A_N AT SMALL NEGATIVE VALUES OF x_F IN THE REACTION $p + p_\uparrow \rightarrow \pi^0 + X$ AT 70 GEV AND UNIVERSAL THRESHOLD IN INCLUSIVE PION PRODUCTION. *

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The talk continues the series of Single Spin Asymmetry (SSA) π^0 inclusive measurements carried out at Protvino 70 GeV accelerator. The asymmetry in the polarized target fragmentation region grows up in absolute value with x_F decreasing and equals to $(-16 \pm 5)\%$ at $-0.4 < x_F < -0.25$. The result of the current experiment is in agreement with the universal threshold in pion asymmetries.

The experiment was carried out at the PROZA-M experimental set-up [1] in U-70 Protvino accelerator at 1996. In previous measurements performed in Protvino[2−5] we observed significant asymmetry in the reaction $\pi^- + p_\uparrow \rightarrow \pi^0 + X$ at the central and the polarized target fragmentation regions, whereas the asymmetry in the reaction $p + p_\uparrow \rightarrow \pi^0 + X$ in the central region was compatible with zero. Present talk is devoted to SSA measurement at

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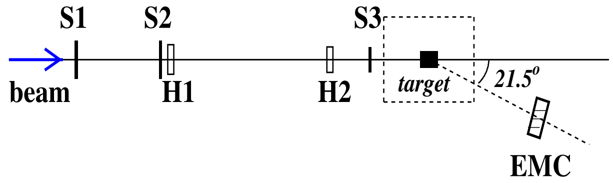

Figure 1. Experimental set-up PROZA-M; S1-S3 – scintillation counters, H1-H2 – two-coordinate hodoscopes, EMC – electromagnetic calorimeter, *target* - polarized target.

small negative values of $x_{\rm F}$ in the reaction $\mathrm{p} + \mathrm{p}_\uparrow \to \pi^0 + X$.

A 70 GeV proton beam extracted from the U-70 main ring with the use of bent crystal had intensity in the range $(3-6)\cdot 10^7$ protons/10 sec. cycle. Frozen polarized target ($C_3H_8O_2$) with a dilution factor $D \approx 10$ operated with 80% average polarization (see Fig. 1). γ-quanta were detected by electromagnetic calorimeter (144 lead glasses) placed 2.8 m downstream target at 21.5° on respect to the beam direction. Three scintillation counters S1-S3 and two hodoscopes H1-H2 were used for beam particle detection and zero level trigger. First level trigger provided the events selection with the energy deposited in the calorimeter above 1 GeV.

The asymmetry was calculated as

$$A_N = \frac{D(x_{\rm F},p_T)}{P_{target}} \cdot A_N^{raw}(x_{\rm F},p_T) = \frac{D(x_{\rm F},p_T)}{P_{target}} \cdot \frac{n_\uparrow(x_{\rm F},p_T) - n_\downarrow(x_{\rm F},p_T)}{n_\uparrow(x_{\rm F},p_T) + n_\downarrow(x_{\rm F},p_T)} \quad (1)$$

where P_{target} – average target polarization;D - target dilution factor. The azimuthal angle was closed to 180°, thus we neglected the SSA dependence on $\cos\phi$.

Measurements were performed at narrow solid angle (see Fig.2), π^0-mass width was in range 11-17 MeV/c^2 for different kinematic regions.

False asymmetry was compatible with zero (Fig. 3). The asymmetry was also close to zero at small absolute values of $x_{\rm F}$ and grows in magnitude with $|x_{\rm F}|$ increase. The combined result $(-16 \pm 5)\%$ is in agreement with other experiments in polarized particle fragmentation region: $A_N = (12.4 \pm 1.4)\%$ at E704 (FNAL)[6], $(14 \pm 4)\%$ at STAR (BNL)[7] in the reaction $\mathrm{p}_\uparrow + \mathrm{p} \to \pi^0 + X$and $(13.8 \pm 3.8)\%$ in the reaction $\pi^- + p_\uparrow \to \pi^0 + X$ at PROZA-M (Protvino)[3].

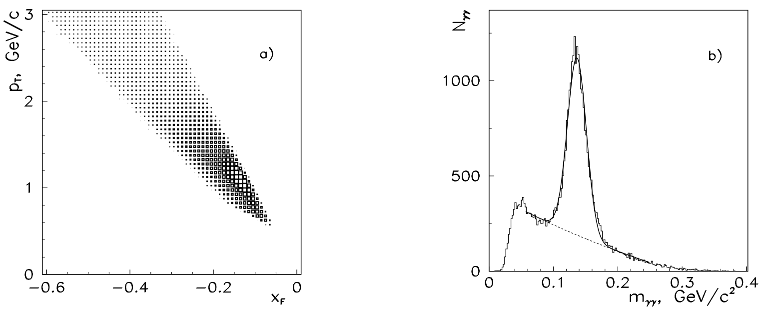

Figure 2. Two-dimensional distribution on p_T and x_F (a) and Two-gamma mass spectrum (b)

The result is in good agreement with the observation of the universal threshold E_0^{cms} in SSA if the particle is formed from valence quark, which polarization follows the nucleon polarization[8]. The summary of the universal threshold search for non-zero results is presented in the Table 1. All the data were fitted by the function:

$$A_N = \begin{cases} 0 & \text{, if } E < E_0 \\ k \cdot (E - E_0) & \text{, if } E \geq E_0 \end{cases} \qquad (2)$$

The value of E_0^{cms} equals to (1.5 ± 0.2) GeV for current experiment.

