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

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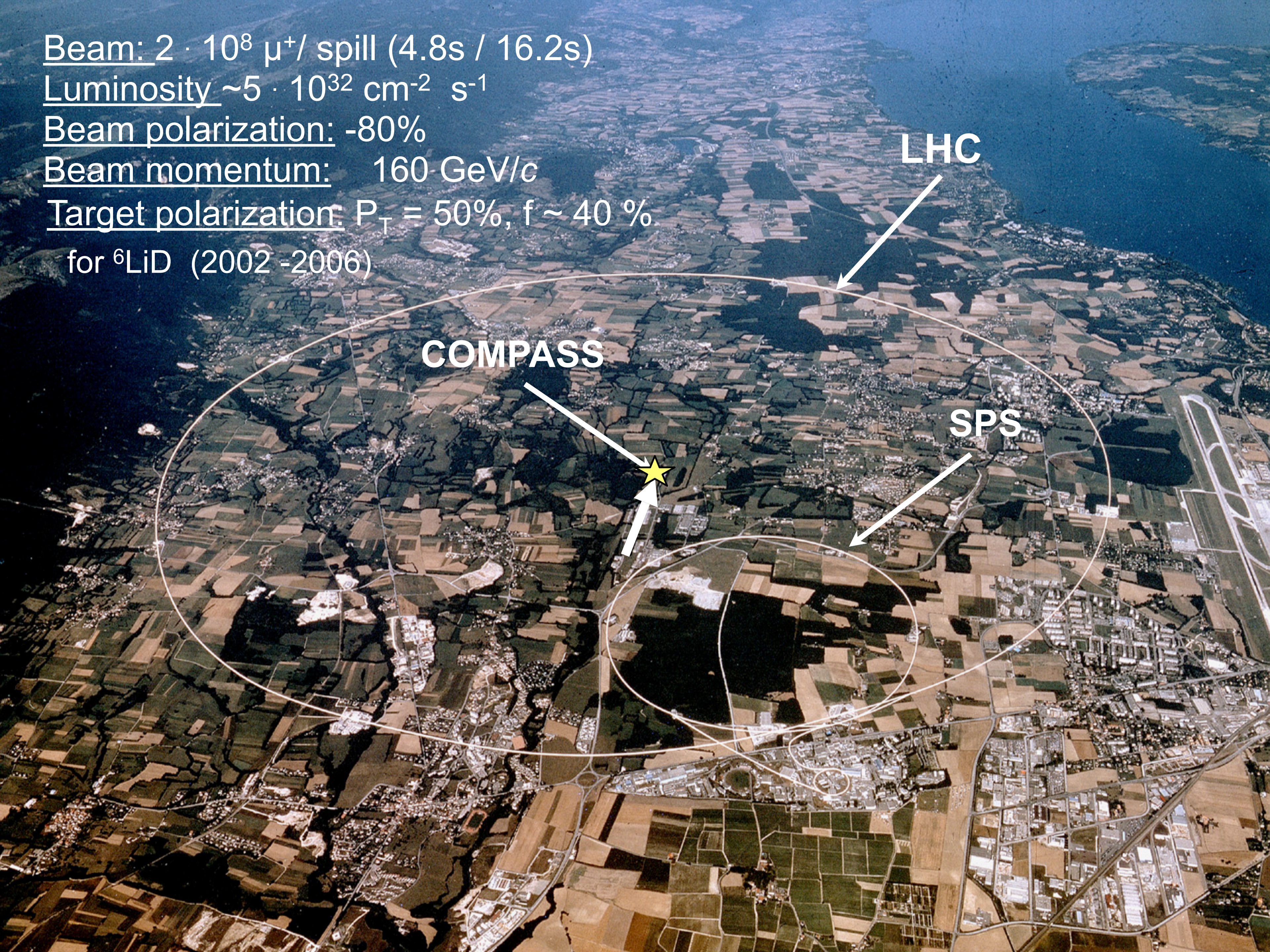
COMPASS

European Physical Society
HEP 2009

16-22 July, Krakow, Poland


Beam: 2 · 10^8 μ^+/ spill (4.8s / 16.2s)
Luminosity ~5 · 10^{32} cm^{-2} s^{-1}
Beam polarization: -80%
Beam momentum: 160 GeV/*c*
Target polarization: P_T = 50%, f ~ 40 %
for ^{6}LiD (2002 -2006)
LHC
COMPASS
SPS

COMPASS Collaboration at CERN

Common Muon and Proton Apparatus

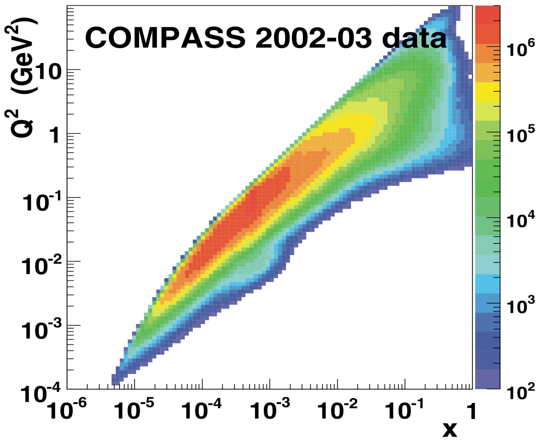
for Structure and Spectroscopy

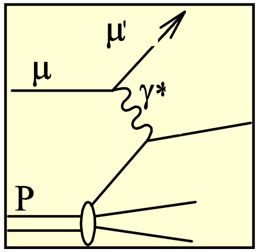
Czech Rep., France, Germany, India, Israel, Italy, Japan, Poland, Portugal, Russia and CERN

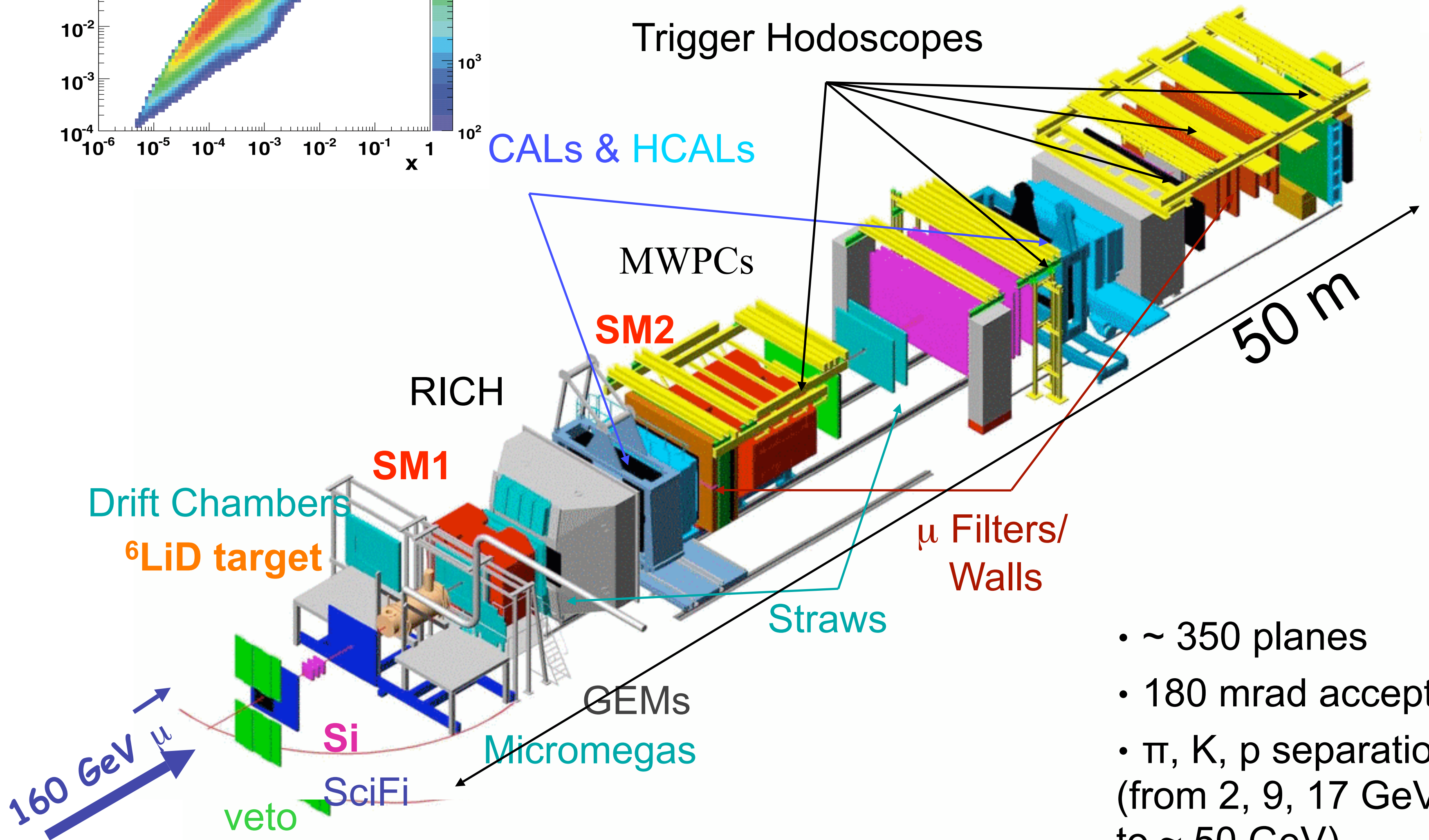
Bielefeld, Bochum, Bonn, Burdwan and Calcutta, CERN, Dubna, Erlangen, Freiburg, Lisbon, Mainz, Moscow, Munich, Prague, Protvino, Saclay, Tel Aviv, Torino, Trieste, Warsaw, Yamagata

~240 physicists, 30 institutes

COMPASS in muon run
NIM A 577(2007) 455

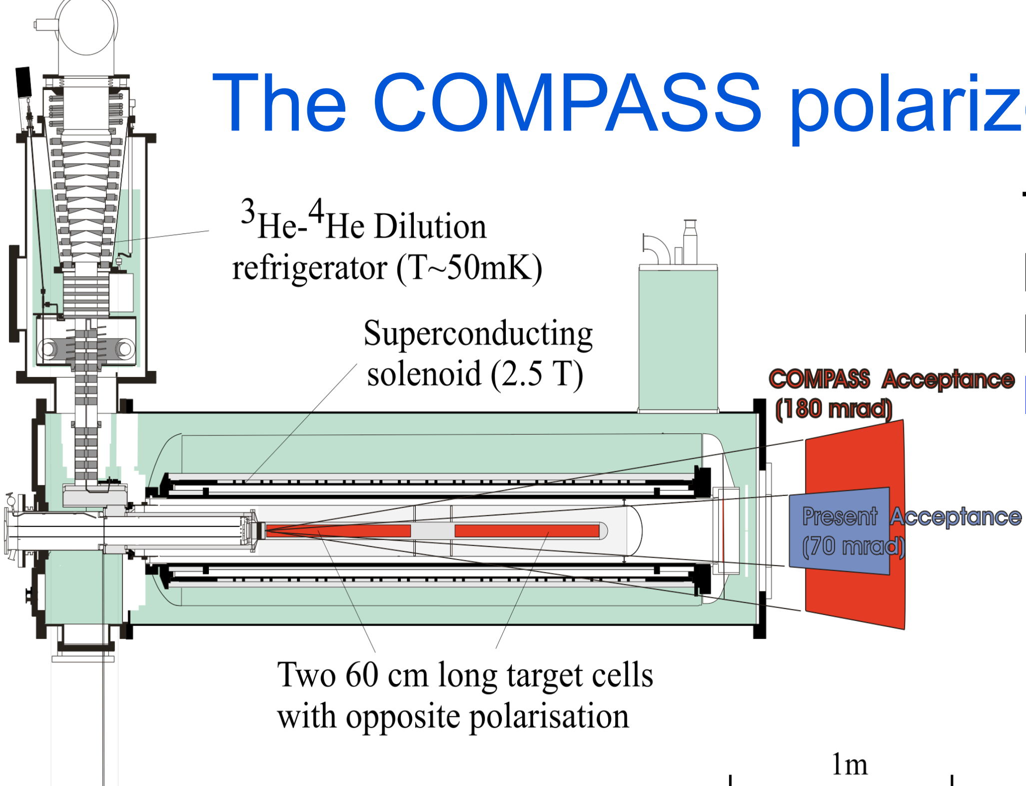






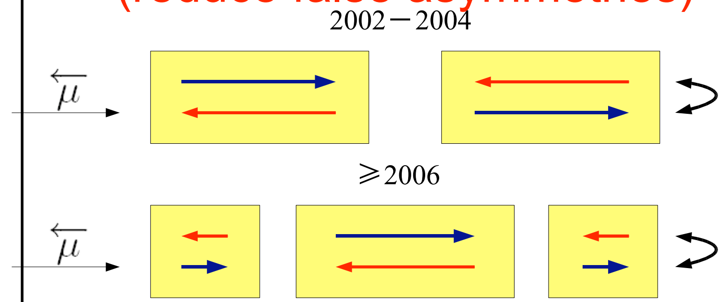
- ~ 350 planes
- 180 mrad acceptance
- π, K, p separation (from 2, 9, 17 GeV up to ~ 50 GeV)

