



Valence quark helicity distribution from COMPASS

Elena Zemlyanichkina, JINR
on behalf of the COMPASS collaboration

Hadron Structure and QCD 2008
Gatchina, Russia,
June 30 - July 4, 2008



Physics motivation

$$\frac{1}{2} = \frac{1}{2}\Delta\Sigma + \Delta G + L_Z^q + L_Z^G$$

naive QPM	$\Delta\Sigma = 1$
weak barion decays ($J^P = \frac{1}{2}^+$)	$\Delta\Sigma = 0.58 \pm 0.03$ $\Delta s \equiv 0$
DIS (EMC, 1988)	$\Delta\Sigma = 0.12 \pm 0.09 \pm 0.04$ $\Delta s = -0.19 \pm 0.03 \pm 0.04$
DIS (QCD analysis of the world data)	$\Delta\Sigma = 0.30 \pm 0.01 \pm 0.02$ $\Delta s = -0.08 \pm 0.01 \pm 0.02$

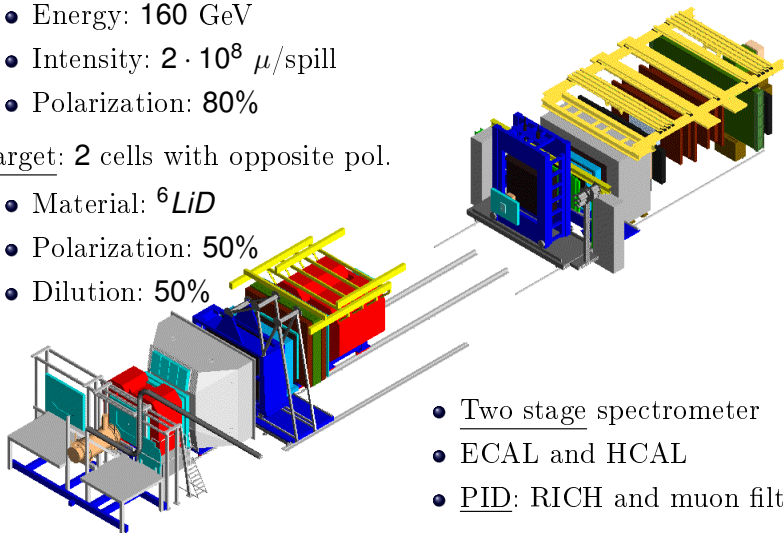
COMPASS Spectrometer

μ^+ - beam:

- Energy: 160 GeV
- Intensity: $2 \cdot 10^8 \mu/\text{spill}$
- Polarization: 80%

Target: 2 cells with opposite pol.

- Material: ${}^6\text{LiD}$
- Polarization: 50%
- Dilution: 50%

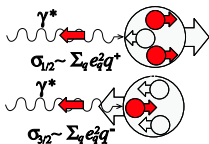


- Two stage spectrometer
- ECAL and HCAL
- PID: RICH and muon filter

Hadron asymmetries

$$q(x) = q^+(x) + q^-(x)$$

$$\Delta q(x) = q^+(x) - q^-(x)$$



SIDIS asymmetries

$$A^+ = \frac{\sigma_{\uparrow\downarrow}^{h^+} - \sigma_{\uparrow\uparrow}^{h^+}}{\sigma_{\uparrow\downarrow}^{h^+} + \sigma_{\uparrow\uparrow}^{h^+}}, \quad A^- = \frac{\sigma_{\uparrow\downarrow}^{h^-} - \sigma_{\uparrow\uparrow}^{h^-}}{\sigma_{\uparrow\downarrow}^{h^-} + \sigma_{\uparrow\uparrow}^{h^-}}$$

$$A_1^h(x) = \frac{\sum_q e_q^2 (\Delta q(x) D_q^h + \Delta \bar{q}(x) D_{\bar{q}}^h)}{\sum_q e_q^2 (q(x) D_q^h + \bar{q}(x) D_{\bar{q}}^h)}$$

