STUDY OF EFFECTS OF LEADING AND HIGHER TWISTS IN ONE-SPIN ASYMMETRIES IN pp ↑ INTERACTIONS AT 70 GeV/c AND πp ↑ INTERACTIONS AT 40 GeV/c
(Proposal of the RAMPEX experiment, IHEP)

V.G.Vovchenko, A.A.Zhdanov, V.I.Murzin, P.V.Neustroev, V.V.Poliakov, S.F.Udalova, O.Ya.Fedorov, Yu.A.Chestnov, S.A.Akimenko[1], G.A.Alekseev[1], Yu.I.Arestov[1], L.S.Barabash[2], N.S.Borisov[2], E.I.Bunjatova[2], O.V.Bujanov[1], V.N.Grishin[1], A.A.Derevschikov[1], S.Erin[1], V.A.Kachanov[1], Yu.M.Kazarinov[2], D.Krendal[3], A.D.Krisch[3], M.Yu.Liburg[2], A.Lin[3], V.N.Matafonov[2], V.A.Medvedev[1], A.P.Meschanin[1], N.G.Minaev[1], V.V.Mochalov[1], A.B.Neganov[2], D.I.Patalakha[1], R.Phelps[3], Yu.A.Plis[2], A.F.Prutkogliad[1], R.Raymond[3], V.V.Rykalin[1], P.A.Semenov[1], V.A.Sen'ko[1], V.L.Solovianov[1], S.M.Stepushkin[1], M.N.Ukhanov[1], A.G.Ufimtsev[1], Yu.A.Usov[2], Yu.V.Kharlov[1], V.Yu.Khodyrev[1], B.V.Chueiko[1], O.D.Tsaei[1]

[1] *Institute of High Energy Physics, Protvino*
[2] *Joint Institute for Nuclear Research, Dubna*
[3] *Michigan University, Ann Arbor, Michigan, USA*

Physical Program and Motivations

Wide class of polarization phenomena is described in terms of quark and gluon distributions of twist-2 obtained as a result of expansion of the nonperturbative proton matrix elements. The most valuable of them is the function $g_1(x, Q^2)$ that gives distribution of quarks in a longitudinally polarized proton. This function was studied in scattering of longitudinally polarized leptons (e, μ) on longitudinally polarized protons (deuterons) [1]. There are 9 quark distribution functions: three functions per every twist - 2,3,4. In addition to regular parton distributions in a polarized proton $g_1(x), g_2(x)$, more sophisticated distributions are also considered [2]. Now experimental information on higher twists contribution is much more poor than existing data on leading twists contribution. But there exist processes where the contribution of the higher twists dominates. As a source of the *twist-3* contribution data the present proposal uses one-spin asymmetries in hadron production on a polarized target in reaction $p + p \uparrow \rightarrow h + X$. The contribution of the *twist-2* is determined from asymmetries in reactions $p + p \uparrow \rightarrow h_1 + h_2 + X$. The RAMPEX (Russian - AMerican - Polarization - EXperiment) includes the consistent program of the single spin asymmetry measurements in reactions $p + p \uparrow \rightarrow h + X$ (70 GeV/c) and $\pi^- + p \uparrow \rightarrow h + X$ (40 GeV/c). The symbol h means π and K mesons, proton, neutron, Λ, K^*_{890} and $\phi(1020)$ resonances.

Experimental Layout

Full scale version of the experimental installation shown in Fig.1 includes two arms. One arm consists of a magnetic spectrometer, that includes a magnet **M** and proportional chambers **PC1-PC5**, two Cherenkov counters **C1**, **C2**, electromagnetic and hadronic calorimeters. The electromagnetic calorimeter located at 9° to the beam axis is used as a second arm.

