Indian J. Phys. 49, 407–410 (1975)

A fast electronic circuit designed to process ion beam in interaction $\pi^- p \rightarrow X^- p$ *

P. N. Upadhyay

Department of Physics, Gaya College, Gaya (Bihar)

(*Received* 10 *June* 1974)

The production of mesons X produced in interactions

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

and

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

was studied near their production thresholds. The missing mass was calculated by measuring the nucleon time-of-flight and the incident pion beam momentum.

The nucleons were detected at a laboratory angle of $3.8° \pm 1.7°$ by a ring of six identical scintillation counters N_{1-6} placed 5.15 meter downstream of a liquid hydrogen target (figure 1). The front of each of the N_{1-6} counters was covered by thin scintillation counters A_{1-6}. In case of a neutron, the signal is obtained only from one of the N_{1-6} counters whereas a proton gives simultaneous signal in the corresponding A_{1-6} counters. The nucleon momentum is determined by its time-of-flight between the counter N_{1-6} and a timing counter S placed just upstream of the hydrogen target.

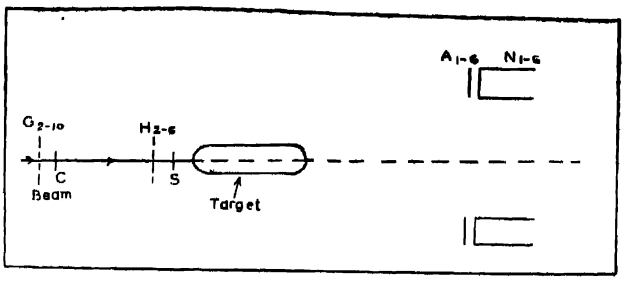

Fig. 1. The experimental lay-out.

The pion beam produced by the interaction of proton of energy 6 GeV on a Copper target placed in one of the octant of the proton Synchrotron at the High Energy Rutherford Laboratory, U.K. The pion beam was directed to a hydrogen target by quadrupoles and bending magnets. The determination of the pion momentum relied upon its detection by hodoscope counters which consisted of two

*Work done at the Rutherford Laboratory, Chilton, Didcot, Berks.

arrays of scientillation counters G2-10 and H_{2-6}. Five momentum channels P_1, P_2, ... P_5 were formed by grouping their G_iH_j combinations such that $8 \leqslant (i+j) \leqslant 12$ and the values of $(i+j) = 8, 9, 10, 11$ and 12 for P_1, P_2, P_3, P_4, P_5 respectively. This was possible because G and H counters were placed at conjugate planes of unit magnification of the quadrupole and the dipole. The five momentum channels were combined together to form a $\sum_{i=1} P\pi_i$ channel. The hodoscope counters were calibrated by a floating wire experiment (Binnie & Duane 1970).

For a *genuine pion beam*, a pulse from only a single counter of each hodoscope array, no pulse from the Cerenkov Counter, C (figure 1) to reject the electrons and a pulse from the timing counter S were demanded. The events with two or more particles detected by the G or the H-Counters were rejected by a circuit called $2G$-2H veto. This was designed to avoid ambiguity in the momentum determination of the beam and to reduce the accidentals. In order to reject an event with two or three particles coming within 304 Sec of each othr, a circuit called *Interference Remover* or (IR) was designed (Upadhyay 1973). So a genuine beam particle would satisfy the following condition

$$S.G_iH_j.\bar{c}\,(\overline{2G.2H})\ (\overline{IR}) \text{ with}$$
$$8 \leqslant (i+j) \leqslant 12.$$

The electronic circuits were designed by employing standard cards (Milborros 1973) available in useful forms like discriminator, Fan, OR gate AND gate, Set-Reset, levelchanger etc. The circuit diagram of the beam logic has been shown in figure 2 (in five stages).

The photomultiplier pulse of the S-Counter as well as each of the G and the H counters was fed to a discriminator. The discriminated photomultiplier pulse of the S-counter was fanned to obtain several pulses (stage 3; figure 2). In order to ascertain that a particle detected by one of the hodoscope-counters was also simultaneously detected by the S-counter, the pulse of each of the hodoscope counters was separately strobed by the S-counter pulse. This was done by resetting all the relevant set-resets (SR). In presence of the G or the H pulse, the respective SR was set by its discriminated pulse and an output was obtained from the corresponding AND gate within a typical resolving time of 10 *n*sec (stages 1 & 2 of figure 2).

The S-counter pulse was further examined by the IR, 2G-2H veto, and the Cerenkov veto circuits in stage 3 of figure 2 and a pulse S_1 is obtained. Different combinations of G_iH_j were formed by the standard coincidence circuits; in which a 10 *n*sec gate was formed by one of the strobed H-pulses. The G-pulse was allowed to arrive within the gate. Such combinations of the H_6-Counters have been shown in stage 4 of figure 2. Five separate momentum channels $P\pi i$ formed by grouping different G_iH_j combination have been shown in stage 5 of figure 2. These were obtained by strobing them by the pure S_1. Finally all the five momentum channels were added together to form a combined momentum channel $\Sigma P\pi_i$.

