

Improved LO extraction of the gluon polarisation using COMPASS data

HK 40.2

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bmb+f - Förderungswertpunkt
COMPASS
Großgeräte der physikalischen
Grundlagenforschung



Semi Inclusive Deep Inelastic Scattering

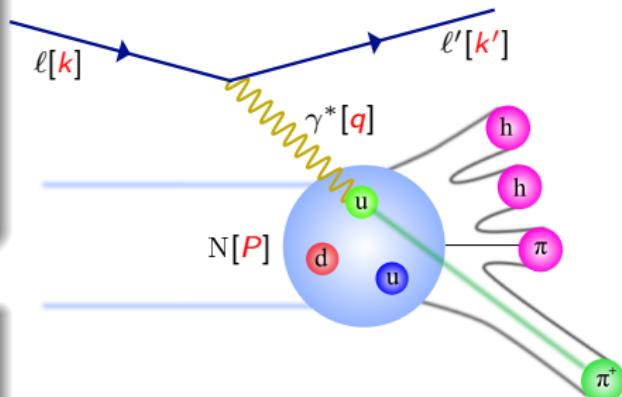
- SIDIS: $\ell + N \rightarrow \ell' + h + X$

DIS variables

- Photon virtuality: $Q^2 = -\mathbf{q}^2$
- Bjorken scaling variable: $x = \frac{Q^2}{2 \cdot \mathbf{P} \cdot \mathbf{q}}$
- Relative photon energy: $y = \frac{E - E'}{E}$

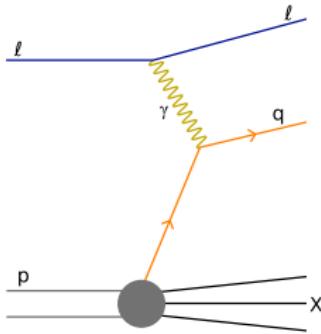
Hadron variables

- Hadron energy fraction: $z = \frac{E_h}{E - E'}$
- Transverse momentum: \mathbf{p}_T
- Longitudinal momentum: \mathbf{p}_L

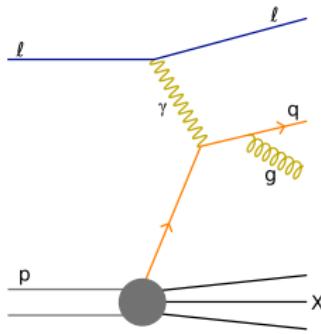


Introduction

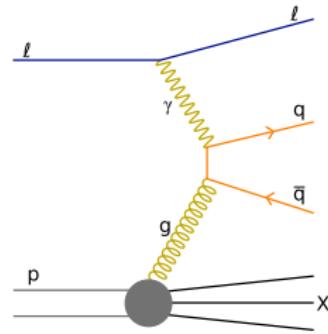
- Contribution from three processes to the cross section



