EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

PH I/COM - 73/8
22 February 1973

PHYSICS I

ELECTRONICS EXPERIMENTS COMMITTEE

PROPOSAL TO USE THE OMEGA SYSTEM TO STUDY THE SPECTRUM OF STRANGE BOSONS - PH 1/COM - 70/64 ADDENDUM

B. Ghidini, A. Palano, G. Zito.
Bari.

K. Müller, E. Paul, W. Rühmer.
Bonn.

M.G. Bowler, J. Eades, B.R. French, A. Grant, J. Moebes, F. Navach, L. Mandelli, V. Picciarelli.
CERN.

M. Edwards*, I. Smith, B. Zacharov.
Daresbury.

T. Armstrong*, W.R. Hogg, I.S. Hughes, C. Lewis, J. McCormick, R. Turnbull.
Glasgow.

R.A. Donald*, D. Edwards, J.R. Fry, M. Houlden.
Liverpool.

Also interested in participating are:
P. Borzatta, C. Cerrina, L. Tallone.
Milano.

* Subject to approval by DNPL Selection Committee.

The object of this note is to confirm our interest in using the Ω to study the spectrum of strange bosons produced against Λ hyperons by a π^- beam.

Since the original proposal there have been significant technical developments:

(1) Film readout from the optical spark chambers has been replaced by plumbicons.

(2) The slow proton trigger has been shown to work, with an efficiency of ~ 75%.

(3) At present it does not seem feasible to work with more than ~ 10^5 particles/burst, whereas the original proposal anticipated 3×10^5 π^-/burst, yielding an estimated 1.6 genuine triggers/burst, at 8 GeV/c incident momentum.

We now propose to run with the slow proton trigger T counter rotated ~ 20^o from the standard position, augmented by a lucite Cerenkov counter behind the scintillator to distinguish protons from pions without timing. We would then accept Λ's emerging on both the right and the left of a 60 cm target, decaying between veto counters (V) 3 cm from the axis of the target and acceptance counters (A) 9 cm from the axis of the target (see fig. 1). Both the V and A counters would be 1 mm scintillators. The Λ trigger condition would be $\bar{V}_L A_L T$ or $\bar{V}_R A_R T$. With this set-up, we estimate the trigger rate to be $4/10^5 \pi^-$/mb of seen Λ cross section, before taking into account the effect of secondaries other than from Λ decay hitting the veto counters. The V-A assemblies on the two sides of the target would operate independently, and after allowing for neutral Λ decays and spurious signals in the veto counters, we estimate ~ 2. triggers/$10^5 \pi^-$/mb of Λ cross section.

At 12 GeV/c the inclusive Λ cross section is $\gtrsim$ 0.5 mb (1,2) and so we expect ~ 1.1 genuine trigger/burst at this momentum. We prefer this momentum to that of 8 GeV/c suggested in the original proposal, for the cross sections in the most interesting channels have decreased by less than a factor of 2 and the increased kinematic separation of different dynamical regions is advantageous. We will also be able to make a direct comparison with Λ events collected in the course of our forthcoming slow proton run. We should point out that in this run, approved for April 1973, we expect to collect Λ data at a rate ~ 0.6/burst of $10^5\pi^-$. This data, while unbiased by the presence of veto counters, will not be distinguished by a hardware trigger, and its utilisation depends on the software presently being developed.

On the basis of a run of 3×10^5 bursts of $10^5\pi^-$, we thus expect $\gtrsim 3 \times 10^5$ Λ events with our proposed trigger $^+$. (3×10^5 bursts represent 300 hours at 1000 machine pulses per hour: 15 days running at 50% efficiency). In 7 days of running on π^- with the slow proton trigger we expect to accumulate ~ 6×10^4 Λ events among the slow proton data. In the $K\pi\pi$ mass spectrum between 1 and 2 GeV/c^2, we expect ~ 3×10^4 and 6×10^3 events respectively. Extensive data in this mass region at high energy in non-diffractive channels may be crucial in understanding the unnatural spin-parity strange meson spectrum, particularly in the Q region (3,4). In strangeness and charge exchange reactions there are persistent and fascinating hints of a $K\pi\pi$ state at ~ 1.26 GeV/c^2, with a dominant $K\rho$ decay mode, which it is tempting to identify with the lower half of the Q.

