THE CHARGED EXCHANGE SCATTERING $\pi^- + p \to \pi^0 + n$ AT 6 AND 10 GeV/c

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(Presented by P. FLEURY)

20.000 pictures were taken at each of the two beam momenta studied so far, using the experimental layout shown in Fig. 1. Half of the above pictures contain 2γ events, and these are being measured and analyzed at present.

Another 40.000 pictures have been taken:

a) 20.000 to look for background and biases;

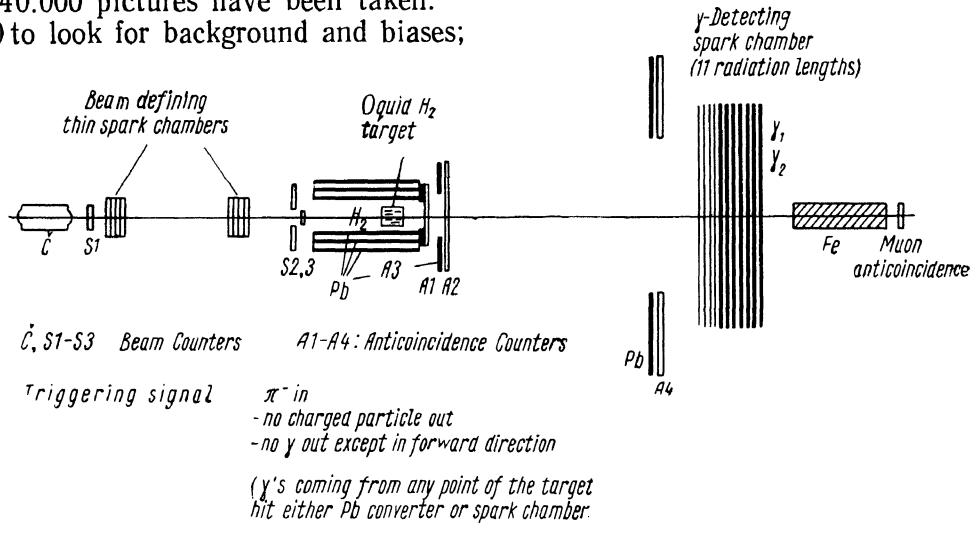

Fig. 1. Experimental layout.

b) 20.000 in a different geometry to study the production of other neutral particles.

It is the purpose of this report to give an account of the first results which emerge from the analysis (based on 1500 events processed at each momentum) and from the study of possible sources of contamination.

1. PRELIMINARY RESULTS

The differential cross-sections are shown on Fig. 2. Their shape seems to deviate from a simple exponential near the forward direction. It is similar to the angular distribution of K^-p charge exchange [1]. At zero momentum transfer, the real part of the scattering amplitude seems to be comparable to the imaginary part, as calculated from the total $\pi^\pm p$ cross-sections [2].

As the cross-section is strongly peaked at small angles, our geometry detects over 90% of the events in the peak, and the integral under the peak is essentially the total cross-section. The values so determined are:

Total cross-section for $\pi^- p \to \pi^0 n$ at 6 GeV/c = $= 79 \pm 12 \mu b$ at 10 GeV/c = $43 \pm 7 \mu b$.

2. POSSIBLE CONTAMINATION

The error bars given on the results reflect our uncertainty concerning the following sources of error:

i) Of the pictures containing 2γ events, 5% have been classed doubtful for various

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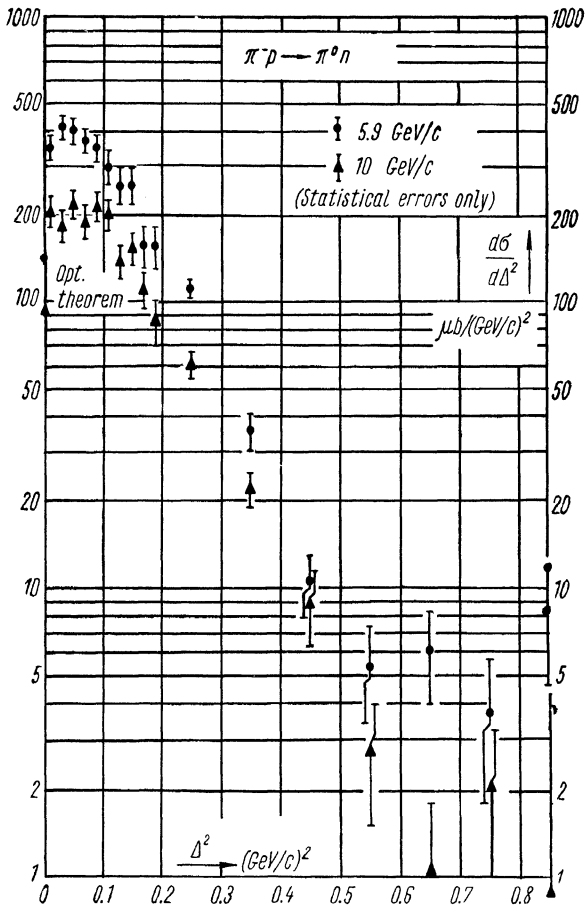


Fig. 2. Differential cross-section.

reasons, and have been excluded from the analysis for the moment.

ii) We are carefully studying the possible contamination from reactions other than elastic charge exchange, with these «inelastic». processes also giving rise to pictures with 2γ's.

