PS Nuclear Physics Group/1
November 1957

THE PS RESEARCH PROBLEM. I.

24/10/1957

1. Task.

The immediate task of the PS Nuclear Physics Group is to provide the data necessary for planning and arranging the experimental facilities around the proton synchrotron. The most important of these facilities are:

1) beams and beam transport facilities
2) big bubble chambers
3) instrumentation
4) detectors.

The most urgent of these problems are the first two points which involve heavy financial commitments and will take a long time to develop. Preliminary decisions and cost estimates for these facilities must be made in time for the budget 1959, and the orders must be placed during the beginning of 1959.

2. Research Programme.

The choice of the experimental facilities will depend on the future research programme with the proton synchrotron. Prof. Ferretti has established a list of experiments, which would give answers to important theoretical problems. A discussion on this programme took place in Venice in September 1957. To shed light on the experimental facilities needed a representative number of likely experiments must be studied in more detail. This selection should cover experiments using beams of the various kinds which can be produced with the C.P.S., namely protons, pions, charged K-meson and antiprotons. In addition the γ-rays coming out from the machine should be considered as suggested by Prof. Salvini.

The study of the test experiments should be made as if the experiment were to be made in the near future. In fact, however, it is quite likely that by the time the proton synchrotron comes into operation quite different experiments will be indicated by the actual state of physics. The general facilities which have been made available on the basis of the test experiments should, however, prove useful in any research program.

A list of the suggested test experiments as selected from Ferretti's list is given in Table 1.

The pairs of experiments 1 - 3a, 4 - 5 and 7 - 8a provide cases where the relative merits of counters and bubble chambers may be compared. The three experiments 3a, 3b and 3c may well degenerate into a single experiment in which a bubble chamber is exposed to the proton beam. Similarly experiment 5 should give information on all types of interactions between K-mesons and protons.

For each experiment an important decision will have to be taken on the range of the incoming particle energies over which the experiment is to be performed, usually as a compromise between the desire to go to as high energies as possible and practical limitations, particularly on the beam transport facilities. To make full use of the high primary energy of the CERN PS it is natural that one would strive to extend each experiment to as high energies as is feasible. In particular one should avoid experiments which can be done on already existing machines. This does not mean that all experiments will be concerned with high momentum particles, since in many cases experiments in the low momentum range will only be possible with a higher energy machine either for intensity reasons or because of a high threshold energy. It is therefore probably that the C.P.S. would have to be equipped for work both in the high and low momentum region.

Emulsion experiments have not been explicitly included in the list of test experiments, since it is believed that the general facilities for counter experiments and bubble chambers will in general also be adequate for emulsion experiments.

3. Structure of the Study Group.

The preliminary investigations of the test experiments will be carried out along three lines:

1) A group of experimental physicists will study the experimental set-up, and investigate the optimum dimensions and the apparatus which is involved.

2) Theoretical physicists will calculate the yield of reactions in the PS energy range. Such predictions, even of a rough nature are essential for the design of the experiment.

3) The beam transport andbeam defining facilities needed for the experiment will be studied in close detail from the point of cost and performance. Once the parameters have been frozen, detailed design drawings will be made and submitted for tender.

In principle these three lines will be best handled respectively by experimental nuclear physicists, theoretical physicists and physicists having experience with beam transport problems. It is, however, obvious that the problems are very closely connected and that a very close contact must be kept between these categories and the groups constructing the proton-synchrotron.

The following initial staff is considered:

From the SC-division:
von Dardel (full time from November 15th, 1957)
Citron (half-time from January 1st, 1958)
Hedin (half-time from January 1st, 1958)

From the PS-division:
de Raad (half-time from January 1st, 1958)

From the Cosmic-Ray group:
2 members of this group (not yet chosen)

From the Theoretical group:
Hagedorn
Cerulus.

None of these group members has direct practical experience with a big machine. This must be compensated for in two ways:

1) Invitation on a Ford fellowship of a physicist with Cosmotron- or Bevatron experience.

2) By close contact with the persons in CERN with machine experience, such as Merrison, Lundby, Keller, Harting, who would be asked to take a direct part in the PS research program during those periods when they are not performing experiments with the synchrocyclotron.

It is also clear that a very close connection must be created between the PS Nuclear Physics group and the Bubble Chamber group and the Data Handling group, since both of these groups are in fact already preparing apparatus for the PS research programme. It seem reasonable that the detailed study of test experiments involving bubble chambers is made by physicists in these groups in cooperation with the PS Nuclear Physics group.

Long Term Programme.

Once the study of the test experiments has been concluded the work should be continued along the following lines:

1) Design of beam transport and beam separation facilities. An estimated by Mr. Adams indicates that this would require about 10 staff plus design effort.

2) Bubble chamber development. This would of course be handled by the STS bubble chamber group, whose size would have to be adjusted to the size of the programme.

3) Instrumentation. At present instrumentation for nuclear physics within CERN is chiefly handled by the electronics and physics groups in the SC-division. Most of the standard equipment for the CPS can be identical to that used already on the CSC. In cases where the instrumentation would have to be improved to cater for the needs of CPS this would also be in the interest of the work with CSC. It would, however, be necessary to have some staff from 1959 for purchasing equipment for the CPS.

4) Detectors. The experimental physicists of the PS Research group would, once the detailed study of the test experiments has been brought to a point where the beam transport facilities have been decided, devote themselves to the study of the detection problems. Suitable technical assistance would be needed at this stage. New ideas for detectors for discrimination of particles in the high energy range should be investigated and tried out at the CSC and other existing machines.

v. Dardel !!

G. von Dardel.

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27.11.57

Table 1

Preliminary list of experiments.

to be studied for the CERN-PS .

Nr.	Experiment	Detector	Special problems	Nr. on Ferretti's list
1	p-p-scattering, total and differential cross sections	Counters		D_1
2	π-p-scattering, total and differential cross sections	"	Discrimination against p.	D_1
3	π-p-interactions: a) Total and differential cross section b) Production of hyperon pairs c) Decay modes of anti hyperons	Bubble chamber	Separation of π from p	D_1 $C_{3,2}$ E_1
4	Scattering of K^+-mesons against protons	Counters	Discrimination against p and π	D_2, $D_{2,1}$, $D_{2,2}$
5	" " " " " "	Bubble chamber	Separation of K^+ from p and π	D_2, $D_{2.1}$, $D_{2.2}$, $D_{2.3}$ ($D_{2.4}$)
6	Diffractive production of π by protons on nuclei	"		$C_{1.2}$
7	Proton-antiproton, total and differential cross sections	Counters	Identification of antiprotons	$D_{3.1}$, $D_{3.2}$, $D_{3.3.1}$
8	Proton-antiproton interactions	Bubble chamber	Separated beam of antiprotons	D_3
9	Interactions of high-energy γ-rays	counter	?	

5 counters
4 b.ch.