completed and one may anticipate a sample of about 130 leptonic decays.

The apparatus for the determination of the parity of the E^- has been installed. The E^- are produced in the reaction $K^- + p \rightarrow K^+ + E^-$. The trigger is made by a K^+ detector and the E^- and its decay products are detected in a spark chamber arrangement. A first test run with a polyethylene target and a polarized proton target has taken place.

The polarized target from Saclay was tested in a p-p scattering experiment at the SC and gave a value of 50% polarization in agreement with the value given by the nuclear magnetic resonance signal.

The study of $p\bar{p}$ annihilation into muon pairs was continued. A total of 7×10^9 antiprotons were sent into the target. The corresponding cross-section is found to be less than or equal to 10 nanobarns. A new very compact electron telescope has been constructed and tested.

The Neutrino Spark Chamber Group has essentially concluded the analysis of the 1963 and 1964 neutrino experiments in which a total of some 10 000 neutrino events were found.

The most important result of the experiments was a lower limit to the mass of a possible intermediate boson responsible for the weak interaction. A signature for the production and decay of an intermediate boson would be the appearance of muon pairs. No evidence of such pairs was found from a study of secondary interactions. A subsequent search in the magnetic chamber for events with two long tracks, of which the longest was positive, allowed a lower limit of 1.8 GeV to be set to the mass of the boson, provided the branching ratio of leptonic to non-leptonic boson decays is ≈ 1 . The same conclusion was drawn from the observed rate of possible (μe) candidates.

Other results of interest obtained in the spark chamber are the first data on the differential cross-sections for the rare electron neutrinos. These results provide a check on the fact that the muon-type neutrino appears universally together with the muon.

Data obtained from the events produced by muon neutrinos, which constitute the bulk of the events, are consistent with the conclusion obtained in the parallel experiment of the CERN Heavy Liquid Bubble Chamber Group, i.e. that the axial vector form factor in the elastic transformation of a muon-neutrino into a muon is approximately equal to the vector form factor.

The presence of magnetic chambers in the experimental arrangement allowed the study of the sign distribution of the muons produced by the almost pure neutrino beam. The result confirms lepton conservation to hold, in the sense that muon-neutrinos produce

negative muons, but not positive ones. An upper limit of 1% was placed on the intensity of a lepton number violating interaction. This is the most accurate test on lepton conservation performed so far.

The results of these studies are being published.

The Group is continuing investigations of some of the details of the experimental results. In addition, preliminary studies are being made of future neutrino experiments with spark chambers.

The Emulsion Group, in collaboration with Bristol, Lausanne and Munich, obtained preliminary results for the magnetic moment of the Λ^0 hyperon (0.54 ± 0.24 nucleon magnetons).

Several production runs were made of the experiment designed to measure the magnetic moment of the Σ^+ hyperon (collaboration: Bristol, CERN, Lausanne, Munich, Rome).

During the neutrino run in May, a pilot experiment was carried out using spark chambers in conjunction with a 10-litre emulsion stack to study neutrino interactions in emulsion (collaboration: U.C. London, CERN, Brussels). To date, four clear neutrino-induced events have been observed and studied in detail.

In July, four stacks were irradiated to a total of 2×10^6 antiprotons of 5 GeV/c momentum for the French collaboration (Clermont-Ferrand, Lyon, Paris, Strasbourg) and for Bern and Osmania University (India). One stack of loaded emulsions was exposed to a 5 GeV/c K^- beam for Strasbourg.

In September, an experiment on baryon spectroscopy using the PS internal beam at ten different energies ranging from 6 GeV up to 28 GeV was carried out by the Copenhagen-Bombay collaboration.

In collaboration with the CERN Nuclear Chemistry Group and with the Naples Emulsion Group, a visiting scientist from Warsaw (J. Zakrzewski) successfully initiated a programme of work on fission studies using mica detectors. Up to the present, all the irradiations have been made to the internal proton beam at the PS.

The Group in charge of the muon storage ring project (anomalous magnetic moment of the muon experiment) carried out two pilot experiments to measure particle backgrounds and efficiencies of various detectors in situations simulating the final experiment. Calculations, in considerable detail, on the expected signal and its dependence on various factors have been made. The results have enabled the Group to proceed with the designs for shielding, detectors, electronic logic and timing, magnetic field measurement probes, and final details for the storage magnet and vacuum tank. The construction of these items is proceeding; the actual assembly of the ring at CERN is foreseen to start next February.

An experiment was made to make an accurate check of Einstein's second postulate of relativity in the GeV region. The velocity of γ rays emitted by π^0 mesons moving at a $\beta = 0.99975$ was found to agree with the standard velocity of light 1 part in 10^4 .

2. Experiments at the synchro-cyclotron

At the SC, besides the continuation of pion physics, several experiments were devoted to the study of nuclear structure problems. By the use of advanced techniques - we refer in particular to the use of current-chambers and Čerenkov counters with high selection power - new ways of investigating nuclear levels were opened.

More data on the beta decay of the π^+ ($\pi^+ \rightarrow \pi^0 + e^+ + \nu$) were taken with a new apparatus with a higher π^0 detection efficiency compared to the original one. A total of 230 $\pi^+ \rightarrow \pi^0$ events has been collected and analysed up till now. A preliminary evaluation gives for the branching ratio $R \frac{\pi^+\pi^0}{\pi^+\mu^+}$, a value which is in agreement with the conserved vector current prediction within the experimental uncertainty of 10%.

The study of $\pi^+\pi^-$ interaction at low energy continued with an incident π^- kinetic energy of 250 MeV. A new run was done with the aim of measuring the scattering length for $\pi^+\pi^+ \rightarrow \pi^0 + \pi^0$ charge exchange collisions.

The process of the double charge exchange in nuclei has now also been observed with incident π^- in He, Li, Be and C. A special search for the production of tetra neutron (n^4) in He⁴ and hydrogen seven (H^7) in Li⁷ led to an upper limit for the production cross-section of 10^{-31} cm²/steradian.

Preliminary measurements of π^- inelastic scattering revealed a number of γ lines already known as well as new transitions in light nuclei.

In collaboration with the Orsay Laboratory, an experiment on the reaction $\pi(\text{Li}^6 \text{ } 2p)\text{He}^4$ was done. A new method was successfully used to localize the incoming π and the outgoing protons in spark chambers by measuring currents. The range of the protons is also automatically measured with spark chambers. Evidence was obtained for an excited state of He⁴.

A study of μ mesic X rays with high precision in order to obtain accurate data on nuclear radii and on the quadrupole structure of heavy nuclei has been started. A lithium-drifted germanium detector operated at low temperatures is used. It has a resolution for γ ray energy measurements of 15 keV.

The Chemistry Group made studies relating to a possible project to operate an isotope separator directly connected to targets in the external proton beam of the SC. The time of transfer of nuclear reaction products from the target to a collector was investigated. The diffusion out of the target and the subsequent flow to the ion source of the separator were measured. The average time, for Xe formed in uranium targets, can be as low as 4 seconds.

3. General activities

The Electronics Group devoted a great deal of effort to the building of equipment for the computer on-line experiments. Equipment required for the fast transfer ($8 \mu\text{s}$) of 24-bit numbers, in parallel between scalars of ferrite core buffers and the SDS computer, has been completed and successfully tested. The ferrite core buffer which replaces scalars in sonic chamber applications has also been completed and tested.

A second magnetic tape recording system has been brought into service. It receives data from a sonic chamber via scalar buffers, and records on the magnetic tape in IBM format for subsequent 7090 processing.

The new 100 megacycle/s nucleonic modules have been successfully utilized in PS experiments. A visiting engineer from Berkeley has devised a system for recording several sparks from sonic chambers. Pulse-height converters have been constructed and successfully employed in a current-ratio chamber equipment.

The Data Handling Group has continued to give support to NP physics groups in specific problems of spark chamber analysis and has operated a general consulting service on programming problems in the Division. In an attempt to avoid unnecessary multiplication of programming within NP, particular emphasis has been given to the generality of programmes written. Typical problems treated have resulted in fairly general routines for linear-track geometrical reconstruction and optimization, and fitting of particle trajectories in magnetic fields.

The SDS 920 purchased by NP arrived on 18 June 1964 as planned. The two magnetic tape units, however, arrived only in September. At the present time, the computer is connected up for data-taking with the p-p small-angle scattering experiment via interface electronics made by the Electronics Group.

The high-intensity separated beam designed by the Technical Assistance Group is now in full use and the intensity is 20 000 K^- at 1.8 GeV/c and 50 000 \bar{p} at 2.3 GeV/c with 10^{12} circulating protons.

The purity of the beam is approximately 7 pions per 1 K^- and 4 π^- per \bar{p} . A new version for the high-energy π beam (d_{17}) with variable momentum from 4 to 15 GeV/c was designed and operated.

A double spectrometer magnet weighing about 100 tons and producing a field of 14 000 gauss in a volume of 1 m³ was designed and the order has been placed.

Studies are being made on a long-pulse radio-frequency separator for counter beams at higher energies as well as on a very large magnet for spark chambers.

A high-precision Čerenkov (DISC) counter has been tested. It gives an over-all resolution on the velocity of charged particles of 5×10^{-6} . This precision allows an easy discrimination of π and μ up to the highest energy of the PS beams.

A large-size scintillation counter system was developed which measures the time-of-flight and the trajectory of a particle simultaneously. It can be used as a hodoscope or for a decision-making triggering system. The precision obtained is 2 cm in position and 0.2 nanosecond in time.

4. Staff

The total staff number of the NP Division is 187. The actual strength of physicists involved in electronics, emulsion and nuclear chemistry experiments is 60 staff members and 107 visitors and fellows. For the first time, an outside visiting team (from Saclay-Orsay) carried out an electronics experiment at the PS bringing the complete equipment with them.

IV. DATA HANDLING DIVISION

by G.R. Macleod

DATA HANDLING DIVISION

1. General

The major effort of the Division is being put into preparations for the Control Data Corporation 6600 computer. The building has now been completed under the supervision of the SB Division and the installation plans have been drawn up with CDC. The CERN Support Group has been set up by CDC in Geneva in accordance with the purchase contract, and a close working relation has been established between them and various groups in the Division; staff of the Division have also visited CDC groups in the United States. Engineering design for the attachment of special devices to the 6600 is well advanced, and detailed work on systems programming has begun. CDC have delivered the first 6600 computer to the Lawrence Radiation Laboratory at Livermore, and it is now in regular operation. CDC exercised the option, provided in the contract, to postpone installation of the CERN computer until January, and it seems at present that they will be about one month late delivering the computer itself, and somewhat longer for the operating system, compiler and assemblers.

The work load on the IBM 7090 computer has continued to increase, and the computer is now fully saturated. The Mercury computer has been successfully used in the first experiment at CERN to use a computer on-line. This was a missing-mass experiment carried out at the proton synchrotron in collaboration with NP Division.

