New results on quark helicity distributions and gluon polarization from the COMPASS experiment at CERN

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SINS, Warsaw

16-22 July, Krakow, Poland
Beam: $2 \times 10^8 \, \mu^+$/spill (4.8s / 16.2s)
Luminosity $\sim 5 \times 10^{32} \, \text{cm}^{-2} \, \text{s}^{-1}$
Beam polarization: -80%
Beam momentum: 160 GeV/c
Target polarization: $P_T = 50\%$, $f \sim 40 \%$
for $^6\text{LiD}$ (2002 - 2006)
COMPASS Collaboration at CERN

Common Muon and Proton Apparatus
for Structure and Spectroscopy

Czech Rep., France, Germany, India, Israel, Italy,
Japan, Poland, Portugal, Russia and CERN

Bielefeld, Bochum, Bonn, Burdwan and Calcutta, CERN, Dubna, Erlangen,
Freiburg, Lisbon, Mainz, Moscow, Munich, Prague, Protvino, Saclay,
Tel Aviv, Torino, Trieste, Warsaw, Yamagata

~240 physicists, 30 institutes
New results on quark helicity distributions and gluon polarization from COMPASS

COMPASS in muon run
NIM A 577(2007) 455

- ~ 350 planes
- 180 mrad acceptance
- $\pi$, K, p separation (from 2, 9, 17 GeV up to ~ 50 GeV)
The COMPASS polarized target

Target material: $^6$LiD
Polarisation: >50%
Dilution factor: ~0.4

Dynamic Nuclear Polarization

2006 - new solenoid with acceptance 180 mrad
3 target cells (reduce false asymmetries)

RICH 2006 upgrade: better PID
MAPMTs in central region
APV electronics in periphery
Contents

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• New results on quark helicity distributions
• Gluon polarization from high-$p_T$ hadron pairs
• New result on gluon polarization from open-charm measurement
• Summary
Introduction

Helicity distributions

High-\(p_T\) hadrons \(\Delta G/G\) from open-charm

3 years of deuteron data taking in COMPASS:

2002-2004 : 89*10^6 events for \(Q^2 >1\) (GeV/c)^2

Compass only

\[ \Gamma_1^N(Q^2) = \frac{1}{9} \left(1 - \frac{\alpha_s(Q^2)}{\pi} + O(\alpha_s^2) \right) \left( a_0(Q^2) + \frac{1}{4} a_8 \right) \]

\[ a_{0|Q_0^2=3(GeV/c)^2} = 0.35 \pm 0.03(stat) \pm 0.05(syst) \]

\[ a_{0|Q^2 \rightarrow \infty} = 0.33 \pm 0.03(stat) \pm 0.05(syst) \]

\[ (\Delta s + \Delta \bar{s}) = \frac{1}{3} (\hat{a}_0 - a_8) = -0.08 \pm 0.01(stat) \pm 0.02(syst) \]


from Y. Goto et al., PRD 62 (2000) 034017: (SU(3)_f assumed for weak decays)

\[ a_8 = 0.585 \pm 0.025 \]

QCD NLO beyond NLO


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\[ a_8 = 0.585 \pm 0.025 \]

QCD NLO beyond NLO

$$A^{\pi^+ - \pi^-}(x) = A^{K^+ - K^-}(x) = \frac{\Delta u_v(x) + \Delta d_v(x)}{u_v(x) + d_v(x)}$$

Fragmentation functions cancel out in LO and under the assumption of independent fragmentation.

$$A^{++} = \frac{(\sigma^{h^+}_{\uparrow\downarrow} - \sigma^{h^-}_{\uparrow\downarrow}) - (\sigma^{h^+}_{\uparrow\uparrow} - \sigma^{h^-}_{\uparrow\uparrow})}{(\sigma^{h^+}_{\uparrow\downarrow} - \sigma^{h^-}_{\uparrow\downarrow}) + (\sigma^{h^+}_{\uparrow\uparrow} - \sigma^{h^-}_{\uparrow\uparrow})}$$

Only valence quarks!