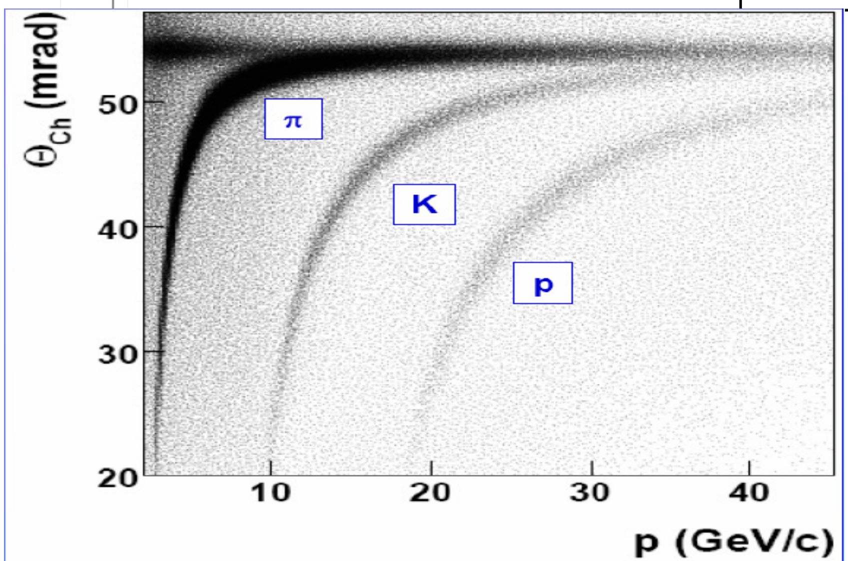
The COMPASS polarized target



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

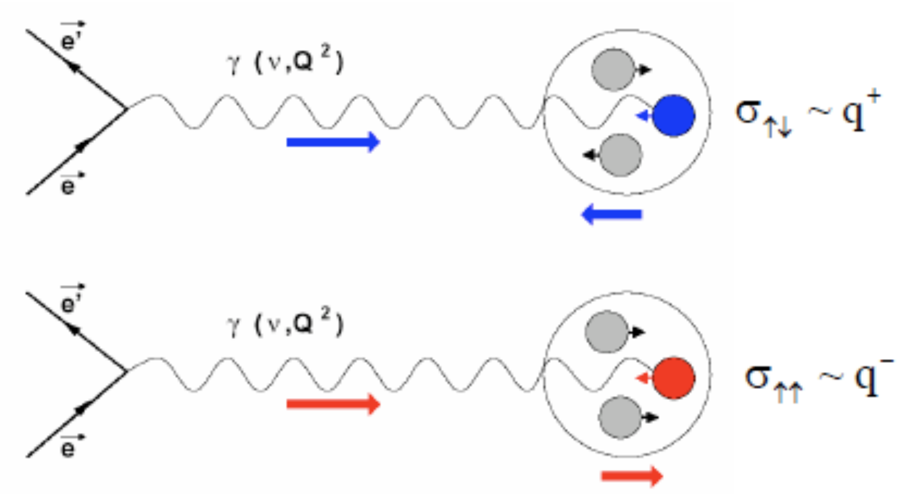
MAPMTs in central region

APV electronics in periphery

Contents

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

Polarized Deep Inelastic scattering



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

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

+ quark ↑↑ nucleon

− quark ↑↓ nucleon

Inclusive asymmetry:

$$A_1(x,Q^2) = \frac{\sigma_{\uparrow\downarrow} - \sigma_{\uparrow\uparrow}}{\sigma_{\uparrow\downarrow} + \sigma_{\uparrow\uparrow}} \approx \frac{\sum_q e_q^2\, \Delta q(x,Q^2)}{\sum_q e_q^2\, q(x,Q^2)} = \frac{g_1(x,Q^2)}{F_1(x,Q^2)}$$

Semi-inclusive asymmetry:

$$A_1^h(x,z,Q^2) = \frac{\sigma_{\uparrow\downarrow}^h - \sigma_{\uparrow\uparrow}^h}{\sigma_{\uparrow\downarrow}^h + \sigma_{\uparrow\uparrow}^h} \approx \frac{\sum_q e_q^2\, \Delta q(x,Q^2) D_q^h(z,Q^2)}{\sum_q e_q^2\, q(x,Q^2) D_q^h(z,Q^2)}$$

3 years of deuteron data taking in COMPASS:
2002-2004 : $89 \cdot 10^6$ events for $Q^2 > 1\ (\mathrm{GeV}/c)^2$

Phys.Lett.B 647 (2007)8

First moment of g_1

Compass only

Phys.Lett.B 647 (2007)8

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

from Y. Goto *et al.*, PRD62 (2000) 034017: (SU(3)$_f$ assumed for weak decays)
$a_8 = 0.585 \pm 0.025$

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

QCD NLO

$$a_{0|Q^2\to\infty} = 0.33 \pm 0.03(stat) \pm 0.05(syst)$$

beyond NLO

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

Difference asymmetries

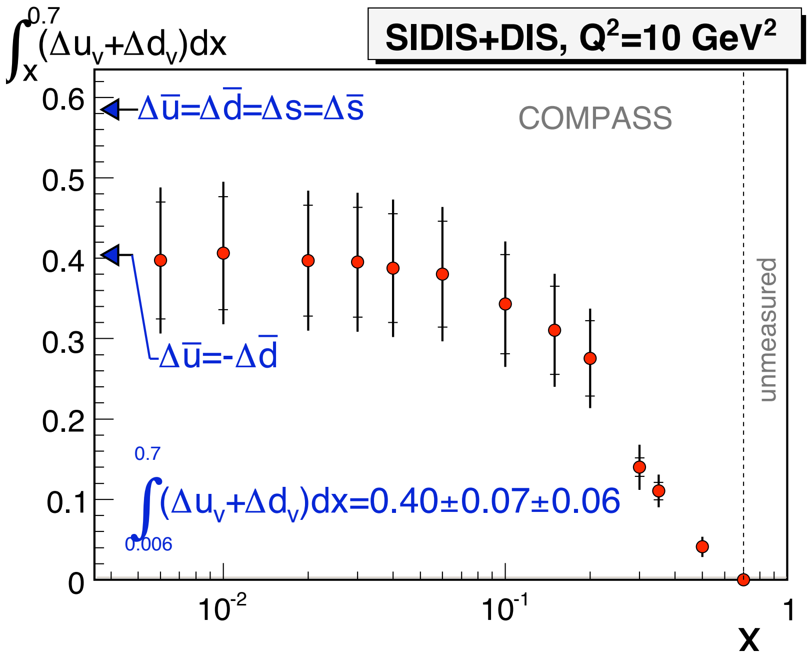
Idea: Phys.Lett.B230(1989)141,
SMC:Phys.Lett.B369(1996)93,
COMPASS: Phys.Lett.B660(2008)458

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

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

Only valence quarks!

Fragmentation functions cancell out in LO and under the assuption of independent fragmentation.



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

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

Gluon polarization

✦QCD evolution $g_1(x,Q^2) = \frac{1}{2}\langle e^2\rangle\left[C_q^s \otimes \Delta\Sigma + C_q^{NS} \otimes \Delta q^{NS} + 2n_f C_G \otimes \Delta G\right]$

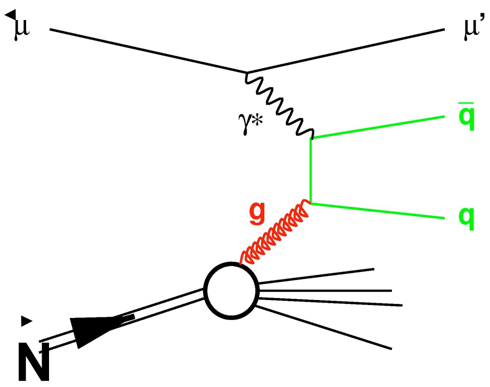
✦Semi-inclusive asymmetries compared to theory predictions based on gluon polarization “model” (method used in RHIC)

✦“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

high-p_T hadron pairs

R.D.Carlitz, J.C.Collins and A.H.Mueller, Phys.Lett.B 214, 229 (1988)
Revisited by A.Bravar,D.von Harrach and A.Kotzinian, Phys.Lett.B 421, 349 (1998)
Applied by SMC, HERMES and COMPASS



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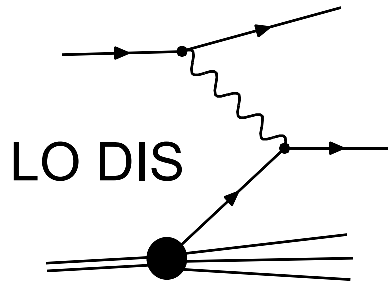

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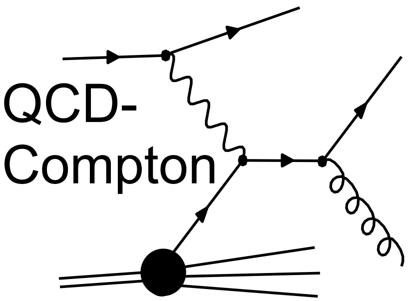


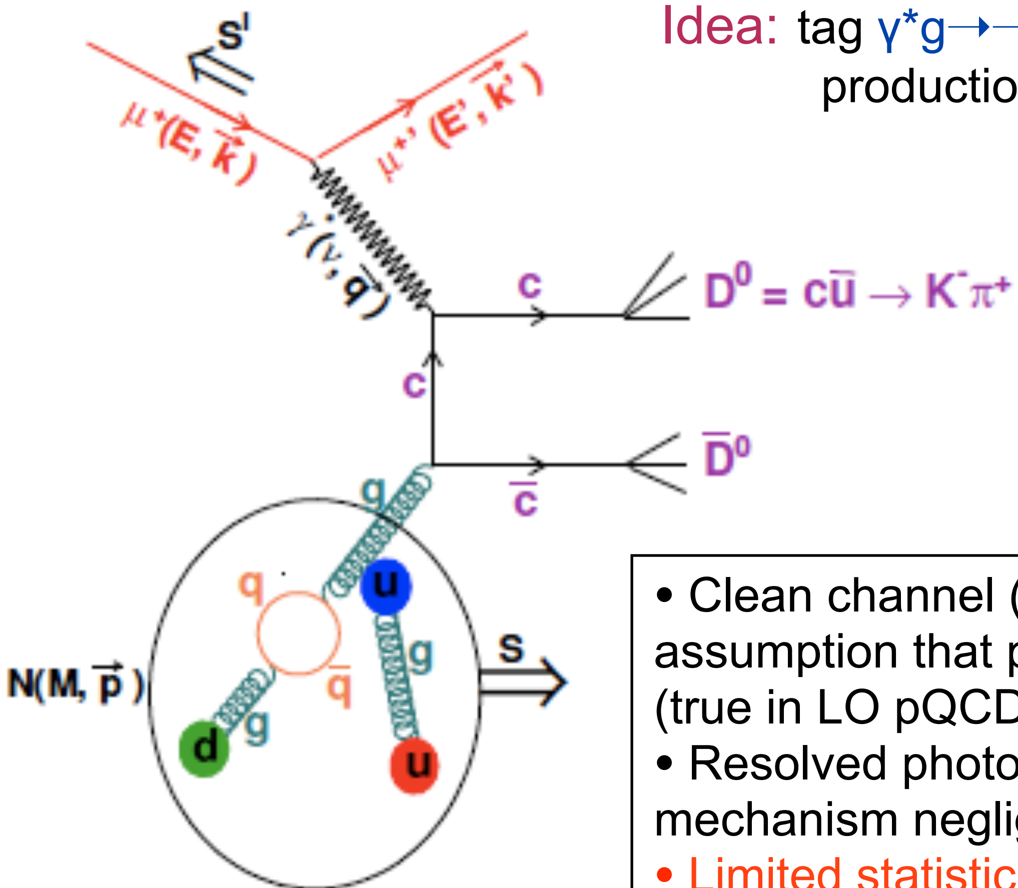
The simple idea: three basic processes, PGF probes gluons