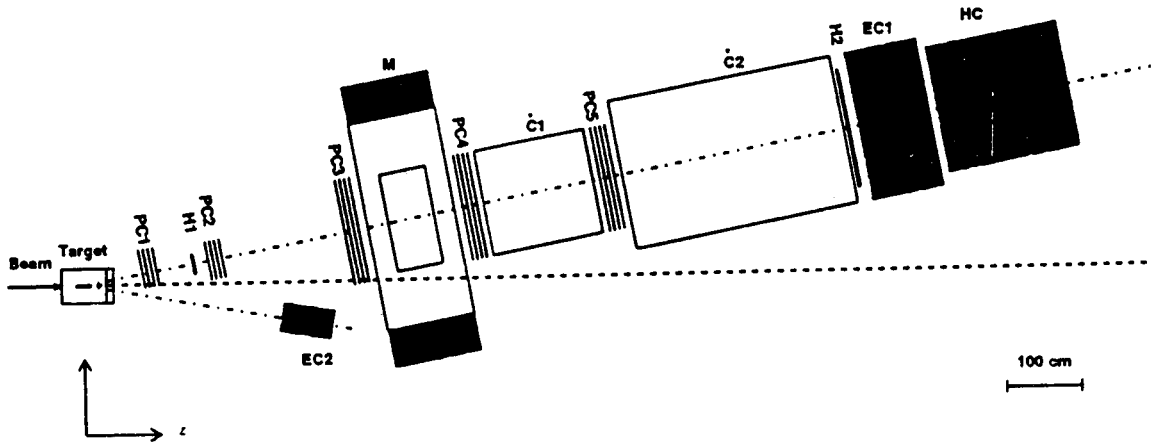

Fig.1. Experimental layout

Beam: Existing equipment of the IHEP accelerator U70 allows to use π^--beam at 40 GeV or proton beam at 70 GeV. Both beams are extracted from the accelerator by the bent silicon crystal. Beam intensity is 5×10^6 protons or pions in a 1s bunch every 9 seconds. The size of meson beam is $\Delta_x = \pm 8$ mm, $\Delta_y = \pm 6$ mm. The proton beam is twice smaller.

Polarized target: Polarized proton target [3] is a cylindrical container filled with propanediol $C_3H_8O_2$. Target diameter is 20 mm, length is 200 mm. Expected polarization is 80%, dilution factor is about (6–10). Target contains 9.3×10^{24} nucleons/cm^2.

Magnetic spectrometer: The magnetic spectrometer designed for the NEPTUN experiment is used as the base of the construction. It includes magnet **M** and 5 modules of proportional chambers **PC1 - PC5**. Every module contains 2 pairs of mutually perpendicular wire planes: X , Y and U, V. Module U, V is turned by 10° to the X, Y module. Size of modules is 2 modules - 530×384 mm^2 and 3 modules - 1422×896 mm^2.

Particle selection: Two threshold multichannel Cherenkov counters **C1** and **C2** are used for the particle separation. Counter **C1** has 8 channels, counter **C2** has 16 channels. Counters are able to identify π^--mesons with momenta (3.1–20) GeV/c and K-mesons with (10–20) GeV/c in high multiplicity conditions.

Electromagnetic calorimeters: Modules of the lead-scintillator type (2.5 mm+ 5 mm, 3 mm+5 mm) designed for NEPTUN experiment are used in the calorimeter **EC1**. Energy resolution follows the dependence $\delta_E/E \approx 9\%/\sqrt{E} + 0.5\%$. A monocrystal of $PbWO_4$ (the energy resolution is $\delta_E/E \approx 3\% / \sqrt{E} + 0.5\%$) is used as a radiator for the **EC2** calorimeter.

Hadronic calorimeter: Lead-scintillator (4:1) sandwich is used as a hadronic calorimeter with 10×10 cm^2 transverse size. Expected energy resolution is $\delta_E/E \approx 57\% / \sqrt{E}$.

Trigger hodoscopes: Scintillation hodoscopes **H1**, **H2** are used for the fast preliminary momentum estimation and rejection. Both hodoscopes have two planes and are of size 260×130 mm^2 (26×13 channels) and 1600×1100 mm^2 (32×22 channels).

Performance: The data acquisition system provides performance of 2000 events (1 Mb) per bunch.