$$\int_x^{0.7} (\Delta u_v + \Delta d_v) dx = 0.40 \pm 0.07 \pm 0.06$$

$$\Delta \bar{u} = \Delta \bar{d} = \Delta s = \Delta \bar{s}$$

$$\Delta \bar{u} = -\Delta \bar{d}$$

NEW results on quark helicity distributions and gluon polarization from COMPASS

EPS HEP 2009, 16-22 July, Krakow, Poland
Krzysztof Kurek
**QCD evolution** \( g_1(x,Q^2) = \frac{1}{2} \langle e^2 \rangle \left[ C_q^s \otimes \Delta \Sigma + C_q^{NS} \otimes \Delta q^{NS} + 2n_f C_G \otimes \Delta G \right] \)

**Semi-inclusive asymmetries compared to theory predictions based on gluon polarization “model” (method used in RHIC)**

**“Direct” measurement: idea - tag photon-gluon fusion (PGF) process**
- Observation of the two hadrons with high-\( p_T \)
- Observation of the charmed mesons produced via open-charm mechanism
Applied by SMC, HERMES and COMPASS

The simple idea: three basic processes, PGF probes gluons

Large statistics but Monte Carlo dependent analysis, limited to LO

Two kinematical regions:
• small $Q^2$ - $Q^2<1$ (GeV/c)$^2$ - here $p_T$ is a perturbative scale, also resolved photon contribution important (~50%) - COMPASS 2002-2003 data PLB 633 (2006) 25-32
• large $Q^2$ - $Q^2>1$ (GeV/c)$^2$ - scale $Q^2$ - 2002-2004 data, new method based on Neural Network approach used - this talk
Idea: tag $\gamma^* g \rightarrow c\bar{c}$ via open-charm production mechanism

- Clean channel (less MC dependent) under the assumption that production mechanism is PGF only (true in LO pQCD)
- Resolved photon and “intrinsic” charm production mechanism negligible in COMPASS kinematics
- Limited statistics (no vertex detector - long polarized target)
- Huge combinatorial background
- NLO corrections potentially important

COMPASS: PLB676(2009)31
Weighted method for open-charm analysis

\[
A_{\text{raw}} = \frac{N_{\uparrow\downarrow} - N_{\uparrow\uparrow}}{N_{\uparrow\downarrow} + N_{\uparrow\uparrow}} = P_B P_T f a_{LL} \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}} \frac{\Delta g}{g} + A_{bgd}
\]

\(P_B, P_T\) - are beam and target polarizations,
\(f\) - dilution factor (~0.4 for \(^6\text{LiD}\) target)
\(a_{LL}\) is a partonic asymmetry (analyzing power) for subprocess: \(\mu g \rightarrow \text{ccbar} \, \mu'\)

\(\frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}}\) is parameterized in terms of 10 variables, not just as a function of the reconstructed mass.

Each event is weighted with its analyzing power:
\[
f P_B a_{LL} \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}}
\]

Large gain in statistics (\(a_{LL}\) has positive and negative values)

Events are simultaneously weighted with (\(\ldots \frac{\sigma_{BDG}}{\sigma_{PGF} + \sigma_{bgd}}\))

\(\Rightarrow\) allows simultaneous extraction of signal and background asymmetries,
more efficient than side band subtraction
Helicity distributions
New results on quark helicity distributions and gluon polarization from COMPASS

Introduction

Helicity distributions

High-\(p_T\) hadrons \(\Delta G/G\) from open-charm

Very good agreement between experiments
New: Proton data 2007

Analysis of COMPASS data alone

QCD NLO fit allows to estimate first moment and test Bjorken sum rule:

\[ \Gamma_1^{NS}(Q^2) = \frac{1}{6} \frac{g_A}{g_V} C_1^{NS}(Q^2) \]

\[ g_A/g_V = 1.29 \pm 0.05 \text{(stat.)} \]

\[ C^{NS} = 0.89 \quad Q^2 = 3 \text{ (GeV/c)}^2 \]
**Introduction**

**Helicity distributions**

**High-$p_T$ hadrons**

$\Delta G/G$ from open-charm

$\Delta s$ from charged Kaon's asymmetry

\[
\frac{\Delta s}{s} = A_1^d + \left( A_1^{K^+K^-} - A_1^d \right) \frac{Q/s + \alpha}{\alpha - 0.8}
\]

\[
\alpha = \frac{2R_{UF} + 2R_{SF}}{3R_{UF} + 2}
\]

\[
Q = u + \bar{u} + d + \bar{d}
\]

\[
R_{UF} = \frac{\int D_d^K (z) dz}{\int D_u^K (z) dz}
\]

\[
R_{SF} = \frac{\int D_\bar{s}^K (z) dz}{\int D_u^K (z) dz}
\]

