 EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

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MEMORANDUM

To : Electronics Experiments Committee

From : R. Blieden, L. Dubal*), Maria Focacci, W. Kienzle, F. Lefebvres, B. Levrat*), M. Martin*), B. Maglić.

Subject: Status of MM-spectrometer experiment and proposal to continue research programme after the PS shut-down

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STATUS OF THE EXPERIMENT

Reaction:

$\pi^- + p \rightarrow p + X^-$. (Mass of X, momentum transfer, and number of charged decay products of X, measured in each event).

1. Number of events obtained

The total number of "good" events (events that are accepted by the SUMX selection criteria and plotted into histograms) obtained until now is 65,000; 30,000 of these were obtained during the last one week of running with the redesigned spectrometer system. A total of 12,000 events has been obtained in the mass region 650 - 850 MeV. The number of events in other regions is given in Fig. 1.

2. Mass Resolution

For an average sample, the recently obtained mass-resolution is ± 12 MeV at M = 750 MeV; ± 8 MeV at M = 1 GeV; which implies ± 10 MeV at M = 2 GeV.

3. Investigated regions of boson mass and momentum transfer

Until now, the work has been confined to the so-called well-investigated mass region, from 0.600 to 1.1 GeV. It is felt that a sufficient degree of experience and confidence in the instrument has been gained to proceed immediately to the mass region 1.1 - 2.1 GeV, not investigated before in pion-induced reactions.

The areas in the meson mass versus momentum transfer plane that will have been explored by the MM-spectrometer before the PS shut-down, are shown in Fig. 1. Each run covers typically a mass-range of $\Delta M_X \cong 500$ MeV and a momentum transfer range $\Delta t \simeq 120$ MeV/c. Area covered in one MM-spectrometer run in the reaction $\pi^- + p \rightarrow p + X^-$:

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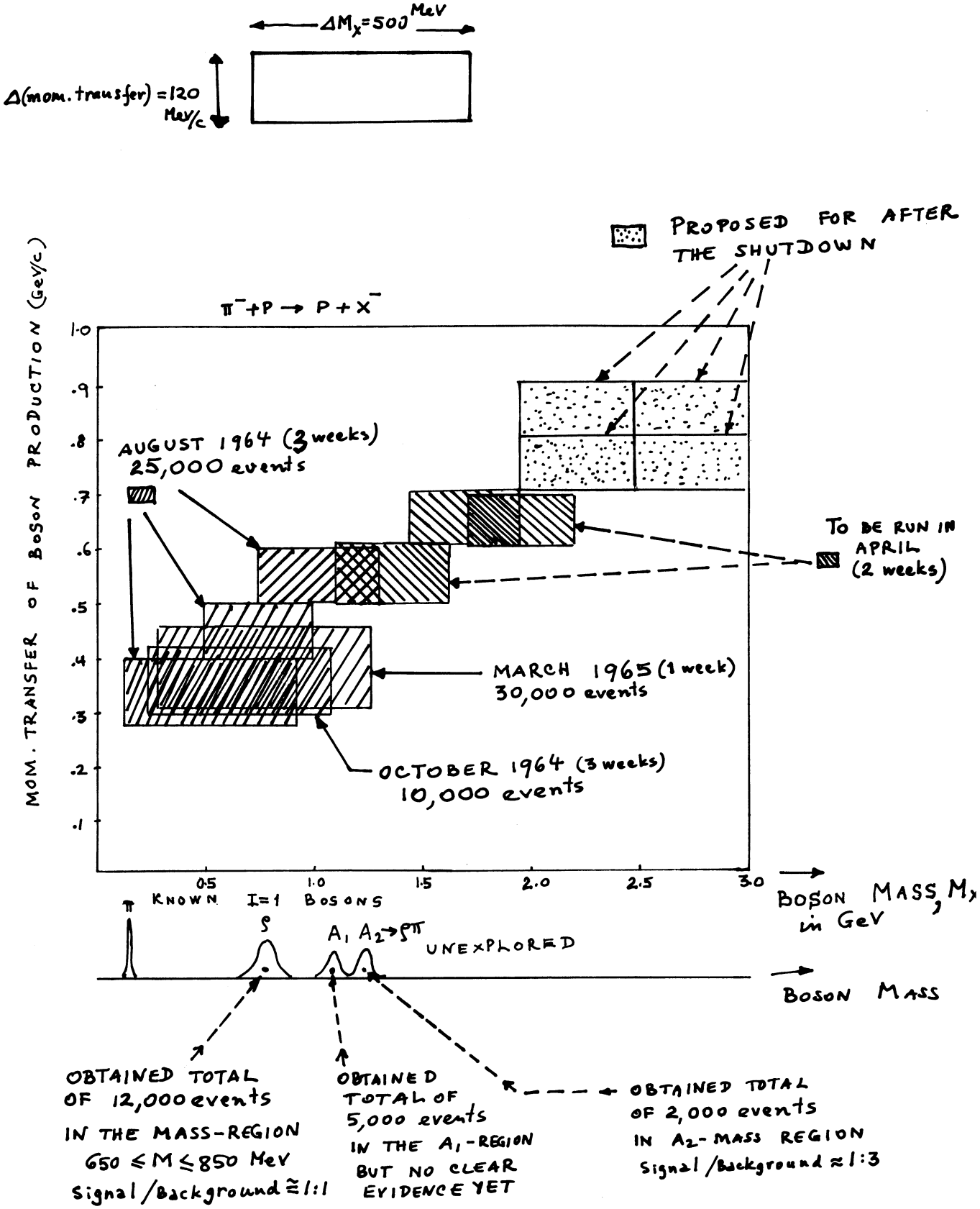