Regular measurement of film from the first bubble chamber experiment to be analysed at CERN using the mechanical flying spot digitizer (HPD) on the IBM 7090 has now begun in collaboration with TC Division, after successful analysis of a test batch of 500 events.

Recruiting in the junior and middle grades has been more successful than earlier in the year, but the work of the Division is still hampered by the difficulty in recruiting adequately experienced staff for senior posts.

2. Electronic Computers

(a) Computing Service

The IBM 7090 is now operating round the clock seven days per week, processing an average of 350 jobs per day. Automatic control of time used and printer output for each job has been introduced, and this facility has been used to provide an express

service which allows users to make short tests with a much reduced turn-around time. To aid in throughput studies, an automatic record is now kept of various characteristics of each job processed by the 7090. A new paper-tape reader has been installed on one 1401 and further routines for paper-tape input have been provided. Additional card handling equipment has been made available to users as the increasing volume of work demanded.

The Mercury computer has been used exclusively in on-line applications, and programmes and electronic circuitry have been developed for these, which include data-link connection to a sonic spark chamber experiment; to a vidicon spark chamber system and a IEP. A typewriter input-output has been used to provide pilot "desk-calculator" facilities.

(b) Applied mathematics

Programmes have been written for the TH Division concerning calculation of cross-sections and for AR Division concerning surveying problems for a large accelerator. An average of 11 enquiries a day have been answered by the Programming Enquiry Office, and 28 new programmes have been added to the CERN programme library. Conversion of this library to the 6600 has begun.

(c) Preparations for the 6600

The new computer building is now complete. The motor generator sets for the computer power supply have arrived, and a new users' area providing much better and centralized services for card handling and input and output of jobs has been put into service.

A CERN FORTRAN language has been defined as a means of maintaining programme compatibility between CERN and laboratories in Member States using other CDC or IBM computers. Lecture courses on the CERN FORTRAN have been given and the modified SIFT programme put into general use to convert programmes into CERN FORTRAN.

Much detailed work has been done in collaboration with the Support Group set up by CDC on understanding the operating system, assemblers and compiler to be provided by CDC. Modifications and additions necessary for CERN have been specified and some programming started.

After studies made with CDC about the connection of low-speed devices to the 6600, a multiplexer has been ordered to allow all such devices to be served by one computer channel. Engineering work is going ahead to connect a paper-tape reader, paper-tape punch and a graph plotter to the multiplexer, as well as a system of tape number display units which are being constructed to indicate magnetic tape reel numbers to the computer operators.

A CERN FORTRAN Manual has been completed, and other manuals together with a set of information files on the use of the 6600 are being prepared. A paper-tape controlled typewriter has been used in preparing these texts; a programme is under development to assist in editing and correcting texts.

Visits have been made to Livermore and various CDC plants by engineers and programmers of the Division to discuss various aspects of the 6600 work.

(d) Computer development

A new group has been set up to carry out studies necessary for the long-term development of CERN's computing facilities. Simulation studies are being made on the problems of job-scheduling on the 6600, and problems associated with the use of many remote consoles are being examined.

3. Data Handling Development

(a) Scanning tables and IEPs

The prototype scanning table for the CERN 2 m hydrogen bubble chamber has proved very satisfactory in use; the assembly of a further 8 tables is well under way, and several laboratories in Member States have expressed interest in having tables built to this design. The second IEP to be modified for larger film format is undergoing final tests, and one IEP has been fitted with a prototype track-following device. New digital circuitry has been designed, and eleven sets have been constructed and are now ready for testing. One IEP has been connected to the Mercury computer, and the experience gained has led to a detailed proposal being made for the connection of several IEPs to the 6600 computer.

Detailed improvements have been made to the bubble chamber analysis programmes, and the work of conversion of these for the 6600 computer - now about 80% complete - is being done in collaboration with TC Division.

(b) Mechanical flying spot digitizer (HPD)

A test sample of about 500 events (four-prong interactions of 5.7 GeV/c antiproton interactions in the Saclay 81 cm hydrogen bubble chamber) has now been successfully analysed by the HPD system. Scanning and rough measurement averaged 5 events per hour on the Milady digitized tables and measuring on the HPD I averaged 54 events per hour. A detailed comparison has been made of the results of a set of events measured both on the IEPs and on HPD, and the results show that the majority of the difficulties met with the earlier programmes have been overcome in the new version.

Measurement and analysis with HPD of the film for this experiment have therefore been begun on a routine basis in collaboration with TC Division. Automatic measurement of ionization is being used in the HPD analysis programmes for this experiment.

Programme development for the analysis on HPD of a new experiment with NP Division using the magnetic spark chamber is going well. To date 31 test events have been analysed in detail, and in all of them the curved tracks from K^0 decays have been satisfactorily measured.

The mechanical part of HPD II is now installed and being tested. The film transport model has been satisfactorily tested and is now being engineered. The design of the digital and control circuitry is complete, and construction has begun. Detailed discussions with CDC on the attachment of the HPDs to the 6600 led to CDC developing and marketing a new standard interface satisfactory for any high-speed device, and this will be used for the CERN flying spot digitizers. Electronic design for the connection of HPDs to this interface is well under way.

(c) Cathode ray tube flying spot digitizer (Luciole)

Luciole I has been used regularly on the 7090 to provide test data for the development of programmes. A detailed comparison has been made of a set of spark chamber pictures measured automatically and by hand. Certain small discrepancies remain, due to difficulties of calibration of the scanning raster, and tests are being made at present with a new calibration programme to overcome these difficulties. Construction of the digital circuitry for connection of the device to the 6600 is nearly complete. A new test bench with improved facilities has been set up for further investigations into precision cathode ray tubes.

(d) On-line computer experiments

The first experiment at CERN using a computer on-line was carried out in association with NP Division. The Mercury computer and its 1 km data link to the PS South hall were used successfully in a missing-mass experiment; one event per burst was recorded and analysed between bursts, the computer determining the momentum and scattering angle of the charged secondary particle.

Sonic spark chamber reconstruction programmes have been developed for an experiment using the SDS 920 computer on-line. The system works satisfactorily, after some initial electronic difficulties with the computer have been overcome, recording data from up to 12 events per PS burst.

(e) Miscellaneous

Circuitry has been developed for the binary picture number display on the CERN 2 m bubble chamber. Studies have been made on the use of storage tube devices for display of computer data. An International Meeting on Electronics and Programming for Flying Spot Digitizers was held in collaboration with the "Centro Nazionale Analisi Fotogrammi" at Bologna from 5 to 9 October. The development work in the Division has benefited very much from the presence of a number of visitors from laboratories in Member States.

4. Scientific Information Service

(a) Library

There was a considerable increase in preprints received from scientists and institutions all over the world, which made necessary a change in the loan system for this material, in order to relieve pressure at the issue desk. Since 1 September, a simplified loan system for preprints is working successfully. The growth of the book, periodical and report collection of the Library made it necessary to order additional furniture and to remove older editions and duplicate copies to a stock room. Out of a total of 10 544 reprints in the Pauli Collection, 9 490 have been fully catalogued to date.

(b) Publications and exchange

During the period under review, 19 CERN reports have been distributed. Thirty-two new addresses were added to the mailing list for CERN reports. Thus the total number of recipients is 655 located in 54 countries. Twenty-eight copies of the Proceedings of the 1962 International Conference on High-Energy Physics have been sold, thus leaving only 52 copies in stock out of an edition of 1 700.

(c) Photography and offset

The continually growing demand for offset reproduction of documents made it necessary to order a new offset printing machine. It is hoped that this machine, which will be installed by the end of the year, will enable us to cope with printing work during the next few years.

V. THEORETICAL STUDY DIVISION

by L. Van Hove

THEORETICAL STUDY DIVISION

1. Personnel

While the staff strength of the Division remained at 15 (11 of which are scientific staff), the number of fellows and research associates from CERN Member States increased to 24. The number of visiting scientists, rather high as usual in the summer months, was 24 in November, 9 from Member States and 15 from other countries. Two of each group were paid out of CERN funds, the others being supported by their home countries.

2. Research Activity

- (a) The work on strong interactions, especially SU₃ symmetry and peripheral collisions, which was very extensive in the first half of 1964, was continued in the period under review. It was largely overshadowed, however, by the many theoretical investigations prompted by the experimental discovery of the decay $K_2^0 \rightarrow \pi^+ + \pi^-$ in July 1964 in Brookhaven. Staff members as well as summer visitors of the Division speculated about possible explanations of this unexpected decay mode, proposing either a specific mechanism of CP violation in weak interactions or the existence of a new long range force generated on cosmological scale by the stars and galaxies surrounding us. Much work was devoted to exploring the theoretical possibilities implied by such new phenomena, as well as their experimental implications. The question of CP violation was discussed in particular for $K\mu_3$ decay and neutrino reactions. Great attention was also devoted to the many alternative mechanisms of CP violation proposed outside CERN.
- (b) Further work on weak interactions dealt with a scheme incorporating intermediate bosons into the framework of SU₃ symmetry, with the production of the (3/2, 3/2) nucleon isobar as well as of mesonic resonances in neutrino reactions, and with the relation between μ capture and $K\mu_3$ decay. A thorough review of the present evidence concerning μ capture coupling constants was carried out for presentation at the Dubna Conference and revealed good agreement with the values expected theoretically. As another study on μ capture, we mention an investigation of the reaction $\mu^- + D \rightarrow 2n + \nu$ which would also be of interest to study the neutron-neutron interaction.

- (c) On strong interactions, in addition to work on SU_3 symmetry (dealing mainly with various basic triplet models) and on peripheral collisions at medium and high energies, the investigation of large angle scattering at high energies on the basis of the statistical model was pursued further. More ambitious attempts were also started to reformulate the statistical model for a rapidly increasing mass spectrum of elementary particles, which would cause an extremely slow increase of the temperature with energy as suggested by the experimental data and by machine computations.

Another theoretical approach to large angle scattering, based on the analyticity properties of the amplitude at fixed energy, was carried further. Its interest stems from the fact that the observed decrease of cross-section with energy is about as fast as is reconcilable with the analyticity properties of the amplitude.

The use of analyticity properties to study strong interaction amplitudes was also applied to $\pi\pi$ scattering, with the remarkable result that an upper bound depending only on the π mass was found for the strength of the interaction.

- (d) Considerable effort was spent on the study of the non-relativistic Schrödinger equation with potentials strongly singular at the origin. Various methods were successfully developed to treat the repulsive case. It is hoped that relativistic generalizations will be found which would enable one to approach the problem of non-renormalizable field theories.
- (e) Sum rules have been proposed for the renormalization constants of a renormalizable field theory. They are applied to renormalization effects for partially conserved currents, as occur in weak interactions, and attempt to express these effects in terms of observable quantities.
- (f) In nuclear physics, earlier work on the pion optical potential is being extended in various directions. It provides support to the existence of short-range correlations in the nucleus. Nuclear π absorption is investigated, especially for reactions leading to specific nuclear states. Also the study of quadrupole effects in mesic atoms, initiated earlier, has been pursued.

