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ELECTRONICS EXPERIMENTS COMMITTEE

A proposal to study $\pi^- p \rightarrow (K\bar{K})^{\pm}\pi^{\mp} n$ using Omega

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Introduction

We propose to study the processes

$$\pi^- p \rightarrow K^o K^- \pi^+ n \qquad (1)$$

and $$\pi^- p \rightarrow \bar{K}^o K^+ \pi^- n \qquad (2)$$

at 10 GeV/c with the Omega spectrometer. This proposal consists of a continuation, with incident π^-, of experiment S116 and will use as a trigger system the topology trigger already successfully used in experiment S116. The only addition will be a new anticoincidence counter around the hydrogen target. The low pressure Cerenkov counter at Omega will be used to solve the K-π ambiguity.

In our letter of intent CERN/EEC-74/34 we have already described the trigger system and the test run which we have performed at the end of S116. In the meantime we have analysed a small portion of these data. The results obtained encourage us to ask for 7 days of running time to do the experiment.

Physics interest

The detection of narrow resonances at 3.1 and 3.7 GeV may give additional interest to the exploration of reactions (1) and (2). But beforehand we want to repeat the reasons which led us to consider the experiment in August 1974.

Channels (1) and (2) have not been studied with high statistics in HBC because of the K-π ambiguity. In the $(K\bar{K}\pi)^o$ channel the $D^o(1285)$, $E^o(1420)$ and the $F_1(1540)$ are seen in $\bar{p}p$ annihilation HBC experiments which suffer from low statistics and from the problems of reflections in multibody final states. Very little is known about their production in $\pi^- p$.

In the case of the D^o $I^G = 0^+$ is established and $J^P = 0^-, 1^+, 2^-$ are still possible with strong preference of $J \geq 1$. In a recent $\bar{p}p$ experiment only 163 events are seen in the peak of the D^o 1).

The E^o is exclusively seen in $\bar{p}p$ experiments. Here again $I^G = 0^+$ is established, but the J^P assignment is unknown; the E^o does not fit into any low-lying multiplet. The third object, the F_1, is least understood. Only I = 1 is known.

The proposed experiment will allow us to do a spin parity analysis and to study the production mechanism of these objects (if they are produced with $\sigma \geq 0.1$ μb) and any other present.

Another aspect will be the investigation of the $K\bar{K}$ system where solving the $K\pi$ ambiguity will help very much. Several experiments have seen I = 1 peaks near the $K\bar{K}$ threshold. But the nature of these peaks (usually connected to the δ(970)) is controversial.

The recent discovery of narrow resonances has created a new interest in the spectroscopy of mesons that do not easily fit into the well known meson multiplets and that do not seem to be produced via meson exchange. It is not excluded that, for example, the E meson is connected with $c\bar{c}$ (c for charmed quark), with colour or any new scheme (see for example ref. 2).

We will test the E^o production mechanism with high sensitivity; an upper limit on its production in $\pi^- p \to E^o n$ will be ≤ 0.05 μb, depending on the background. If its peripheral production cross-section were ≤ 0.05 μb this would be an interesting fact to be explained (charm involved?). If its production is comparable to that of the X^o, we would conclude that there is nothing wrong with E^o production; the statistics would then allow us to determine its J^P.

We will obviously scan the whole accessible mass region for any narrow peak in the $K\bar{K}\pi$-mass that might be identified with the pseudoscalar $c\bar{c}$, $\eta_c \to K\bar{K}\pi$. Unfortunately, the acceptance of the trigger system becomes quite low in the 3 GeV mass region.

Today it has been pointed out to us by the Saclay Omega group that this trigger appears to be the most efficient (or the least inefficient) for

$\pi^- p \rightarrow \eta_c n$, $\eta_c \rightarrow K\bar{K}\pi$. The Saclay Omega group is presently studying the acceptance problem and possible means to overcome it. Depending on the conclusions, they might join us.