If $A_1^d = A_1^{K^+K^-}$, $\Rightarrow \Delta s \geq 0$, insensitive to FFs

If $A_1^{K^+K^-} < 0$ (at low $x$), $\Rightarrow \Delta s < 0$
Introduction

Helicity distributions

High-\(p_T\) hadrons \(\Delta G/G\) from open-charm

- \(R_{UF}\) fixed at 0.14 from the DSS fragmentation functions
- Large statistical uncertainty due to \(R_{SF}\), slight dependence on \(R_{UF}\)
- If \(R_{SF}>5\) \(\Delta s(SIDIS)>\Delta s(DIS)\) and \(\Delta s<0\) for \(x<0.004\)
- If \(R_{SF}<4\): \(A^K\) becomes insensitive to \(\Delta s\)

\[\Delta s \text{ (inclusive)} = -0.045 \pm 0.005 \pm 0.010\]

\[\Delta s \text{ (SIDIS)} = -0.01 \pm 0.01 \pm 0.01\]

in LO pQCD
New: Proton data 2007, flavour separation

**Introduction**

Helicity distributions

High-\(p_T\) hadrons \(\Delta G/G\) from open-charm

New results on quark helicity distributions and gluon polarization from COMPASS

\[ Q^2 = 3 \text{ (GeV/c)}^2 \]

Curves are NLO predictions from DSSV Group (D. De Florian, R. Sassot, M. Stratmann and W. Vogelsang)
ΔG/G from high-\(p_T\) hadron pairs
\[
\frac{\Delta G}{G}(x_G) = \frac{A_{LL}^{2h}(x_{Bj}) + A_{corr}}{\beta}
\]

\[
\beta = a_{LL}^{PGF} R_{PGF} - a_{LL}^{PGF,incl} R_{PGF}^{incl} \left( \frac{R_L}{R_L^{incl}} + \frac{R_C}{R_L^{incl}} \frac{a_C^C}{D} \right)
\]

\[
A_{corr} = -A_1(x_{Bj}) D \frac{R_L}{R_L^{incl}} - A_1(x_C) \beta_1 + A_1(x_C') \beta_2
\]

\[
\beta_1 = \frac{1}{R_L^{incl}} (a_{LL}^C R_C - a_{LL}^{C,incl} R_C^{incl} \frac{R_L}{R_L^{incl}}) \quad \beta_2 = a_{LL}^{C,incl} \frac{R_C R_C^{incl}}{(R_L^{incl})^2} \frac{a_C^C}{D}
\]

R’s are fractions of the sub-processes (LO, PGF, QCDC) in high-\(p_T\) and inclusive samples, respectively. 
a\(_{LL}\) ‘s are so-called analysing powers for LO, PGF and QCDC (the ratio of partonic polarised and unpolarised cross sections for sub-processes). D is a depolarization factor.
• Cuts on inclusive variables:
  \[ Q^2 > 1 \text{ (GeV/c)}^2 \] (Scale of the process)
  \[ 0.1 < y < 0.9 \]
• Cuts on hadronic variables:
  \[ p_{T1} > 0.7 \text{ GeV/c and } p_{T2} > 0.7 \text{ GeV/c} \]
  \[ x_{F1,2} > 0, \ z_{1,2} > 0, \ z_1 + z_2 < 0.95 \]
  inv. mass of two hadrons > 1.5 (GeV/c)^2

Total number of events in the selected sample: \(~500\) kevents
2002-2004 data
2 variables $o_1$ and $o_2$ are used (R’s sum up to 1)

\[ R_{PGF} = 1 - o_1 - \frac{1}{\sqrt{3}} o_2 \]
\[ R_C = o_1 - \frac{1}{\sqrt{3}} o_2 \]
\[ R_L = \frac{2}{\sqrt{3}} o_2 \]
Introduction

Helicity distributions

High-\(p_T\) hadrons \(\Delta G/G\) from open-charm

Data/MC comparison

Comparison: MC/data for high \(p_T\) sample; \(x, y\) and \(Q^2\)
Comparison: MC/data for high $p_T$ sample; transverse momenta of leading and sub-leading hadrons

