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letter of intention

LETTER OF INTENTION

E.E.C.

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SMALL ANGLE πp SCATTERING

CERN - Institut de Radium (Paris) Collaboration

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Introduction

In this note, we are reconsidering our letter of intention on Pion-Nucleon Diffraction Scattering [1] submitted to the E.E.C. in September 1962.

Since then, experimental data on (π p) diffraction scattering have become available [2) 3)] for momentum transfers $-t \geq 0.2$ (Gev/c)^2. The experimental situation concerning (πp) elastic scattering at small angles is still very poor. Recent data [4] from a bubble chamber experiment on (π^- p) scattering at 10 Gev/c exhibited a striking departure from an exponential behaviour in this range.

Small angle (π p) scattering can also give information on the real part of the forward scattering amplitude; in particular on the ratio Re f (s,0)/ Im f (s,0) and its energy dependence. No experimental information is available in the Gev range. Theoretically, the ratio is predicted to be 0.3 at 3 Gev/c from dispersion relations for the forward scattering amplitude [5].

The ratio Re f(s,0)/Imf(s,0) is obtained from a measurement of the differential cross section, $d\sigma/d\Omega$, in the angle range where the Coulomb amplitude equals the imaginary part of the scattering amplitude. The error in the determination of the ratio is then determined by the error in $d\sigma/d\Omega$ and σ_T only. The relevant angle range varies from 10 to 5 mrad in the momentum range of 5 to 10 Gev/c. The aim of the proposed experiment is to measure $d\sigma/d\Omega$ to 3% for positive and negative pions at 10 angles between 1 and 20 mrad in the momentum range 5 to 10 Gev/c.

Experimentally, the situation is very different from (p p) small angle scattering. Having a diffracted proton beam of 10^8 p/burst available, a pencil beam can be prepared by collimation and the small angle range made accessible to reasonable trigger conditions for spark chambers. With the intensities currently available in secondary pion beams from the CERN proton synchrotron, this method is prohibitive. That is why we have reconsidered our letter of intention[1] and propose a new method for small angle (π p) scattering. The experimental arrangement is shown in the figure. Pions are incident on a 10 cm hydrogen target. A focusing and self-collimating gas Čerenkov counter, $\check{C}_1$, selects pions in a defined angular range of ± 0.1 mrad and with a r.m.s. momentum band of $\langle (\Delta p/p)^2 \rangle^{1/2} \simeq 2.8 \cdot 10^{-6}\, \gamma_\pi^2$ ($\pm 1.7 \cdot 10^{-3}$ at 5 Gev/c and $\pm 7 \cdot 10^{-3}$ at 10 Gev/c) . To compensate the restriction in beam acceptance and momentum band, the beam is allowed to have an area of $\simeq 60$ cm^2 (6 cm vertically and 10 cm horizontally) at the target.

Pions traversing the target without interaction are rejected by a similar counter, $\check{C}_2$, in anti-coincidence. The scattering angle will be measured in a pair of 5 gap spark chambers, Sc 1 and Sc 2, 7 m apart, and the momentum, after analysis in a 2 m bending magnet B, by a third spark chamber, Sc 3.

With this system a total angular resolution of 0.5 mrad is obtained, including multiple scattering. With a bending angle of 60 mrad, determined to an accuracy of 0.5 mrad, a momentum resolution of 1% is obtained. A signal $C_1 \overline{C_2}\ M_1 M_2\ \overline{A}_2$ triggers the system of spark chambers. Suitable combinations of counters in the hodoscopes M_1 and M_2 restrict the inelasticity of events to $\Delta p/p \approx 30\%$. In the angular range of 1 - 13 mrad all elastic events are accepted. For inelastic events the solid angle is reduced. Rejection of most near elastic events is possible by requiring no signal from a counter A_1, which is wrapping the target. Counter A_2 in anti-coincidence rejects events with high multiplicity.

Rates

In a suitably modified beam of the type d_{15} , about $5 \cdot 10^3$ pions/b will meet the selection of divergence and momentum band by the Čerenkov counter $\check{C}_1$. The intensity of particles rejected by this selection will be minimized by proper matching and collimation.

