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SMC HIGH-P_T ANALYSIS

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Results of the asymmetry measurements for the production of at least two hadrons with large transverse momentum in muon-nucleon DIS interactions collected by SMC experiment are presented. The data sample was selected by imposing standard cuts and by using neural network. Measured asymmetries for the proton and deuteron data and for both selection methods are compatible and consistent with zero. The interpretation of the results in the LO QCD calculations gives possibility to determine directly gluon polarization. The better statistical precision for gluon polarization was achieved using neural network approach and the derived value is $\Delta G/G = -0.20 \pm 0.28 \pm 0.10$ at an average fraction of nucleon momentum carried by gluons $\langle \eta \rangle = 0.07$.

A direct measurement of the gluon polarization $\Delta G/G$ is possible in a reaction which proceeds via the photon-gluon fusion process (PGF) (see Fig. 1c) where gluons enter in the initial state for the hard scattering process at lowest order in α_s.
Experimentally, the PGF process is searched by selecting events where a charm particle is produced or events with hadrons of large transverse momentum, p_T, calculated with respect to the virtual photon direction. However, for the second method the non-negligible background arises from the two hard scattering processes contributed to the DIS cross section at the lowest order, namely the virtual photon absorption (leading process "LP") (Fig. 1a) and gluon radiation (QCD Compton "QCD-C") (Fig 1b).

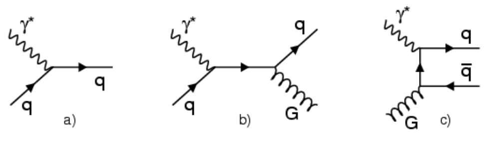

Figure 1. Lowest order diagrams for DIS γ^* absorption: a) leading process - (LP), b) gluon radiation (QCD-C), c) photon-gluon fusion (PGF).

The analysis is based on data collected by Spin Muon Collaboration at CERN on polarized protons and deuterons and with the high energy muon beam of 190 GeV. The standard cuts on inclusive kinematic variables [1] were imposed. Additional

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cuts were applied in close relation to the formalism used in the analysis [2]. A cut Q^2 >1 GeV^2 was used to reject the region dominated by nonperturbative effects and allows the interpretation of the results in terms of partons.
The criteria for the selection of PGF process were studied in LEPTO generator which gives the description of DIS data in terms of the three processes presented in Fig. 1. In kinematic region of SMC experiment, the generated sample with at least two hadrons in the final state was composed of 11% of PGF. After selections on p_T >0.7 GeV, the fractions of PGF events increased to 25%. To further enhance the fraction of the PGF process, both conventional cuts and neural network technique (NN) were tried. The selection criteria are searched which enhance the fraction of the PGF events R_{PGF} (*purity*) while keeping as high as possible $efficiency$ defined as the percentage of PGF events from the input which survived the selections.
The studies of different selections based on cuts [3,4] have showed that a cut on a combination of transverse momentum of the selected hadrons, $\sum p_T^2$, gives the best selection criterion to enhance the PGF purity with sufficient efficiency. In terms of purity the optimal value for the $\sum p_T^2$ cut is about 2.5 GeV^2. A further increase of the cut value reduce substantially the remaining sample without improving significantly the PGF purity. Neural network developed for this analysis [5] uses at the

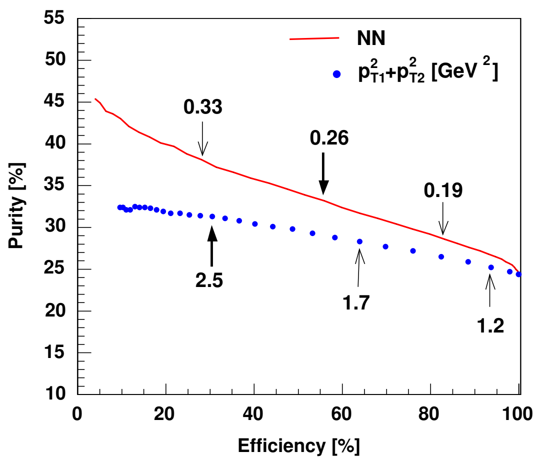

Figure 2. Comparison of purity and efficiency for the selection methods based on the cut on $\sum p_T^2$ and the neural network response. Simulations correspond to the proton sample.