3. Contacts with Experimentalists, Discussion Groups, Lectures

Among the many questions discussed with experimentalists, two have been in the forefront of interest: CP violation in weak interactions (prompted by the 2π decay of K_2^0) and nuclear structure problems (which now form an important part of the experimental programme at the CERN synchro-cyclotron).

Theoretical discussions were held to study the contents and significance of recent work by Gürsey, Radicati, Pais and others, which introduces a new symmetry group SU_6 combining SU_3 symmetry and ordinary spin rotation.

Two lecture series were given by members of the Division, one dealing with strong interactions at high energy and the other with SU_3 and weak interactions.

The papers and reports written in the Division, and the lectures given at the Theoretical Seminar, are listed below.

4. List of Publications (April-October, 1964)

- | | |
|-------------------------------------|--|
| G. Segrè | Effect of a phenomenological S wave from pion interaction on the photo-production of a pion pair in a Coulomb field. |
| L.L. Foldy and J.D. Walecka | Muon capture in nuclei. |
| B. Zumino | Charge conservation and the mass of the photon. |
| A. Deloff and J. Wrzecionko | The low energy Λ -N and Λ - Λ interaction. |
| G. Fast, G. Ranft and J.J. de Swart | Λ nucleon potential. |
| K. Gottfried and J.D. Jackson | Influence of absorption due to competing processes on peripheral reactions. |
| M. Nauenberg | Electromagnetic mass splittings and the baryon octet mass formula. |
| K. Dietz and G. Domokos | Bootstrapping of vector mesons. |

- R. Oehme and G. Segrè On the commutation relations of weak currents.
- G. Domokos, P. Suranyi and A. Vancura Theory of Fermi interactions.
- R. Hagedorn Large angle cross-sections $p + p \rightarrow A + B$ and $\pi + p \rightarrow A + B$ at high energies predicted by the statistical model.
- M.H. Cha and J. Sucher Polarization of a decay particle in a two step process: $A + B \rightarrow C + D$, $D \rightarrow E + F$.
- H.M. Chan, K. Dietz and C. Wilkin One particle exchange forces and meson supermultiplets in a SU_3 invariant model.
- H.M. Chan The prediction of 1^+ , 2^- , 2^+ meson supermultiplets in the GeV region by a self-consistent bootstrap model.
- D. Amati, H. Bacry, J. Nuyts and J. Prentki SU_4 and strong interactions.
- H. Bacry, J. Nuyts and L. Van Hove Symplectic symmetry of hadrons.
- A. Tenore and A. Verganelakis Elastic photon-deuteron scattering and the nucleon polarizability.
- M. Nauenberg and A. Pais Peaks in mesonic systems.
- H. Cornille and E. Predazzi Singular potentials with short range.
- G. Domokos Higher order corrections and coupling constants in weak interactions.
- H. Bacry, J. Nuyts and L. Van Hove Symplectic symmetry of hadrons.
- S.F. Tuan Energy peaks for three-body meson systems.
- K. Gottfried, J.D. Jackson and B. Svensson Influence of absorption due to competing processes on peripheral reactions.

- S.L. Glashow, S. Coleman,
H.J. Schnitzer and R. Socolow
Electromagnetic mass differences of
strongly interacting particles.
- J. Nuyts and H. Ruegg
Vector current and violation of SU_3 .
- J. Løvseth and J.D. Walecka
Radiative charged lepton production
by neutrinos.
- D. Amati
Nuclear forces.
- G. Jona-Lasinio
Relativistic field theories with
symmetry breaking solutions.
- G.R. Henry, J. Løvseth and
J.D. Walecka
Peripheral production of single pions
and kaons by neutrinos.
- G. Furlan, R. Gatto and G. Longhi
Radiative corrections to
 $e^+ + e^- \rightarrow \mu^+ \mu^-$.
- G. Furlan and G. Mahoux
Some remarks on the renormalization
constants and the bound state
condition.
- L.L. Foldy and J.D. Walecka
Nuclear correlation functions and
muon capture.
- S.M. Berman and M. Veltman
Baryon resonance production by
neutrinos.
- H. Bacry and J. Nuyts
Remarks on classifications of hadrons
according to spin and internal
symmetries.
- N. Cabibbo
Weak interactions and the unitary
symmetry.
- C. Bouchiat and Ph. Meyer
First order violation of SU_3 invari-
ance in the vector amplitude of
leptonic decays of strange particles.
- G. Auberson and B. Escoubès
Production of light bosons by central
collisions of very high energies.
- A. Bialas and V.F. Weisskopf
Statistical theory of elastic proton-
proton scattering at large angles.
- C. Kacser
Theoretical and experimental
relationship between triangle
singularities, Peierls mechanism
and resonance poles.

- D. Morgan
Marginally singular forces and their role in producing pseudovector resonances.
- N. Cabibbo
Possibility of large CP and T violation in weak interactions.
- J. Bernstein, N. Cabibbo and T.D. Lee
CP invariance and the 2π decay mode of the K_2^0 .
- T.D. Lee
Symmetry properties of leptons in the zero mass limit.
- T.D. Lee
Remarks on triplet models in SU_3 symmetry.
- M. Lévy and M. Nauenberg
Apparent CP violation due to a new vector boson.
- A. Galindo, F. Hadjioannou and P. Pascual
Spectral representation and mass formula for spin 3/2 particles.
- H. Bacry, J. Nuyts and L. Van Hove
Pseudoscalar meson of mass 960 MeV and symplectic extension of SU_3 symmetry.
- L. Bertocchi, S. Fubini and G. Furlan
The short wavelength approximation to the Schrödinger equation.
- C. Fronsdal
Elementary particles in a curved space.
- T.E.O. Ericson
Recent developments in μ capture.
- W. Kummer
An SU_3 estimate of the effective non-leptonic parity violating coupling in strangeness conserving weak processes.
- L. Bertocchi, S. Fubini and G. Furlan
On the theory of scattering by singular potentials.
- A. Galindo
On the uniqueness of the position operator for relativistic elementary systems.
- H. Cornille
Singular potentials in co-ordinate space.

G. Ranft	Calculation of the Λ binding energy in nuclear matter.
B. d'Espagnat	SU_3 et interactions faibles.
H.M. Chan and C. Wilkin	A dynamical scheme of meson supermultiplets, possible assignments and Bronzan-Low quantum numbers.
A. Kihlberg	On the "minimal internal coupling".
R. Hagedorn	Thermodynamics of distinguishable particles - a key to high-energy strong interactions?

5. Theoretical Seminars (April-October, 1964)

L. Spruch	New York Univ. and Oxford	29 April	Variational and minimum principles in scattering theory.
J.A. Wheeler	Princeton Univ.	6 May	Gravitational collapse.
H. Cornille	CERN	13 May	Singular potentials with short range.
H. Pilkuhn	CERN	20 May	Double-peripheral model.
T. Toyoda	Padua	27 May	Complex Lorentz group.
W. Alles	CERN	5 June	Some consequences of Schwinger W_3 group.
A.P. Balachandran	Chicago, E. Fermi Institute	9 June	Application of the method of moments to partial-wave dispersion relations.
L.L. Foldy	CERN	17 June	Muon capture in light nuclei.
G. Domokos	CERN	24 June	Some questions of high-energy lepton physics.
S.L. Glashow	CERN	26 June	SU_4 and elementary particles.
M. Moshinsky	Mexico	29 June	Bases for the irreducible representations of Lie groups.

S. Coleman	Harvard	1 July	Tadpoles and electromagnetic mass differences.
E. Guth	Oak Ridge	15 July	Proton-proton scattering in the GeV range.
S.F. Tuan	CERN	17 July	Status of Peierls mechanism for baryon and meson systems.
T.W. Ruijgrok	CERN	21 July	A two-body model for very high energy collisions.
K. Gottfried	CERN	24 July	Peripheral production processes.
P. Signell	Bonn	27 July	The moderate energy nucleon-nucleon interaction.
T.D. Lee	Columbia Univ. and CERN	29 July	Possible implications of the observed approximate SU_3 symmetry.
R.A. Bryan	Orsay	31 July	One-boson exchange potentials for N-N scattering.
F. Gürsey	Brookhaven and Ankara	9 September	Spin and unitary spin independence of strong interactions.
S. Deser	Brandeis Univ.	14 September	Spontaneous symmetry breakdowns and μ -e electrodynamics.
C. Fronsdal	UCLA	23 September	Elementary particles in a curved space.
B. Stech	Heidelberg and CERN	30 September	Is the nucleon a bound state?
L. Wolfenstein	CERN	7 October	Transformation properties of weak interaction currents.
A. Kihlberg	CERN	13 October	Internal and space-time symmetries.

A. Martin	CERN	14 October	Quantitative bound on the $\pi-\pi$ amplitude.
R. Hagedorn	CERN	21 October	Thermodynamics of distinguishable particles - a key to high energy strong interactions?
H. Ruegg	CERN	23 October	SU ₆ and related topics.
J. Mandelbrojt	Marseilles	28 October	A mathematical study of the cut-off procedure.

VI. DIVISION DES CHAMBRES A TRACES

par C. Peyrou

DIVISION DES CHAMBRES A TRACES

1. Faisceau - Prise de photographies

Le nouveau faisceau k_4 du hall Nord du PS est entré en fonctionnement à la date prévue de façon entièrement satisfaisante. Ce faisceau fournit des mésons K^\pm séparés dans une bande d'impulsion allant de 800 MeV/c à 1,2 GeV/c. L'intensité du faisceau correspond aux valeurs calculées et permet la réalisation de la plupart des expériences en n'utilisant qu'une fraction (généralement plus petite que 25%) de l'intensité du PS.

La chambre de 81 cm de Saclay, installée à l'extrémité de ce faisceau, a pris jusqu'à ce jour:

dans l'hydrogène	300 000	photographies de \bar{p} de 1,2 GeV/c
	250 000	" de K^- à différents moments échelonnés entre 0,8 et 1,2 GeV/c,
dans le deutérium	120 000	photographies de K^+ arrêtés
	80 000	" de \bar{p} de 0,6 GeV/c
	70 000	" de \bar{p} arrêtés,

soit en tout 820 000 photographies. Les groupes intéressés par ces photographies étaient: CERN, Saclay, Heidelberg, Collège de France, Liverpool, Turin, Padoue, Pise, Rome, etc.