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

Open-charm analysis



Idea: tag $\gamma^*g \rightarrow c\bar{c}$ via open-charm production mechanism

COMPASS: PLB676(2009)31

- 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

Weighted method for open-charm analysis

$$A^{raw} = \frac{N^{\uparrow\downarrow} - N^{\uparrow\uparrow}}{N^{\uparrow\downarrow} + N^{\uparrow\uparrow}} = P_B P_T f a_{LL} \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}} \frac{\Delta g}{g} + A^{bgd}$$

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

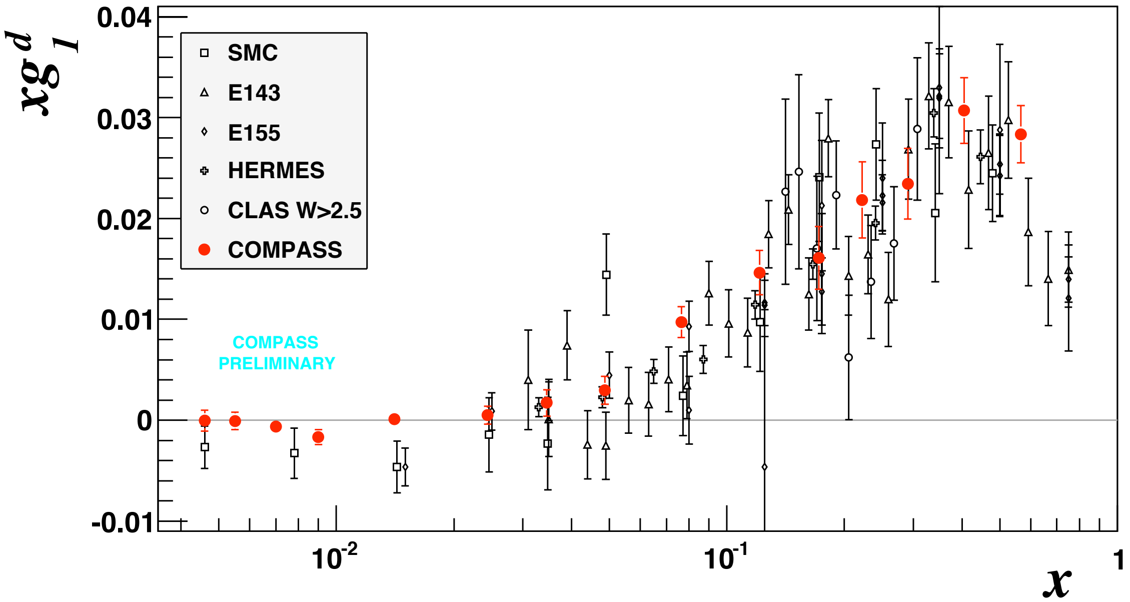
- $\frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}}$ is parameterized in terms of 10 variables, not just as a function of the reconstructed mass.
- each event is weighted with its analyzing power:

  $$f P_B a_{LL} \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}}$$

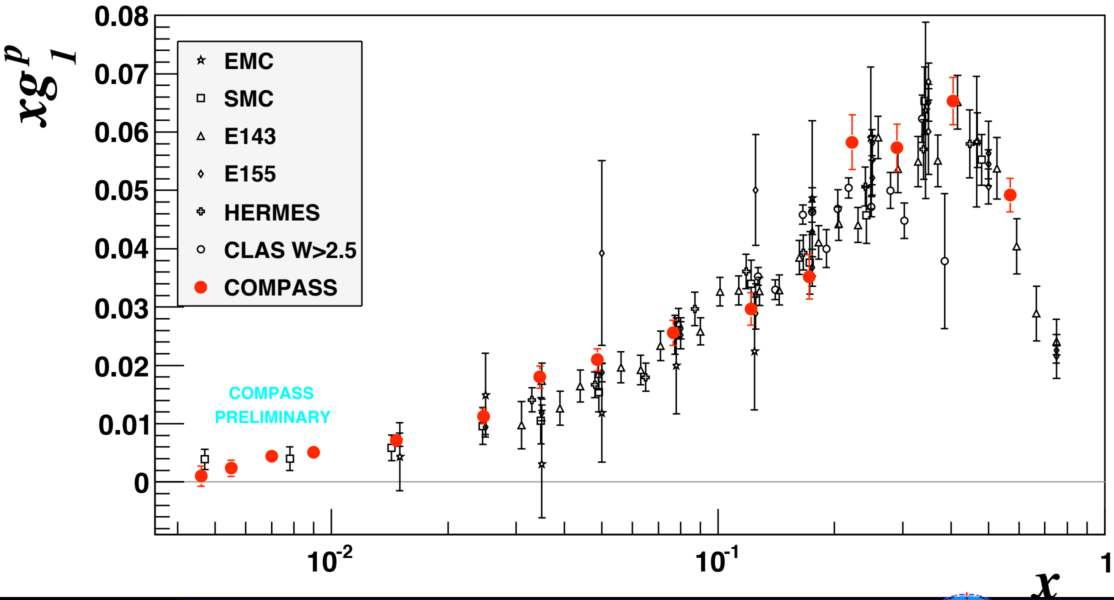
  Large gain in statistics (a_{LL} has positive and negative values)
- events are simultaneously weighted with $(\ldots \frac{\sigma_{BGD}}{\sigma_{PGF} + \sigma_{bgd}})$
  $\Rightarrow$ allows simultaneous extraction of signal and background asymmetries,
  more efficient than side band subtraction

Helicity distributions

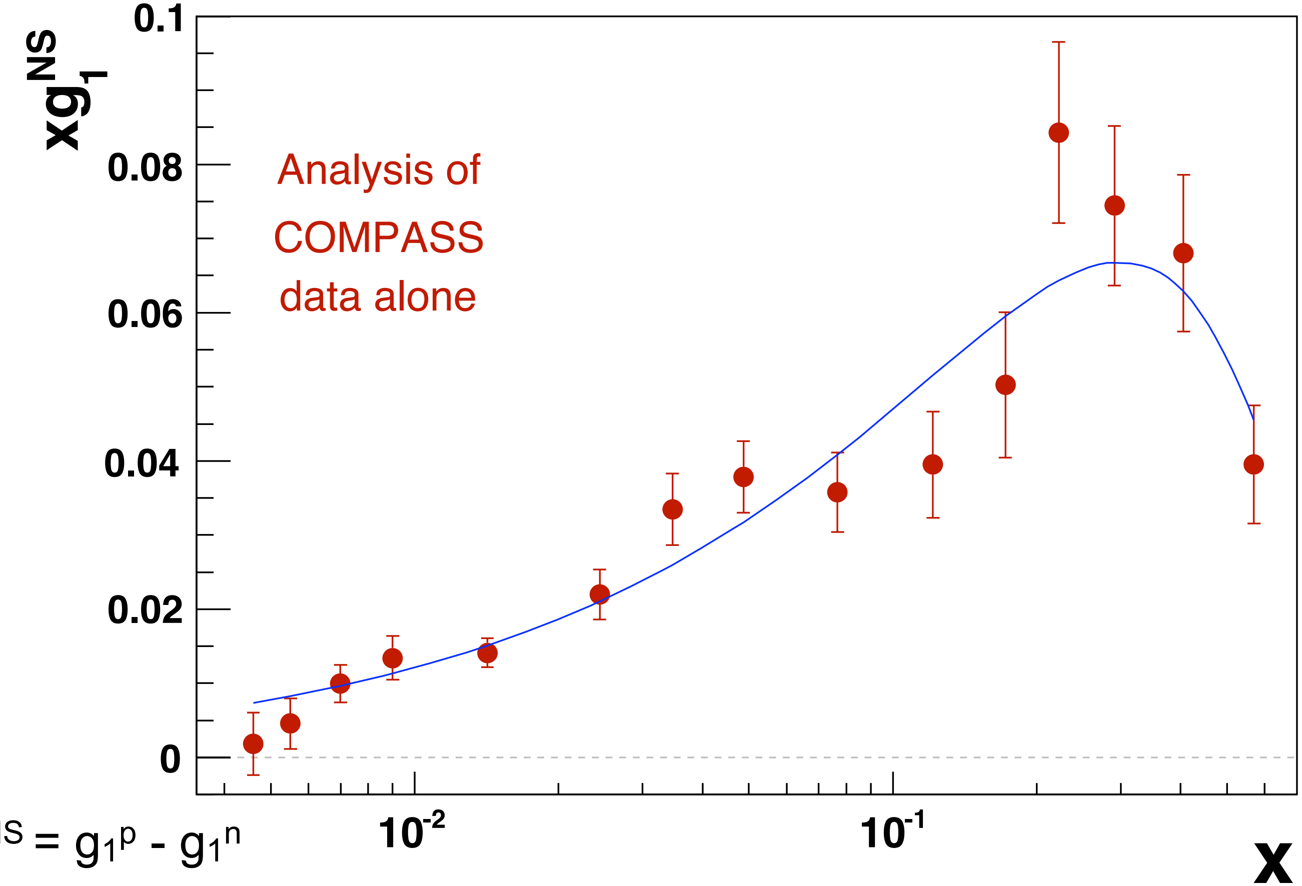
New: Proton data 2007, g_1



Very good agreement between experiments



New: Proton data 2007



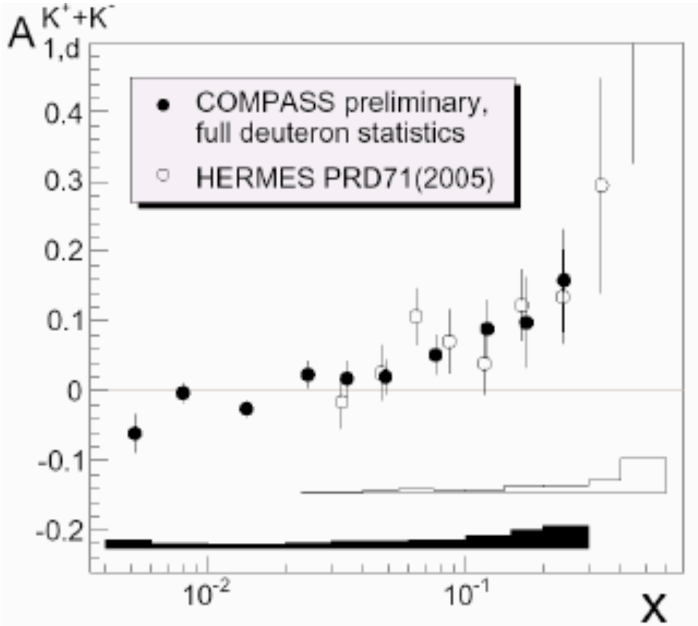
$g_1^{NS} = g_1^p - g_1^n$

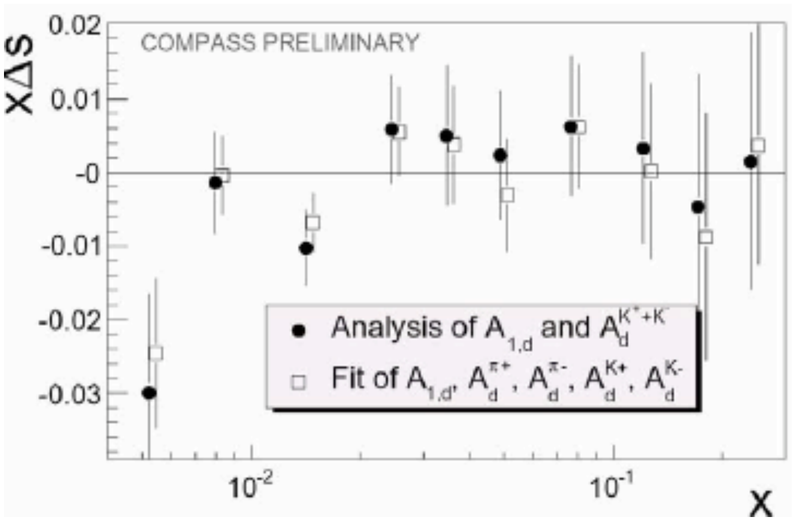
QCD NLO fit allows to estimate first moment and test Bjorken sum rule:

$$\Gamma_1^{NS}(Q^2) = \frac{1}{6}\frac{g_A}{g_V}C_1^{NS}(Q^2) \qquad g_A/g_V = 1.29 \pm 0.05(\text{stat.})$$