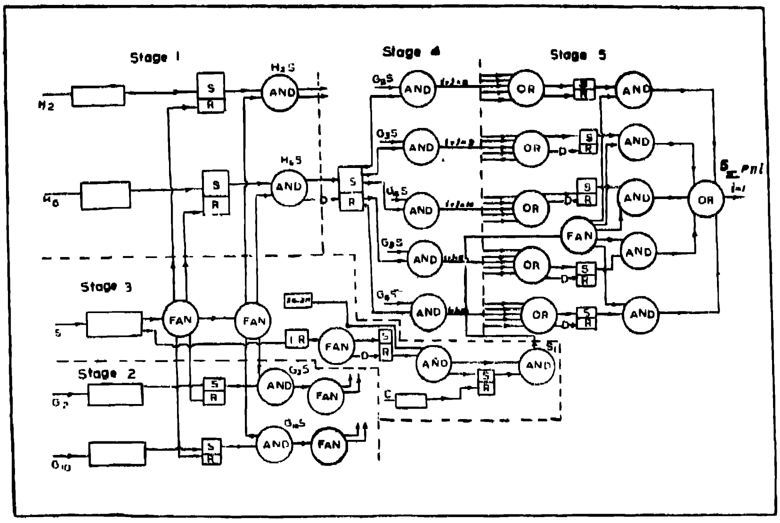

Fig 2. Shows the beam logic. S/R and D reprosent respectively the discriminator, Set Reset and 10 nSec delay.

In Stages 1 and 2 the hodoscope counters H2-6 and G2-10 are strobed by the discriminated pulse (stage 3) of the timing counter S.

In Stato 3 a pulse S1 is obtained after checking the beam particle (defected by the S Counter Counter) by the Interference remover, the 2G-2H Veto and the Cerenkov veto circuits,

In Stage 4, different combinations of GiHj form with H-6 has been shown in which are grouped together in such a way that 8 $(i+j)$ 12. Five corresponding momentum channels $P\pi i$ strobed by S1 have been formed in stage 5. Finally all these channels are combined together to form a combined momen- tum channels $\sum_{i=1}^{S} P\pi i$.

The individual and the combined momentum channels were scaled and recorded on the magnetic tapes by a on-line PDP-8 Computer. With the occurrence of a genuine pion beam, the computer also recorded the states of the G and the H counters which were fired. Results (Upadhyay 1973) obtained by this experiment on the X^0 (Binnie *et al* 1972), the δ the A_2^- (Binnie *et al* 1971)mesons have already been published.

ACKNOWLEDGMENT

The author wishes to thank his colleagues at Imperial College, London and Southampton University, Southampton who collaborated in this work. The studies were carried out at the Rutherford Labofatory, Chilton, Didcot, Berks, U.K.

References

Binnie D. M. & Duane A. 1970 *Nucl. Inst. Meth.* **77**, 329.
Binnie, D. M., Camillieri L., Duane A. *et. al.* 1971 *Phys. Letts* **36B**, 257, 537
Binnie D. M. Camilleri L., Duane A. *et al* 1972*Phys. Letters*, **39B**, 275.
Upadhyay P. N. 1973 *Ind. Jour. Pure & Appl. Phys.* **11**, 425.

Indian J. Phys. **49**, 410–411 (1975)

A preliminary study of the $\pi^+\pi^-\pi^+\pi^-$ decay mode of the X^0 meson

P. N. Upadhyay

Department of Physics, Gaya College, Gaya, Bihar

(*Received* 10 *June* 1974)

An enhancement near the X^0 region at mass 956 ± 2 MeV/c^2 and width $\leqslant$ 12 MeV/c^2 produced in $\pi^- p \rightarrow X^0 n$ have already been reported (Upadhyay 1973). The $X^0 \rightarrow \pi\pi\eta$ decay mode was also studied (Upadhyay 1971). Some data was further analysed to study a rare decay mode $\pi^+\pi^-\pi^+\pi^-$ of the X^0 meosn reported by Barash-Schmidt *et al* (1973).

The missing mass of the X^0 meson was determined by measuring the neutron time-of-flight and incident pion momentum. The number of the charged particles and the neutral particles was determined by an array of the scintillation counters which surrounded a liquid hydrogen target. The details of the apparatus have been given by Upadhyay (1973).

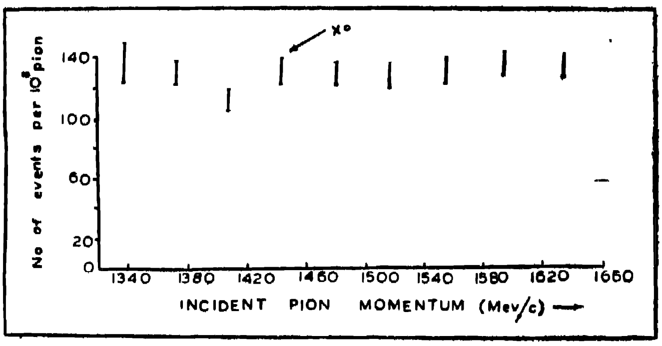

Fig 1. Yield curve for the $X^0 \rightarrow \pi^+\pi^-\pi^+\pi^-$ events in the four-momentum transfer region ranging from -0.38 to -0.79 (GeV/c)^2.