La chambre à bulles britannique de 1,50 m, qui avait passé au début de l'année par une période d'essais techniques et de mise au point, a commencé en juin son activité de production de photographies. Elle fonctionne de manière très satisfaisante. A ce jour elle a pris:

140 000	photographies de K^- d'impulsion 5 GeV/c
400 000	" de K^- " 6 GeV/c
60 000	" de K^+ " 5 GeV/c.

Les groupes intéressés étaient en particulier: Imperial College, Oxford, Birmingham, NIRNS, Munich, CERN, etc.

Le faisceau utilisé était le faisceau o_2 déjà mentionné dans les rapports précédents.

De plus, les essais du séparateur radio-fréquence construit par la Division AR ont commencé dans le faisceau o_2 avec l'aide de physiciens de groupes extérieurs et de la Division TC.

La chambre à liquide lourd de l'Ecole Polytechnique a fonctionné dans le faisceau σ_3 (dérivation du σ_2). Elle a réalisé un type d'expérience spécial dans lequel les primaires (protons ou mésons π) arrivaient sous la forme d'un faisceau très fin qui frappait une cible métallique intérieure. La chambre a pris dans ces conditions:

90 000 photographies avec des p de 20 GeV/c
pour une expérience de calibration nécessaire à l'expérience neutrino,

100 000 photographies avec des π^- de 16 GeV/c
pour l'étude de la désintégration du ρ en $\pi+\gamma$ par observation du phénomène inverse $\pi+\gamma \rightarrow \rho$, le photon virtuel provenant du champ coulombien d'un noyau lourd.

2. Résultats scientifiques

Il convient de rappeler ici que tous les groupes de la Division TC collaborent scientifiquement avec un ou plusieurs groupes extérieurs. Les résultats annoncés ci-dessous sont donc des résultats de collaboration qui ont tous fait l'objet de publications communes. La plupart de ces résultats ont été aussi présentés à la Conférence de Dubna. Ce qui suit en donne un bref résumé:

a) \bar{p} arrêtés dans l'hydrogène

L'étude de la résonance C_0 (dont la découverte était mentionnée dans le rapport précédent) a continué. Il a été établi qu'elle se décomposait aussi bien par le canal $K^* \pi$ que par le canal $K\rho$. L'analyse détaillée de la cinématique de désintégration en vue d'établir les nombres quantiques du C_0 est très difficile en raison de la présence de phénomènes compliqués d'interférence. Le travail d'interprétation se poursuit en coopération étroite avec des physiciens de la Division d'Etudes théoriques. L'étude des annihilations en trois corps $K^+K^- \pi$ donne des résultats importants sur le système $(K\bar{K})$ chargé. Ici aussi on se heurte à certaines difficultés d'interprétation qui seront sans doute résolues par un accroissement des statistiques.

b) \bar{p} de 3 GeV/c

L'analyse des phénomènes d'annihilation du type

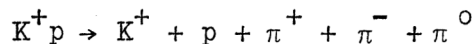
$$\bar{p} p \rightarrow 2K + 3\pi$$

a révélé l'existence d'une résonance du système $K^* \pi$ dans l'état de spin isotopique $3/2$. La masse de cette résonance est (1270 ± 20) MeV et sa largeur (60 ± 20) MeV. La désintégration de cette résonance en $K\rho$ a probablement été observée mais la certitude statistique est moins grande.

La masse 1270 apparaît comme significativement plus grande que celle du C_0 . Néanmoins les conditions d'observation sont très différentes, en particulier du point de vue de l'influence des interférences, et il n'est pas encore sûr que cette résonance soit distincte du C_0 .

c) K^+ de 3 - 3,5 GeV/c

L'étude de la réaction

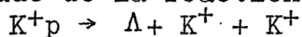


a permis à ce groupe de confirmer l'existence de la résonance mentionnée ci-dessus se désintégrant en $K\pi$. La masse et la largeur sont en bon accord, le spin isotopique $3/2$ semble également confirmé.

Ce groupe a apporté une confirmation très solide de la présence dans certaines réactions de la résonance $K \rightarrow K + \pi$ de masse 735 MeV dont l'existence indiquée tout d'abord à Berkeley avait été ensuite sérieusement mise en doute, probablement en raison du comportement capricieux de la production de cette particule.

Les preuves trouvées dans l'expérience K^+ semblent bonnes et il a été établi de plus que, contrairement au K^* (880) ordinaire, le K n'est pas produit en même temps que le N^* (1238).

L'étude de la réaction



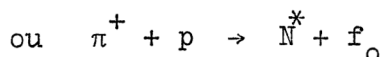
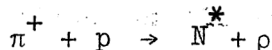
semble indiquer l'existence d'un état résonnant du système K^+K^+ . La statistique est encore un peu faible pour acquérir une certitude absolue. L'intérêt de cette étude est qu'elle concerne un système d'étrangeté + 2 qui n'a pratiquement pas été étudié jusqu'ici.

d) π^+ de 8 GeV/c

L'intérêt de cette expérience est que, si elle n'est pas la première expérience utilisant des primaires de haute énergie, elle est la première à appliquer à ces phénomènes la méthode d'analyse cinématique rigoureuse employée aux énergies plus basses. Ceci n'est possible dans une chambre relativement petite (81 cm) que parce que l'énergie est encore assez faible et aussi parce que le système initial ayant une charge 2 la production de particules neutres est moins grande que dans le cas des interactions πp .

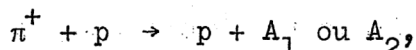
Cette expérience a confirmé le fait que les interactions de haute énergie ont en majorité un caractère très périphérique.

De plus, elle a établi que ces phénomènes, d'apparence compliquée, étaient très souvent des phénomènes à deux corps (hypothèse qui avait été souvent avancée mais jamais rigoureusement vérifiée). Ainsi on observe fréquemment les réactions



qui conduisent à l'état final $p + 3\pi$.

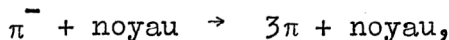
Si le N^* n'est pas produit, on observe encore des réactions à deux corps du type



A_1 et A_2 étant des résonances (récemment découvertes) du système ($\rho\pi$), ce qui conduit (du point de vue phénoménologique) au même état final $p + 3\pi$. De plus, le caractère périphérique des réactions conduit à une séparation très nette de deux systèmes distincts et donc à une possibilité d'étude des résonances peu influencée par les phénomènes d'interférence.

e) π^- de 16 GeV/c

Cette expérience a confirmé l'existence des phénomènes dits de dissociation par diffraction dans lesquels on a



le noyau ne subissant aucune désintégration. Les 3π apparaissent la plupart du temps dans la résonance A_1 mais non dans A_2 . Cette expérience a permis d'étudier le spin et la parité du A_1 , les hypothèses retenues étant 1^+ et 2^- .

3. Chambre à bulles de 2 m

Le montage complet approche de sa fin. La chambre et les tanks froids sont en place. Le système optique a été monté et essayé. La tuyauterie interne est montée. L'enceinte à vide sera fermée dans quelques jours. La prévision de la date du premier essai complet dépend plus maintenant du résultat des essais préliminaires (vide) que du travail qui reste à faire.

4. Gaz liquides

Les liquéfacteurs d'hydrogène et d'hélium ont continué leur production à la satisfaction générale. 150 000 litres d'hydrogène liquide et 1 600 litres d'hélium liquide ont été produits.

1 600 000 litres d'azote liquide ont été achetés au cours des dix premiers mois de 1964. La chambre à bulles britannique a consommé à peu près la moitié de cette quantité, le reste a été distribué à différents utilisateurs au CERN.

VII. NUCLEAR PHYSICS APPARATUS DIVISION

by C.A. Ramm

NUCLEAR PHYSICS APPARATUS DIVISION

1. Neutrino Beam

Since June 1963 the neutrino experiment has used 1.05×10^6 PS pulses, totalling 7.3×10^{17} extracted protons. The analysis of the bubble chamber pictures, which is still in progress, poses new problems. Some results have been reported already, it will still be some time before all possible information is extracted.

Valuable experience has been gained in the operation and monitoring of the fast ejection system, pulsed beam transport and the magnetic horn. Although the PS intensity was slightly lower than normal, the last run was one of the most efficient, as shown in the following table:

Statistics from the neutrino run 28.5.64 to 6.6.64

Dates	28	29	30	31	1	2	3	4	5	6	Total
Extr. protons ($\times 10^{14}$)	45	164	168	168	179	29	170	167	177	65	1332
Extr. efficiency %	86	90	92	94	95	86	89	89	95	96	91
Time loss due to:											
Ejection system %	1	5.3	0	0	0.1	0	0	4.5	0	0	1.3
Beam transport %	0	0	0	0	0	0	0	0	0	0	0
Magnetic horn %	16	3	0.9	4.2	0	0	2.2	0.7	0	2.4	1.3
External causes %	4	4.5	2.3	6.4	1	8.3	6.4	5.5	2.8	23	5
HLBC* photos ($\times 10^2$)	37	113	136	123	125	20	130	116	129	50	979
ν events	2	14	19	19	19	5	21	9	9	2	119
Triggers in SC**	176	797	1063	1077	1268	249	1027	1126	1256	451	8490

2. Fast Ejection System

Present work is aimed to improving the lifetime of the equipment, simplifying the operation and increasing the facility of beam sharing. The bending magnet is being modified to reduce the effects of radiation damage. An operational version of the beam-sharing device is almost ready for testing.

* One picture in the heavy liquid bubble chamber per two pulses of PS.

** Spark chamber reported in NP Division.

3. Neutrino Spectrum

A further run of the Ecole Polytechnique HLBC has yielded 90 000 photos, which are being scanned in an experiment to determine the neutrino parent spectrum from protons in a copper target.

The muon attenuation in the shielding has been measured to provide an experimental basis for the design of a new layout, perhaps with a heavier shielding medium than that used at present. Studies of possibilities of measuring the pion and kaon spectrum from the magnetic horn are continuing, as well as preliminary experiments to study the feasibility of analysing the charged particle flux in the decay tunnel during the 2 μ s burst from the magnetic horn.

4. Bubble Chamber

The study of the neutrino events in the fiducial volume continues with great interest. Although their number of 454 is greater than was anticipated, it imposes a severe statistical limitation on the possibilities of interpretation. The most recent reports of the progress of the work were given at the Dubna Conference and in Physics Letters (Oct. 1964).

Effort is presently concentrated on the understanding of the secondary processes in heavy nuclei of the bubble chamber medium. Detailed studies for proposals for further experiments are also being made. The programme of work connected with bubble chamber technique continues with growing importance, in preparation for the operation of the enlarged chamber body.

5. The Enlarged Bubble Chamber

All machining operations on the new chamber body have been completed, testing and assembly will start early in December. The magnet, which was transported to the manufacturer in August for enlargement, is almost ready. It is expected that the magnetic field will be nearly as high as previously. Testing of another glass window is expected before the end of November, in preparation for mounting in the chamber body early in December. Many items for the cooling system for the flashes, temperature regulation, pneumatic systems, control and safety apparatus are being manufactured to a very limited time-scale in order to meet the schedule.