We are planning to carry out new experiment to improve the accuracy and to measure asymmetry at different angles. The detector of 720 cells will be placed on 30° to cover $-0.8 < x_\mathrm{F} < -0.25$ region.

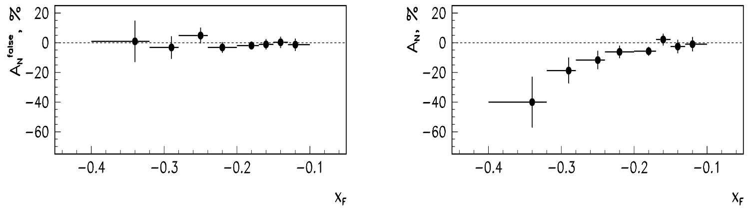

Figure 3. False (left) and real (right) π^0 asymmetry

Table 1. The search of the universal threshold in the center of mass frame for different experiments

Reaction	Energy	E_0^{cms}, GeV	χ^2/N	$k \cdot (E_{max}^{cms} - E_0^{cms})$, %
$p_\uparrow + p \to \pi^+ + X$	13.3	1.26 ± 0.1	0.9	52 ± 6
$p_\uparrow + p \to \pi^+ + X$	18.5	1.46 ± 0.15	0.85	63 ± 16
$p_\uparrow + p \to \pi^+ + X$	21.92	1.57 ± 0.1	0.9	68 ± 6
$p_\uparrow + p \to \pi^+ + X$	40	1.64 ± 0.15		
$p_\uparrow + p \to \pi^+ + X$	200	1.68 ± 0.25	1.1	52 ± 5
$\pi^- + p_\uparrow \to \pi^0 + X$	40	1.67 ± 0.15	1.5	107 ± 26
$\pi^- + p_\uparrow \to \pi^0 + X$	40	1.76 ± 0.2	0.7	36 ± 14
$p + p_\uparrow \to \pi^0 + X$	24	1.7 ± 0.15	0.6	334 ± 165
$p + p_\uparrow \to \pi^0 + X$	70	1.5 ± 0.2	0.15	50 ± 15
$p_\uparrow + p \to \pi^0 + X$	200	2.1 ± 0.3	0.5	26 ± 5
$\bar{p}_\uparrow + p \to \pi^0 + X$	200	0.9 ± 0.6	0.5	13 ± 4
$p_\uparrow + p \to \pi^- + X$	21.92	1.95 ± 0.1	0.5	-87 ± 11
$p_\uparrow + p \to \pi^- + X$	200	2.9 ± 0.2	<0.1	-51 ± 6
$\bar{p}_\uparrow + p \to \pi^+ + X$	200	3.1 ± 0.5	<0.1	-59 ± 16
$\bar{p}_\uparrow + p \to \pi^- + X$	200	1.0 ± 2.2	0.1	25 ± 15

Conclusion

— SSA in the reaction $\mathrm{p} + \mathrm{p}_\uparrow \to \pi^0 + X$was measured at 70 GeV in the kinematic region $-0.4 < x_\mathrm{F} < -0.1$ and $0.9 < p_T < 2.5$ GeV$/c$.
— Asymmetry equals zero at $-0.2 < x_\mathrm{F} < -0.1$ and $0.5 < p_T < 1.5$ GeV$/c$, and $A_N = (-16 \pm 5)\%$ at $-0.4 < x_\mathrm{F} < -0.25$ and $1.3 < p_T < 3.0$ GeV$/c$.
— The asymmetry starts to grow up at $E_0^{cms} = (1.5 \pm 0.2)$ GeV in agreement with the universal threshold. This behavior can be explained inside constituent quark model[9].
— New measurements will be carried out in next two years in the $\mathrm{p} + \mathrm{p}_\uparrow \to \pi^0 + X$reaction at the target fragmentation region.

References

1. V.D Apokin *et al.Instrum. Exp. Tech.* **41**, 464 (1998).
2. V.D. Apokin *et al.Phys. Lett.* **B243**, 461 (1990).
3. A.N. Vasiliev *et al. Phys. of Atom. Nucl.* **67, No 8**, 1495 (2004); *Yad. Fizika* **67, No 8**, 1520 (2004); Prepr. IHEP 2003-21.
4. A.N. Vasiliev *et al. Phys. of Atom. Nucl.* **67, No 8**, 1487 (2004), *Yad. Fizika* **67, No 8**, 1512 (2004); Prepr. IHEP 2003-22.
5. S.B. Nurushev talk, this conference.
6. D.L. Adams *et al. Z.Phys.* **C56**, 181 (1992).
7. L.C. Bland *AIP Conf.Proc.* **675**, 98 (2003); e-Print Archive: hep-ex/0212013.
8. V. Mochalov and A. Vasiliev *Phys. of Atom. Nucl.* **67, No 12**, 2169 (2004); e-Print Archive: hep-ex/0312007.
9. V. Mochalov, S. Troshin and A. Vasiliev *Phys. Rev.* **D69**, 077503 (2004); e-Print Archive: hep-ph/0310224.