FIGURE 1

STATUS OF THE MM-SPEC. EXPERIMENT AND PROPOSAL TO CONTINUE PROGRAMME AFTER ...

3. Incident pion energies

Used so far: 4.5, 5.0 and 5.6 GeV/c. Will run before shut-down at 10 and 12 GeV/c.

4. Major failure

The three weeks of running in October 1964 is considered a failure from the point of view of data taking, because the pion beam intensity was 3×10^4 π/burst in contrast to the 3×10^5 π/burst that are normally available. So far, only a factor of 2 could be accounted for as due to the misalignment of the vacuum chamber No. 6 in the PS, which produced the drop in target No. 1 efficiency.

5. Shortcomings of the system and redesigned MM-spectrometer

- The three planes of proton counters, containing 12 large (45×85 cm^2) scintillators, were replaced by four scintillators, two of 80×130 cm^2 and two of 80×70 cm^2, in order to avoid discontinuities in the mass spectrum.
- The number of charged decay products of the unstable boson X, was obtained in 1964 only on the average (statistically) from pulse-height distributions in two forward counters, referred to as vertex counters. In order to obtain the exact number of decay products for each event, a matrix of 28 crossed counters was added to the system ("vertex matrix").

Both the large proton counters and the vertex matrix were installed, tested and used in production runs in weeks 10 and 11 (March 1965).

5. New equipment, built and tested, but not yet used in production

- Neutron hodoscope with 30 elements, to measure missing-mass spectrum of neutrons in the concurrent reaction $\pi^- + p \rightarrow n + X^0$, with the mass resolution of ± 10 MeV.

- Sonic spark chambers with hole for the beam. They are intended for measurement of the c.m. angular distribution of any boson decaying into two bodies, e.g. $X^- \rightarrow \pi^- + \pi^0$; or $X^0 \rightarrow \pi^+\pi^-$ or $\rightarrow K^+K^-$. At the same time, these chambers can measure the vertex point in the liquid hydrogen of the events $\pi^- + p \rightarrow n + X^0$ which thus results in high angular (mass) resolution for the neutron.

  It is not intended to use the above devices before the shut-down.

PROPOSAL

In view of the fact that all the bugs in the MM-spectrometer system are ironed out, that in weeks 11 and 12 a smooth operation was achieved, and that the method was tested in the well-investigated low-mass region, we can attack our main objective: investigation of the unexplored regions of the mass spectrum, up to M_X = 3 GeV.

Before the shut-down we plan to investigate the spectrum up to 2.1 GeV.

After the shut-down we propose to investigate the mass-region from 1.8 to 3 GeV in the momentum transfer range 0.5 to 1 GeV/c, using both proton and neutron MM-spectrometer, i.e. the reactions

$$\pi^- + p \rightarrow p + X^-$$

and

$$\pi^- + p \rightarrow n + X^0$$

simultaneously.

We wish to point out that, apart from the fact that the above mass region is completely uninvestigated, very little is known of the prediction of bosons at the momentum transfer near 1 GeV/c. Thus, it would also be of interest to spend some time in investigating medium mass-range 1.1 to 2.1 GeV at the momentum transfer $\leq$ 1 GeV/c.

For this programme, we request 48 shifts in Period II, if possible before the d-beam is used by the CERN/ETH magnetic spark chamber experiment, i.e. before our present beam transport plus spectrometer turntable system is perturbed. The time will be broken down as follows:

Mass-spectrum region	PS machine time
$2 < M_X < 3$ GeV	32 shifts
$1.5 < M_X < 2.1$ GeV	16 shifts