6. Electrostatic Separators

A systematic study of different types of electrodes has led to the development of alumina-coated electrodes. Full-scale tests on a 3 m separator confirmed the results obtained in model studies,

and enough operational life is achieved by leaking helium instead of nitrogen into the vacuum tank. The results are better than has been claimed for glass electrodes.

The latest 3 m separator equipped with the new alumina-coated electrodes has operated under test with 810 kV across a 9 cm gap, with a few sparks per hour. Under similar conditions, 600 kV can be maintained on a 5 cm gap and 420 kV on 3 cm. The separator will be installed in the k₄ beam in November.

7. Muon Storage Ring

Progress on this project, which is in collaboration with NP Division, is on schedule. Machining of the magnet will be finished in February 1965. The vacuum chamber is designed and partly completed together with the injector, magnetic horn and the pulsed power supply. The prototype servo nuclear resonance magnetic spectrometer developed for the field measurements has a precision of ± 0.07 gauss and a locking range of 500 gauss.

VIII. ACCELERATOR RESEARCH DIVISION

by A. Schoch

ACCELERATOR RESEARCH DIVISION1. CERN Electron Storage and Accumulation Ring (CESAR) (3 scientific staff + 2 fellows)

Since the last progress report, CESAR has moved definitely into the stage of experimental utilization.

A bakeout of the vacuum chamber was made in the summer. Owing to the appearance of many leaks during the first phase of this bakeout, it was necessary to reduce the bakeout temperature to about 150°C and to restrict the bakeout to about half the total surface of the vacuum chamber. Even so, the pressure came down to 2×10^{-9} torr and has remained at that level ever since. A proper bakeout is planned for the beginning of next year, from which it seems reasonable to expect a further improvement in the vacuum. The beam half-life against gas scattering at the present pressure is about 1 second over most of the available aperture, and this is enough for a preliminary series of stacking experiments, and agrees with theory.

Extensive measurements were made of the vertical and horizontal Q values. There were very strong indications that non-linear resonances up to fifth order at least caused loss or destruction of the beam (depending upon the rate of acceleration through the resonance).

The measured Q variations across the aperture differed considerably from the computed variation. The vertical Q, in particular, increased about twice as fast as it was supposed to decrease. Since this was suspected to be due to the interference of the fringe field of the bending magnets with the sextupole shims, it was decided to replace all the sextupole shims on the defocusing lenses by shorter ones, in order to correct this effect, and thereby to reduce the movement of the operating point (Q_H , Q_V).

This necessitated a shut-down of a month, during which the whole magnet and lens system was re-aligned.

When operation was resumed, the measured Q variations were found to have been reduced, as expected. Further measurements showed, however, that there remains a number of mysteries in the transverse plane dynamics of CESAR which should be unravelled at an appropriate time.

Systematic measurements of radio-frequency stacking are now in progress. Their main purpose is to measure the stacking efficiency as a function of the mode of stacking, the number of pulses stacked and the various parameters of the RF programme. Up to 100 pulses and up to 20 mA have been stacked with efficiencies approaching 100% in certain cases. The main difficulty is to eliminate from these measurements

extraneous effects due to higher order non-linear transverse instabilities, negative mass instabilities and possibly other space-charge effects. Work along these lines is in progress.

Instabilities which seem to be of the negative mass type have been observed with the electrostatic pick-up. Systematic studies are foreseen for a later stage in the programme.

The so-called "Stanford effect" is being studied theoretically, and plans for an experimental check are being considered.

With the spectrometer slit system stabilizing the Van de Graaff by feedback on the tank liner, the voltage stability has been further improved. The next stage will be to install the fast auto-stabilizer, which uses the spectrometer beam itself as a variable load on the Van de Graaff. If, as is hoped, this improves the Van de Graaff stability by a further factor of 4 or 5, it may be possible to stack more than 200 pulses in CESAR.

2. RF Separator (5 scientific staff)

On 1 November 1964, the microwave particle separator successfully completed its first separation tests in a beam of high-energy particles (10 GeV/c). Using two RF deflectors spaced about 50 m apart, rejection of protons and positive pions by a factor of 500 to 1 000 produced an enriched K^+ beam of approximately equal numbers of wanted and unwanted particles. Cerenkov and scintillation counters were used for particle identification.

The rejection factor against unwanted particles was limited during these tests by erratic behaviour of the master oscillator and consequent frequency instability. The causes of this are now known and are being removed. This should considerably improve the separation. Furthermore, a new RF drive system is under construction, which will greatly improve the stability and reliability of operation.

Previous to the separation tests, a deflection test had clearly confirmed the theory of the hybrid E_{11}/H_{11} deflecting mode in the CERN disc-loaded waveguide.

Testing and operation with the 1.52 metre British hydrogen bubble chamber, using a secondary beam of 2 microseconds duration, is planned to start in the next few weeks.

Improvements to the apparatus, both technical and operational, continue to be incorporated; the tests yielded much useful experience for these improvements.

3. General Studies (1 scientific staff)

In the first line the Marx-type generator for nanosecond high-voltage pulses, designed for "three-dimensional" wide gap spark chambers, has been further developed and thoroughly tested. A "shielded strip" 85 ohm transmission line with a capacitive voltage divider has been made for the measurement of pulse shape and amplitude, with an attenuation ratio of 10^4 and an upper frequency limit of about 10^{10} Hz. The pulse shape was found to agree with theoretical expectations. Rise and fall time are about 2 ns, the amplitude on the 85 ohm load is 200 kV. Two generators working in parallel give also reliable results, so that it is possible to work with a smaller characteristic impedance; i.e. wider chambers ($10 \times 20 \text{ cm}^2$) are possible.

The next stage of experiments will involve image intensifiers for taking pictures of particle tracks; accessory electronics required (40 kV voltage divider, 2-18 kV pulse generator with flat top for triggering the image tube, etc.) has been constructed.

4. New Accelerator Projects (25 scientific staff + 5 fellows, research associates and visitors)

Since the Study Group on New Accelerator Projects in May completed the detailed report for the Council on the proposed intersecting storage rings (CERN/542), its effort has been entirely concentrated on the preparation of a similar report on the proposed 300 GeV project. This report has been completed in November as document CERN/563, to which reference is made as an account of the activity during the period covered by the present progress report.

IX. DIVISION SITE ET BATIMENTS

par C. Mallet

DIVISION SITE ET BATIMENTS

Introduction

Le programme de construction 1963-1964 a débuté en juillet 1963. Après un démarrage un peu lent, dû essentiellement au mauvais temps et à la période des vacances, l'exécution a été conduite par la Société Aixoise de Construction à une cadence convenable et finalement les délais sont dans l'ensemble parfaitement respectés. La nouvelle adjudication pour la tranche 1965-1966 a eu pour résultat l'attribution d'un nouveau contrat à la même société, à des prix légèrement inférieurs à ceux du premier contrat, ce qui est logique puisqu'une partie des installations étaient payées par l'application des prix du contrat initial.

1. Etudes

a) Etude et mise en chantier de nouvelles installations

Pendant la période considérée, il a été procédé à la mise au point des avant-projets ainsi qu'à la réalisation des études et plans d'exécution de 49 installations, dont 26 ont fait l'objet de soumissions normales. Les 23 autres ont été commandées directement aux sociétés adjudicataires des contrats de longue durée passés pour la réalisation des installations d'équipement électrique lumière et force et des installations sanitaires. Ces 49 installations étaient destinées:

- i) soit à l'équipement général (électricité, sanitaire, chauffage, ascenseurs, téléphone) de nouveaux bâtiments en cours de réalisation, tels que: bureaux, laboratoires et hall expérimental pour la Division TC; hall d'équipement pour l'éjection des faisceaux du PS dans la zone Est; bureaux pour les Services Etudes et Travaux neufs de la Division SB; bureaux et hall expérimental pour le Service Sécurité du travail; nouveau garage avec annexes; hall expérimental et atelier pour la Division MSC, etc.;
- ii) soit à monter de nouveaux ponts roulants dans l'extension du hall de montage NPA, le hall d'expérimentation Est et l'atelier TC;
- iii) soit, enfin, à compléter les équipements généraux du territoire ainsi que les réseaux d'alimentation et de distribution qui le desservent: nouveau câble 18 kV pour le SC; équipement de la nouvelle sous-station 18 000/380 V; câble téléphonique pour desservir les bâtiments d'essai de cibles à hydrogène, l'éjection Est, le bâtiment de cryogénie; production d'eau chaude domestique pour desservir le laboratoire 13, le hall expérimental du TC, le bâtiment de cryogénie, etc.

b) Etudes pour l'alimentation en énergie et en fluides du territoire actuel et de la future extension française

Celles-ci ont particulièrement porté sur les problèmes suivants:

- augmentation au maximum possible de la puissance calorifique des chaudières de la centrale de distribution, qui sera portée, d'ici à la fin de 1965, de 9 à environ 17 millions de Kcal/h;
- pour faire face aux demandes accrues de consommation, modifications à faire subir:
 - au réseau principal de distribution d'eau surchauffée,
 - au réseau de câbles 18 kV, notamment dans les zones Sud et Sud-Est;
- réalisation des études et participation aux discussions avec les organismes officiels du Canton de Genève pour définir les nouvelles modalités selon lesquelles l'alimentation générale en eau et électricité du territoire actuel sera effectuée dès 1965;
- poursuite de l'étude systématique des différentes possibilités d'alimentation en eau de refroidissement de l'extension française, soit:
 - analyse des résultats des essais de pompage effectués au Puits Mathieu de Thoiry;
 - participation aux études d'avant-projet d'un barrage sur la Valserine;
 - examen d'autres solutions possibles, telles que forage profond, utilisation des eaux de l'Arve.

2. Constructions nouvelles

En cours: laboratoire 13, hall et sous-station - atelier et hall MSC - garage et bureaux SB - bureaux et hall pour le Groupe Sécurité du travail - bâtiment cryogénie - atelier traitement de surfaces - éjection rapide - extension IBM - nouvel atelier MPS - extension du laboratoire 4 - élargissement de la route et construction de tunnels d'accès à la future zone française.

Terminées: extensions NPA, AR, AP, Adams hall.