Difference asymmetry

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

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

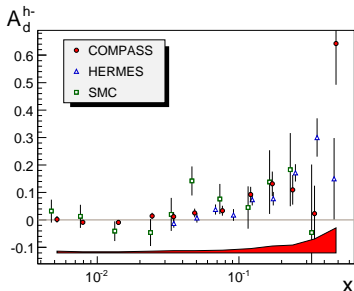
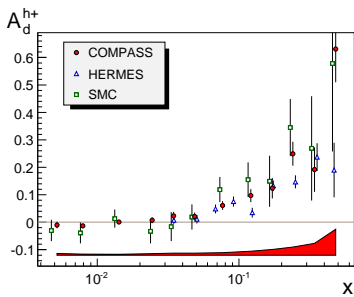
- Fragmentation functions $D_q^h = \int D_q^h(z) dz$ are poorly known
- Difference asymmetry originally was proposed in:

L.Frankfurt et al. Phys.Lett. B230 (1989) 141

- At the first time it was used in SMC: B.Adeva et al. Phys.Lett. B369 (1996) 93

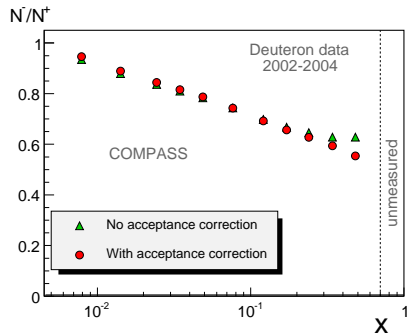
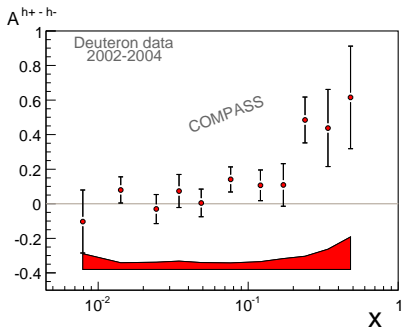
Single hadron asymmetries A^+ and A^-

- Deuteron **data 2002-2004** are used
- Kinematic cuts (DIS region):
 $Q^2 > 1(\text{GeV}/c)^2$, $0.1 < y < 0.9$
- no hadron identification
- current fragmentation region:
 $z > 0.2$
- To avoid ambiguity between secondary μ , and to suppress contribution from diffractive events:
 $z < 0.85$
- **Final statistics:**
 $N^+ = 30 \cdot 10^6$, $N^- = 25 \cdot 10^6$,
 $\text{corr}(N^+, N^-) \approx 20\%$



Difference asymmetry

$$A^{h^+ - h^-} = \frac{1}{1-r} (A^{h^+} - A^{h^-}), \quad r = \frac{\sigma_{\uparrow\downarrow}^{h^-} + \sigma_{\uparrow\uparrow}^{h^-}}{\sigma_{\uparrow\downarrow}^{h^+} + \sigma_{\uparrow\uparrow}^{h^+}} = \frac{\sigma^{h^-}}{\sigma^{h^+}} = \frac{N^{h^-}/a^{h^-}}{N^{h^+}/a^{h^+}}$$



- The measured x range is $0.006 < x < 0.7$, as the precision at smaller x is too low. (The statistical error is inversely proportional to $N^{h^+} - N^{h^-}$)
- For the acceptance studies full chain of MC simulation (spectrometer + the same cuts as for data) with default LEPTO settings was performed