Impact of MC tuning
\[ \frac{\Delta G}{G} = 0.08 \pm 0.10 \pm 0.05 \]

\[ \chi^2_G = 0.082^{+0.041}_{-0.027} \text{ at } \mu^2 \approx 3(\text{GeV}/c)^2 \]

**Results**

Systematic error dominated by MC

**Plot has statistical errors only**

**High-\(p_T\) sample**

**COMPASS 2002-2004**

**New results on quark helicity distributions and gluon polarization from COMPASS**

**Krzysztof Kurek**

**Интервалы»**

\[ \Delta G \]
ΔG/G from open-charm channel
• **Events considered** *(resulting from c quarks fragmentation):*
  - $D^0 \rightarrow K\pi$ *(BR: 4%)*
  - $D^* \rightarrow D^0\pi_s \rightarrow K\pi\pi_s$ *(30% $D^0$ tagged with $D^*$)*

• **Selection to reduce the combinatorial background:**
  - Kinematical cuts: $Z_D$, $D^0$ decay angle, K and π momentum
  - RICH identification: K and π ID + electrons rejected from the $\pi_s$ sample
New results on quark helicity distributions and gluon polarization from COMPASS

Thick target - no $D^0$ vertex reconstruction

$D^0$ reconstruction: $K\pi$ invariant mass + cuts on $D^0$ decay angle + $z_D$ + RICH particle identification (different likelihoods)

**2002 - 2006 $D^0$ Mass Spectrum**

- $nD^0$: 37400

**2002 - 2006 $D^*$ Mass Spectrum**

- $nD^*$: 8675

New!

+2 more channels:
- $D^0 \rightarrow K^-\pi^+ + (\pi^0)$
- $D^{*+} \rightarrow D^0\pi^{soft} \rightarrow K^-\pi^+\pi^{soft}$

(with kaons below RICH threshold of 9 GeV)
Thick target - no $D^0$ vertex reconstruction

$D^0$ reconstruction: $K\pi$ invariant mass + cuts on $D^0$ decay angle + $z_D$ + RICH particle identification (different likelihoods)

**Introduction**

Helicity distributions

High-$p_T$ hadrons

$\Delta G/G$ from open-charm

$D^0$ and $D^*$ meson reconstruction, 2002-2004 and 2006 data

**New results on quark helicity distributions and gluon polarization from COMPASS**
• $a_{LL}$ is dependent on full knowledge of partonic kinematics:

$$a_{LL} = \frac{\Delta \sigma^{PGF}}{\sigma_{PGF}}(y, Q^2, x_g, z_C, \phi)$$

• Can't be experimentally obtained! $\Rightarrow$ only one charmed meson is reconstructed

• $a_{LL}$ is obtained from Monte-Carlo (in LO), to serve as input for a Neural Network parameterization on reconstructed kinematic variables: $y, x_{Bj}, Q^2, z_D$ and $p_{T,D}$

- 82% correlation NN/MC
- very large dispersion of values, even change of sign: weighting essential
Introduction

Helicity distributions

High-\(p_T\) hadrons \(\Delta G/G\) from open-charm

New channels from D*:

\[ (\Sigma) = \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}} \]

• Two real data samples (with same cuts) are compared by the Neural Network (giving as input some kinematic variables as a learning vector):
  
  - Signal model \( \rightarrow \) \(gcc = K^+\pi^-\pi^-_s + K^-\pi^+\pi^+_s\) \((D^*\) spectrum: signal + bg.\)
  
  - Background model \( \rightarrow \) \(wcc = K^+\pi^+\pi^- + K^-\pi^-\pi^+_s\)

• If the background model is good enough: Net is able to distinguish the signal from the combinatorial background on a event by event basis!

\[ \Sigma = \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}} \]

• \(\Sigma\) is built in the same way as for main channels, BUT:
  
  - Only 1 variable is used: Neural Network output
    
    • Sorts the events according to similar kinematic dependences (thus improving our statistical precision)
    
    • Results from 2 real data samples comparison, in a mass window around the meson mass
New results on quark helicity distributions and gluon polarization from COMPASS

\[ \Delta G/G = -0.49 \pm 0.27 \text{ (stat)} \pm 0.11 \text{ (syst)} \]

Systematics:

