COMPASS results on transverse spin asymmetries in identified two-hadron production in SIDIS [1]

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Abstract

COMPASS is a fixed target experiment at CERN where nucleon spin structure and hadron spectroscopy are investigated using a 160 GeV/c polarized μ^+ beam. An important part of its physics program are the measurements of single spin asymmetries (SSA) in semi-inclusive deep inelastic scattering (SIDIS) on transversely polarized targets. Data on a deuteron target (^{6}LiD) were taken in 2002-04. After taking the first data on a transversely polarized proton target (NH_3) in 2007, a full year of data taking followed in 2010 to increase precision. The SSA of identified hadron pairs consisting of charged pions and/or kaons from the 2010 data are shown for the first time and compared to model predictions and results from HERMES.

1 Framework

The parton distribution functions (PDF) h_1 of a transversely polarized quark inside a transversely polarized nucleon, is chiral-odd and therefore is not accessible in simple deep inelastic scattering. It can only be observed in SIDIS in combination with another chirally odd function *e.g.* the two-hadron interference fragmentation function (IFF) $H_1^{\sphericalangle}$ in two-hadron production, which is the subject of this contribution. Other possible channels which have been measured at COMPASS are the production of single hadrons using the Collins effect [1]. An incoming lepton is scattered of a transversely polarized quark inside the nucleon via the exchange of a virtual photon. The struck quark hadronises into two unpolarized hadrons, where R is the normalized relative momentum of these. In the SIDIS cross section the angle Φ_R between the two-hadron plane and the scattering plane and the azimuthal angle of the spin of the initial quark Φ_S appear in an azimuthal modulation as a function of $\Phi_{RS} = \sin(\Phi_R + \Phi_S - \pi)$ [2, 3].

[1]SPIN2012, JINR, Dubna, September 18^{th} 2012.

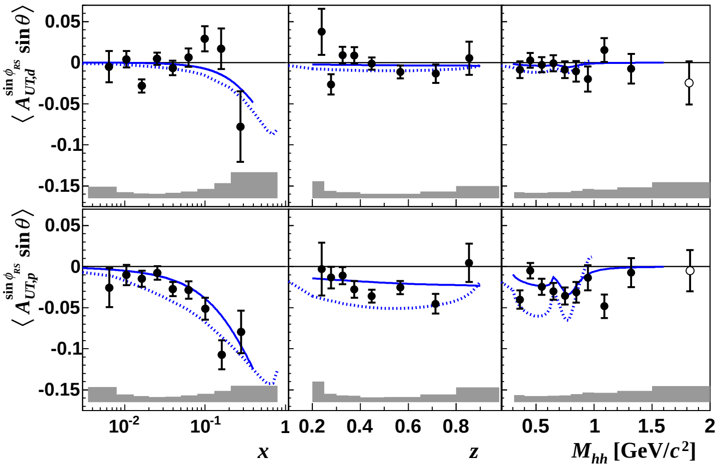

Figure 1: 2002-04 deuteron (top) and 2007 proton (bottom) two-hadron asymmetries of h^+h^- pairs in comparison with model predictions from ref. [6] (solid lines) and ref. [7] (dotted lines).

2 Deuteron 2002-04 and Proton 2007 data

The two-hadron asymmetries of all hadron pairs h^+h^- for the data collected in 2002-04 for the deuteron target are consistently small and compatible with zero within the error bars (fig. 1 top). Furthermore no specific trend is visible for their depenences on x, z and M_{inv}.
The first measurement of the two-hadron asymmetry of h^+h^- pairs on a proton target at COMPASS were performed using the data collected in 2007. The results as a function of x, z and M_{inv} are shown in the bottom part of fig. 1 and [4]. A large asymmetry up to -10% in the valence x-region has been measured. This implies a non-zero h_1 PDF and a non-zero polarized two-hadron IFF $H_1^{\sphericalangle}$. A first extraction of h_1 for proton and deuteron targets can be found in ref. [5]. For the z dependence no specific trend is visible, while for the invariant mass a negative signal around the ρ^0-mass of $0.77\,\mathrm{GeV}/c^2$ is observed and the asymmetry is negative over the whole mass range.