$C^{NS} = 0.89 \quad Q^2 = 3\ (\text{GeV}/c)^2$

Δs from charged Kaon's asymmetry





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

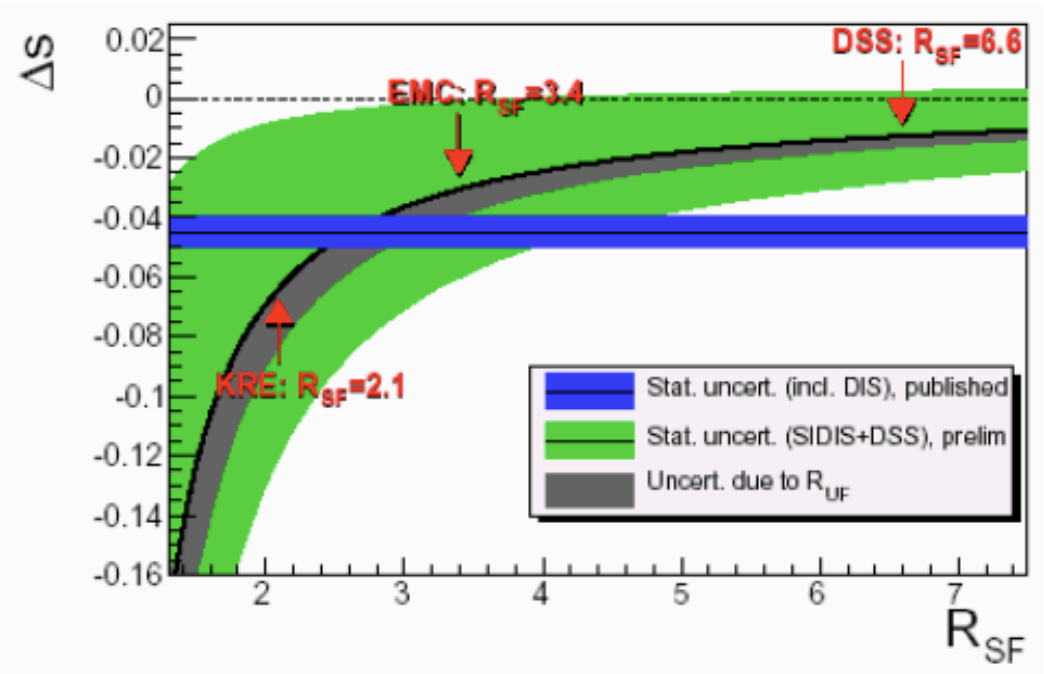
$$\alpha = \frac{2R_{UF} + 2R_{SF}}{3R_{UF} + 2} \qquad Q = u + \bar{u} + d + \bar{d}$$

$$R_{UF} = \frac{\int D_d^{K^+}(z)dz}{\int D_u^{K^+}(z)dz} \qquad R_{SF} = \frac{\int D_{\bar{s}}^{K^+}(z)dz}{\int D_u^{K^+}(z)dz}$$

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

$$\text{if } A^{K^+ + K^-} < 0 \text{ (at low x)} \Rightarrow \Delta s < 0$$

Δs from charged Kaon's asymmetry



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

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

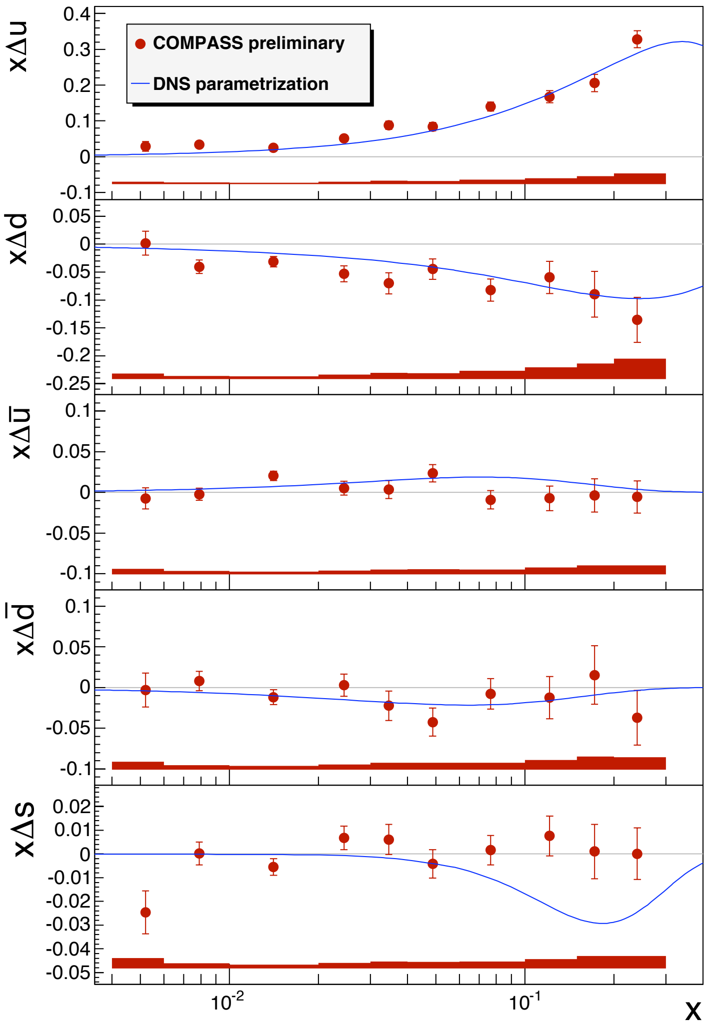
- R_{UF} fixed at 0.14 from the DSS fragmentation functions
- Large statistical uncertainty due to R_{SF}, slight dependence on R_{UF}
- If R_{SF}>5 Δs(SIDIS)>Δs(DIS) and Δs <0 for x<0.004
- If R_{SF}<4: A^K becomes insensitive to Δs

Δs (inclusive) = –0.045 ± 0.005 ± 0.010

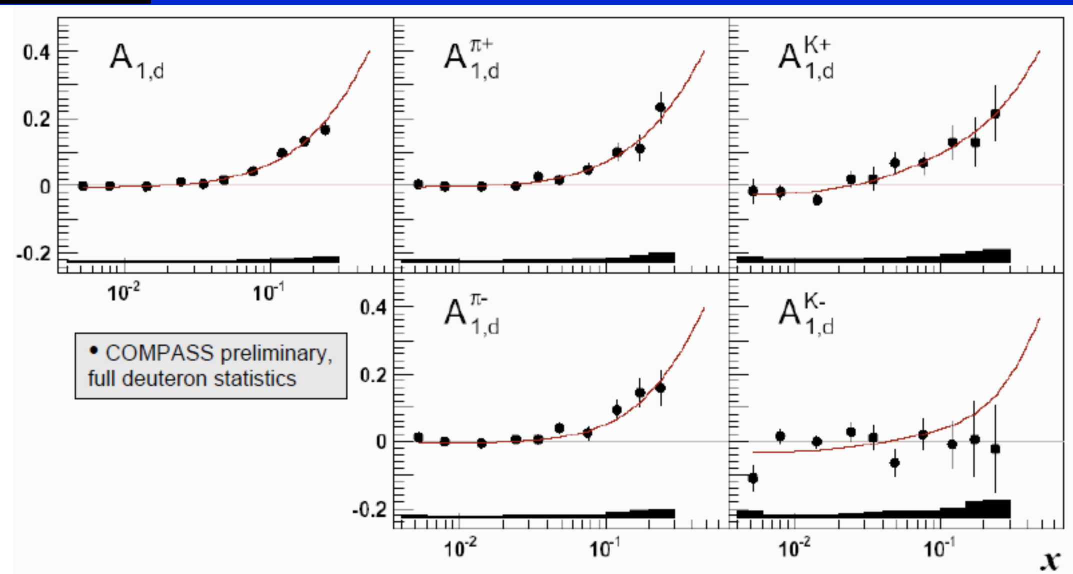
Δs (SIDIS) = –0.01 ± 0.01 ± 0.01

in LO pQCD

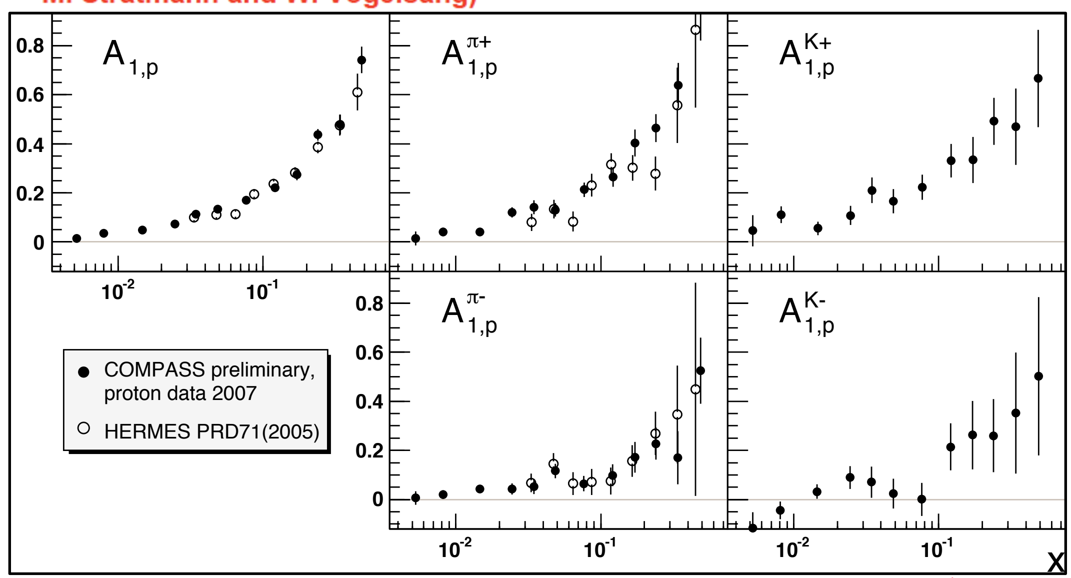
New: Proton data 2007, flavour separation



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



Curves are NLO predictions from DSSV Group (D. De Florian, R. Sassot, M. Stratmann and W. Vogelsang)



$\Delta G/G$ from high-p_T hadron pairs

Extraction formula for ΔG/G

$$\frac{\Delta G}{G}(x_G) = \frac{A_{LL}^{2h}(x_{Bj}) + A^{corr}}{\beta}$$

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

$$A^{corr} = -A_1(x_{Bj}) D \frac{R_L}{R_L^{incl}} - A_1(x_C)\beta_1 + A_1(x'_C)\beta_2$$

$$\beta_1 = \frac{1}{R_L^{incl}} \left(a_{LL}^{C} R_C - a_{LL}^{C,incl} R_C^{incl} \frac{R_L}{R_L^{incl}} \right) \qquad \beta_2 = a_{LL}^{C,incl} \frac{R_C R_C^{incl}}{(R_L^{incl})^2} \frac{a_{LL}^{C}}{D}$$

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.

