VALENCE QUARK HELICITY DISTRIBUTION FROM COMPASS

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on behalf of the COMPASS collaboration

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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)[1]	$\Delta\Sigma = 0.12 \pm 0.09 \pm 0.04$ $\Delta s = -0.19 \pm 0.03 \pm 0.04$
DIS (QCD analysis of the world data)[2]	$\Delta\Sigma = 0.30 \pm 0.01 \pm 0.02$ $\Delta s = -0.08 \pm 0.01 \pm 0.02$

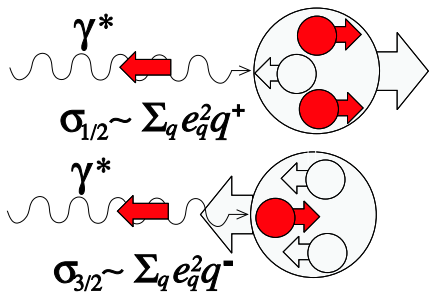
[1] J. Ashman *et al.* [European Muon Collaboration], Phys. Lett. B **206** (1988) 364.

[2] V. Y. Alexakhin *et al.* [COMPASS Collaboration], Phys. Lett. B **647** (2007) 8

HADRON ASYMMETRIES

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

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



SIDIS asymmetries

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

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

Difference asymmetry

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

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

- 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

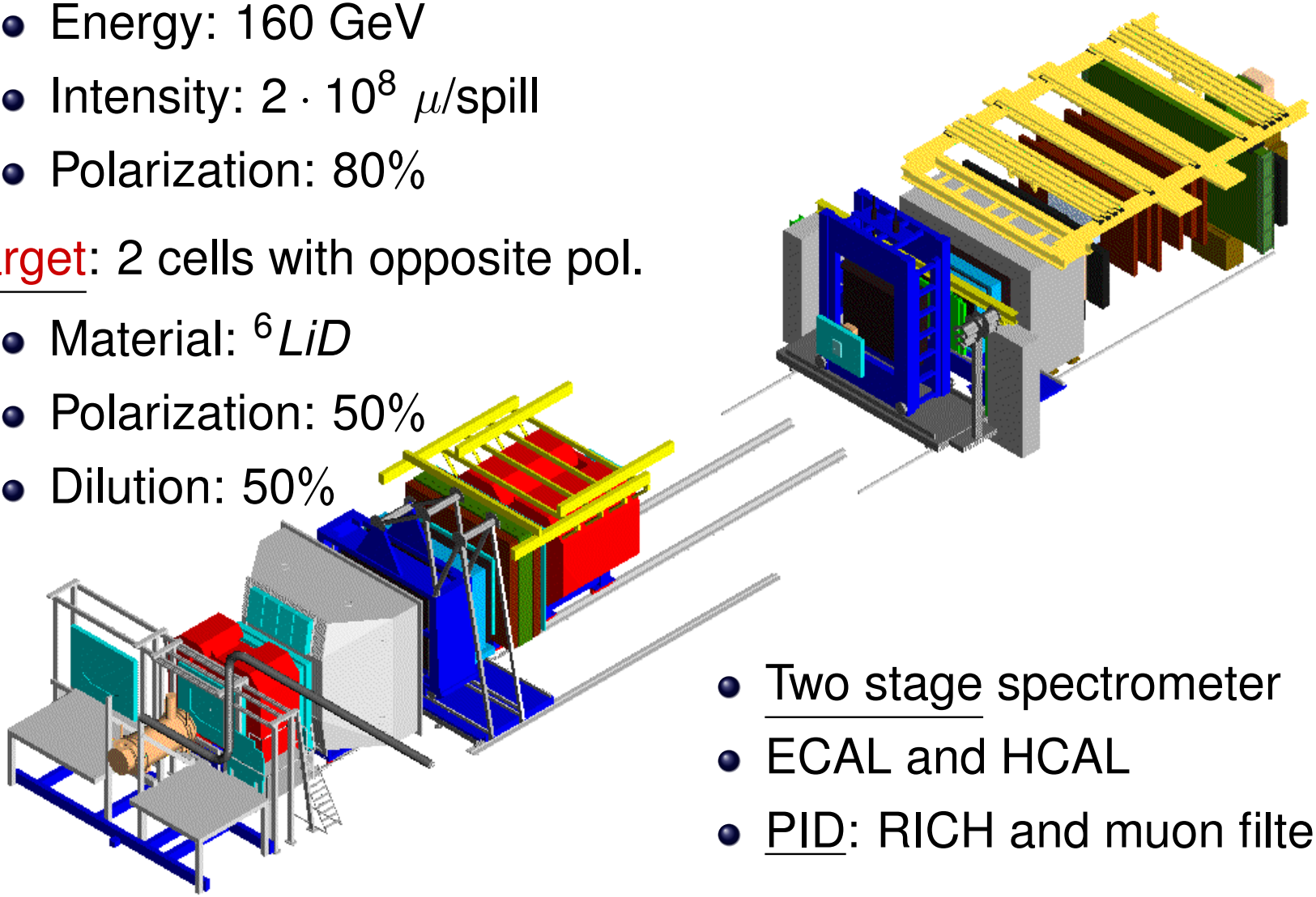
COMPASS SPECTROMETER

μ^+ - beam:

- Energy: 160 GeV
- Intensity: $2 \cdot 10^8$ μ/spill
- Polarization: 80%

Target: 2 cells with opposite pol.

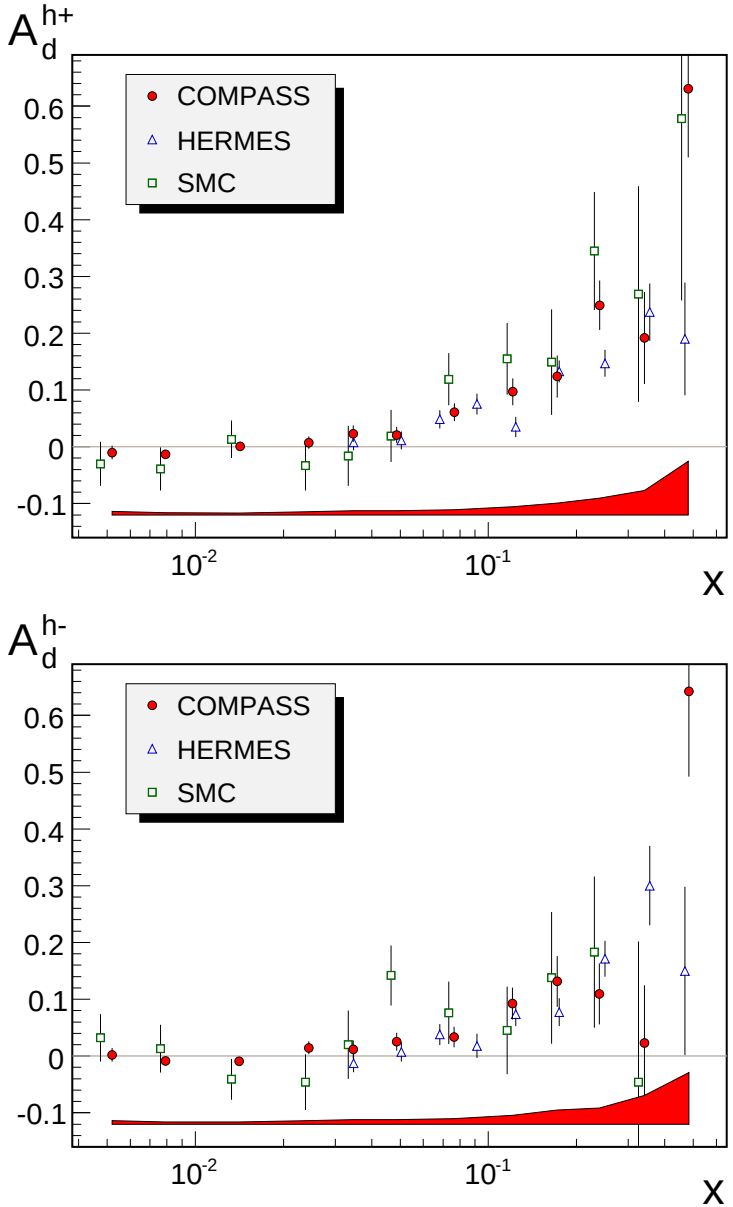
- Material: ^6LiD
- Polarization: 50%
- Dilution: 50%