Fig 2(a) and (b) show respectively the missing mass spectrum and the $K\pi\pi$ spectrum recoiling against the Λ in $\pi^- p$ interactions at 11.2 GeV/c (2). The data comes from ~ 150 K hydrogen bubble chamber pictures, yielding

+ We are exploring the possibility of using the forthcoming proportional wire planes to assist in the rejection of extra beam tracks, in the hope that $3 \times 10^5\pi^-$/burst might then be acceptable. If this is feasible our estimated number of Λ events $\gtrsim 10^6$.

some 2000 Λ events in total. Fig. 3(a) and (b) show the Kππ spectrum against Λ at 4,6 and 6 GeV/c (5). Fig. 4 shows the Kππ spectra produced by change exchange in K^+p reactions leading to a five particle final state: the momentum is 5 GeV/c and the Kππ system is recoiling against ($p\pi^+$) (6). Fig. 5 shows the neutral missing mass spectrum recoiling against Λ at 4.5 GeV/c, from a neutral missing mass spectrometer (7). The bubble chamber experiments suffer from lack of data (and at low energy from the restricted phase space which generates serious reflection problems) and the neutral missing mass spectrometer is restricted to all neutral decay modes of the mesonic system recoiling against the Λ, and is at low energy. A system such as the CERN Ω seems to offer the only chance of doing substantially better.

We would therefore like to ask for ~ 2 days of time to test the possibility of the Λ trigger before the end of 1973, with the aim of taking a 15 day run sometime in 1974.

REFERENCES

(1) CERN/HERA 72-1. Compilation of cross sections π^- and π^+ induced reactions.

(2) M. Dameri et al., N.C. 9A 1 (1972).

(3) M.G. Bowler, Bologna Conference (1971).

(4) G. Fox. Philadelphia Conference (1972).

(5) D. Crennell et al., P.R. D6 1220 (1972).

(6) G. Charrière et al., N.P. B51 317 (1973).

(7) W. Frati et al., P.R. D6 2361 (1972).

FIGURE CAPTIONS

1. The Λ trigger (schematic). Note that the acceptance counters (A), parallel to the target, have a lip extending to the veto counters (V). The target is 60 cm long. The veto counters V_L and V_R and the acceptance counters A_L and A_R are 1 mm scintillator. Protons for Λ decay are registered by the large scintillator T and distinguished from pions by the Cerenkov counter c.

2(a) The mass spectrum of the S = 1 B = 0 system recoiling against Λ at 11.2 GeV/c (ref. 2) ~ 2000 events.

(b) The $K\pi\pi$ mass spectrum recoiling against Λ at 11.2 GeV/c (ref. 2) ~ 400 events.

3(a) The $K\pi$ and $K\pi\pi$ spectra recoiling against Λ at 4.5 GeV/c (ref. 5) ~ 1500 $K\pi\pi$ events.

(b) The $K\pi$ and $K\pi\pi$ spectra recoiling against Λ at 6 GeV/c (ref. 5).