LP



QCDC

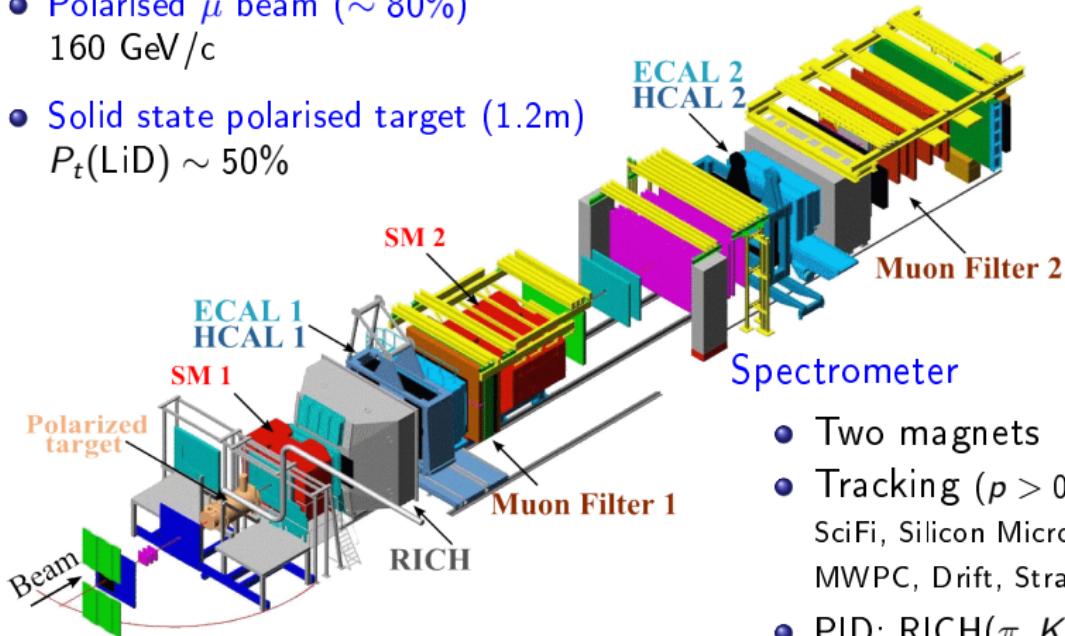


PGF

- $A_{LL}^h = \frac{\sigma_{\uparrow\downarrow} - \sigma_{\uparrow\uparrow}}{\sigma_{\uparrow\downarrow} + \sigma_{\uparrow\uparrow}} = \alpha \cdot A_1^{LO}(x_{Bj}) + \beta \cdot A_1^{LO}(x_c) + \gamma \cdot \Delta g/g(x_g)$
- $A_1^{LO} = \frac{\sum_i e_i^2 \Delta q_i}{\sum_i e_i^2 q_i}$
 - From model
 - Simultaneous extraction

COMPASS @ CERN

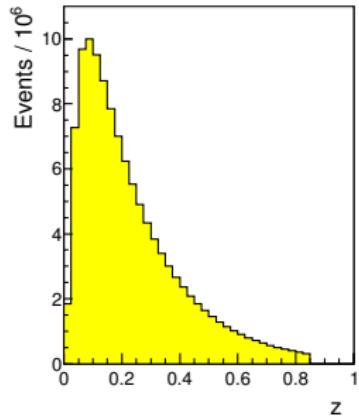
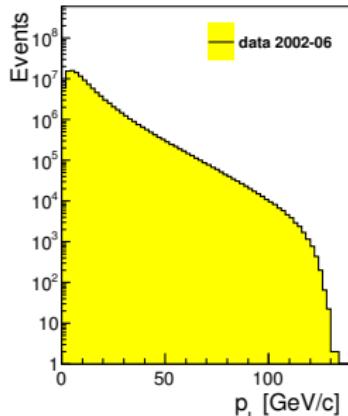
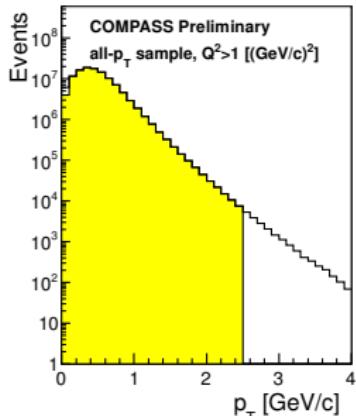
- M2 beamline
 - Polarised μ beam ($\sim 80\%$)
160 GeV/c
 - Solid state polarised target (1.2m)
 $P_t(\text{LiD}) \sim 50\%$



- Two magnets
 - Tracking ($p > 0.5 \text{ GeV}/c$)
SciFi, Silicon MicroMega, Gem
MWPC, Drift, Straws, Drift tubes
 - PID: RICH(π, K, p)
ECAL, HCAL, muon filters

Data selection

- Vertex inside the target
- DIS region
 - $Q^2 > 1 \text{ (GeV}/c)^2$
 - $0.1 < y < 0.9$
- Hadron variables:
 - At least one charged hadron
 - $z < 0.85$ (for all hadrons)
 - $z_1 + z_2 < 0.95$ and $q_1 \neq q_2$ (for exactly 2 hadrons)
 - $p_T < 2.5 \text{ GeV}/c$
No minimal p_T
- Total statistics: 113M events