<table>
<thead>
<tr>
<th>Source</th>
<th>D^0</th>
<th>D^*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam polar</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>Target polar</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>Dil. Fact.</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>False asymmetry</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Signal extraction (Σ)</td>
<td>0.07</td>
<td>0.01</td>
</tr>
<tr>
<td>a_{11} (charm mass)</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>TOTAL</td>
<td>0.11</td>
<td>0.07</td>
</tr>
</tbody>
</table>

\[ \langle x_g \rangle = 0.11^{+0.11}_{-0.05} \]
\[ \langle \mu^2 \rangle = 13 \text{ GeV}^2 \]

published:
PLB676(2009)31
New preliminary result including all channels

\[ \Delta G/G = -0.39 \pm 0.24 \text{ (stat)} \]

Published:

\[ \Delta G/G = -0.49 \pm 0.27 \text{ (stat)} \pm 0.11 \text{ (syst)} \]

\[ \left\langle x_g \right\rangle = 0.11^{+0.11}_{-0.05} \]

\[ \left\langle \mu^2 \right\rangle = 13 \text{ GeV}^2 \]

10% gain in statistical precision!
New results on quark helicity distributions and gluon polarization from COMPASS.
Summary

• New inclusive and semi-inclusive results (A_1 and hadron asymmetries) from COMPASS proton data have been presented
• The evaluation of the first moment of non-singlet g_1 structure function confirms the validity of Bjorken sum rule
• Proton data allow to perform a full flavour separation
• Small value of ΔG/G is preferred - ΔG/G compatible with 0 within 2σ
• Under study for ΔG/G:
  - pure NN approach (fit independent) and NLO for open-charm
  - 2006 data for high-p_T hadron pairs analysis
Compass only

\[ \Gamma_1^N \left( Q_0^2 = 3 GeV^2 \right) = \int_0^1 g_1^N(x) dx = 0.050 \pm 0.003 (\text{stat}) \pm 0.003 (\text{evol}) \pm 0.005 (\text{syst}) \]

\[ \Gamma_1^N \left( Q^2 \right) = \frac{1}{9} \left( 1 - \frac{\alpha_s(Q^2)}{\pi} + O(\alpha_s^2) \right) \left( a_0(Q^2) + \frac{1}{4} a_8 \right) \]

from Y. Goto et al., PRD62 (2000) 034017: (SU(3)_f assumed for weak decays)

\[ a_8 = 0.585 \pm 0.025 \]

\[ a_{0|Q_0^2=3(GeV/c)^2} = 0.35 \pm 0.03 (\text{stat}) \pm 0.05 (\text{syst}) \]  

QCD NLO

\[ \Gamma_1^N \left( Q^2 \right) = \frac{1}{9} C_1^S (Q^2) \tilde{a}_0 + \frac{1}{36} C_1^{NS} (Q^2) a_8 \]  

C_1 calculated behind 3 loops app.


\[ a_{0|Q^2 \rightarrow \infty} = 0.33 \pm 0.03 (\text{stat}) \pm 0.05 (\text{syst}) \]  

beyond NLO

\[ (\Delta s + \Delta \bar{s}) = \frac{1}{3} (\hat{a}_0 - a_8) = -0.08 \pm 0.01 (\text{stat}) \pm 0.02 (\text{syst}) \]
3 years of deuteron data taking 2002-2004: 89*10^6 events


\[ Q^2 > 1 \text{ (GeV/c)}^2 \]

\[ g_1^d = g_1^N \left(1 - \frac{3}{2} \omega_d\right) = \frac{F_2^d}{2x(1+R)} A_1^d \]

Good agreement between experiments
Compatible with 0 for \( x < 0.05 \), large for large \( x \)
Improved significantly statistics at low \( x \) (COMPASS)
No tendency towards negative values at \( x < 0.03 \)
\[ \Gamma_v = \int_0^1 (\Delta u_v(x) + \Delta d_v(x)) \, dx \]

\[ \Delta \bar{u} + \Delta \bar{d} = 3\Gamma_1^N - \frac{1}{2} \Gamma_v + \frac{1}{12} a_8 = (\Delta s + \Delta \bar{s}) + \frac{1}{2} (a_8 - \Gamma_v) \]

\[ \int_x^{0.7} (\Delta u_v + \Delta d_v) \, dx \]