4. The $(K\pi\pi)^{o}$ spectra recoiling against $(p\pi^{+})$ in 5 GeV/c $K^{+}p$ interactions (ref. 6).

5. The neutral spectrum produced against Λ at 4.5 GeV/c (ref. 7) ~ 3000 events.

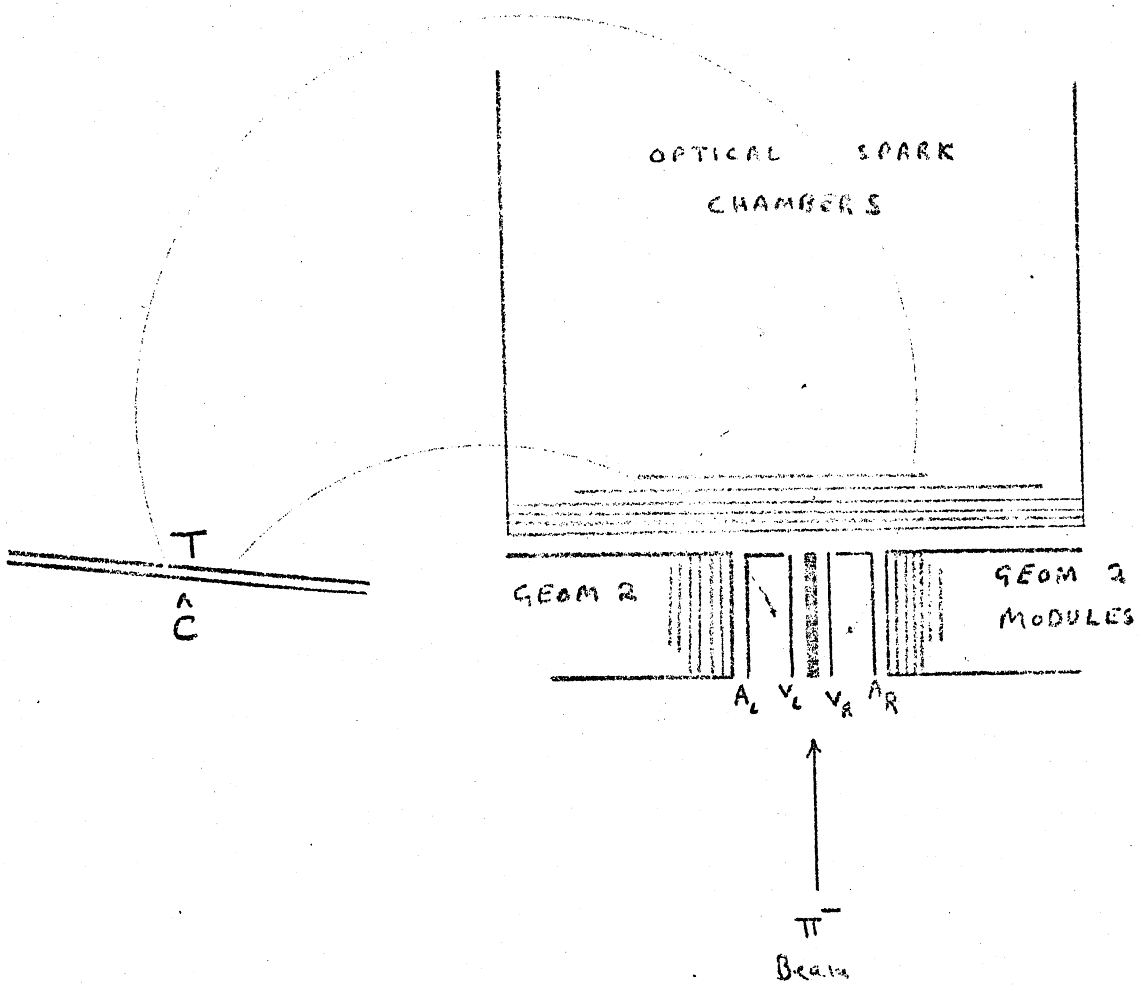
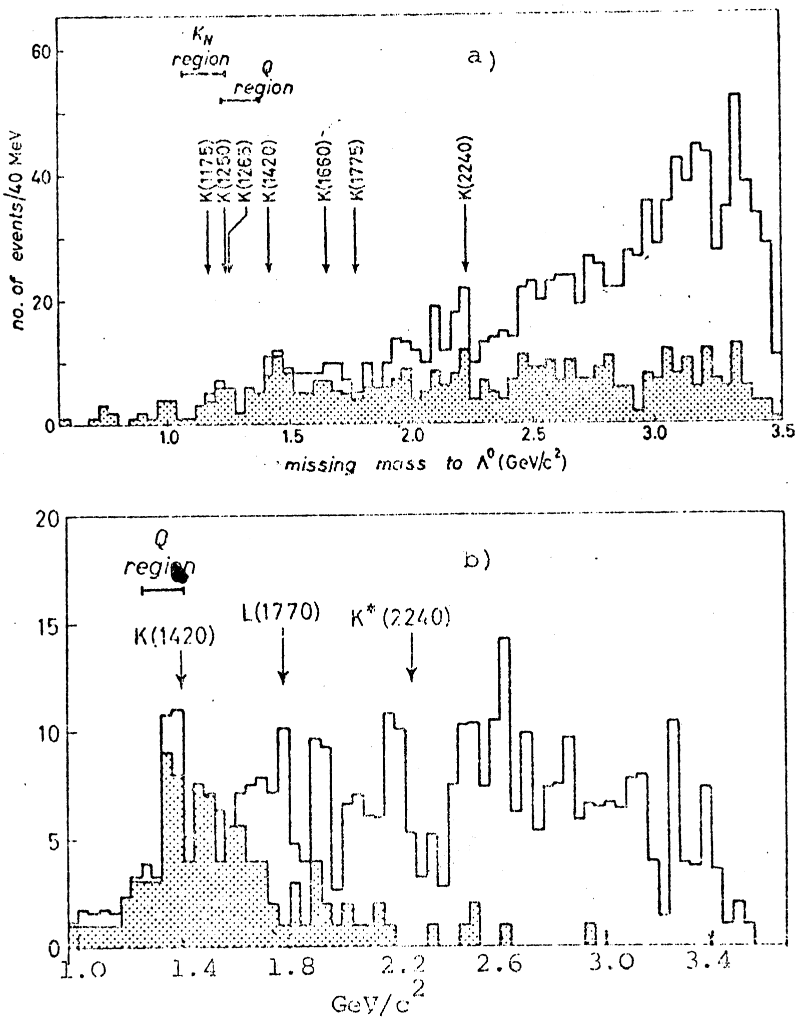
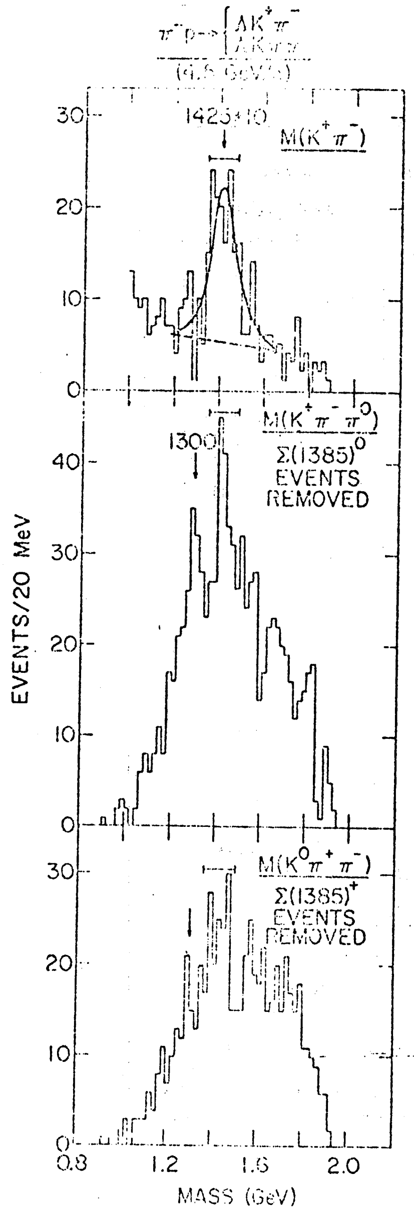