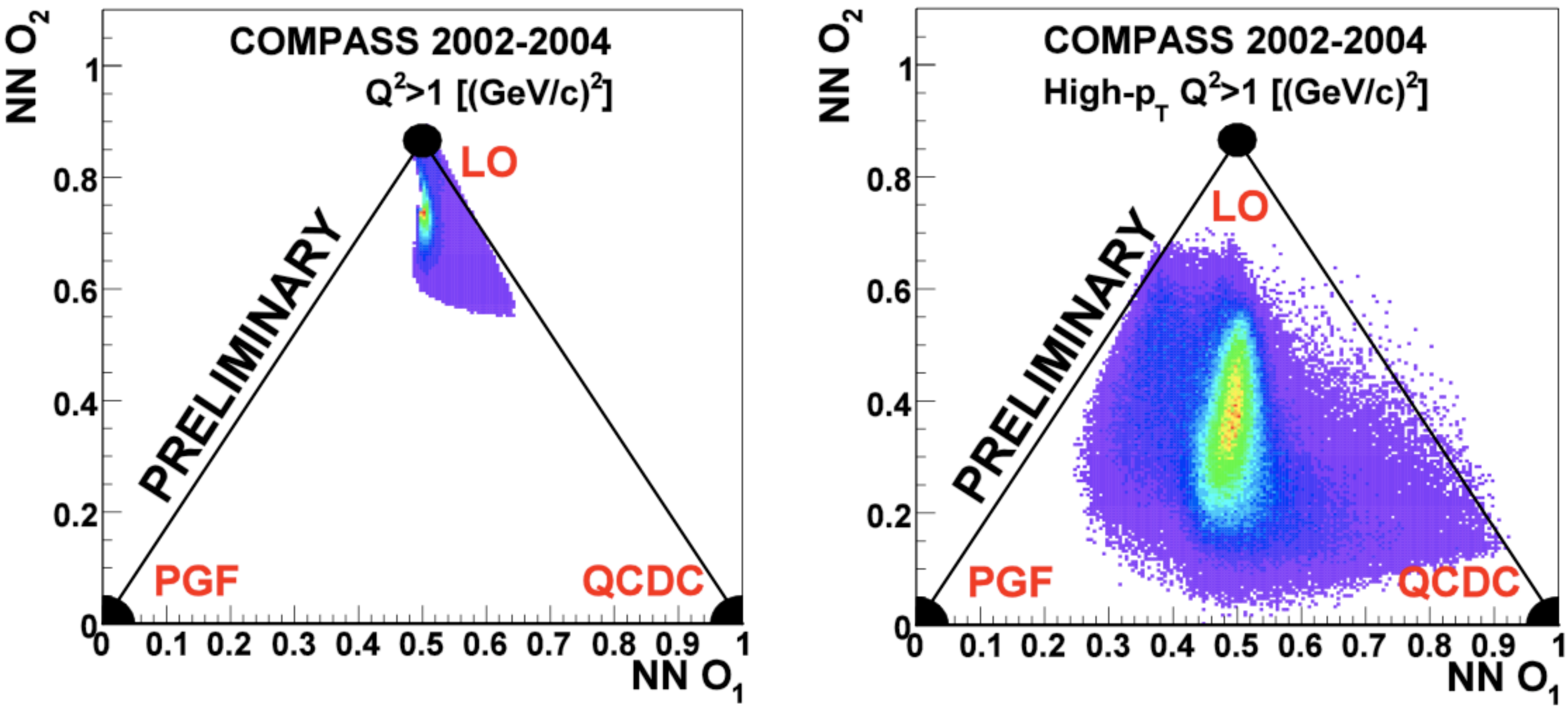
Data selection

- Cuts on inclusive variables:
  $Q^2 > 1\ (GeV/c)^2$ (Scale of the process)
  $0.1 < y < 0.9$
- Cuts on hadronic variables:
  $p_{T1} > 0.7$ GeV/c and $p_{T2} > 0.7$ 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

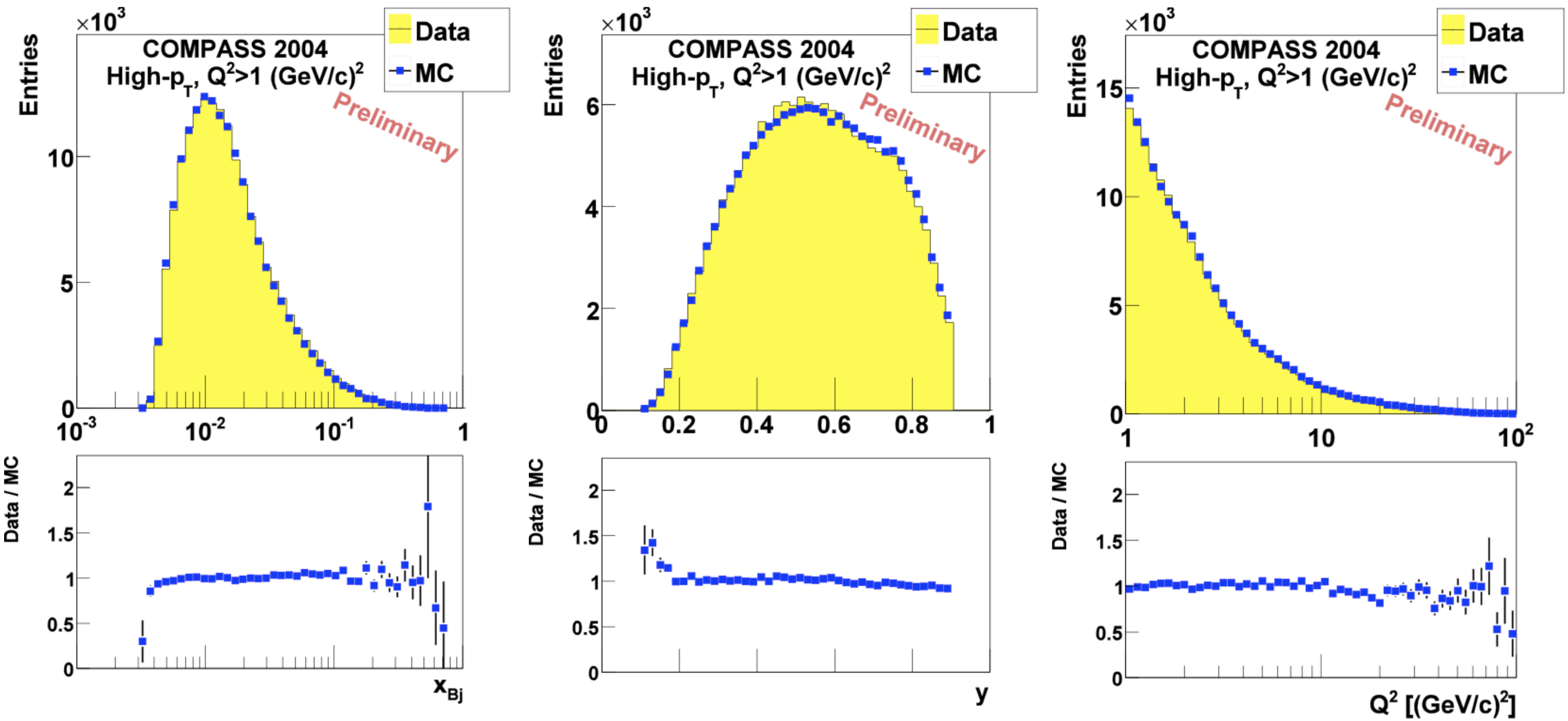
NN parameterization of fractions R

2 variables o_1 and o_2 are used (R's sum up to 1)



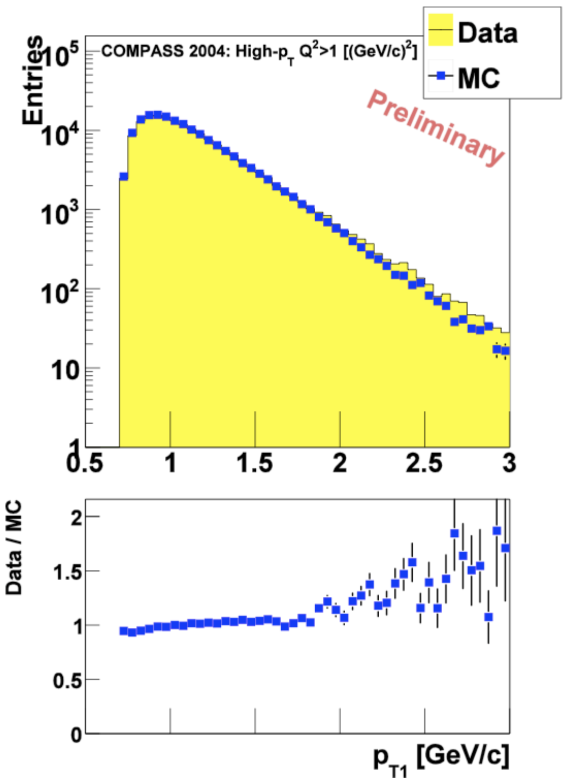
$$R_{PGF} = 1 - o_1 - \frac{1}{\sqrt{3}} o_2 \qquad R_C = o_1 - \frac{1}{\sqrt{3}} o_2 \qquad R_L = \frac{2}{\sqrt{3}} o_2$$

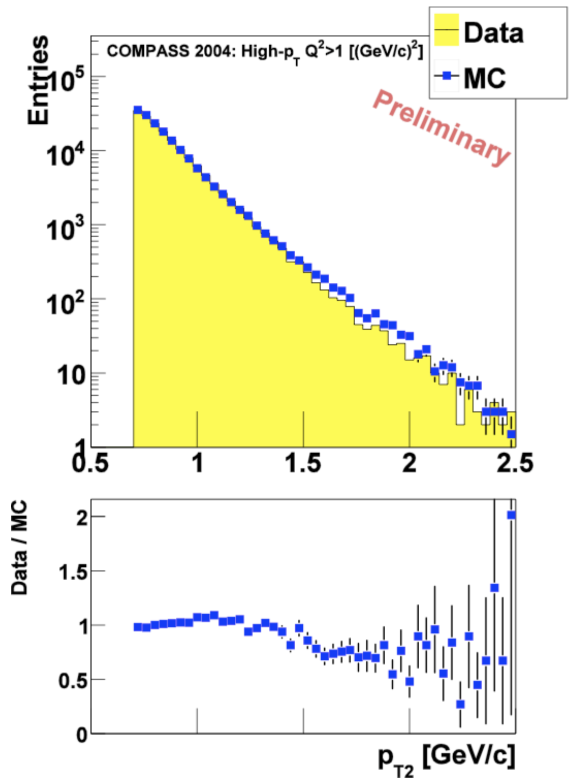
Data/MC comparison

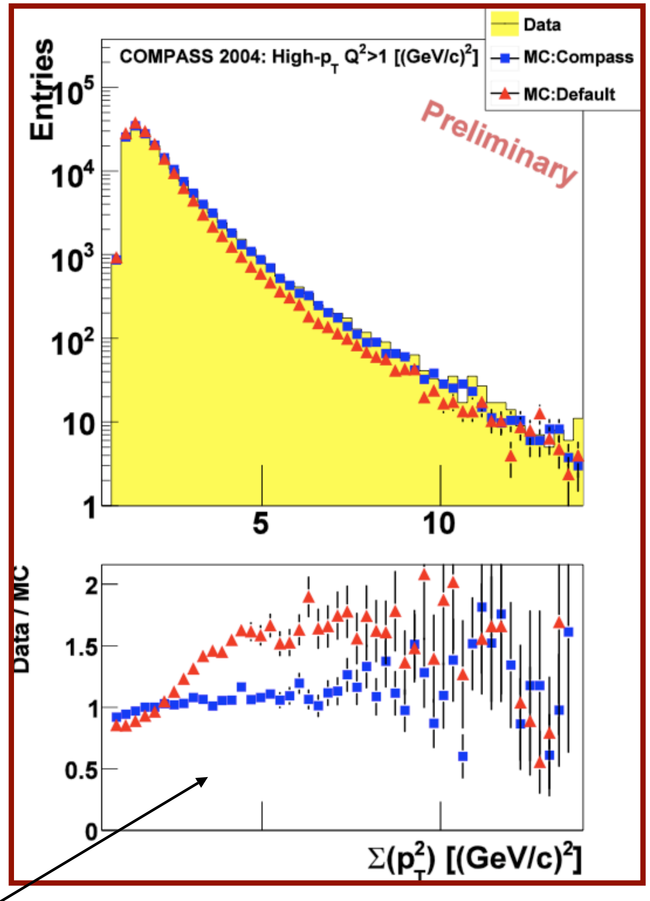


Comparison: MC/data for high p_T sample; x,y and Q^2

Data/MC comparison







Comparison: MC/data for high p_T sample; transverse momenta of leading and sub-leading hadrons