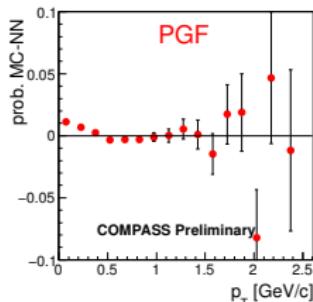
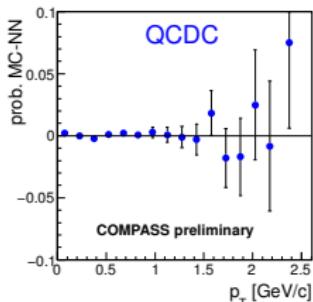
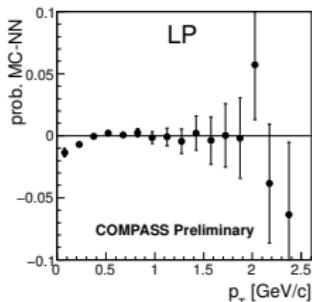
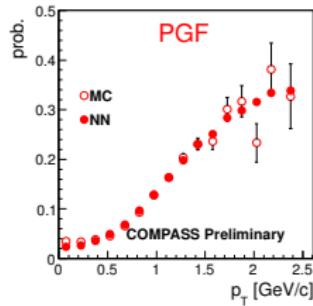
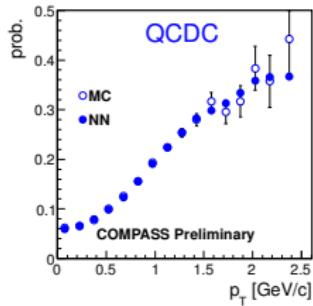
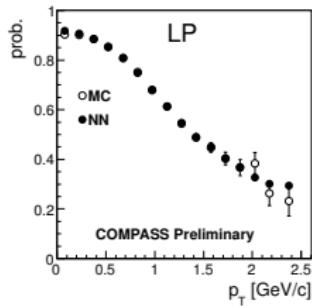


Method

- Treat all processes in the same footing
- Factors α, β, γ depend on: a_{LL}^i, R_i, D
- Use Neural Network to disentangle the processes
→ Events are counted 3 times
- Compare expected and observed number of events
→ Minimise the χ^2
- Expected Number of events depends on:
 $a_{LL}^i, R_i, A_1^{LO}, \Delta g/g$, acceptance, unpol. cross section, flux

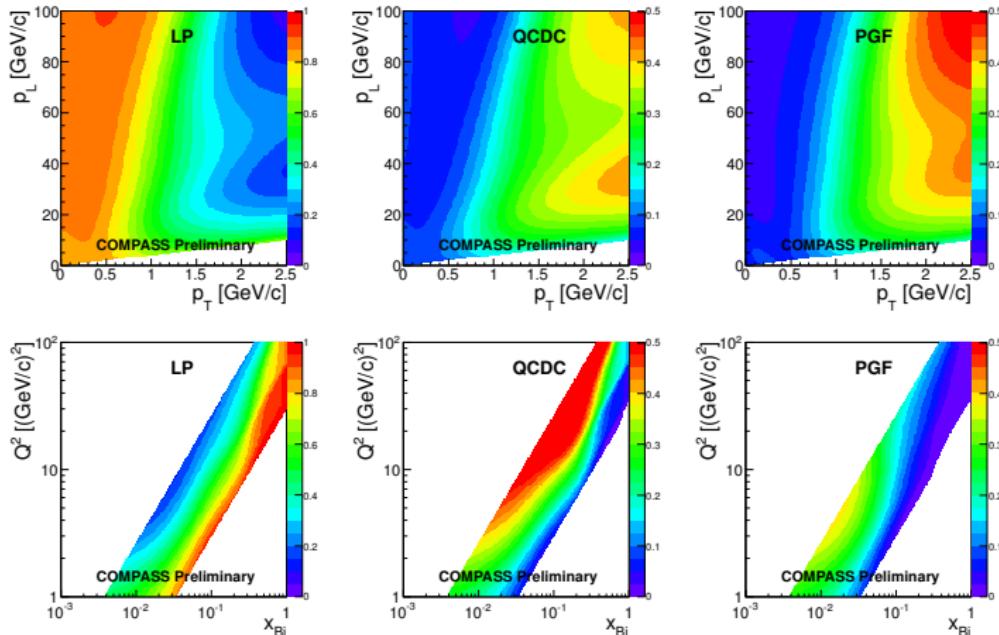
Neural Network

- NN is trained on MC to parametrise R_i, a_{LL}^i, x_c, x_g
- Input parameters: x_{Bj}, Q^2, p_T, p_L
- High p_T : Clean source of PGF/QCDC
- Low p_T : Clean source of LP