OPTICAL SPARK CHAMBERS
T
C
GEOM 2
GEOM 2 MODULES
A_L V_L V_R A_R
π⁻ Beam

fig. 1

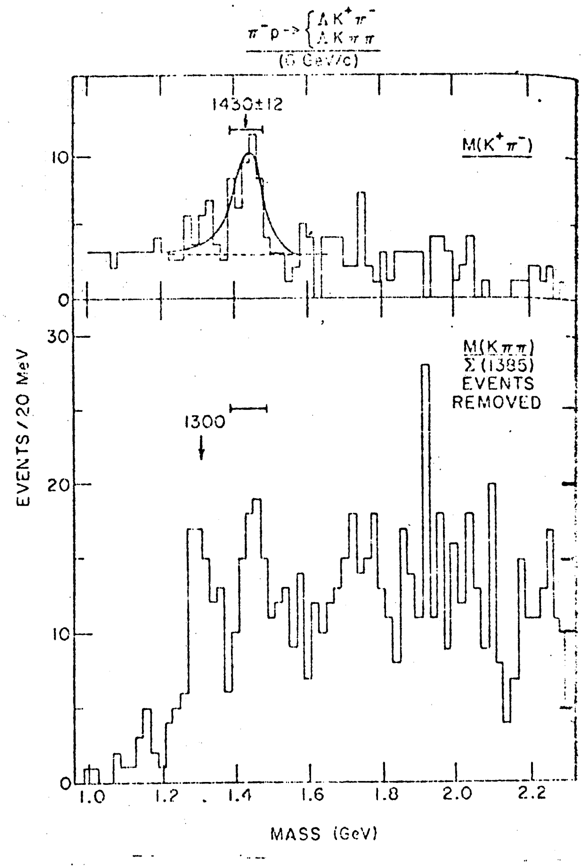
fig. 2


a)
K_N region
Q region
K(1175)
K(1250)
K(1265)
K(1420)
K(1660)
K(1775)
K(2240)
no. of events/40 MeV
missing mass to Λ^0 (GeV/c^2)
0
20
40
60
1.0
1.5
2.0
2.5
3.0
3.5
b)
Q region
K(1420)
L(1770)
K* (2240)
0
5
10
15
20
1.0
1.4
1.8
2.2
2.6
3.0
3.4
GeV/c^2



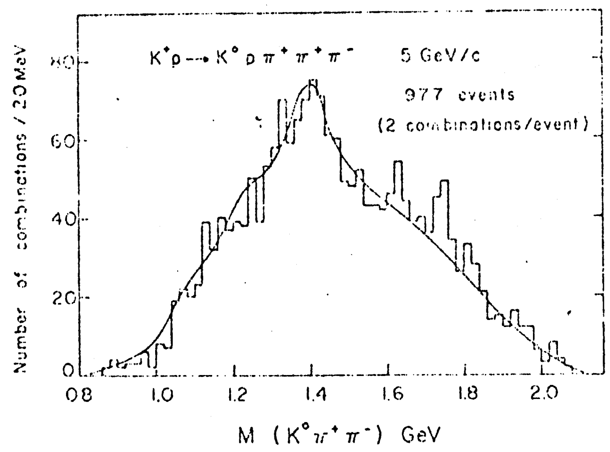
1425±10
M(K⁺π⁻)
1300
M(K⁺π⁻π⁰)
Σ(1385)⁰
EVENTS
REMOVED
M(K⁰π⁺π⁻)
Σ(1385)⁺
EVENTS
REMOVED
EVENTS/20 MeV
MASS (GeV)

fig. 3a

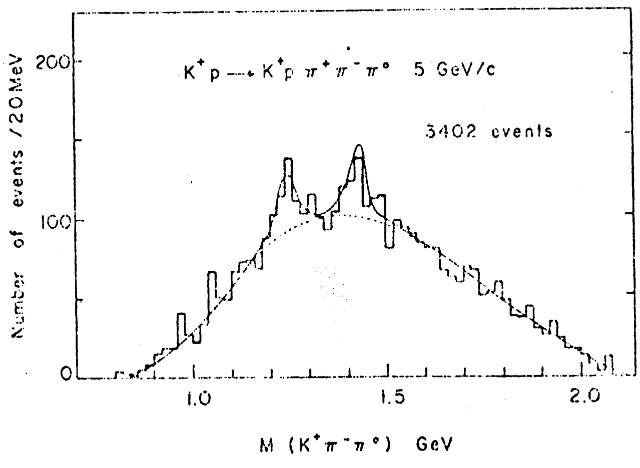


(5 GeV/c)
1430±12
M(K⁺π⁻)
M(Kππ)
Σ(1385)
EVENTS
REMOVED
1300
EVENTS/20 MeV
MASS (GeV)