3. Entretien et exploitation

- a) Entretien général des bâtiments: révisions de diverses installations, en particulier chauffage, chaudières, transformateurs, disjoncteurs HT et BT; environ 8 000 contrôles et dépannages sur les installations électriques et 156 dépannages sur le réseau téléphonique.
- b) Transformations aux bâtiments ou installations: socles et plancher métalliques dans bâtiments des générateurs Sud et Est; socles et caniveaux dans bâtiment hydrogène liquide; socles dans l'atelier principal; aménagement de diverses baraques sur la décharge; local pompe à mercure près du Linac; réfectoire, vestiaires et bureaux de l'atelier principal; déplacement tableaux de chauffage et ventilation au bâtiment d'essai pour cibles à hydrogène No 1 et magasin produits chimiques; installations Cerberus NPA et IBM; réalisation commande à distance d'un pont roulant entre une section de l'anneau et la salle de commande principale du PS; transformation de la 3ème chaudière de la centrale de distribution; conduites gaz zone PS; réseau hydrant laboratoire 13, garage et PS; climatisation cage Faraday et salle de contrôle de la centrale de distribution; chauffage cantine des ouvriers, etc.

c) Demandes de travaux

En cours:	460	Terminés:	1 030
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d) Consommations

Electricité: - 40 430 000 kWh (contre 32 620 000 pendant les 6 derniers mois)
- puissance maximum instantanée: 18 658 kW en juillet 1964.

Eau de réfrigération: - 2 273 000 m³ (contre 1 980 000 pendant les 6 derniers mois).

e) Heures de marche de la centrale de distribution

Pour les 3 chaudières:	2 750 heures	
Pour les 3 compresseurs:	5 440 "	
Groupe Diesel:	66 "	en marche normale.

4. Ateliers

a) Atelier principal

La valeur des travaux exécutés est demeurée stationnaire: 1 085 000 francs contre 1 045 000 francs pendant les 6 mois précédents;

celle du matériel utilisé pour lesdits travaux était de 186 400 francs et le total des heures travaillées s'est monté à 53 370.

L'effectif de cet atelier se composait de 78 fonctionnaires et 14 auxiliaires. Le travail en équipe a dû être continué, la demande restant très forte et les délais courts.

Le parc de machines a été augmenté par l'acquisition d'une fraiseuse et d'une fraiseuse-raboteuse; une grande fraiseuse sera mise en place en novembre.

La Section Travaux extérieurs, créée pour décharger l'atelier, a fait exécuter des travaux à l'extérieur pour une valeur de plus de 250 000 francs pendant la période considérée, représentant 17 740 heures.

En plus des travaux mécaniques courants pour les appareillages destinés aux diverses expériences en cours, l'atelier principal a exécuté des travaux spéciaux, tels que: 2 lentilles plan-convexe en plexiglas de 1 400 mm de diamètre, avec un rayon de 5 000 mm; des plaques de verre gravées pour mires d'alignement; des séries de cadres en plexiglas pour les chambres à étincelles; des "shims" magnétiques; la plus grande partie du système de détente de la chambre à bulles de 2 m; des sabots pour les joints gonflables de la chambre à bulles de 2 m; des essais de soudure et de brasage sous atmosphère réductrice, etc.

b) Atelier Ouest

La valeur des travaux exécutés s'est élevée à 609 700 francs et celle du matériel utilisé pour lesdits travaux à 60 800 francs. Le total des heures travaillées était de 33 450.

L'effectif se composait de 37 fonctionnaires et 6 auxiliaires. Ce personnel étant insuffisant pour faire face à toutes les demandes, des travaux représentant une valeur de 70 000 francs environ ont été placés à l'extérieur.

- Mécanique, plexiglas, araldite, travaux spéciaux

476 demandes ont été honorées, dont une partie assez importante représente des réalisations mécaniques conventionnelles. Parmi les travaux spéciaux, il convient de citer: la fabrication de cibles de haute précision; "kicker" à grande ouverture et volets obturateurs pour le Linac; chambres à étincelles; compteurs Čerenkov; "data-box"; ainsi que de nombreux travaux de laboratoire, soudures et brasures spéciales, etc.

- Tôlerie

365 demandes ont été honorées pendant cette période. Parmi les travaux spéciaux, on peut relever: des prototypes de pièges à azote liquide; colonne en titanium HT et essais de repoussage de titanium; 2 cavités prototypes: 1 acier et 1 inox avec refroidissement; soudures au plasma de treillis inox; cibles à hélium liquide avec fenêtres en tôle inox; nouvelle technique de soudure au chalumeau à plasma, etc.

On peut considérer que le tiers de la totalité des heures d'atelier Ouest est consacré à la mise au point de travaux difficiles.

c) Atelier de traitement de surfaces

A l'exception de certaines installations spéciales, la construction du bâtiment était suffisamment avancée pour permettre l'installation du matériel au cours de cette période, et les locaux seront en partie utilisables au début de novembre.

L'effectif de cet atelier est maintenant de 7 personnes.

La valeur des travaux exécutés s'est élevée à 83 512 francs pour un total de 6 920 heures.

Les principaux travaux ont porté sur l'exécution de conducteurs creux fabriqués par électroformage et destinés aux aimants d'éjection, ainsi que sur le cuivrage d'un modèle de "kicker" d'éjection en ferrite. D'autres travaux de développement ont été exécutés en laboratoire pour la supraconductibilité ainsi que pour la haute tension (amélioration des électrodes des séparateurs).

5. Transports, Labour Pool, Nettoyage

a) Transports

Pendant cette période, ce Service a couvert 205 000 km, dont 55 000 km représentent des parcours à longue distance. Le nombre de passagers transportés s'est élevé à 2 100. Le tonnage manipulé a dépassé 100 000 tonnes.

Quant au parc de véhicules, il est passé de 53 à 63 unités. Parmi les nouvelles acquisitions: un petit tracteur capable de tirer jusqu'à 100 tonnes, ainsi qu'une grande semi-remorque de 8 m de long, adaptable sur camions de 10 et 20 tonnes.

L'effectif de ce Service se montait à 56 personnes, à savoir: 32 fonctionnaires et 24 auxiliaires, comprenant les chauffeurs, grutiers, mécaniciens et préposés au service gare et réception des marchandises.

Pour certaines courses à l'extérieur, on a continué, en période de surcharge, à faire appel à une firme de transports de Genève.

En plus des travaux de routine, on peut citer le déménagement de nombreuses chambres à bulles et le transport du CERN à Zurich d'un aimant de 82 tonnes pour la chambre à propane NPA.

b) Labour Pool

Ce Service, qui compte toujours 27 personnes, a exécuté 67 demandes, représentant un total de 30 100 heures.

c) Nettoyage

Ce Service comprend 59 nettoyeurs, 6 personnes attachées à la section de blanchisserie-couture et 2 personnes affectées à la section des dortoirs.

Les surfaces des sols à entretenir ont passé de 77 000 m² à 81 750 m², soit une augmentation de 4 750 m²; celles des vitres ont passé de 55 000 m² à 56 200 m², soit une augmentation de 1 200 m².

Des firmes spécialisées dans l'organisation du nettoyage de locaux professionnels ont été contactées afin de voir comment ce Service pourrait être amélioré. Il ressort des premières indications reçues que l'effectif devrait être augmenté de 7 unités pour donner toute satisfaction.

La section de blanchisserie-couture assure l'entretien des vêtements professionnels de plus de 1 000 employés.

Enfin, la section des dortoirs est chargée de l'encaissement des locations et du contrôle des 110 à 170 ouvriers, étudiants ou visiteurs qui y logent, en plus du nettoyage de ces locaux.

6. Magasins

a) Zone de l'atelier principal

i) Matières premières: le matériel débité pendant cette période a atteint 529 000 francs; la valeur des stocks à la fin d'octobre était de 762 890 francs; l'aménagement de ce magasin est maintenant terminé.

ii) Produits chimiques: des produits ont été fournis pour un total de 81 650 francs; la valeur du stock à la fin d'octobre était de 98 940 francs.

iii) Outillage: les produits fournis ont atteint le montant de 222 150 francs; à la fin d'octobre la valeur des stocks était de 344 350 francs.

b) Zone SB

i) Electricité, sanitaire, métaux: à la fin d'octobre, la valeur des stocks était de 2 441 000 francs, les sorties se sont montées à 1 214 200 francs.

Les catalogues pour les matières premières et les éléments mécaniques sont sortis; ceux concernant la robinetterie et le sanitaire sont en préparation, de même que ceux pour les matières plastiques et les matériaux de construction. Les efforts de standardisation progressent en ce qui concerne le matériel électronique, la standardisation de tous les condensateurs est terminée, celle des câbles et connexions est en cours. Quant au matériel électrique, la normalisation de tous les magasins est pratiquement terminée. La mise au point des Kardex se poursuit, avec indication du matériel électrique et de ventilation à prévoir pour l'entretien.

ii) Articles de protection: le stock à la fin d'octobre se montait à 43 740 francs; les sorties pour la période considérée ont atteint le montant de 14 450 francs.

iii) Mobilier: le stock à la fin d'octobre était de 176 330 francs et les sorties se sont montées à 250 688 francs.

iv) Economat: le stock à la fin d'octobre était de 106 680 francs et les sorties ont atteint 238 060 francs.

Grâce à la réduction des achats, à la revente des stocks superflus, ainsi qu'à la mise de côté des stocks statiques qui sont maintenant inscrits séparément au budget, la situation financière des magasins à la fin de cette période était satisfaisante.

7. Personnel

L'effectif de la Division s'élevait à la fin d'octobre à 363 fonctionnaires et 139 auxiliaires.

8. Nouveaux projets

Diverses études de génie civil concernant les anneaux de stockage et la machine de 300 GeV ont été faites, en liaison avec la Division AR, en utilisant le personnel embauché au titre du budget supplémentaire et sous la direction de quelques membres de la Division SB.

Conclusion

En dehors de son rôle de constructeur, la Division a continué en 1964 à rendre divers services aux autres divisions. Ces demandes de services de plus en plus nombreuses sont également de plus en plus difficiles à satisfaire en raison du manque de personnel et, notamment, du manque d'ouvriers spécialisés. De nombreuses heures supplémentaires ont été effectuées par le personnel des diverses sections de la Division. En outre, on a dû faire appel aux ouvriers d'entreprises extérieures. Ces ouvriers peuvent donner satisfaction et le font effectivement dans de nombreux cas, mais dans d'autres il est absolument nécessaire d'employer du personnel CERN, en particulier dans les ateliers et aux transports, où l'emploi d'ouvriers en régie est impossible lorsqu'il s'agit d'utiliser des machines ou des engins de grande valeur, ou de conduire des camions ou des véhicules CERN qui assurent des transports dangereux ou à l'étranger. La faible augmentation d'effectif accordée à la Division SB pour 1965 nous placera certainement devant une situation difficile.

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X. DIVISION DES FINANCES

par C. Tièche

DIVISION DES FINANCES

Au cours de la période mai-novembre 1964, la Division des Finances a présenté au Conseil et au Comité des Finances les comptes de l'Organisation et ceux de la Caisse d'Assurances pour l'exercice 1963 et établi le projet de budget de l'exercice 1965.

