SINGLE SPIN ASYMMETRY MEASUREMENTS FOR π^0 INCLUSIVE PRODUCTIONS IN $p + p_\uparrow \rightarrow \pi^0 + X$ AND $\pi^- + p_\uparrow \rightarrow \pi^0 + X$ REACTIONS AT 70 AND 40 GEV RESPECTIVELY. *

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The inclusive π^0 asymmetries were measured in reactions $p + p \uparrow\rightarrow \pi^0 + X$ and $\pi^- + p \uparrow\rightarrow \pi^0 + X$ at 70 and 40 GeV/c respectively. The measurements were made at the central region (for the first reaction) and asymmetry is compatible with zero in the entire measured p_T region. For the second reaction the asymmetry is zero for small x_F region ($-0.4 < x_F < -0.1,\ 0.5 < p_T(GeV/c) < 1.5$) and increases with growth of $\mid x_F \mid$. Averaged over the interval $-0.8 < x_F < -0.4,\ 1 < p_T(GeV/c) < 2$ the asymmetry was $-(13.8 \pm 3.8)\%$.

Two experiments were performed at U70 GeV accelerator of IHEP aiming to measure the single spin asymmetry (SSA) in inclusive π^0 productions.

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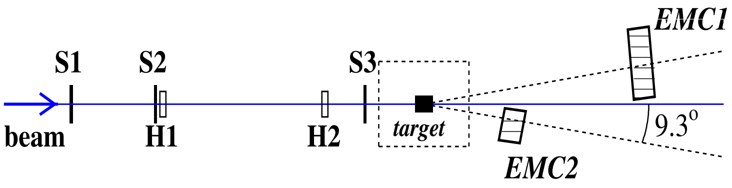

Figure 1. Experimental Set-up PROZA-M; S1-S3 – Scintillation counters, H1-H2 – two-coordinate hodoscopes, EMC – electromagnetic calorimeter, *target* - polarized target.

In one case we studied the reaction $pp_{\uparrow} \to \pi^0 X$ at 70 GeV/c. The interest to such a study was stimulated by two experimental data relevant to above reaction, namely, [1] at 24 GeV/c and [2] at 200 GeV/c. The proton beam of 70 GeV/c momentum was extracted from U70 by the thin Si crystal bent under 80 mrad [3].

The beam parameters measured by counters S1-S3 and hodoscopes H1,H2 (see Fig.1) were: intensity $\approx 1 \cdot 10^6$ p/cycle, $\sigma(x) = 4$ mm, $\sigma(x') = 2$ mrad, $\sigma(y) = 3$ mm, $\sigma(y') = 1$ mrad. The frozen spin polarized target (PT) was made of the propandiole, had the length of 200 mm, diameter of 20 mm. The average polarization was $\approx 80\%$.

Two electromagnetic calorimeters EMC1(480 lead glass counters(lgc)) and EMC2 (144 lgc) were used. They were positioned under π^0 emission angle 90^0 in c.m.s. at 6.9 m and 2.8 m from PT correspondingly. Both calorimeters were composed from the same lead glass cell of size 3.8x3.8x45 cm^3. Calorimeters were calibrated by the electron beam of 26.6 GeV. The energy resolution achieved was $\frac{\sigma(E)}{E} \approx 2.5\%$. The rate of data taking for pp-interactions was 350 events and during 10 days running $2 \cdot 10^7$ events were accumulated, while for $\pi^- p$ it was around 300 events per cycle and 10^8 events were accumulated for 30 days.

The final results on the analyzing power for reaction $\mathrm{p}+\mathrm{p}_{\uparrow} \to \pi^0 + X$ at 70 GeV are presented in Fig.2a (open square). It is evident that the SSA is compatible with zero. The study of the reaction $\pi^- + p_{\uparrow} \to \pi^0 + X$ is similar to the previous one. The beam parameters were: intensity $1 \cdot 10^6$ p/cycle, momentum of 40 GeV/c, the round beam size of 3.5 mm. In this case we use only one EMC with 720 lgc exactly of the same type as before. The calorimeter was positioned at distance of 2.3 m from PT and angle was varied . The more details of the second experiment may be found in paper

[4]. The results are presented in the Fig.2b (open square). If we average SSA over the interval $-0.8 < x_F < -0.4$ we got $A_N(\pi^0) = -(13.8 \pm 3.8)\%$, that is, an essential spin effect. But for the interval $-0.4 < x_F < -0.1$ $A_N(\pi^0) \approx 0$.