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

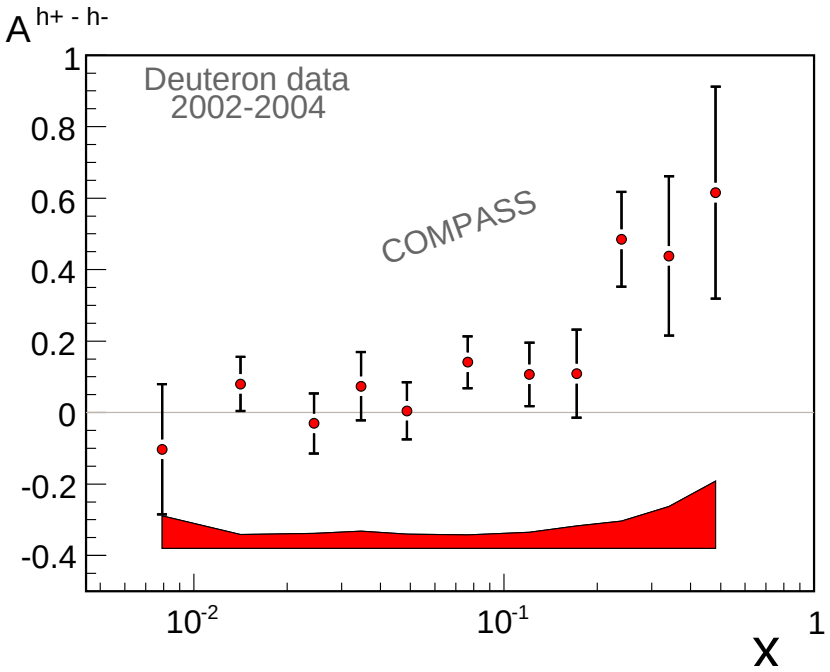
SINGLE HADRON ASYMMETRIES A^+ AND A^-

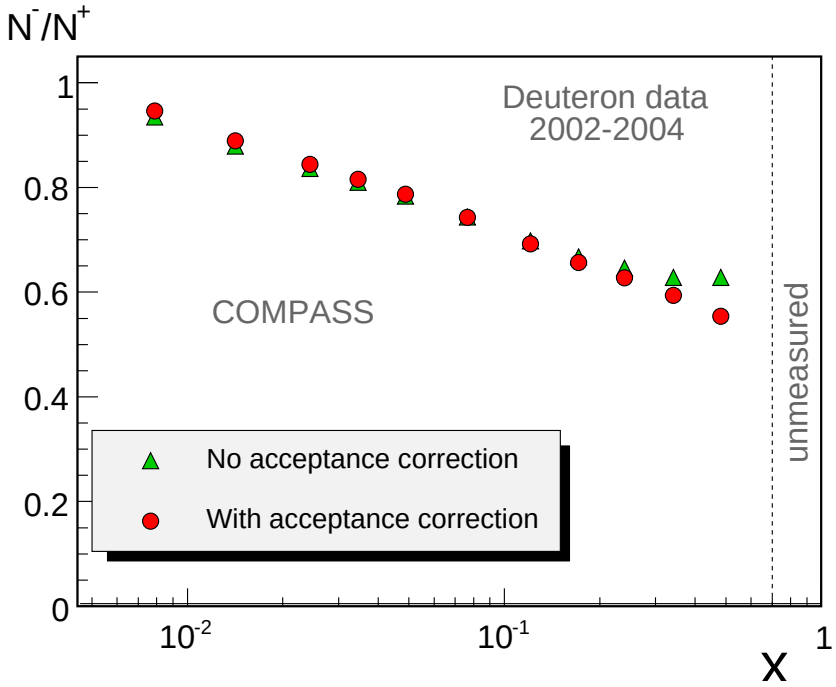
- Deuteron data 2002-2004 are used
- Kinematic cuts (DIS region): $Q^2 > 1(\mathrm{GeV/c})^2$, $0.1 < y < 0.9$
- no hadron identification
- current fragmentation region: $z > 0.2$ (fractional energy)
- To avoid ambiguity between secondary μ, and to suppress contribution from diffractive events: $z <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