Analysis of the test run data

We have recorded ∿ 90,000 triggers at half the normal Omega field with incident π^- of 10 GeV/c. Out of those we have passed 7,000 triggers ($^3/_4$ hour of running time) through pattern recognition and geometry (Omega program ROMEO). We got 732 reconstructed K^o_s + 2 prong candidates. This is a lower limit since the ROMEO program is not yet optimized for our purpose. In 311 events the $K\pi$ ambiguity could be solved with the help of the signals from the low pressure Cerenkov counter. This figure may also be regarded as a lower limit since for this analysis we grouped the 32 cells of the Cerenkov together in 16 groups and used a rather crude method to extrapolate the particle trajectories into the Cerenkov counter. In figure 1 the missing mass distribution of these events is shown. A clear neutron peak with a FHM = 180 MeV/c^2 is seen. This resolution should enable us to separate events on neutrons from those on lambdas or $n + \pi^o$.

In figures 2 and 3 the momentumtransfer $t' = t - t_{min}$ and the $K^oK\pi$ invariant mass are shown for the events on neutrons. The slope parameter for the t' distribution is ∿ 3.5 $(GeV/c)^{-2}$. The $K^oK\pi$ mass spectrum seems to follow phase space up to rather high masses $\geq$ 2.0 GeV/c^2. Although only in about half of the events the K-π ambiguity can be solved directly, selection criteria for attributing the K mass might be found which would enable us to use the ambiguous events for some aspects in addition.

As a conclusion we can say that we are able to detect reactions (1) and (2) quite clearly. The lower limit of 100 fully analysable events taken in $^3/4$ hour makes us expect good statistics to be taken in 6 days of effective running time. Estimating the increase in efficiency due to the enlarged veto counter to be a factor 1.5 and the analysis efficiency increase also 1.5, we expect to observe about 35,000 clean events. This is two orders of magnitude more than typical modern bubble chamber experiment

References

1) J. Duboc, M. Goldberg, B. Makowski, A.M. Touchard, R.A. Donald, D.N. Edwards, J. Galletly and N. West, Nuclear Physics B46 (1972) 429.

2) G. Altarelli, N. Cabibbo, R. Petronzio, L. Maiani, G. Paris, Rome-Frascati preprint (1974).