Les problèmes d'organisation les plus urgents ont trouvé une solution, mais l'application en est retardée du fait des difficultés de recrutement de personnel. Il avait été prévu d'affecter trois acheteurs à des groupes de divisions afin de faciliter la collaboration avec le Service des Achats. Un seul acheteur a pu être engagé jusqu'à maintenant; il entrera en fonctions en janvier 1965. Un conseiller en organisation et méthodes, qui fait partie de la Division depuis septembre dernier, consacre ses premières activités à la simplification de l'organisation administrative, notamment à la réception et au contrôle des marchandises livrées.

La calculatrice électronique NCR 390 a été livrée en juillet 1964. La programmation des salaires est maintenant terminée et l'enregistrement normal pourra débuter en janvier 1965. En ce qui concerne la comptabilité générale, les études sont encore en cours et l'enregistrement devrait pouvoir débuter en juillet 1965.

Un gestionnaire des magasins commencera ses activités en janvier 1965. Il a donc été décidé d'attendre l'année prochaine pour procéder à un nouvel inventaire complet des stocks et pour préparer l'enregistrement de la comptabilité des magasins sur le grand ordinateur du CERN.

Une nouvelle codification des dépenses est à l'étude et doit permettre d'obtenir plus facilement de nouveaux éléments statistiques indispensables.

Le taux d'intérêt des fonds placés à court terme est passé de 2 3/4% au printemps 1964 à 3 1/2% au début de juillet 1964. Les taux d'intérêt des fonds placés à long terme ont tendance à se rapprocher de 5%.

Un groupe de travail a été désigné par le Comité des Finances pour l'étude, en collaboration avec l'Administration, des amendements devant être apportés au Règlement financier. Le texte définitif en sera soumis à l'approbation du Comité des Finances et du Conseil.

Les commissaires aux comptes ont procédé à une première révision des comptes de l'exercice 1964 du 28 septembre au 23 octobre dernier.

Au cours des six derniers mois, le Service des Achats a passé en moyenne 1 760 commandes par mois. De nouveaux contrats ont été négociés, portant notamment sur des aimants, des générateurs, du deutérium pour les chambres à bulles et sur la seconde tranche de travaux de construction.

Le marché présente toujours une tendance à la hausse, particulièrement dans le domaine de l'équipement électrique et électronique.

XI. PERSONNEL DIVISION

by G. Ullmann

PERSONNEL DIVISION

The period under review has seen increased activities in all sections of Personnel Division. A brief account of some of these activities is given below. Wherever useful, comparative figures from previous reports are shown.

1. Personnel Section

The Personnel Section received an average of 630 applications per month (400 in the same period last year), arranged for 110 Selection Boards (78 last year) and interviewed 530 candidates (380 last year). The number of candidates appointed to new posts or as replacements for staff leaving rose to 215. Although the rate of departures is still considered low in comparison with outside employers ($\sim 5\%$ over 6 months), approximately 100 of the new-comers were needed to fill gaps created by staff members leaving CERN employment. This development needs careful observation and analysis.

Under our fellowship, visiting scientist and vacation student schemes, some 250 scientists joined CERN for periods varying from one month to two years. These scientists, whose contribution to the research programme of the Organization is a most important factor, form the majority of CERN's research personnel.

Statistics of arrivals and departures between 16 May, 1964 and 15 November, 1964, and the resulting over-all CERN personnel figures are given in the tables below.

2. Salary Administration Section

The Salary Administration Section has continued to contribute to the work of the Experts' Group on the pay and allowance structure and conditions of CERN, a time-consuming effort of considerable implications. In addition, routine job surveys continued with improvements in their method and in the assistance given to supervisors. This Section is expecting visitors from a national research establishment who will come to study our job evaluation programme and obtain training in its techniques.

3. Training and Education

In the field of training and education, preparations were made for the new term. Academic education offers four series of courses: theoretical physics, experimental physics, applied physics and a basic course in physics and mathematics.

The technical training programme gained from the experience made during the first two years of its existence and introduced modifications to its organization and course contents. Three levels of courses exist: elementary, intermediate and advanced, spreading over two or three consecutive years. The new technique of "programmed instruction" will be tried out for an elementary physics course.

A list of all courses scheduled to be given is attached.

4. Welfare Section

The Welfare Section examined CERN's obligations towards its personnel and their families in assisting them in their individual social and community problems. In particular, the reception and settling in of new-comers is being critically reviewed and plans for improvements are envisaged. The Housing Service (part of the Welfare Section) is playing an important rôle in the very difficult context of the critical Geneva housing situation. Accommodation is found for 50 to 70 CERN staff each month, but the list of staff wishing to change house is considerable and priority must be given to new-comers. The CERN Housing and Canteen Committees are now under the chairmanship of the Head of the Welfare Section.

5. Office Services

In addition to the activities described above, Personnel Division provided the following office services:

- Typing and document reproduction

Particular efforts have been made to improve the preparation of scientific reports.

- Telephones

Limited technical installations have caused some difficulty in coping with the 10% increase in calls to 38 000 per month.

- Messenger service

An average of 49 000 letters have been handled per month, 4 500 more than during the same period last year.

6. Statistical Personnel Survey

A statistical personnel survey of the first ten years of the Organization is in preparation, and efforts are being made to put this and other administrative data on the CERN computer to achieve greater efficiency.

7. Medical Services

A medical doctor is about to be recruited, our activities in the field of medical services having up to the present been limited to liaison work with the Health Insurance Company. Following this recruitment, it is expected that further expansion of Personnel Division would be restricted to that necessitated by increase in the over-all personnel strength.

CERN Personnel as at 15 November, 1964

	MI	MPS	TC	AR	NA	NPA	MSC	NP	DD	SB	TH	FIN	PE	TOTAL
Staff Members		262	122	38	51	81	83	187	125	365	14	65	84	1 592
Mil. Sec		-	-	-	-	-	-	(1)	-	-	-	-	-	(1)
Supern. Aux.	4	14	46	3	3	9	3	10	3	137	-	5	20	257
Lab.	3	-	75	-	-	14	-	39	13	-	-	-	-	144
Temp.	3	1	-	-	-	1	-	-	1	2	-	1	2	11
Fellows CERN	70(1)	(3)	(13)	(3)	(1)	(3)	(2)	(19)	(3)	-	(22)	-	-	70
Vis. CERN	2	-	16	-	2	4	4	66	6	-	23	-	-	123
Vis. FORD	10	-	(2)	-	-	(1)	-	(1)	(4)	-	(2)	-	-	10
Vis. Teams	-	-	51	-	-	-	-	18	1	-	-	-	-	70
Students	-	2	-	-	-	-	-	3	-	-	-	-	-	5

Movement of CERN Personnel - Period 16 May, 1964 to 15 November, 1964

	STAFF MEMBERS				SUPERNUMERARIES			FELLOWS			VISITORS			STUDENTS	TOTAL
	Sc./Eng.	Techn.	Adm.	Anc.	Aux.	Lab.	Temp.	Fel./R.A.	FORD	CERN	Teams				
Numbers at 15.5.1964	297	838	211	172	236	143	12	69	24	133	93	5	2233		
Total Joining	32	64	13	23	45	25	13	23	8	132	17	76	471		
Total Leaving	12	14	12	20	24	24	14	22	22	142	40	76	422		
Numbers at 15.11.1964	317	888	212	175	257	144	11	70	10	123	70	5	2282		

LIST OF COURSES 1964-1965

1. Academic Courses

(a) Theoretical Physics

- Strong interactions at high energies (Part IV).
- Weak interactions.
- Relativistic description of spin, especially helicity formalism.

(b) Experimental Physics

- High-energy neutrino interactions.
- Radiogalaxies and high-energy physics.
- Some methods of spin determination of elementary particles and resonances.
- Experimental methods in the physics of unstable particles.

(c) Applied Physics

- Beam optics.
- Superconductivity.

(d) Basic Courses in Physics and Mathematics

- Introduction to group theory and to the classification of the elementary particles.

2. Technical Courses

(a) Elementary Level

- Mathematics; Physics.

(b) Intermediate Level

- Mathematics; Electronics.

(c) Advanced Level

- Mathematics; Electronics; Vacuum Technique; Mechanics.

XII.

1. GENERAL SAFETY GROUP

by A.H. Pietersen

GENERAL SAFETY GROUP

During the period of 1 May 1964 until 1 November 1964, the following activities were carried out by the three sections of the General Safety Group.

As the organization for the accident prevention programme at CERN has now been settled, and as safety ideas have been generally accepted, during this period much stress was laid on safety training of staff members. Indoctrination courses were given to heads and foremen of the different workshops, and rules and regulations were prepared.

1. Industrial Safety

Education

- 147 staff members received safety training.
- general safety bulletins were issued.
- 5 safety codes were revised.

Inspections

- 27 area inspections were made and recommendations issued.
- 159 studies and tests were made for new projects, installations, etc.
- 9 special studies were made in connection with the physicists concerned regarding experimental projects.

General

- 228 medical examinations were made for those working with toxic materials.
- 27 studies were made regarding fire protection, chemical products and emergency electrical supply.

2. Material and Equipment Inspections

Lifting equipment

- 64 new lifting facilities were checked and passed an acceptance test.

- 3 373 lifting facilities passed the periodical tests and inspections.
- 43 designs of lifting equipment were checked.

Pressure vessels and similar systems

- 45 new pressure vessels and pressurized systems were checked and passed an acceptance test.
- 5 studies were made for specific types of pressure vessels, such as the new propane bubble chamber, the CO₂ purification installation of the Van der Graaff accelerator, etc.
- 87 X-ray photos were made of welds of new constructions.
- 357 pressure vessels and accessories were inspected and passed the periodical test.

3. Hydrogen Safety

- 58 inspections were made of hydrogen areas and consequent recommendations were made.
- 23 special studies were made for Čerenkov counters, targets, of which 20 items were tested and accepted.
- safety training was given to the hydrogen safety monitors.
- 4 improvements were made on hydrogen safety by installation of hydrogen storage facilities and hydrogen gas detector systems.

4. Site Safety Committee

During this period, 4 Safety Committee meetings were held, during which 14 different items were studied and completed.

Sub-committees were set up to prepare, in connection with the General Safety Group, the different safety codes.

5. Accidents

The following results show that the decrease in frequency rate obtained in 1963 was maintained, and the statistics of accidents are the following:

	<u>1.5.64 to 1.11.64</u>	<u>Same period 1963</u>
Number of disabling accidents	15	15
Frequency rate*	0.54	0.57
Lost days	181	170
Severity rate**	6.5	6.5
Number of non-disabling accidents	81	86

* Frequency rate = number of disabling accidents per 100 000 worked man-hours.

** Severity rate = number of lost days per 100 000 worked man-hours.

XII.