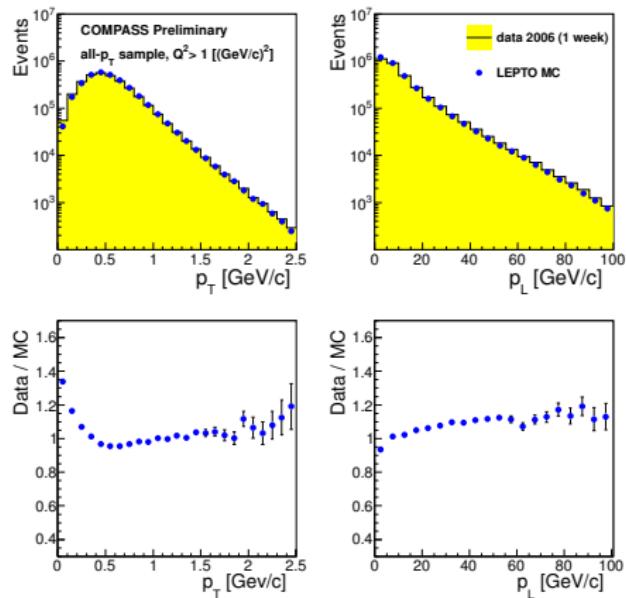
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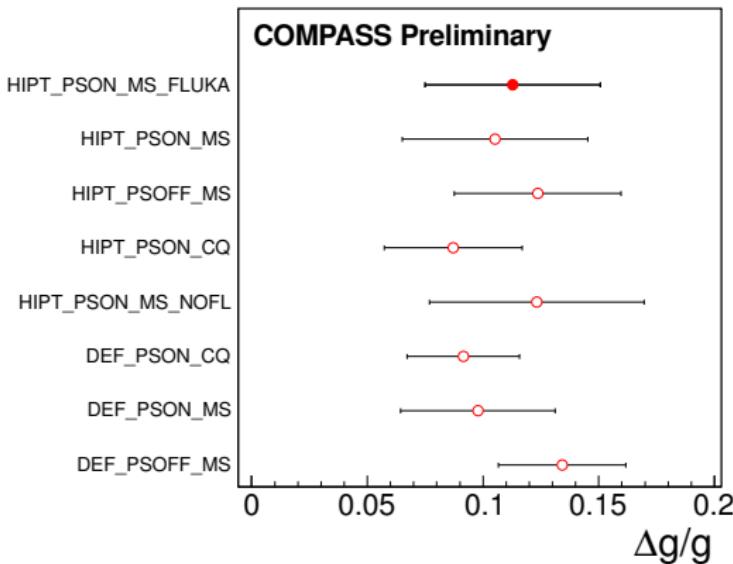
Monte Carlo

- Important variables estimate by MC:
 R_i, a_{LL}^i, x_c, x_g
- Good MC description important
- Same tuning as in previous analysis
- Reasonable description of the data
- Some improvements possible
- Tuning for high p_T sample



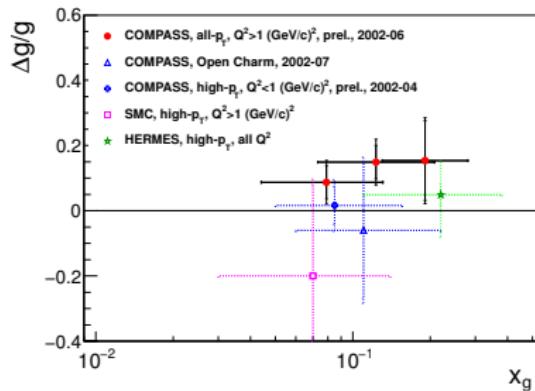
Systematic studies

- Analysis depends on MC
- 8 MC samples
- Different PDF, models for sec. interactions ...
- RMS represents systematic uncertainty
- Results are very stable
- Uncertainties change



Results

- $\Delta g/g = 0.113 \pm 0.038 \pm 0.035$
 - $\langle Q^2 \rangle \approx 3(\text{GeV}/c)^2$, $\langle x_g \rangle \approx 0.10$
 - Assuming $A_1^{QCDC}(x_c) = A_1^{LP}(x_{Bj})$ for $x_c = x_{Bj}$
- Best combined uncertainty
- Good statistic $\rightarrow 3 x_g$ bins
- First measurement of a positive $\Delta g/g$



Summary

- Reanalysis of COMPASS deuteron data
- New method to extract $\Delta g/g$
- New consistency checks possible
- Reduction of statistical and systematic uncertainties
- $\Delta g/g = 0.113 \pm 0.038 \pm 0.035$
- Positive value of $\Delta g/g$ measured