The trigger rate for a 10 cm hydrogen target is $dI = 10^{-4}\ I_o$ at 5 Gev/c for a forward scattering cross section of $4.6 \cdot 10^{-25}\ cm^2/sr$, or $dI = 0.5$ / burst. The time to record 10^4 events in the angular range 1 - 13 mrad is then about 40 hours. Including setting up, the running time i estimated to be 10 shifts per energy and pion charge. Data at 5, 7.5 and 10 Gev/c would then result in a total request of 60 shifts. Some time for testing will be necessary.

Analysis

About 10^5 frames will be taken for this experiment. Each event is fully determined by two lines, giving the scattering angle and the momentum. For this, two stereo views of the three spark chambers have to be measured.

The INSTITUT DE RADIUM (Paris) has offered to collaborate in the analysis by building a simple flying spot scanner, programmed to scan one line per gap. The data output will be coupled directly to an IBM 650, programmed for event reconstruction and checks. The computer is owned by that laboratory.

Two conventional digitized measuring tables are also made available for this experiment.

Time-Table

Construction of the flying spot scanner will start during this summer. It is hoped that the device can be tested by the end of this year.

Construction of the self collimating Čerenkov counters could start by the end of this year if the optics were ordered now. The whole apparatus could be ready for test runs in February-March 1964, and for data taking in April-May 1964. The preparations for the proposed experiment will not interfere with the running of the experiment on backward scattering of pions (S18).

REFERENCES

1) Pion-Nucleon Diffraction Sacttering,
K. Winter, D. Dekkers, R. Mermod, M. Vivargent, G. Weber, September 1962.

2) S. Lindenbaum et al, post deadline paper APS meeting, New York, January 1963.

3) D. Harting et al, private communication.

4) S. Brandt, V.T. Cocconi, D.R.O. Morrison, A. Wroblewski, P. Fleury, G. Kayas, F. Muller, C. Pelletier (to be published in P.R.L.).

5) J.W. Cronin, Phys.Rev. 118, 824 (1960).

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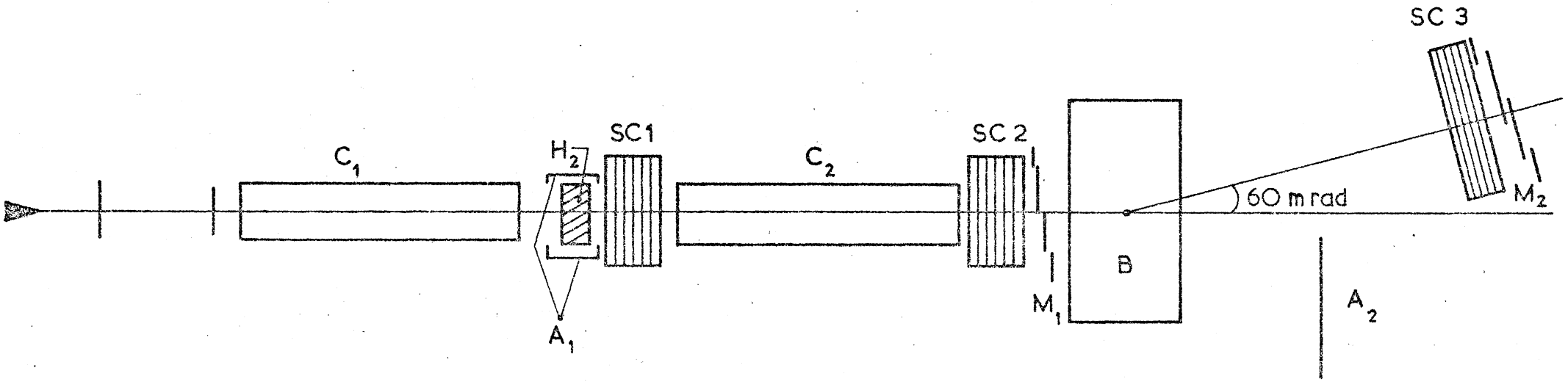

TRIGGER : $C_1 \bar{C}_2 M_1 M_2 \bar{A}_2$