**SIDIS+DIS, Q^2=10 GeV^2**

\[ \Delta \bar{u} = \Delta \bar{d} = \Delta s = \Delta \bar{s} \quad \text{symmetric scenario} \]

\[ \Delta \bar{u} = -\Delta \bar{d} \quad \text{asymmetric scenario} \]

\[ \int_x^{0.7} (\Delta u_v + \Delta d_v) \, dx = 0.40 \pm 0.07 \pm 0.06 \]
• 2 MC samples were used in the analysis: high-$p_T$ and inclusive
• Input: LEPTO generator and full simulation of the detector
  PDFs: MRST2004LO
• Gluon radiations in final and initial states – simulation of the part of
  NLO corrections:
  - Parton Shower on were used for DG/G extraction (means NN training)
  - Parton Shower off were tested and included in the systematics
• To improve data/MC agreement - LEPTO was tuned
  ($k_T$ and parameters of fragmentation)
• Default MC parameters were used in systematic studies

<table>
<thead>
<tr>
<th></th>
<th>Final MC</th>
</tr>
</thead>
<tbody>
<tr>
<td>$&lt;a^{LO}&gt;$</td>
<td>0.63</td>
</tr>
<tr>
<td>$&lt;a^C&gt;$</td>
<td>0.50</td>
</tr>
<tr>
<td>$&lt;a^{PGF}&gt;$</td>
<td>-0.36</td>
</tr>
<tr>
<td>$R_L$</td>
<td>0.40</td>
</tr>
<tr>
<td>$R_C$</td>
<td>0.29</td>
</tr>
<tr>
<td>$R_{PGF}$</td>
<td>0.31</td>
</tr>
</tbody>
</table>
New channels from D* 

Because the channel is very clean from background contamination (due to a 3-body mass cut), the following contributions can be added:

- $\pi^0$ reflection “bump”: $D^0 \rightarrow K\pi\pi^0 \Rightarrow$ Mass window increased to $\pm 600$ MeV/$c^2$ to obtain a better fit on the bump!
- RICH sub-threshold Kaons events: Include candidates with no positive pion or electron ID

Signal strength parameterization $(\Sigma = S/(S+B))$:

- Problem:
  - Low purity samples with low statistics $\Rightarrow$ Very difficult to build $\Sigma$ in several bins of several variables

- Solution:
  - Multi-dimensional parameterization using a Neural Network (all kinematic and RICH dependences taken into account at same time)
Preliminary results including all channels

• For all $\pi^0$ decays from a $D^0$ ("bump"), a specific parameterization for the partonic asymmetry ($a_{LL}$) was used.

• New channels contributions to $\Delta G/G$:
  - $\Delta G/G$: $-0.15 \pm 0.63$
  - Bg. Asymmetry: $0.02 \pm 0.03$

  $\rightarrow$ 2002–2006 data: $\pi^0$ reflection "bump"

  $\Delta G/G$: $0.57 \pm 1.02$
  - Bg. Asymmetry: $-0.04 \pm 0.05$

  $\rightarrow$ 2002–2006 data: Sub-threshold Kaons

• Final result (no systematic contribution is available yet for the new channels):
  \[
  \frac{\Delta G}{G} = -0.39 \pm 0.24 \text{ (stat)} \quad @ \quad \langle x >_g = 0.11, \quad \langle \mu^2 > = 13 \text{ GeV}^2
  \]

  10% improvement in our statistical significance
Why measure gluon spin from Open-Charm?

- $\bar{c}c$ production is dominated by the PGF process, and free from physical background (ideal for probing gluon polarisation)
  - In our center of mass energy, the contribution from intrinsic charm ($c$ quarks not coming from hard gluons) in the nucleon is negligible
  - Perturbative scale set by charm mass $4m_c^2$
  - Nonperturbative sea models predict at most 0.7% for intrinsic charm contribution
    - Expected at high $x_{Bj}$ (compass $x_{Bj} < 0.1$)
  - $\bar{c}c$ suppressed during fragmentation (at our energies)

Intrinsic charm predictions: CTEQ6.5c

- In the COMPASS kinematic domain:
  - No intrinsic charm contamination is predicted by the theory driven results
  - Only the more phenomenological “See-like” scenario should be taken into account (under study)

![Comparison of models graph](image-url)
Validation of parameterization (2006 example)

Data vs. $\Sigma$-Parameterization in $\Sigma$ bins (2006 $D^0$-tagged)

Data vs. $\Sigma$-Parameterization in weight bins (2006 $D^0$-tagged)

COMPASS Preliminary

New results on quark helicity distributions and gluon polarization from COMPASS