Prospects for gluon polarization measurement at COMPASS

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The COMPASS experiment at CERN consists of a two stage magnetic spectrometer. In its initial phase, it is equipped with all necessary detectors to measure the gluon polarization through the photon gluon fusion mechanism, either by direct observation of charmed mesons D^0 or from high p_T pairs. After an overview of first data taken in 2002, expectations for extraction of gluon polarization in the near future will be presented.

1 Introduction

One of the most interesting result provided by DIS experiments in spin physics in the last decade was to find that only about 30% of the spin of the nucleon is carried by quarks. Since then, the focus is to find where resides the rest, and the two obvious candidates are angular momentum of quarks and gluon polarization:

$$S_z = \frac{1}{2} = \frac{1}{2}\Delta\Sigma_q + L_q + L_g + \Delta G$$

The main goal of the COMPASS experiment [1] for its muon program is the measurement of the helicity contribution of the gluon to the nucleon spin, ΔG, wich will be studied using the photon-gluon fusion process, either by direct dedtection of charmed mesons, or high pt hadron pairs. Information on angular momentum couldbe gained in a second stage of the experiment through studies of Generalized Parton Distributions in DVCS.
In addition to the gluon polarization, COMPASS muon program will also provide usefull data to measure:

* a flavor decomposition of the quark helicity distributions

* the transverse spin distribution function $\Delta_{Tq}(x)$

2 The COMPASS experimental setup

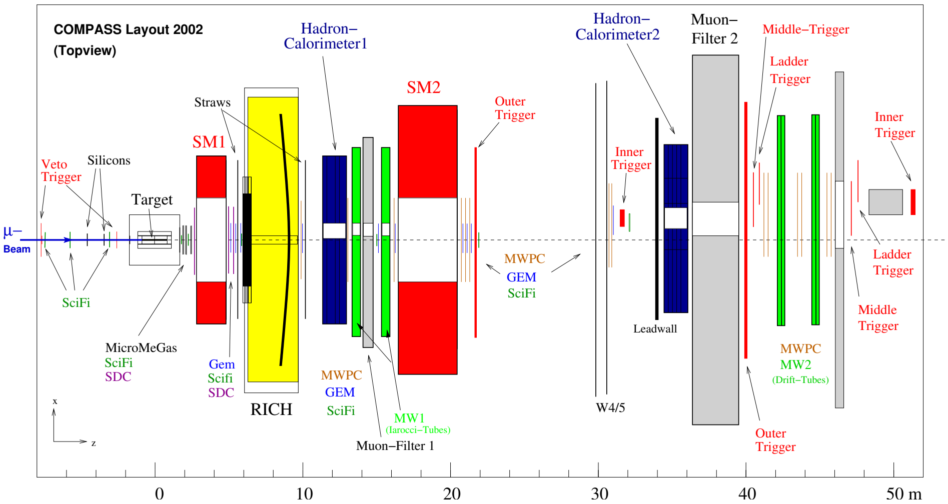

Figure 1: COMPASS setup for 2002 data taking

The COMPASS spectrometer has been fully operationnal in its initial phase for the 2002 run (see figure 1.). The 160 GeV muons are delivered in the M2 line of the SPS accelerator at CERN, in spills of 5s every 14.4s, each spill containing about $2.10^{8}\mu$ polarised at $\approx 80\%$, and analysed by a set of scintillating fibers and silicon strip detectors. They impinge on two 60 cm long $Li^{6}D$ target cells, polarised in opposite direction. Average polarisations of up to 55% are obtained using dynamic nuclear polarisation. The scattered muons and the produced hadrons are detected in a two stage spectrometer, equipped with a set of position sensitive detectors including from small to large angles: Scintillating fibers, MicroStrip gaseous chambers (GEM and MicroMegas), small pitch Drift chambers, Straw tube detectors, MWPCs, Iarocci tubes for muon tagging. For particle identification, in addition to hadron calorimetry, a large volume RICH detector allows $\pi - K$ separation up to 50 GeV/c, crucial to single out charm events like $D^{0} - > K + \pi$.

3 First physiscs results from 2002 data

In 2002, about 3.8 10^9 events for longitudinal polarization (resp. 1.2 10^9 for transverse polarization) have been recorded, in a Q^2 range spanning from quasi-real photoproduction to about 10 GeV^2. Excluding ΔG, selected physics channels analyzed so far concern:

1. Low-Q^2 vector mesons ρ^0 and ϕ production and decay [2].
2. Λ and $\overline{\Lambda}$ hyperon polarizations [3].
3. Collins asymmetry and transversity [4].