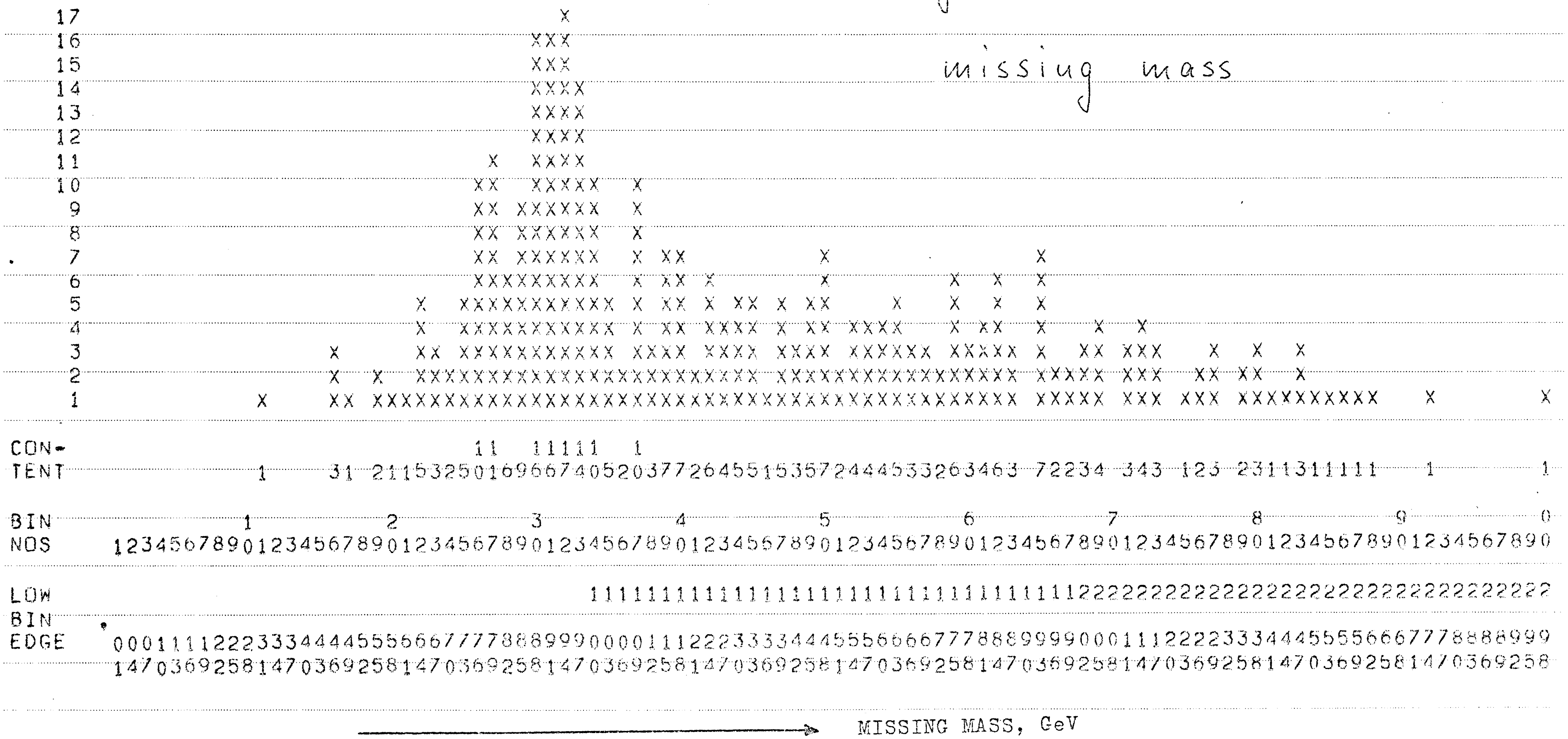
Figure captions

Figure 1. Plot of missing mass m_x in $\pi^- p \to K\bar{K}\pi\, x$ for events with identified K .

Figure 2. Momentum transfer $t' = t - t_{min}$ for events with a missing mass $.82 \leq m_x \leq 1.09$ GeV.

Figure 3. $K\bar{K}\pi$ invariant mass for events with $.82 \leq m_x \leq 1.09$ GeV.

Figure 1 : missing mass



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          27   X
          26   X
          25   X
          24   X
          23   X
          22   X
          21  XX
          20  XX
          19  XX
          18  XX
          17  XX
          16  XX
          15  XX
          14  XX
          13  XX
          12  XXX
          11  XXXX
          10  XXXX
           9  XXXX
           8  XXXX
           7  XXXX
           6  XXXXX
           5  XXXXX
           4  XXXXXX
           3  XXXXXXXX
           2  XXXXXXXXX
           1  XXXXXXXXXX   X XXX         X

 CON=         2211
 TENT         1721643321   1 111         1

 BIN                   1         2
 NOS          12345678901234567890123456789

 LOW                    1111111111222222222
 BIN
 EDGE         01234567890123456789012345678
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→ t' $(GeV/c)^2$

Figure 2

Figure 3: $K\bar{K}\pi$ mass

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  5                          X      X
  4                       XX X      X      X
  3        X         X    XXXX XX XXXX X   X
  2        XX    XXXXX    XXXX XX XXXX XX  X   XX  X X      X        XX
  1       XXX    XXXXXXXX XXXXXXXXXXXXXXXX XXX XXXXX XXX    XX  X    XX     X       X         X

CON-      132    22223111 4435133133531321 411 22112 211    21  1    22     1       1         1
TENT

BIN              1         2         3         4         5         6         7         8
NOS     1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678

LOW     1111111111111111111111111111111111111111222222222222222222222222222222222222222222222222
BIN     2222233333444445555566666777778888899999000001111122222333334444455555666667777788888999
EDGE    0246802468024680246802468024680246802468024680246802468024680246802468024680246802468024

                ------------------------------>   M(KK̄π), GeV
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