DIFFERENCE ASYMMETRY

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





- 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

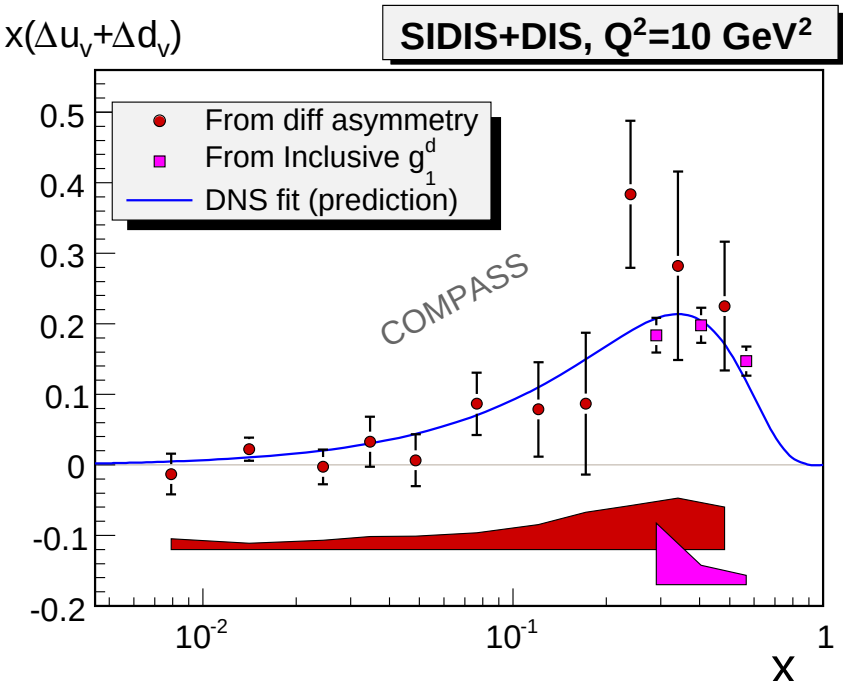
VALENCE QUARK POLARISATIONS

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

$$\omega_D = 0.05 \pm 0.01$$

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

For unpolarized PDF LO MRST04 was chosen

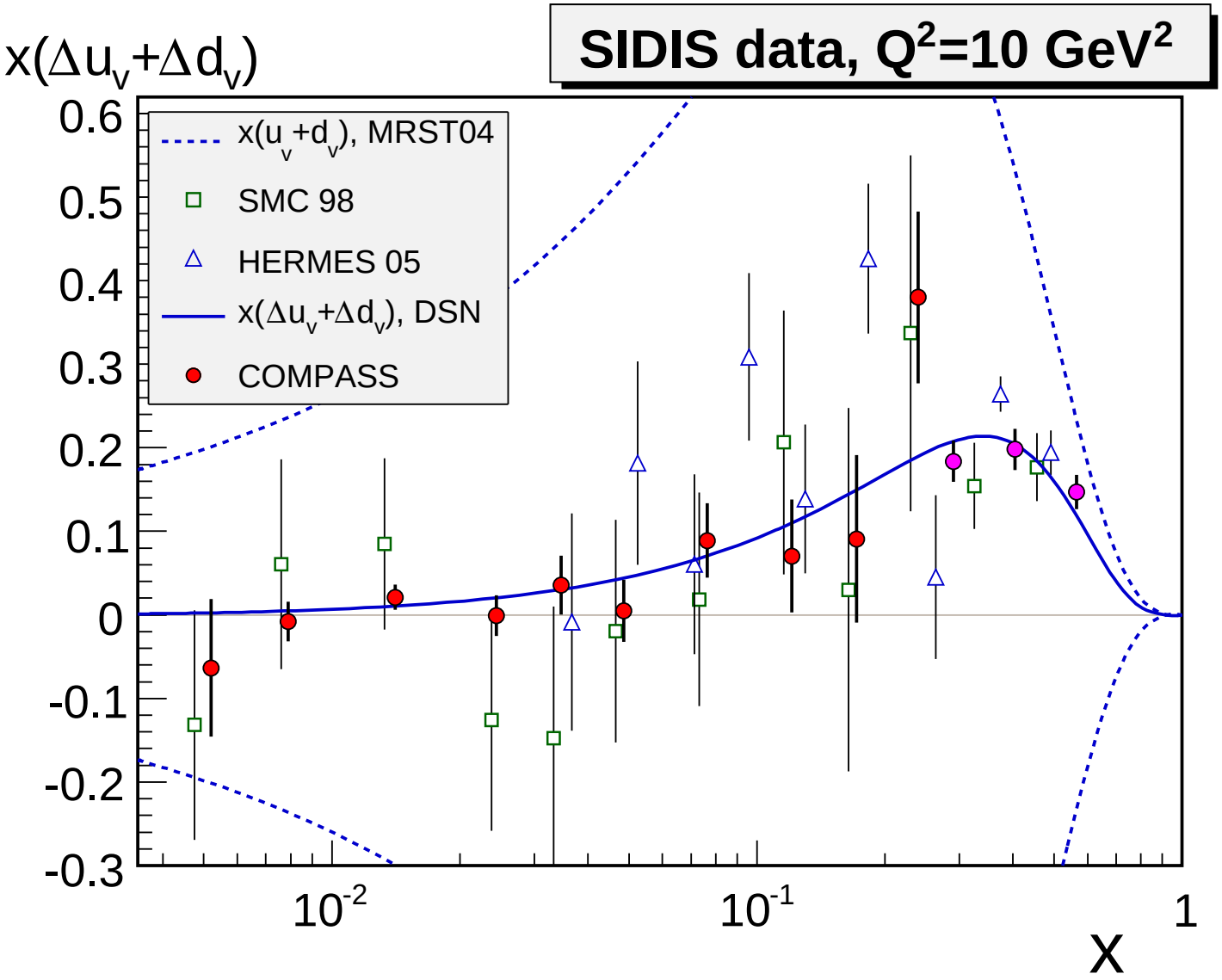