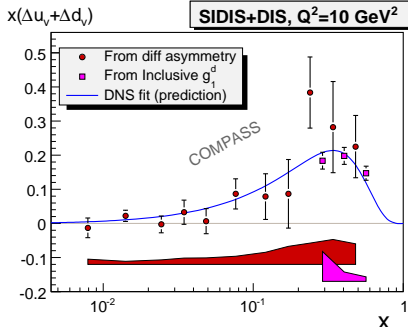
Valence quark polarisations

$$\Delta u_v + \Delta d_v = \frac{u_v + d_v}{(1+R)(1-1.5\omega_D)} A_d^{+-}$$

$$\omega_D = 0.05 \pm 0.01$$

$$R = \sigma^L / \sigma^T$$

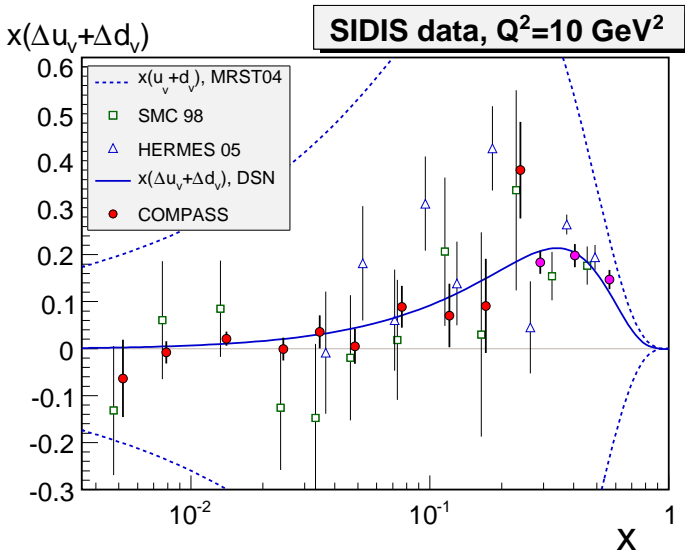
For unpolarized PDF LO MRST was chosen



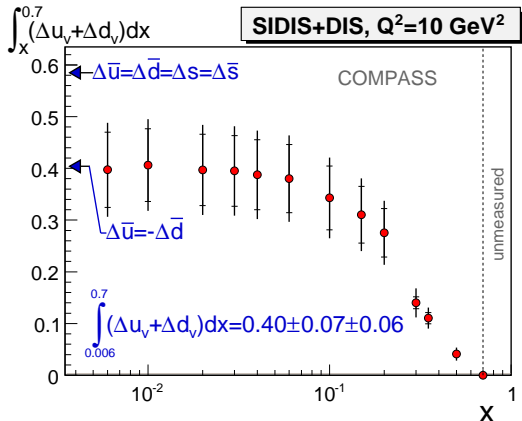
- Unpol. sea contribution to F_2 vanishes for $x > 0.3$
 - $|\Delta \bar{u}_v + \Delta \bar{d}_v| < \bar{u}_v + \bar{d}_v$
 - Constraint as in SMC & HERMES analyses:
 $\Delta \bar{u} = \Delta \bar{d} = \Delta s = 0$ at $x > 0.3$
- $$\Delta u_v + \Delta d_v \simeq \frac{36 g_1^d(x, Q^2)}{5(1 - 1.5\omega_D)}$$

- The used parametrisation for evolution towards $Q^2 = 10 \text{ GeV}^2$:
 (DNS) D. de Florian, G.A.Navarro and R.Sassot, Phys. Rev. D71 (2005) 094018. (based on KKP param. of FF)

Comparison with other experiments



Estimate for the first moments (LO)



$$\Gamma_v = \int_0^1 (\Delta u_v(x) + \Delta d_v(x)) dx$$

- Contribution from unmeasured high x region (DNS fit):

$$\int_{0.7}^1 (\Delta u_v + \Delta d_v) dx = 0.004$$

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

	x-range	Q^2 GeV 2	$\Delta u_v + \Delta d_v$		$\Delta \bar{u} + \Delta \bar{d}$	
			meas.	DNS	meas.	DNS
SMC 98	0.003 – 0.7	10	$0.26 \pm 0.21 \pm 0.11$	0.386	$0.02 \pm 0.08 \pm 0.06$	-0.009
HERMES 05	0.023 – 0.6	2.5	$0.43 \pm 0.07 \pm 0.06$	0.363	$-0.06 \pm 0.04 \pm 0.03$	-0.005
COMPASS	0.006 – 0.7	10	$0.40 \pm 0.07 \pm 0.05$	0.385	$0.00 \pm 0.04 \pm 0.03$	-0.007

Conclusion

Summary

- The deuteron data collected in years **2002 – 2004** have been used
- $\Delta u_v + \Delta d_v$ have been extracted from difference asymmetry at $x < 0.3$ and from g_1^d at $x > 0.3$:
$$\int_{0.006}^{0.7} (\Delta u_v + \Delta d_v) dx = 0.40 \pm 0.07 \pm 0.06, \quad \Delta \bar{u} = -\Delta \bar{d}$$
- Published in: M.Alekseev et al., PLB 660 (2008) 458-465.
- Increase of the precision at small x by a factor of ~ 6 as compared to SMC

Outlook

- Deuteron data **2006** have been processed. Update is coming soon
- Production of **2007** proton data and particle identification are ongoing.