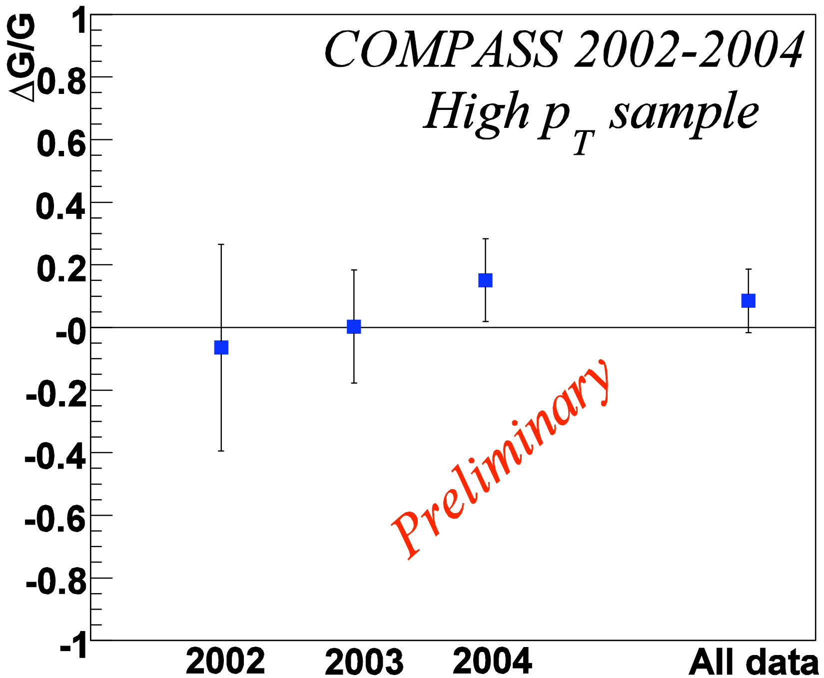
Impact of MC tuning

Results

$$\frac{\Delta G}{G} = 0.08 \pm 0.10 \pm 0.05$$

Systematic error dominated by MC

$$x_G = 0.082^{+0.041}_{-0.027} \ @\ \mu^2 \approx 3(GeV/c)^2$$



Plot has statistical errors only

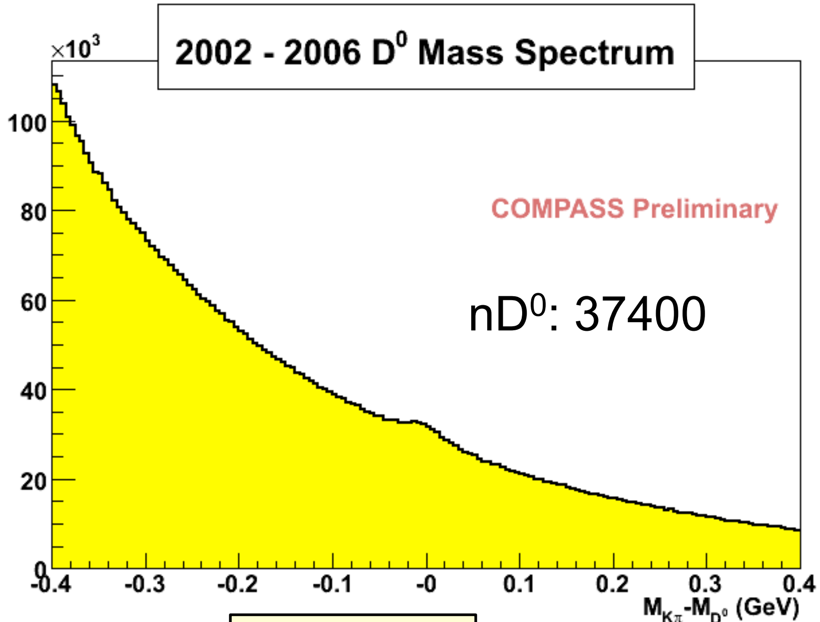
ΔG/G from open-charm channel

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

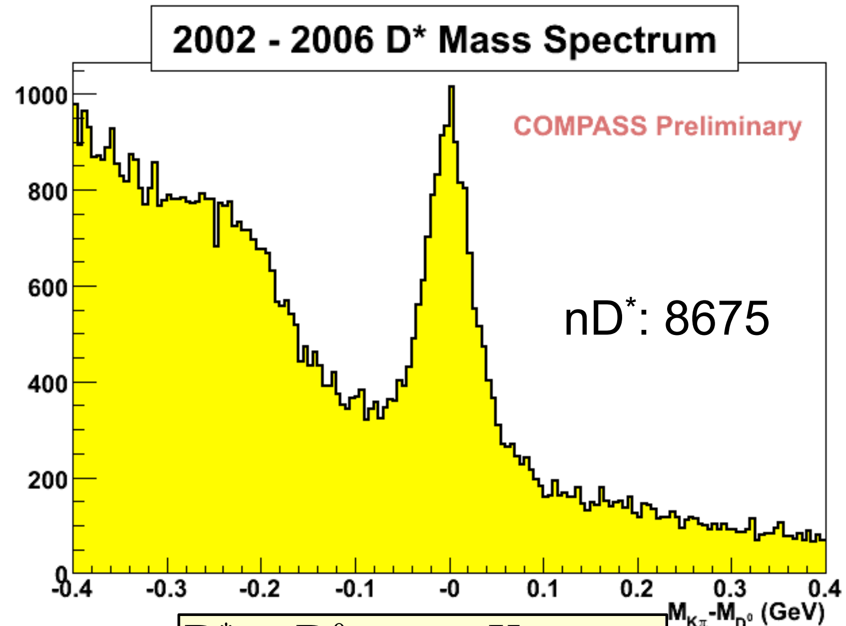
- **Events considered** *(resulting from c quarks fragmentation):*
  - $D^0 \rightarrow K\pi$ *(BR: 4%)*
  - $D^* \rightarrow D^0\pi_s \rightarrow K\pi\pi_s$ *(30% D^0 tagged with D^*)*
- **Selection to reduce the combinatorial background:**
  - Kinematical cuts: Z_D, D^0 decay angle, K and π momentum
  - RICH identification: K and π ID + electrons rejected from the π_s sample

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

Thick target - no D^0 vertex reconstruction
D^0 reconstruction: Kπ invariant mass + cuts on D^0 decay angle + z_D + RICH particle identification (different likelihoods)



$D^0 \rightarrow K + \pi$



$D^* \rightarrow D^0 + \pi_s \rightarrow K + \pi + \pi_s$

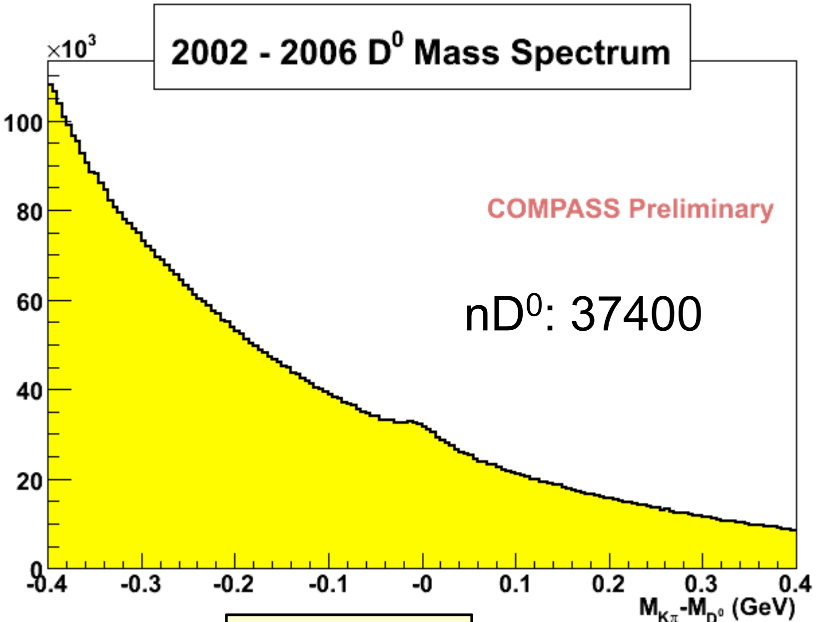
+2 more channels :

- $D^0 \rightarrow K^- \pi^+ + (\pi^0)$
- $D^{*+} \rightarrow D^0 \pi^+_{soft} \rightarrow K^- \pi^+ \pi^+_{soft}$ (with kaons below RICH threshold of 9 GeV)

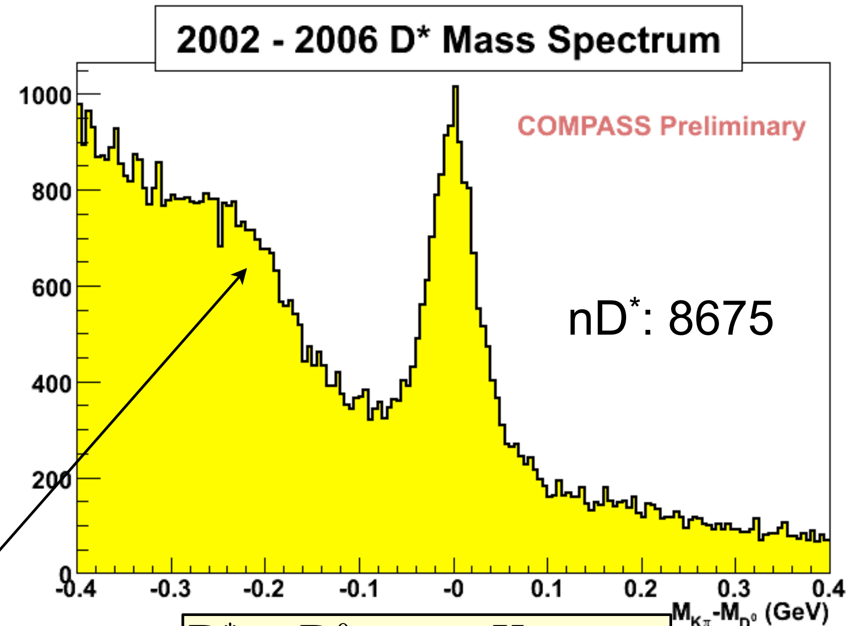
New!

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

Thick target - no D^0 vertex reconstruction
D^0 reconstruction: Kπ invariant mass + cuts on D^0 decay angle + z_D + RICH particle identification (different likelihoods)



$D^0 \rightarrow K + \pi$



$D^* \rightarrow D^0 + \pi_s \rightarrow K + \pi + \pi_s$

+2 more channels :

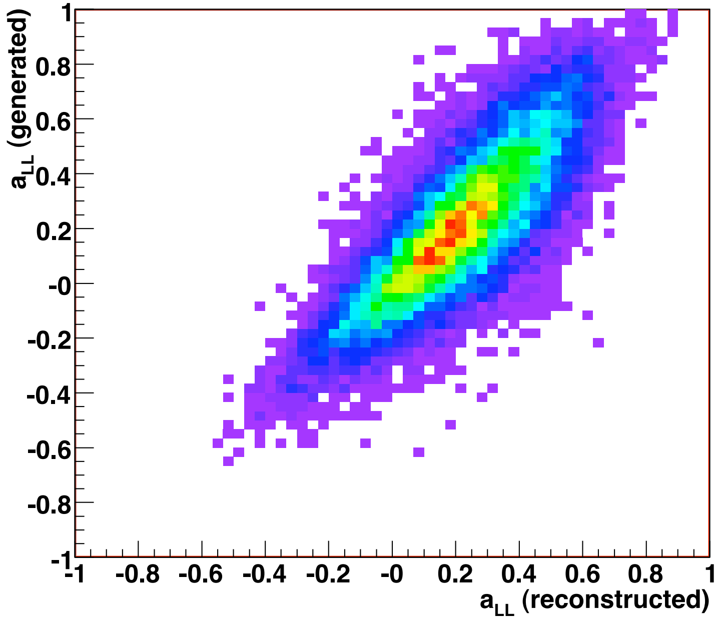
- $D^0 \rightarrow K^-\pi^+ + (\pi^0)$
- $D^{*+} \rightarrow D^0\pi^+_{soft} \rightarrow K^-\pi^+\pi^+_{soft}$
  (with kaons below RICH threshold of 9 GeV)