- Unpol. sea contribution to F_2 vanishes for $x > 0.3$
- $|\Delta\bar{u}_v + \Delta\bar{d}_v| < \bar{u}_v + \bar{d}_v$
- Constraint as in SMC & HERMES analyses: $\Delta\bar{u} = \Delta\bar{d} = \Delta s = 0$ at $x > 0.3$

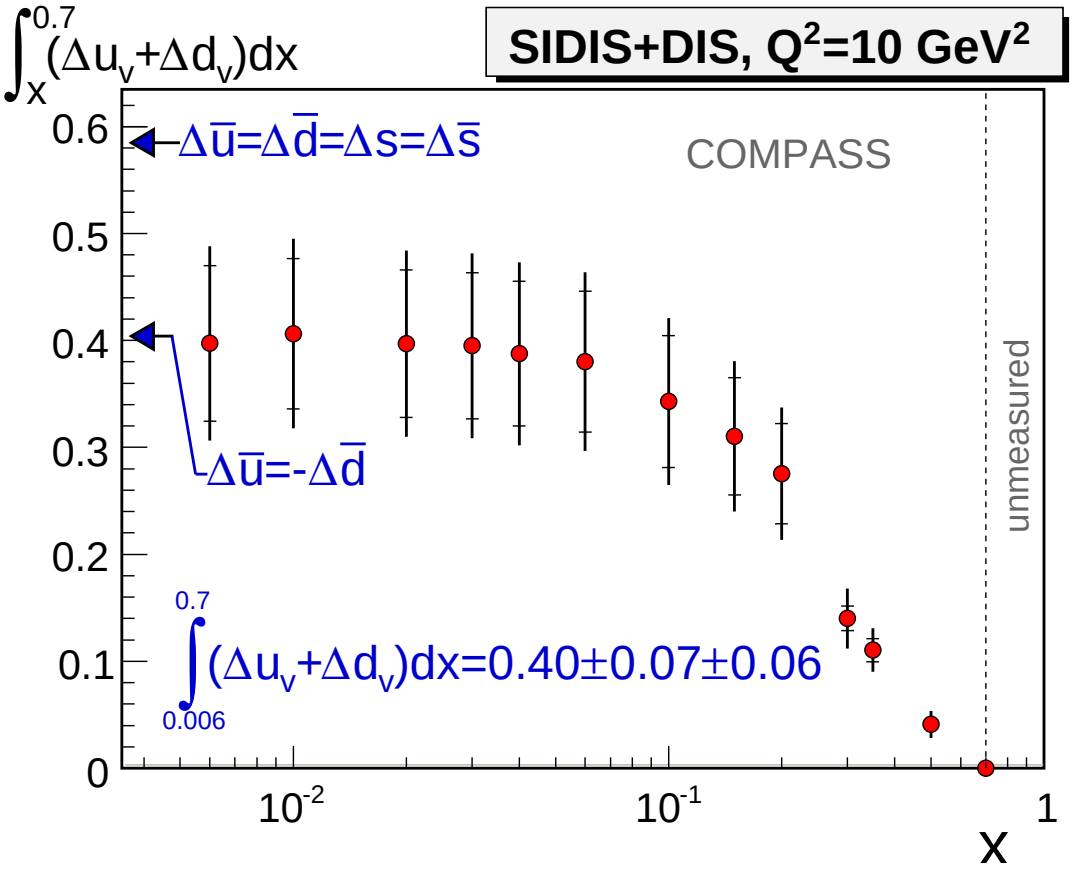
$$\Delta u_v + \Delta d_v \simeq \frac{36}{5} \frac{g_1^d(x,Q^2)}{1-1.5\omega_D}$$

- 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.