Fast Trigger

The coincidence of beam hodoscopes is used as a zero level trigger. Special electronic trigger system with programmable logic designed at PNPI, Gatchina is shown in Fig.2. This system is used for the fast kinematical selection together with the trigger hodoscopes **H1**, **H2** and Cherenkov counters **C1**, **C2**.

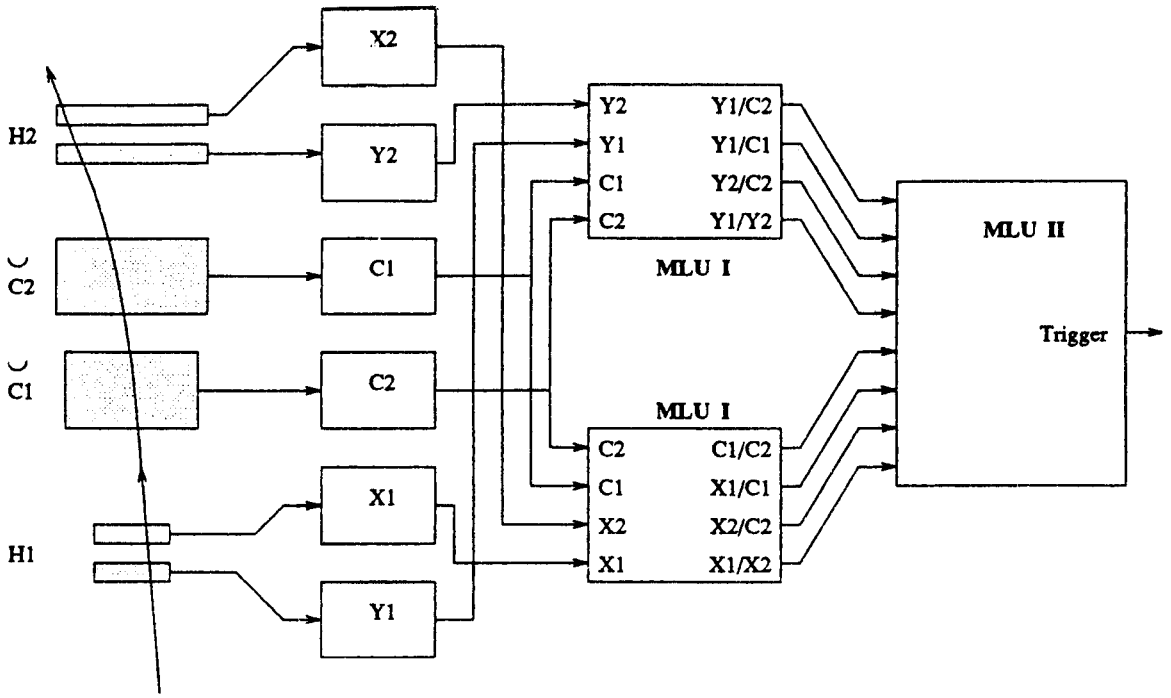

Fig.2. Trigger system

The trigger system includes 32-channel discriminators, 4-coordinates programmable coincidence matrix and logical analysis unit. The dead time is 20 ns, delay is less than 100ns. The information from the trigger hodoscopes and Cherenkov counters after discrimination and preliminary coding comes to the programmable coincidence matrix which checks correlations. Eight pair correlations come to the logical analysis unit which separates particles with respect to their kind and momentum.

Current Proposal Status

Proposal is approved by the Technical and Scientific Council of IHEP and recommended to be presented to the next stage of approving procedure. At the moment main part of hardware is tested and is ready to use in the experiment.

REFERENCES

1. *Thomas A.* Proc. Int. Symp. on High Energy Spin Physics, Bloomington, September 1994.
2. *Jaffe R.L., Ji X.* //Phys.Rev.Lett., 1991. V.67. P.552.; *Ji X.-D.* //Phys.Lett., 1992. V.B284. P.137.
3. *Borisov N.S. et al.* Preprint JINR 13-10253. Dubna, 1976.; Preprint JINR 13-10275. Dubna, 1976.