New!

a_{LL} parameterization with NN

- **a_{LL} is dependent on full knowlege of partonic kinematics:**
  - $$a_{LL} = \frac{\Delta\sigma^{PGF}}{\sigma_{PGF}}(y, Q^2, x_g, z_C, \phi)$$
  - Can't be experimentally obtained! ⇒ 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 kinematical 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

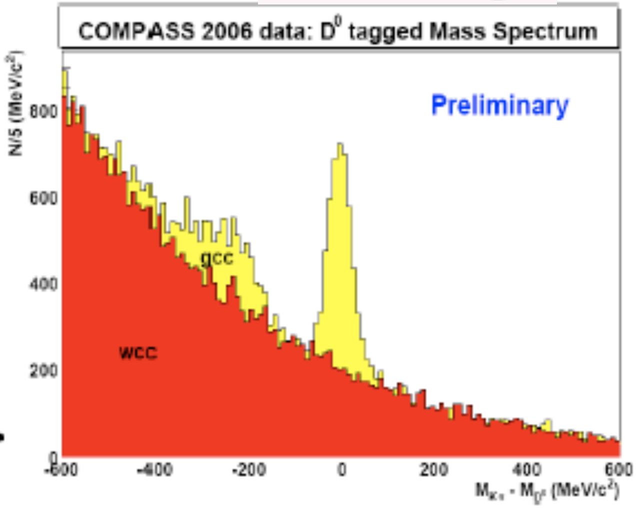


New channels from D^*
NN S/(S+B) parameterization method

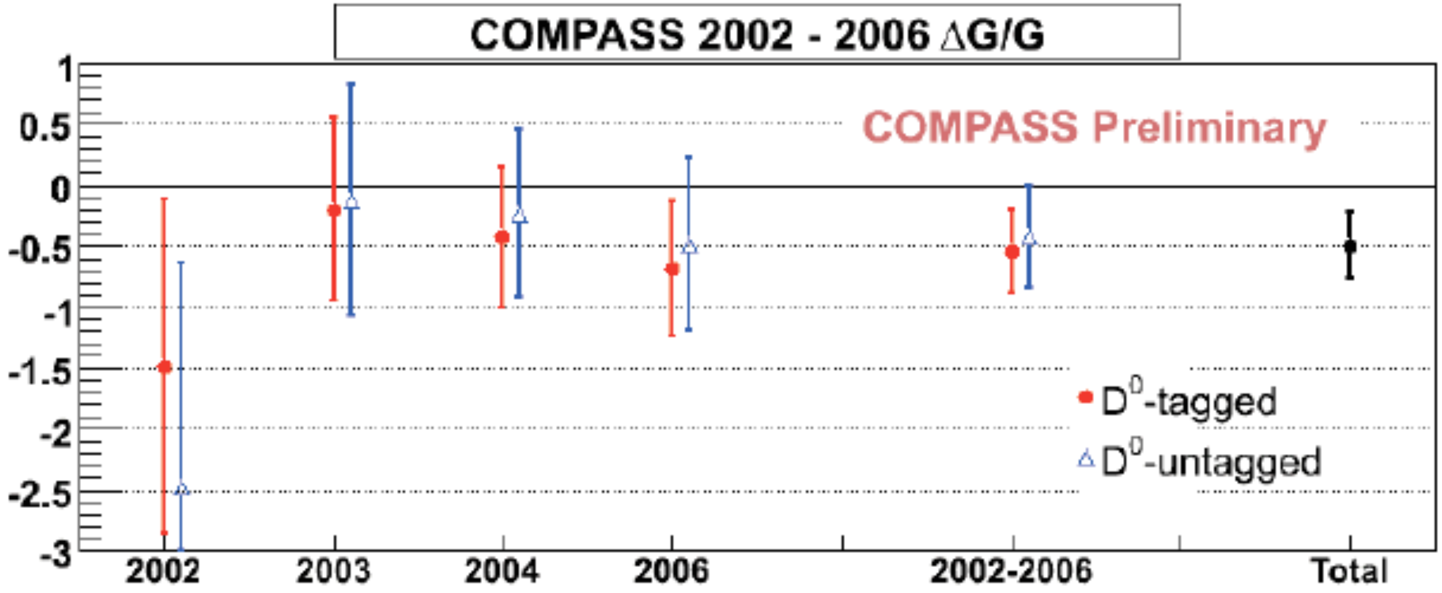
- **Two real data samples** *(with same cuts)* **are compared by the Neural Network** *(giving as input some kinematic variables as a learning vector)*:
  - **Signal model** → **gcc** = $K^+\pi^-\pi_s^- + K^-\pi^+\pi_s^+$ *(D^* spectrum: signal + bg.)*
  - **Background model** → **wcc** = $K^+\pi^+\pi_s^- + K^-\pi^-\pi_s^+$
- **If the background model is good enough:** Net is able to distinguish the signal from the combinatorial background on a event by event basis!
- **Σ is built in the same way as for main channels, BUT:**

$$\Sigma = \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}}$$

  - Only 1variable 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



ΔG/G results



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

Systematics :

Source	D^0	D^*
Beam polar	0.025	0.025
Target polar	0.025	0.025
Dil. Fact.	0.025	0.025
False asymmetry	0.05	0.05
Signal extraction (Σ)	0.07	0.01
a_{LL} (charm mass)	0.05	0.03
TOTAL	**0.11**	**0.07**

$$\langle x_g \rangle = 0.11^{+0.11}_{-0.05}$$

$$\langle \mu^2 \rangle = 13\, GeV^2$$

published:
PLB676(2009)31

ΔG/G results

New preliminary result including all channels

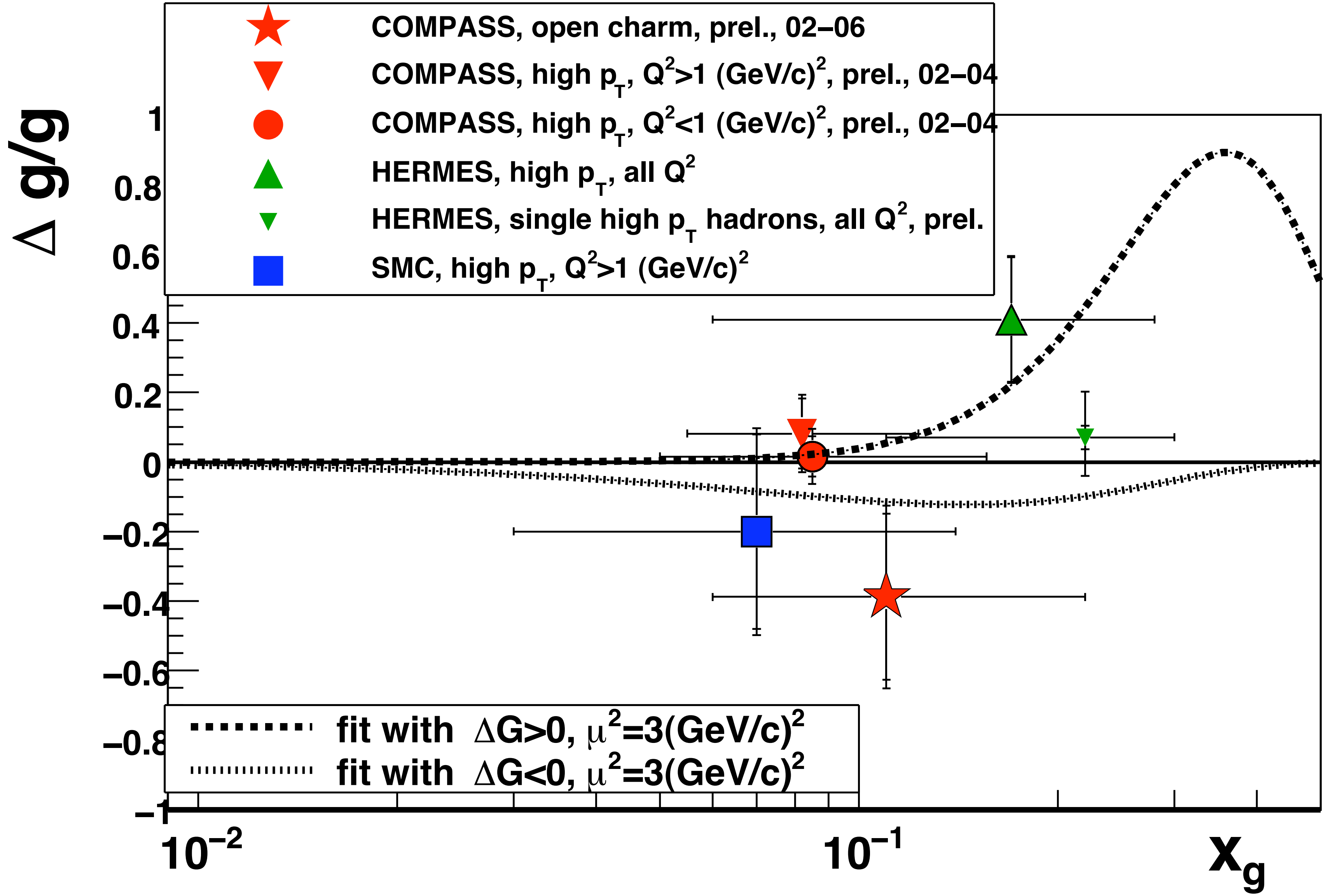
$$\Delta G/G = -0.39 \pm 0.24 \text{ (stat)}$$

published: $\Delta G/G = -0.49 \pm 0.27 \text{ (stat)} \pm 0.11 \text{ (syst)}$

$$\langle x_g \rangle = 0.11^{+0.11}_{-0.05}$$

$$\langle \mu^2 \rangle = 13\, GeV^2$$

10% gain in statistical precision!



Δ g/g
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1
COMPASS, open charm, prel., 02−06
COMPASS, high p_T, Q^2>1 (GeV/c)^2, prel., 02−04
COMPASS, high p_T, Q^2<1 (GeV/c)^2, prel., 02−04
HERMES, high p_T, all Q^2
HERMES, single high p_T hadrons, all Q^2, prel.
SMC, high p_T, Q^2>1 (GeV/c)^2
fit with ΔG>0, μ^2=3(GeV/c)^2
fit with ΔG<0, μ^2=3(GeV/c)^2
10^−2
10^−1
x_g

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 $\Delta G/G$ is preferred - $\Delta G/G$ compatible with 0 within 2σ
- Under study for $\Delta G/G$:
  - pure NN approach (fit independent) and NLO for open-charm
  - 2006 data for high-p_T hadron pairs analysis

Spares

First moment of g_1

Compass only

Phys.Lett.B 647 (2007)8

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

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

from Y. Goto *et al.*, PRD62 (2000) 034017: ($SU(3)_f$ assumed for weak decays)
$a_8 = 0.585 \pm 0.025$

