Memorandum NM-19

To : Ch. Peyrou  
From : B. Maglić  
Subject : Comparison of the three missing-mass experiments

Experiment A (1962) : Missing mass of the K meson in $\pi^- + p \rightarrow K + Y$ and MM of the proton in $\pi^- + p \rightarrow p + X$, at incident pion momentum 1.4-2.4 GeV/c, in 34 steps.

Experiment B (1963) : MM of the K in $\pi^- + p \rightarrow K + Y$, at incident pion momentum 1.0-2.8 GeV/c, in 52 steps.

Experiment C (proposed for 1964) : MM of p in $\pi^- + p \rightarrow p + X$ at incident pion momentum 4-11 GeV/c, in 7 steps.

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Experiment A versus C

The results of experiment A are shown in Figures 1 and 2. The qualitative comparison of the kinematical conditions in experiment A with those in experiment C is shown in Figure 3. It should be pointed out that experiment A was not designed for search of pionic resonances. The background conditions in the region of forward angles, used in experiment A, are unfavourable. It can be shown that the c.m. to lab. transformation makes "noise" 10 times higher around 0°.

Experiment B versus C

The comparison is difficult since the reactions are different: in B, the observed particle is K meson; in C, proton. Also, the Y
production is perhaps not so strongly dependent on the momentum transfer.

The major difference is the mass range at one energy:

Experiment B: mass range is $\pm 30$ MeV (see Fig. 4) with mass resolution $\pm 10$ MeV.

Experiment C: mass range is $\pm 450$ MeV, while mass resolution $\pm 20$ MeV.

Has experiment B failed?

Far from it. The measurements on the spark chamber pictures have not yet started. Only by counting the events in each run was the mass distribution plotted. This corresponds to an MM distribution plot, with mass resolution of $\pm 60$ MeV or worse. Yet, even in this plot, one clearly sees the $\Sigma^-$ and $Y (1385)$ peaks. This is shown in Figure 5. The shaded areas in Figure 6 show the mass resolution which was had in the result in Figure 5.

See enclosed memorandum MM-20 on the results of the test of our MM-spectrometer.

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Fig. 1. Intensity of $K^+$ of 0.94 GeV/c (± 2%) at 0° (± 0.6°) as a function of $\pi^-$ momentum ($\Delta p/p = 3\%$).

**Experiment A:** $\pi^- + p \rightarrow K + Y$

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Fig. 2. Intensity of protons of 1.8 GeV/c (± 1.6%) at 0° (± 0.4°) as a function of $\pi^-$ momentum ($\Delta p/p = 3\%$). The arrows indicate the expected positions of peaks which would correspond to $\zeta^{10}$ and $p^8$ production.

**Experiment B:** $\pi^- + p \rightarrow p + X$
Pionic resonances are believed to be produced mainly at low momentum transfer $\Delta^2$.

In exp. C, the $\Delta^2$ region to be investigated is $0.062 - 1.4$ (GeV/c)^2. In exp. A, Fig. 2, $\Delta^2$ of X-production was $2 - 4$ (GeV/c)^2.

In this type of experiment it seems to be essential to cover the broadest possible mass range without changing the bombarding energy.

In exp. C, mass range is 900 MeV, due to the choice of the angular region. In exp. A, Fig. 2, mass range was about 90 MeV.

The area in cos $\theta$ versus $p$ plane covered by the run at one incident pion momentum.

Experiment C uses "kinetic splitting" of the mass lines; angular resolution needed for $\Delta M \approx 15$ MeV is $\approx 0.5^\circ$.

Momentum resolution needed for the same mass resolution is typically 20% to 45%.

In exp. A, corresponding momentum resolution needed is $\approx 1\%$.

Dotted line is the line corresponding to mass of 1.5 GeV at incident momentum of 8 GeV/c. All solid lines correspond to incident momentum of 6 GeV/c. The mass line shifts $\approx 3^\circ$ per 1 GeV/c.

This property provides a check of the effect in NN-distribution, if some observed.
**Fig. 4, Experiment B**

Kinematic conditions

**Fig. 5**

Preliminary result of Experiment B

**Fig. 6, Experiment B**

Shaded areas show the region from which the events were used in Figure 5