The status of the COMPASS experiment

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Abstract. The COMPASS experiment at the SPS at CERN is investigating the spin structure of the nucleon via deep inelastic scattering of polarised muons on polarised nucleons. Currently, the main emphasis lies on the measurement of the gluon polarisation and a study of transverse quark distributions. For this purpose we use a newly built 2-stage large acceptance spectrometer supplemented by particle identification via RICH, calorimetry and muon identification. This setup allows to detect events in the quasi-real photoproduction regime which is required for the measurement of the gluon polarisation. First data were taken in 2002 with longitudinally and transversely polarised LiD targets. Currently the data are being analysed, the reconstruction is mostly done while improvements of the algorithms are still going on. The Analysis is concentrated on Λ polarisation, vector meson production, gluon polarisation, transverse asymmetries and semi-inclusive DIS.

INTRODUCTION

During the past two decades experiments at SLAC, CERN and DESY did a detailed investigation of inclusive deep inelastic scattering of polarized charged leptons off polarized protons and neutrons. The main aim of these investigations was the determination of the spin structure functions g_1 and g_2 using longitudinally and transversely polarized target nucleons. One important result is that the net contribution of the quarks to the nucleon spin is only about 25 – 30%. So the remaining part has to be carried by gluons and orbital angular momentum.

While it is very difficult to access the orbital angular momentum contribution e.g. via deeply virtual Compton scattering the gluon contribution to the nucleon helicity, ΔG, can be studied with the help of the photon gluon fusion process especially in the quasi-real photoproduction region ($Q^2 \approx 0$) where cross sections are reasonably high. To disentangle these processes from the normal DIS processes on quarks two strategies have been developed: The first uses the production of a heavy quark pair ($c\bar{c}$) which is signalled by open charm production, resulting in fragmentation mainly to D mesons. They can be reconstructed from their subsequent decay to e.g. a πK-pair [1]. The second method tries to use all produced quark flavours but enriches the photon gluon fusion process by selecting oppositely charged hadron pairs with high transverse momentum and opposite azimuth [2]. This selection yields much higher statistics than the open charm tagging but the signal is diluted by a considerable background mainly from the QCD Compton process and resolved photon processes at low Q^2.

THE COMPASS EXPERIMENT

The COMPASS experiment has been set up at the M2 muon beam line of the CERN SPS. Although it focuses on the measurement of ΔG in the initial phase it is a general purpose experiment to be used with hadron and muon beams to study a variety of physics items ranging from the Primakoff effect, glue balls, charmed baryons with hadron beams to the gluon polarisation, polarised quark distributions, transversity, lambda and vector meson production with the muon beam.

In 2002 the initial phase was completed and data taking for ΔG started. Fig. 1 shows the 2002 setup. In addition to the initial setup already some large-angle tracking (W4/5) is present to enlarge the kinematic range of the measurements.