   By operating the target in transverse polarization mode, we measure the transverse polarized parton distribution function $\Delta_T q(x)$ via the azimuthal dependence (Collins angle ϕ_C) of the hadron yield.

4. Flavor decomposition of polarized Parton Distribution Functions (pPDF).

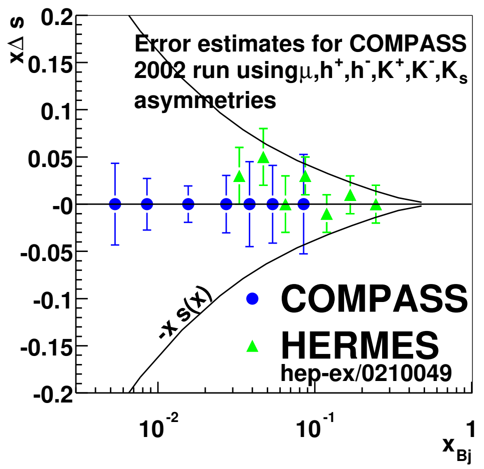

Figure 2: Flavor decomposition of $\Delta\Sigma$,expected error on xΔs.

The large statistics of semi-inclusive DIS events along with the good identification of final state hadrons will allow us to perform the flavor decomposition of $\Delta\Sigma$. A selection of events with a kaon identified by the RICH enhances the relative amount of interaction of s and $\bar{s}$ quarks. Figure 2. shows the expected error on the quantity $x\Delta s$ when combining the 2002 COMPASS data set with the existing proton and deuteron SMC data. Note the good coverage at low x for these data.

4 Prospects for Gluon Polarization

1. $\Delta G/G$ from high-P_T hadron pairs.

   Figure 3. shows the distribution of transverse momentum for the highest P_T hadron for a scattered event with 2 hadrons with the following selection: $P_T > 0.7$ GeV/c and $P_{T,1}^2 + P_{T,2}^2 > 2.5$ (GeV/c)^2 from a sample of the 2002 data.
   Substracting from the measured data yield the contribution from QCD Compton and leading order processes [5], one gets access to the Photon-Gluon Fusion process. The table shows an estimate of the error on $\Delta G/G$ from this channel extrapolated to the full 2002 statistics with and without a cut $Q^2 > 1$ (GeV/c)^2. The latter cut removes efficiently additional background contributions from resolved photons and thus keep the theoretical uncertainty under control.

Expected statistical error on $\Delta G/G$ from high P_T hadron pairs	
N_{events} 2002	$\delta(\frac{\Delta G}{G})$
$\simeq 18000$, $Q^2 > 1$ GeV^2	0.31
$\simeq 160000$, *all* Q^2	≈ 0.1

   Extrapolating the above error estimate for $\Delta G/G$ from high P_T hadron pairs, we expect by 2005 a statistical error of about 0.15 on this quantity applying the $Q^2 > 1$ GeV^2 cut. About 10 times more statistics becomes available if we release this cut.

2. $\Delta G/G$ from charmed mesons.

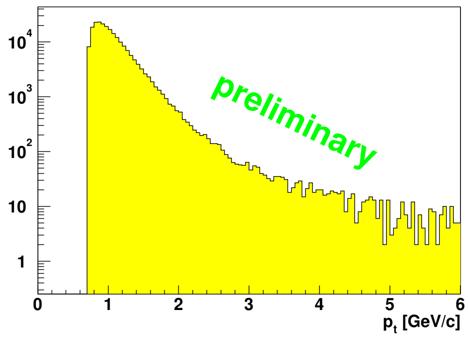

Figure 3: Transverse momentum of hadron with highest P_T for hadron pairs.

The COMPASS trigger has been setup to favour quasi-real photoproduction, and thus enhance the signal for charmed mesons. D^0 production, detected through its $K-\pi$ decay channel, will allow a direct measurement of Photon-Gluon Fusion, as the intrinsic charm content of the proton is negligible. The analysis of this channel is still very preliminary, and we cannot quote a realistic error estimate for $\Delta G/G$ from charmed mesons yet.

References

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