fig. 3b



$K^+p \rightarrow K^\circ p \pi^+ \pi^+ \pi^-$ 5 GeV/c
977 events
(2 combinations/event)
Number of combinations / 20 MeV
M ($K^\circ \pi^+ \pi^-$) GeV



$K^+p \rightarrow K^+p \pi^+ \pi^- \pi^\circ$ 5 GeV/c
3402 events
Number of events / 20 MeV
M ($K^+ \pi^- \pi^\circ$) GeV

fig. 4

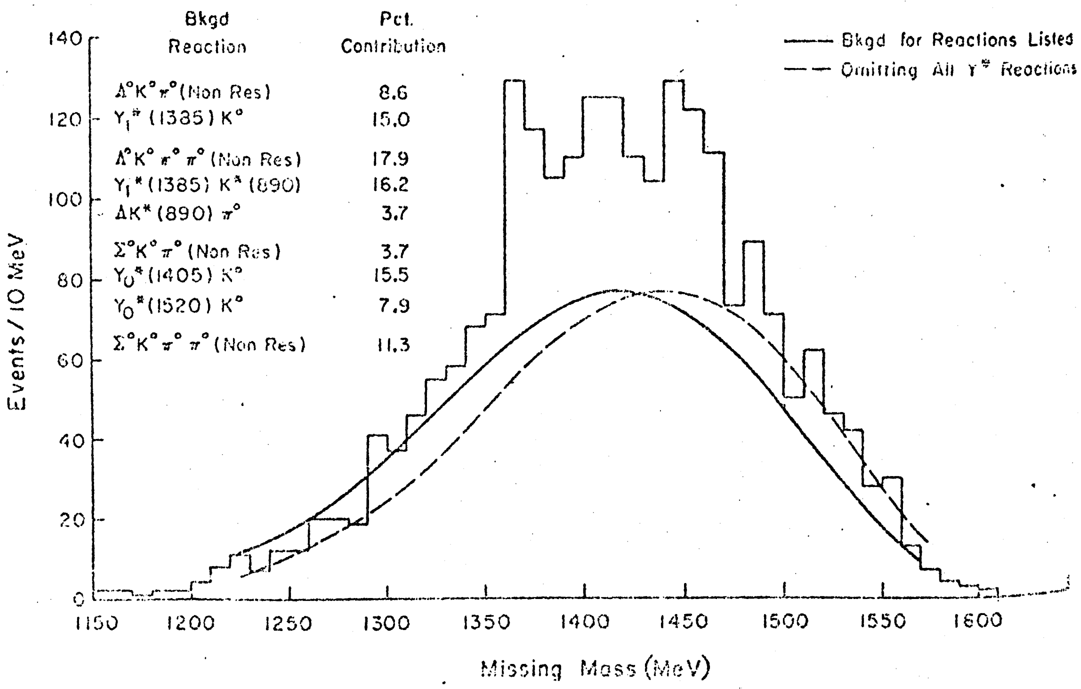

Bkgd Reaction
Pct. Contribution
Λ°K°π°(Non Res) 8.6
Y1* (1385) K° 15.0
Λ°K°π°π°(Non Res) 17.9
Y1*(1385) K*(890) 16.2
ΛK*(890) π° 3.7
Σ°K°π°(Non Res) 3.7
Y0*(1405) K° 15.5
Y0*(1520) K° 7.9
Σ°K°π°π°(Non Res) 11.3
Bkgd for Reactions Listed
Omitting All Y* Reactions
Events / 10 MeV
Missing Mass (MeV)
0
20
40
60
80
100
120
140
1150
1200
1250
1300
1350
1400
1450
1500
1550
1600

fig. 5