The general overview of the theoretical interpretations of our data at 40 and 70 GeV/c leads to the following understandings. Most of the theoretical models based on pQCD are not applicable to our energy and transverse momentum ranges. There are several phenomenological models (orbiting quarks, Sivers and Collins mechanisms, high twist effects, etc.) explaining some aspects of data but not all of them. In this situation we applied the model proposed recently in paper [5] to the present data. . The slope parameter, needed in this model for calculation, was taken either from our experimental data or from the published data [6]. The SSA results for reaction $\mathrm{p} + \mathrm{p}_\uparrow \to \pi^0 + X$ at 70 GeV/c in CR [7] are presented in Fig.2a. The sign of SSA as well as of x_F were changed in order to compare to the E704 data presented in the same Fig.2a. The dotted line is a prediction of the CMSM for 70 GeV/c and the solid line is for the E704 data (see details in [5]). There is fairly well consistency between experimental data and the model prediction.

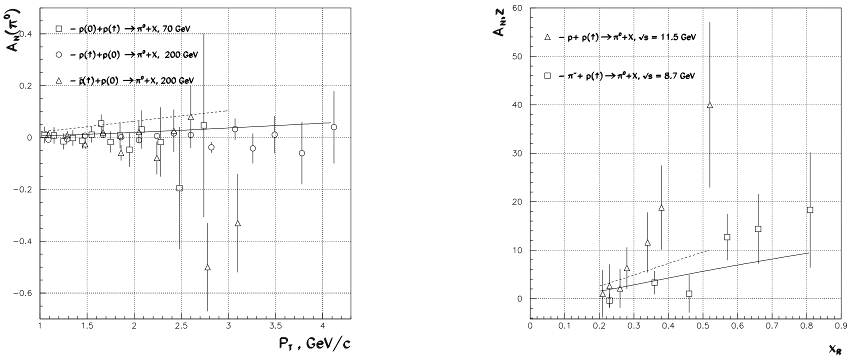

Figure 2. SSA vs p_T for reaction $\mathrm{p} + \mathrm{p}_\uparrow \to \pi^0 + X$(left) and SSA vs x_R for reaction $\pi^- + p_\uparrow \to \pi^0 + X$(right). Lines are the model prediction (see text)

New data on $\pi^- p\uparrow \to \pi^0 X$ at 40 GeV/c are presented in Fig.2b (open square). Since in this case x_F and x_T are comparable in magnitude

$A_N(in\%)$ is plotted versus x_R ($x_R = \sqrt{x_F^2 + x_T^2}$) using following formula

$$A_N(\pi^0) = 11.7 \frac{x_R^{1.5}}{[x_R^{0.5} + 0.64 \cdot (1 - x_R)^{4.5}]}. \quad (1)$$

As seen from Fig.2b (solid line) there is a fairly good description of our data. In the same Fig.2b the SSA data for reaction $pp_\uparrow \to \pi^0 X$ at 70 GeV/c are presented. The detailed discussion was given by Dr. Mochalov in this session [8]. The CMSM predicts the same formula as above but with parameter 20.0 replacing 11.7. In this case the model prediction (the dashed line) does not contradict to the experimental data in the frame of the given error bars.

Summary

The experimental studies of the analyzing powers of reactions p + $\mathrm{p}_\uparrow \to \pi^0 + X$ at 70 GeV and $\pi^- + p_\uparrow \to \pi^0 + X$ at 40 GeV allow to make the following conclusions. For the first time the single spin asymmetry was measured in the polarized target fragmentation region for reaction $\pi^- + p_\uparrow \to \pi^0 + X$ at 40 GeV/c. For kinematical domain $-0.8 < x_F < -0.4$, $1 < p_T(GeV/c) < 2$, $A_N = -(13.8 \pm 3.8)\%$, while in the region $-0.4 < x_F < -0.1$, $0.5 < p_T(GeV/c) < 1.5$ asymmetry is compatible with zero.. Asymmetry measured in the CR is zero for region $1 < pp_T(GeV/c) < 3$ for reaction p + $\mathrm{p}_\uparrow \to \pi^0 + X$ at 70 GeV/c. The results are consistent with E704 data at 200 GeV/c.

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