input variables describing the event and selected hadrons. As the output network gives for each event the single number from range $(0., 1.)$ called network response. By setting threshold on network response a PGF enriched sample is selected for the analysis. A high values of this number correspond to events which according to the network selection are more likely to be PGF than background processes. The optimal threshold was chosen at the value 0.26 which optimizes the error on the gluon polarization. The result of the event classification by neural network is compared in Fig. 2 to the selection based on the $\sum p_T^2$ cut. After selections, the PGF fraction

is about 30% for both methods but the efficiency obtained with neural network is about factor two higher. The purity of the selected sample is factor three higher than for the generated sample.
The cross section asymmetry $A^{lN\to lhhX}$ was calculated for full proton and deuteron initial data samples after p_T >0.7GeV cut as well as, for samples with $\sum p_T^2$ and neural network selections. The description of the method of the asymmetry calculation can be found in [6]. Results are shown in Table. 1 for proton and deuteron and for the two selections. They are all consistent within errors. The change of the asymmetry with the cut is rather small. The errors of the measured asymmetry $A^{lN\to lhhX}$ for the selected samples are dominated by statistics. The main contribution to systematic error on $A^{lN\to lhhX}$ come from the false asymmetries, the uncertainty on the fraction of radiative processes, the polarized radiative corrections and also the precision of beam and target polarization determination.

Selection	$A_p^{lN\to lhhX}$	$A_d^{lN\to lhhX}$
initial sample	0.041±0.037±0.011	0.063±0.050±0.010
$\sum p_T^2$ >2.5 GeV^2	0.018±0.071±0.010	0.054±0.093±0.008
NN response>0.26	0.030±0.057±0.010	0.070±0.076±0.010

Table 1. Measured cross-section asymmetries $A^{lN\to lhhX}$ for proton and deuteron of the data samples: initial after p_T >0.7 GeV cut, selected with the $\sum p_T^2$ cut and with the neural network response threshold, each given with statistical and systematic errors.

The $A^{lN\to lhhX}$ asymmetry can be expressed in terms of three processes as follows:

$$A^{lN\to lhhX} = A_1\langle\hat{a}_{LL}\rangle^{LP} R_{LP} + A_1\langle\hat{a}_{LL}\rangle^{QCD-C} R_{QCD-C} + \frac{\Delta G}{G}\langle\hat{a}_{LL}\rangle^{PGF} R_{PGF}. \tag{1}$$

where A_1 is the virtual photon absorption asymmetry well known from the inclusive measurements, $\langle\hat{a}_{LL}\rangle = \langle\Delta\hat{\sigma}/2\hat{\sigma}\rangle$ are the average partonic asymmetries and R the cross section ratios of the different processes shown in Fig. 1, with respect to the total cross section in the selected sample. Other processes such as those involving resolved photons are expected to have small contribution for Q^2 above 1 GeV^2 and are not considered here.
The gluon polarization can be calculated from Eq. 1 providing other factors are known. The value of the A_1 asymmetry was calculated from the parametrization with coefficients determined from the fit to the experimental data. Other quantities i.e. the fraction of the contributed processes R and the parton asymmetries $\langle a_{LL}\rangle$ are provided by Monte Carlo simulations. In view of the strong dependence of the resulting gluon polarization on information from Monte Carlo, special attention was paid to the agreement between data and Monte Carlo.
Results on the gluon polarization and an average fraction of nucleon momentum carried by gluons, $\langle\eta\rangle$ are presented in Table 2. The better statistical precision was achieved using neural network approach and the derived gluon polarization

Selection	$\left(\frac{\Delta G}{G}\right)_p$	$\left(\frac{\Delta G}{G}\right)_d$	$\langle\eta\rangle$
$\sum p_T^2 > 2.5$ GeV^2	0.11±0.51±0.11	-0.37±0.66±0.11	0.09
NN response> 0.26	-0.06±0.35±0.11	-0.48±0.50±0.11	0.07

Table 2. Gluon polarization for proton and deuteron for two methods used to improve sample purity: the Σp_T^2 cut and the neural network selection.

averaged over proton and deuteron is

$$\Delta G/G = -0.20 \pm 0.28 \pm 0.10.$$

The corresponding value for $\sum p_T^2 > 2.5$ GeV^2 cut is

$$\Delta G/G = -0.07 \pm 0.40 \pm 0.12.$$

The obtained value for gluon polarization within statistical error is consistent with zero. The systematic errors, in addition to the uncertainties of the measured asymmetry given in Table. 1, include contributions due to the uncertainty on the A_1 asymmetry and several factors from simulations [2]. The systematic errors are still significantly smaller than the statistical error.
The similar method was used previously in different kinematic and experimental conditions for *ep* data from the HERMES [7] experiment. It can be also used to analyze data from COMPASS [8] experiment presently running at CERN.

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