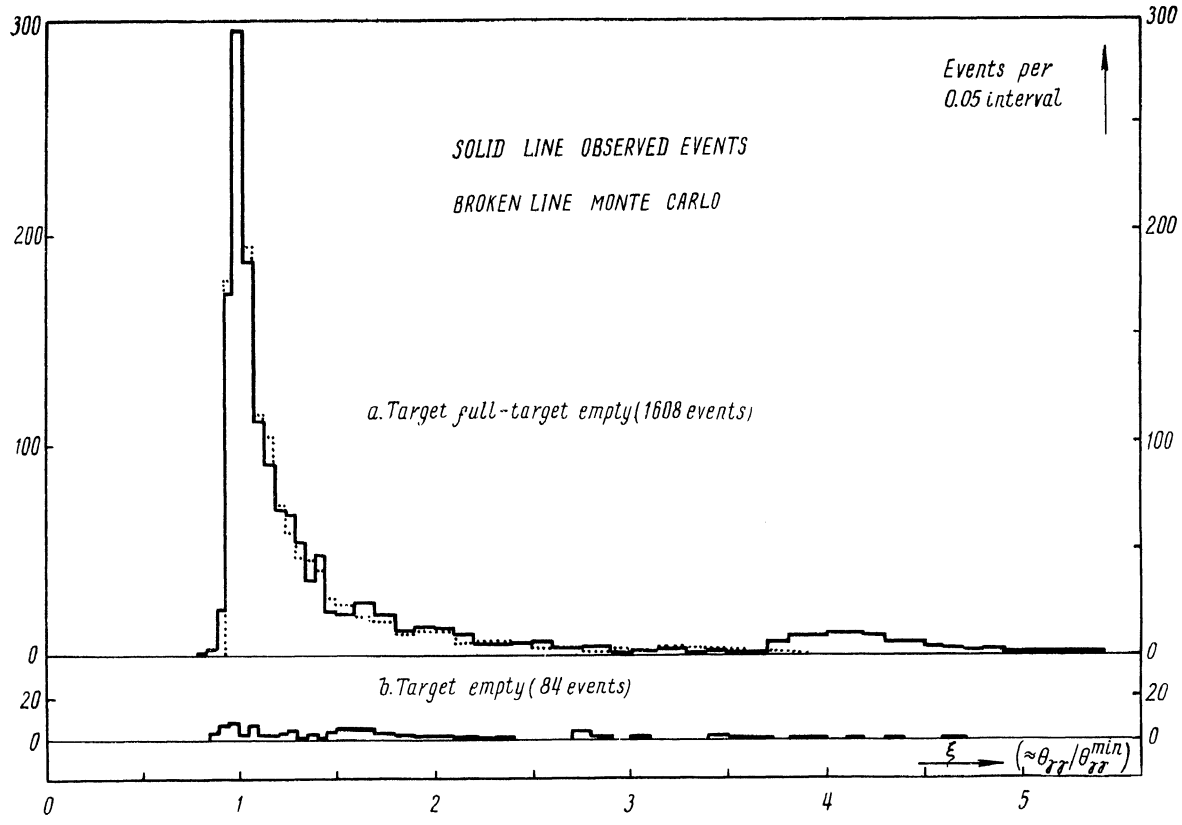
a) We studied the distribution of opening angles between the two γ's. The distribution (after the «target empty» effect has been subtracted) is shown on Fig. 3. The momentum-invariant variable

$$\xi = \mathrm{tg}\frac{\theta_{\gamma\gamma}}{2} \times \frac{p_{\pi_0}}{m_{\pi 0}} \approx \frac{\theta_{\gamma\gamma}}{\theta_{\gamma\gamma\,\mathrm{min}}}$$

is used for convenience. Superimposed on the same graph is the distribution expected on the basis of our geometry, and calculated using the Monte Carlo method. The excellent agreement limits the fraction of inelastic contamination of a random nature to less than 5%.

b) In addition of the random type of background, one has to worry about the effect of «almost elastic» events, arising from reactions like $\pi^- p \to N^0\ \pi^0$. These involve particles with

Fig. 3. γγ-Opening angle distribution at 5.9 GeV/c.



low lab. energy, which may escape the anti-coincidence system, and add to our 2γ pictures. In addition their distribution on opening angles [see (a) above] will be quite similar to those of the desired elastic events. To test for this kind of contamination we varied the thickness of lead in the anticoincidence sandwiches in such a way that the cut-off energy either for low energy γ's or for charged particles was changed by a factor of two. In four different configurations no such effect was found to within 5%.

c) For an independent test we have taken 20.000 pictures at 6 GeV/c with the lead-plate spark chamber covering a three times larger solid angle than under normal conditions. Under these circumstances the triggering rate and the fraction of 2γ events on the pictures have both varied, but the cross-section found for the forward charge-exchange peak remained the same within the statistics (~10%).

On the basis of the measurements and tests performed so far we conclude that the systematic errors on the cross-sections given are less than 15%.

We expect to get smaller uncertainty after completion of the analysis.

NOTE ADDED IN PROOF

Our cross-section at 6 GeV/c is in good agreement with yet unpublished results of a similar experiment done at the AGS (private communication by Dr. I. Mannelli).

REFERENCES

1. The charge exchange $K^- + p \to \bar{K}^\circ +$ n at 10 GeV by P. Astbury, G. Finocchiaro, A. Michelini, C. Verkerk, D. Websdale and C. West (CERN) and W. Beusch, B. Gobbi, M. Pepin, M. Pouchon and E. Polgar (ETH Zurich) (stencil No. 9002).
2. The imaginary parts, whose squares are shown on Fig. 2 («Optical Theorem») were calculated from yet unpublished results from a BNL Group, kindly supplied to us by Dr. I. Mannelli. They should not be quoted.