2. HEALTH PHYSICS GROUP

by J. Baarli

HEALTH PHYSICS GROUP

The CERN Health Physics Group had a strength of 24 members, 1 medical consultant, 2 half-time medical technicians, 1 research associate and 1 visiting scientist during the period in question. The steadily increasing demand for more services from the Group could only partially be met with this personnel, and difficulties were experienced in recruiting trained personnel for this branch of activity.

The main effort of the Group was directed towards radiation protection work; very limited research activity was undertaken. The work was divided into the following categories:

- (a) site radiation surveys and control;
- (b) personal radiation control;
- (c) instrumentation and calibration;
- (d) research and studies.

1. Site Radiation Surveys and Control

The dose rates in the experimental halls of the PS machine increased as a result of higher beam intensity. Improvement in the local shielding between the North and South experimental halls was required in order to keep the dose rates below 100 mrem per 40-hour week, particularly when operating targets 6 and 10.

Shielding blocks covering the ventilation holes in the roof of the SC machine reduced scattered radiation from this accelerator by a factor of 4 when using internal targets. The use of the extracted proton beam from the SC was limited and was only operated in conjunction with complete shielding in the form of a beam tunnel.

The scattered radiation on the Site was measured by 4 permanently operating monitor stations. These showed dose-rate variations with factors of up to 7 during normal use of the accelerators, and an average dose rate not exceeding 15% of the accepted tolerance for non-radiation workers at CERN (1.5 rem/year).

The dose rate from induced radioactivity of the PS accelerator increased by 15% compared with 1963, but air and dust radioactivity continued to show relatively low values. Near targets, dust radioactivity was measured and was found to have a maximum of $13 \times 10^{-4} \mu\text{C}/\text{cm}^2$.

In order to assure the lowest possible exposure of people during machine shut-downs, a more strict control was exercised during shut-down of both accelerators.

Twenty-seven radioactive sources were brought onto the Site and 5 were sent out to other laboratories during this period. Thirty special alpha and beta sources were made by the Group and 32 sources were lent out to various people on the Site.

2. Personal Radiation Control

The Film-Badge Service treated about 1 700 gamma and 520 neutron film-badges on average per month. The number of people under regular control was about 1 050 - 950 monthly and 100 weekly. About 300 films were used per month by occasional visitors to radiation areas. The use of neutron film-badges increased by 25% because of higher neutron intensities in the experimental halls of the PS.

Eight people were advised to keep away from radiation work for certain periods, in order to avoid exceeding their personal permissible dose.

Routine blood examinations were carried out for about 900 people, and an eye inspection took place for 380 people.

A new and more suitable film-badge holder was selected and an improved system for data evaluation of personal radiation exposure at CERN was taken up for detailed study.

3. Instrumentation and Calibration

The first series of transistorized electronics developed in the Group has been extensively tested and put into operation. A second series of 15 units is nearing completion. A mobile monitor station and a fixed station at the CERN Nursery School were commissioned. One monitor station was connected on-line to the Health Physics barrack to provide continuous recording of radiation levels and machine operation.

An automatic source-moving device was developed and put into operation in the calibration barrack, which considerably facilitates routine calibrations. Forty-two routine calibrations of survey instruments have been made during the period, as well as of many hand monitors, pocket dosimeters and film-badges.

The routine counting laboratory continued to provide a service for radiation surveys of dust, air, water, oil and other samples needing to be measured for protection purposes.

4. Research and Studies

Dosimetry studies of the 600 MeV proton beam continued and biological experiments were carried out in this beam, involving drosophila (Dr. Purdom, Medical Research Council, Harwell), rats (Dr. Legeay, Saclay), mice (Professor Bonét-Maury, "Institut du Radium", Paris), mice (Dr. Bühner, University of Geneva) and mushrooms (Professor Pasinetti, University of Palermo).

The Advisory Committee on High-Energy Radiobiology (members: Dr. Neary, Medical Research Council, Harwell, Professor Tubiana, "Institut Gustave Roussy", Paris, and Dr. Baarli, CERN) submitted a programme for further radiobiological research involving the CERN accelerators.

A simple method of estimating the time variation of dose rates from induced radioactivity in high-energy machines was found and tested. The studies of activation detectors to replace counters for surveys during short-burst operation of the accelerators were concluded, and a shielding experiment was carried out in collaboration with AR Division.

5. List of Publications

Members of the Group prepared 22 internal reports on various aspects of health physics and submitted the following papers:

- P. Bonét-Maury, J. Baarli, T. Kahn,
G. Dardenne, M. Frilley and A. Deysine "Efficacité biologique relative sur la souris et d'autres organismes des protons et des électrons de haute énergie". *
- G. Bühner and J. Baarli "Effects on Some Metabolic Processes in Mice irradiated with 600 MeV Protons".
Symposium on Radiobiology, Vienna, September 1964, pp. 357-361.
- A.H. Sullivan and T.R. Overton "Time Variation of the Dose Rate from Radioactivity induced in High-Energy Particle Accelerators".
Submitted to Health Physics Journal.
- J. Baarli and A.H. Sullivan "Radiation Dosimetry for Protection Purposes near High-Energy Accelerators".
Health Physics Journal (in press).
- J. Baarli, K. Goebel and A.H. Sullivan "Measurements of the Penetration of a 10 and 19.2 GeV/c Proton Beam in Steel using Ionization Chambers and Plastic Phosphors".
Nuclear Instruments and Methods (in press).
- L. Hoffmann and A.H. Sullivan "Studies of the Shielding required for the Secondary Radiation produced by a Target in a High-Energy Proton Beam".
Nuclear Instruments and Methods (in press).

* add. Proceedings of the Conference on Biological Effects of Neutron and Proton Irradiations, 1964, pp. 261-277.

J. Baarli

"Problems of Radiation Protection
near the Large CERN Accelerators".

Invited paper presented at the
Conference on the Relation
between Physics and Medicine,
Roncegno (Trento), Italy,
September, 1964.

XII.

3. PUBLIC INFORMATION OFFICE

by R. Anthoine

PUBLIC INFORMATION OFFICE

Demands for the services of the PIO continue to grow, and the service which can be given is limited only by the money which can be made available for this small but important part of CERN's activity. A reappraisal of public information policy is taking place to make sure that these limited resources are deployed to further in the best possible way a wider understanding of the Organization's work and the rôle in modern culture of co-operative fundamental research of this nature. The following paragraphs outline some of the more important aspects of the work of this office, without attempting to describe the ever-growing volume of routine business.

1. Press and External Relations

Twenty-eight individual journalists or photographers and one group of twenty visited the Organization. In addition, 152 journalists came to CERN for the four special occasions when the Laboratory was open to the press, i.e. the technical press day, held on 19 May, the start of the British National Bubble Chamber, the Third U.N. Atoms for Peace Conference, and the visit of Ministers from Member States.

Twenty press releases were issued as well as one feature article and five specially prepared articles; the daily and periodical press continued to report frequently on CERN activities.

There were six radio interviews or programmes about CERN (Austria, Germany, Sweden and Switzerland), and the German and Swiss TV networks had altogether four TV sequences on the air.

2. Public Documentation

The circulation of the "CERN COURIER" has now passed the 5 000 mark, of which 2 300 copies are circulated to CERN workers and the rest to outside readers. Some 2 000 copies are in English and about 3 000 in French.

3. Visits

Apart from journalists, 3 649 visitors in 103 groups came to CERN, mostly in the Saturday visits scheme.

Amongst the prominent visitors were, in chronological order:

- 22.6 - Professor Gjaerevoll, Minister of Social Affairs, Norway,
- 1.9 - Dr. G. Seaborg, Chairman, US Atomic Energy Commission,
- 4.9 - Dr. H. Lenz, "Bundesminister für Wissenschaftliche Forschung", German Federal Republic,
- 10.10 - Ministers and officials from CERN Member States.

4. Visual Aids

An outside firm was commissioned to shoot a short technical film about a spark chamber experiment, and a 15-minute historical film on accélérateurs was produced, using mainly sequences from foreign films.

Material was prepared for CERN participation in four exhibitions - in France, Germany, the Netherlands and Switzerland, including an exhibit in the Swiss National Exhibition (EXPO) in Lausanne.

The Photographic Section continued to provide a service of still photography of industrial, documentary and scientific subjects.

5. Publications

Apart from routine contributions, three articles were written for outside journals:

- "La physique nucléaire fondamentale et le CERN".
(Plaquette commémorative de l'Association des Elèves Ingénieurs de l'Institut Industriel du Nord, Lille, May 1964)
- "Alla ricerca dell'infinitamente piccolo".
(Rivista di Ingegneria Nucleare, Rome, November 1964)
- "High-Energy Physics Research at CERN".
(Nuclear Engineering, London, December 1964).

XII

4. GENERAL SERVICES

by B.W. Gamble

GENERAL SERVICES

1. Security, Fire and First Aid Section

Demands for the services of this Section, in one or another of its various capacities, continue to grow, in spite of which the Section has been maintained at the same level of staffing for a number of years. Attention is being directed currently towards methods whereby members of the fire-fighting teams can be kept up to date with the latest techniques, particularly of dealing with such special hazards as liquid hydrogen, propane, etc.

2. Gardening Section

This Section of four men is occupied essentially in routine work. However, plans are at present in preparation to improve the appearance of those areas of the Site now virtually devoid of all vegetation.

3. Conference Rooms

In addition to normal routine, a number of improvements have been carried out in the two main conference rooms, and others are being studied. In addition to handling some 200 conferences in CERN, technicians from the Section helped at a number of external conferences in which CERN was participating.

4. Scientific Conference Secretariat

This Section, in addition to providing a service for the standing CERN Experiments and Research Committees, carried out, in collaboration with the European delegates and the Russian Organizing Committee, the preparatory work for the European Advisory Committee for the Twelfth International Conference on High-Energy Physics held at Dubna in August.

The Secretariat also organized the CERN Easter School and Symposium, attended by 120 students of 24 nationalities, and the Fifth International Conference on Nuclear Photography, which brought together 133 participants from 77 laboratories. Help was also given to the Italian Physical Society in connection with an international meeting on "Natural Philosophy Today", organized in connection with the fourth centenary of the birth of Galileo.

XII.

5. TRANSLATION AND MINUTES SERVICE

by P. Mollet

TRANSLATION AND MINUTES SERVICE

Once again there has been an increase of over 30% in the volume of translation work done during the period under review, compared with the corresponding period of 1963.

In order to make available in English the rapporteurs' reviews on the International Conference on High-Energy Physics, held at Dubna in August, the Translation Service had to organize a crash translation programme from Russian: half the reports were translated by CERN physicists and the other half by the Service itself.

Among other important documents translated during the period under review, mention should be made of the Report on the Design Study of a 300 GeV PS of the CERN Study Group on New Accelerators.

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