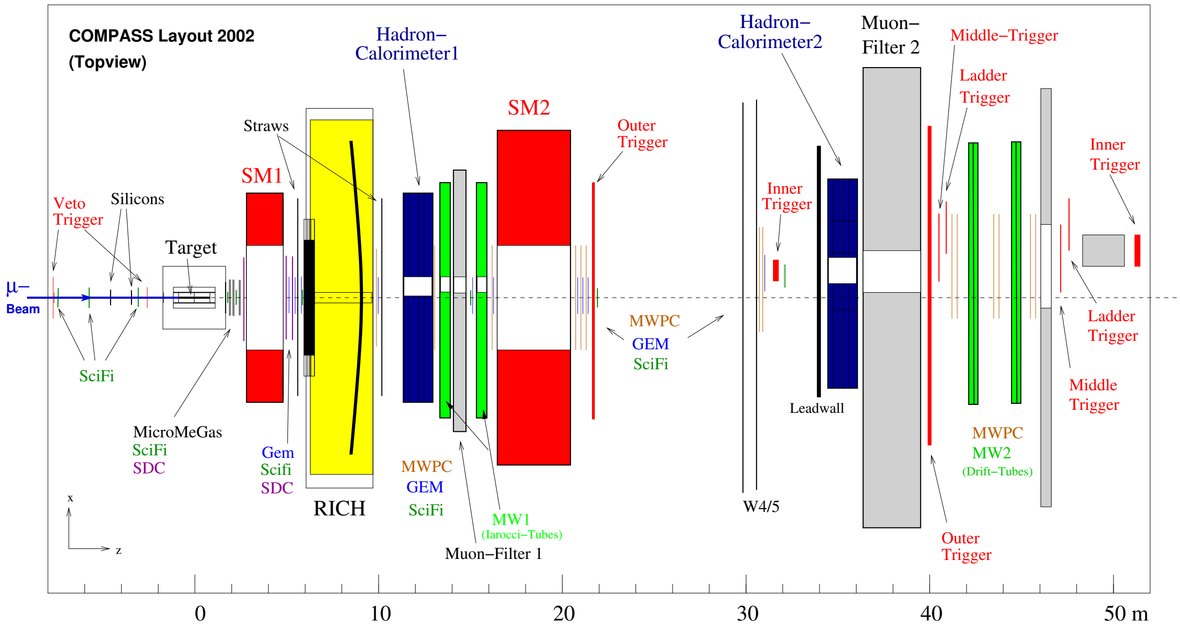

FIGURE 1. Schematic drawing of the COMPASS 2002 setup.

The COMPASS experiment consists of three main parts: the beam region, the target region and the spectrometer:

1) For the ΔG measurement a μ^+ beam of 160 GeV and about 80% polarisation is used. The muon beam has a momentum spread of about 5% and a large emittance of $\varepsilon > 6$ mm·mrad. Each incoming particle is measured in a series of scintillating fiber planes and silicon detectors interleaved with veto hodoscopes for trigger purposes.

2) The heart of the experiment is the polarised solid-state target which consists of two 60 cm long cells in a bath of ^{3}He/^{4}He mixture. The cells are filled with LID and are polarised oppositely. In 2002 target polarisations of up to 57% were obtained routinely.

3) The spectrometer is a large-acceptance two-stage spectrometer which covers a very large kinematic range from quasi-real photoproduction to the DIS region. A large-gap 1.5 Tm dipole magnet (SM1) in the first stage is used to measure low-momentum tracks, mainly hadrons produced in the target, whereas in the second stage a 5.2 Tm dipole magnet (SM2) is used for the scattered muons and high-momentum tracks. Both magnets are surrounded by a large number of tracking detectors to determine the trajectories

with high precision. Both stages use hadronic calorimetry for hadron and absorber walls (muon filter) for muon identification. In addition a RICH detector in stage 1 is used for π/K/p separation up to 50 GeV. At the end of the spectrometer most hodoscopes of the trigger system are located.

Depending on the distance to the muon beam different tracking chambers are used ranging from scintillating fibers in the beam region, GEM and MicroMega detectors close to the beam to MWPC, drift and straw chambers for large areas. Most of them performed very well in 2002 reaching the expected spatial and time resolution while maintaining high efficiencies above 95%.

Also first measurements with the RICH detector were obtained. The preliminary resolution of the measured Cherenkov angle distribution for ultrarelativistic particles is 0.4 mrad, corresponding to π/K separation at 3 sigma level up to 40 GeV/c.

THE 2002 DATA

In 2002 the measurements were split between longitudinally (57 days) and transversely (19 days) polarised targets yielding $3.8 \cdot 10^9$ and $1.2 \cdot 10^9$ events, respectively. The data analysis is in full swing, calibration and alignment are done and most data are reconstructed while improvement of the reconstruction algorithms is still going on.

For the beginning the analysis concentrated on lambda polarisation, vector meson production, ΔG from high p_T hadron pairs and transverse asymmetries. Results are shown from 16% of the longitudinal data. As an example fig. 2 (a) shows the invariant mass distribution for muon pairs in the J/ψ range from events with 3 tracks (among them 2 muons) depicting a clear peak for mainly elastic J/ψ. Fig. 2 (b) shows the invariant mass distribution for hadron pairs from events with 4 tracks (2 muons and 2 hadrons). Here a high statistics ($1.4 \cdot 10^6$) exclusive ρ^0 signal is seen. In this analysis already several kinematic cuts e.g. on the energy transfer and the missing mass were applied. With these ρ mesons analysis of the mass distribution and the angular distributions has been started [3].