3 Proton data 2010

The large amount of data collected in the year 2010 allows not only to confirm and improve the h^+h^- results in terms of statistics, but also to expand the possibilities for further analysis. Nevertheless these two independent mea-

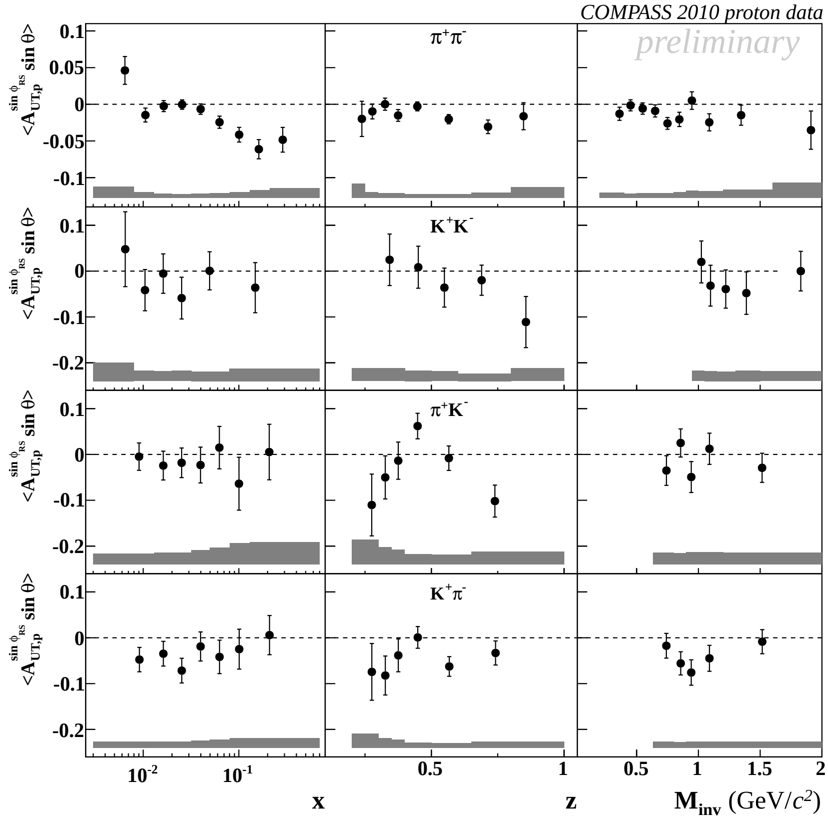

Figure 2: Identified two-hadron asymmetries from 2010 proton data: $\pi^+\pi^-$, K^+K^-, π^+K^- and $K^+\pi^-$ pairs (top to bottom)

surements of the two-hadron asymmetries of all hadron pairs by COMPASS are in good agreement (not shown here for reason of space). The signal in the x valence region is confirmed, nearly constant with a negative asymmetry in z and the structure in M_{inv} is congruent. The COMPASS spectrometer allows a very precise particle identification, which can be used to determine the composition of the h^+h^- in terms of pions and kaons. The results for the possible combinations $\pi^+\pi^-$, K^+K^-, π^+K^- and $K^+\pi^-$ are shown in fig. 2. The pion-pair asymmetries show a clear signal up to -6% in x, the z dependence is compatible with a constant and for M_{inv} a pronounced peak around the ρ^0 mass is found. Exclusively produced ρ^0 mesons were already excluded by a dedicated cut. The kaon pairs however with their large statistical uncertainty show asymmetries compatible with zero, while an indication of a negative mean value in M_{inv} is given. The asymmetries of the mixed pairs are mostly compatible with zero, apart from a positive peak around $z = 0.45$ for

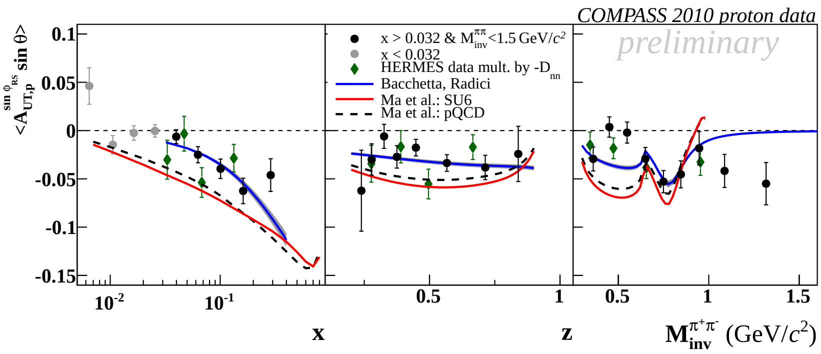

Figure 3: $\pi^+\pi^-$-pair asymmetries from 2010 proton data in comparison with HERMES data from ref. [8] and model predictions from refs. [6, 7]

the π^+K^- and a negative peak around $M_{inv} = 0.9\,\mathrm{GeV}/c^2$ for $K^+\pi^-$. The $\pi^+\pi^-$ asymmetry was also measured by the HERMES experiment [8]. The overall agreement between these two experiments is good within the error bars (fig. 3) bearing in mind the larger kinematical range in x and M_{inv} of COMPASS. This is an important result, also because of the different $\langle Q^2 \rangle$ values in the valance region for the two experiments. Both available model predictions by Bachetta *et al.* [6] and Ma *et al.* [7] show a good confirmation of the trend in x, as well as for the peak around the ρ^0 mass, while the agreement in other mass regions and z is in general poorer, see fig. 3.

References

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