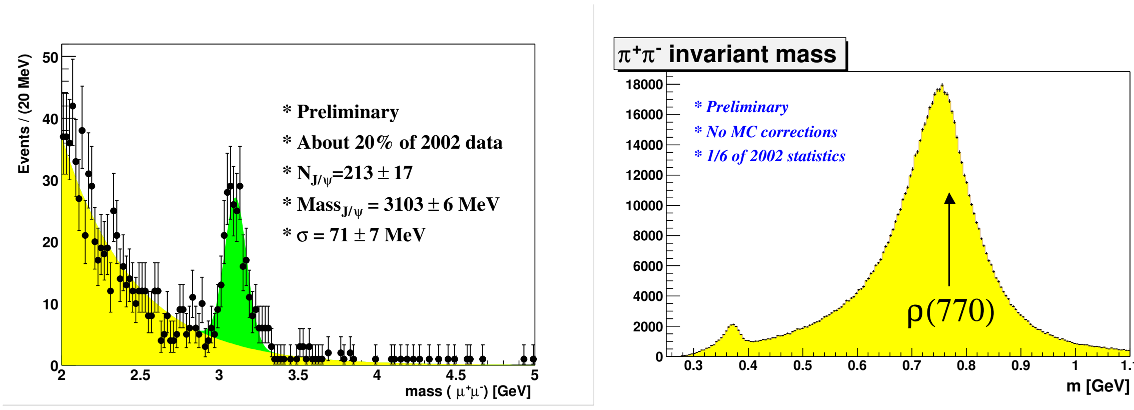

FIGURE 2. Invariant mass distribution for muon pairs (a) and hadron pairs (b)

Good prospects exist for the flavour separation of polarized quark distributions. Using the SMC proton data together with the COMPASS LiD data and making use of the K identification with the RICH a good handle will be obtained on the polarised strange quark distribution extending the HERMES measurement towards low values of x (see fig. 3 (a)).

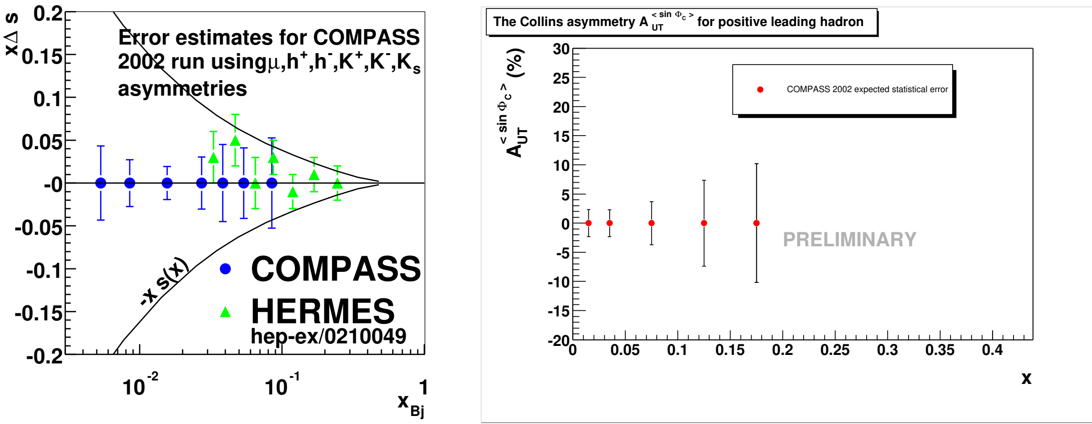

FIGURE 3. Estimated accuracy and kinematic range for the determination of the strange quark polarisation (a) and the transverse asymmetry (b).

Also work on high p_{T} hadron pairs, transverse asymmetries [4] (see fig. 3 (b)) and Λ polarisation [5] shows good perspectives for a first result with the 2002 data.

OUTLOOK

While the analysis of the 2002 data is still ongoing data taking has started in 2003 with the muon beam and the same setup as in 2002. During the shutdown a lot of work was done especially to improve the RICH radiator gas and the photon detectors. The planned hadron physics program using hadron beams will start later, its main topics being a search for glueballs, studies of charmed hadrons and measurements of the pion and kaon polarizabilities. This program will benefit from the planned completion of the spectrometer with a second RICH, full electromagnetic calorimetry and large-angle tracking. In parallel prospects for new topics like generalised parton distributions are being studied.

REFERENCES

1. COMPASS Collaboration, Compass proposal, *CERN/SPSLC* 96-14, *SPSC/P*297, *CERN/SPSLC* 96-30 (1996).
2. A. Bravar, D. v. Harrach, and A. Kotzinian, *Phys. Lett. B*, **421**, 349 (1998).
3. A. Korzenev, Exclusive ρ and ϕ production from COMPASS, *Prodeedings of DIS03*, St. Petersburg, Russia (2003).
4. P. Pagano, Transversity at COMPASS, *Prodeedings of DIS03*, St. Petersburg, Russia (2003).
5. V. Alexakhin, Λ and $\bar{\Lambda}$ hyperon production by polarized muons at COMPASS, *Prodeedings of DIS03*, St. Petersburg, Russia (2003).