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

QCD NLO

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

C_1 calculated behind 3 loops app.
S.A.Larin *et al.*,Phys.Lett.B404(1997)153

$$a_{0|Q^2\to\infty} = 0.33 \pm 0.03(stat) \pm 0.05(syst)$$

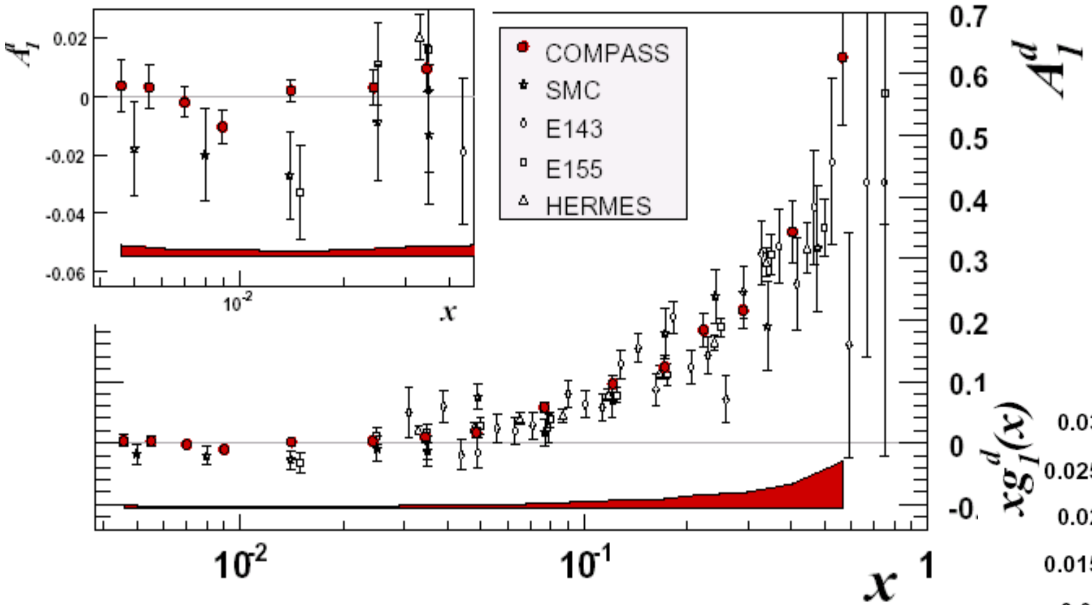
beyond NLO

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

Inclusive DIS asymmetry A_1 and g_1

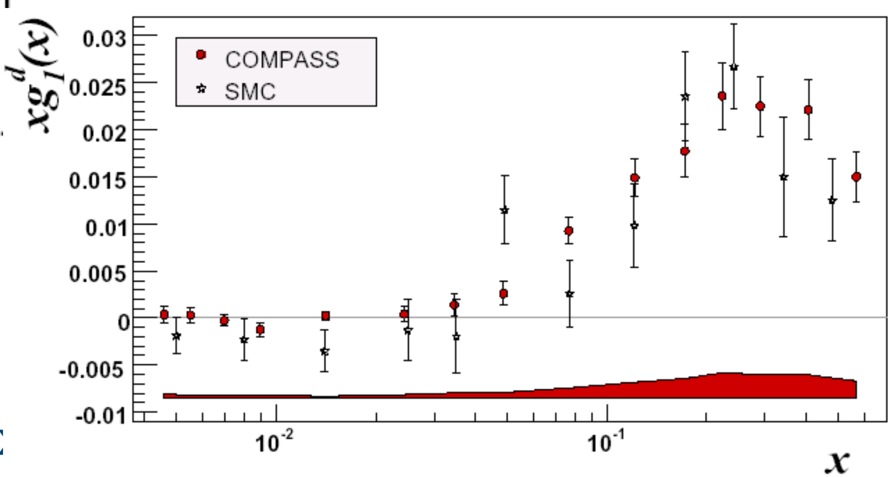
3 years of deuteron data taking 2002-2004 : 89*10^6 events

Phys.Lett.B 647 (2007)8



$Q^2 > 1\ (GeV/c)^2$

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

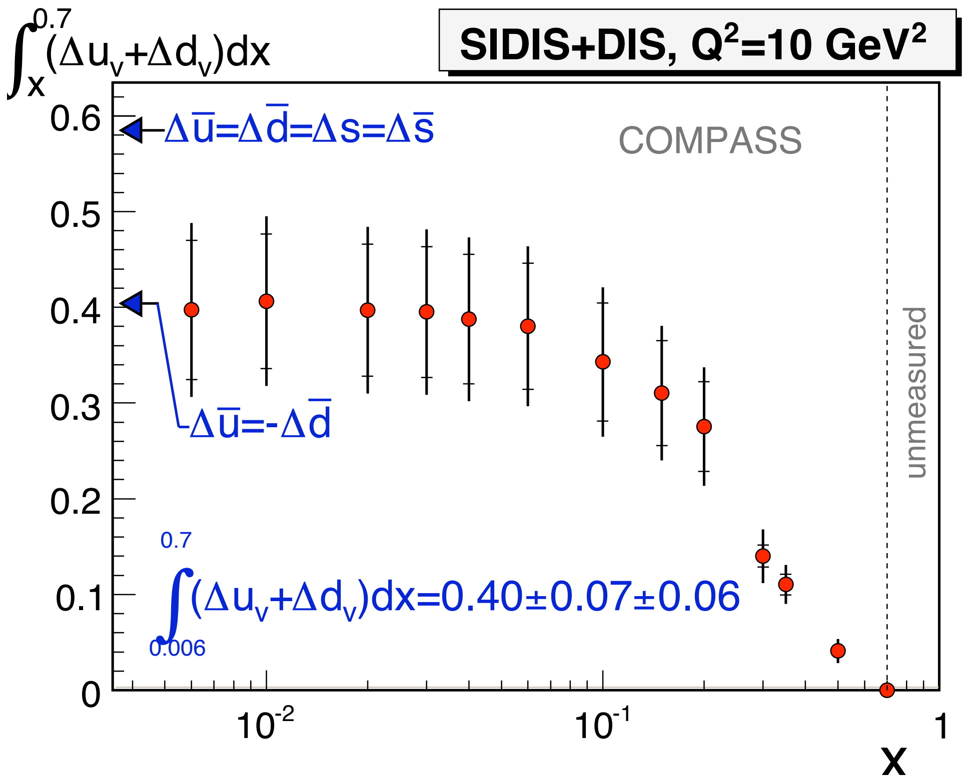


Good agreement between experiments
Compatible with 0 for x<0.05, large for large
Improved significantly statistics at low x (COMPASS)
No tendency towards negative values at x < 0.03

Difference asymmetries

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

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



$\Delta\bar{u} = \Delta\bar{d} = \Delta s = \Delta\bar{s}$ symmetric → scenario

$\Delta\bar{u} = -\Delta\bar{d}$ asymmetric → scenario

MC simulations

- 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 systematics studies

	Final MC
$<a^{LO}>$	0.63
$< a^{C}>$	0.50
$<a^{PGF}>$	-0.36
R_L	0.40
R_C	0.29
R_{PGF}	0.31

	PARJ21	PARJ23	PARJ214	PARJ41	PARJ42
Default	0.36	0.01	2.0	0 .3	0.58
Compass	0.3	0.02	3.5	0.6	0.1

New channels from D^*

- **<u>Because the channel is very clean from background contamination</u>** *(due to a 3-body mass cut)*, **the following contributions can be added:**
  - π^0 reflection "bump": $\mathbf{D^0 \to K\pi\pi^0} \Rightarrow$ Mass window increased to **± 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

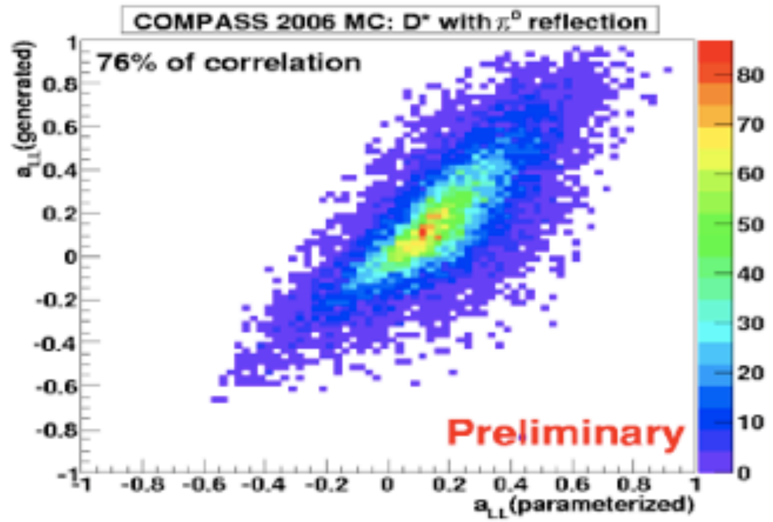
- **Signal strength parameterization** *($\Sigma = S/(S+B)$)*:

$$\Sigma = \frac{\sigma_{PGF}}{\sigma_{PGF} + \sigma_{bgd}}$$

  - **Problem**:
    - <u>Low purity samples with low statistics</u> $\Rightarrow$ Very difficult to build Σ in several bins of several variables
  - **Solution**:
    - Multi-dimentional parameterization using a Neural Network *(all kinematic and RICH dependences taken into account at same time)*

Preliminary results including all channels

- **For all π^0 decays from a D^0** *(" bump")*, **a specific parameterization for the partonic asymmetry** *(a_{LL})* **was used**



- **New channels contributions to ΔG/G:**

ΔG/G: -0.15 ± 0.63 Bg. Asymmetry: 0.02 ± 0.03	→ 2002–2006 data: **π^0 reflection "bump"**
ΔG/G: 0.57 ± 1.02 Bg. Asymmetry: -0.04 ± 0.05	→ 2002–2006 data: **Sub-threshold Kaons**

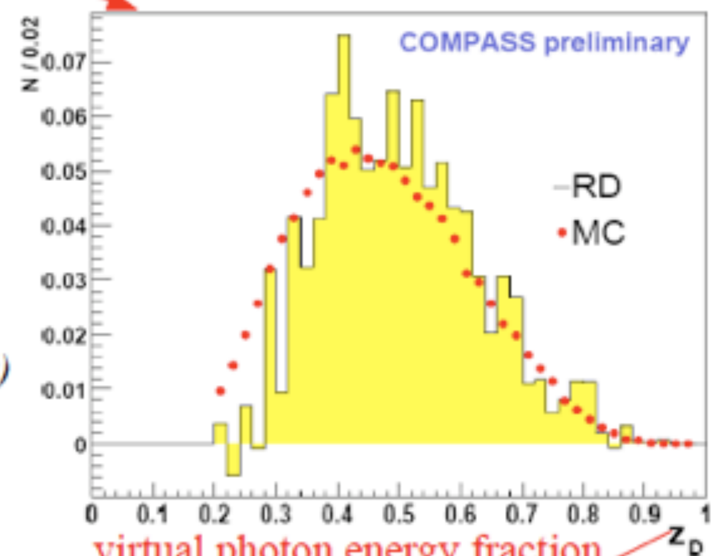
- **Final result** *(no systematic contribution is available yet for the new channels)*:

$$\frac{\Delta G}{G} = -0.39 \pm 0.24\ (stat) \qquad @ \langle x_g \rangle = 0.11,\ \langle \mu^2 \rangle = 13\ \mathrm{GeV}^2$$

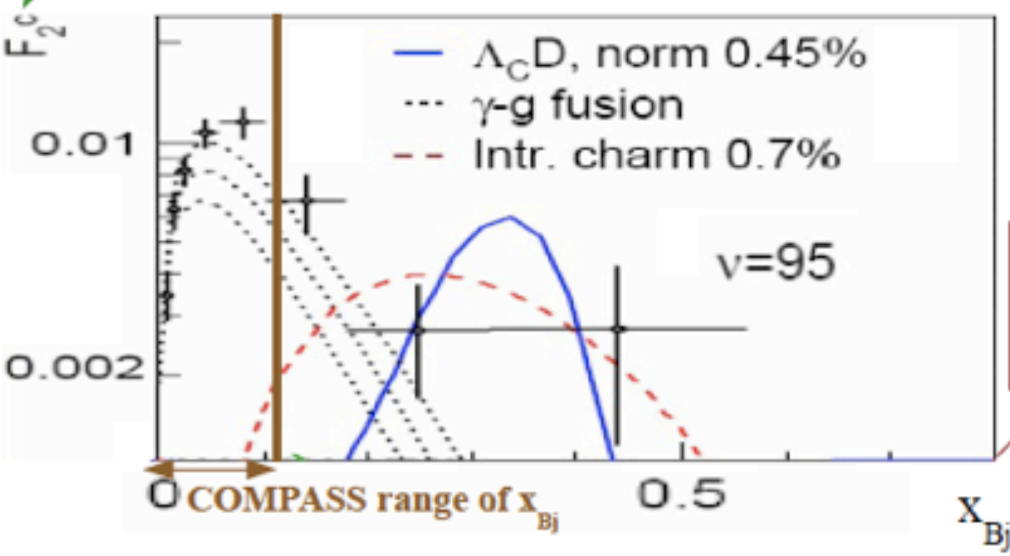
10 % improvement in our statistical significancy

Why measure gluon spin from Open-Charm?

- $c\bar{c}$ production is dominated by the PGF process, and <u>free from physical background</u> *(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)*
  - $c\bar{c}$ supressed during fragmentation *(at our energies)*



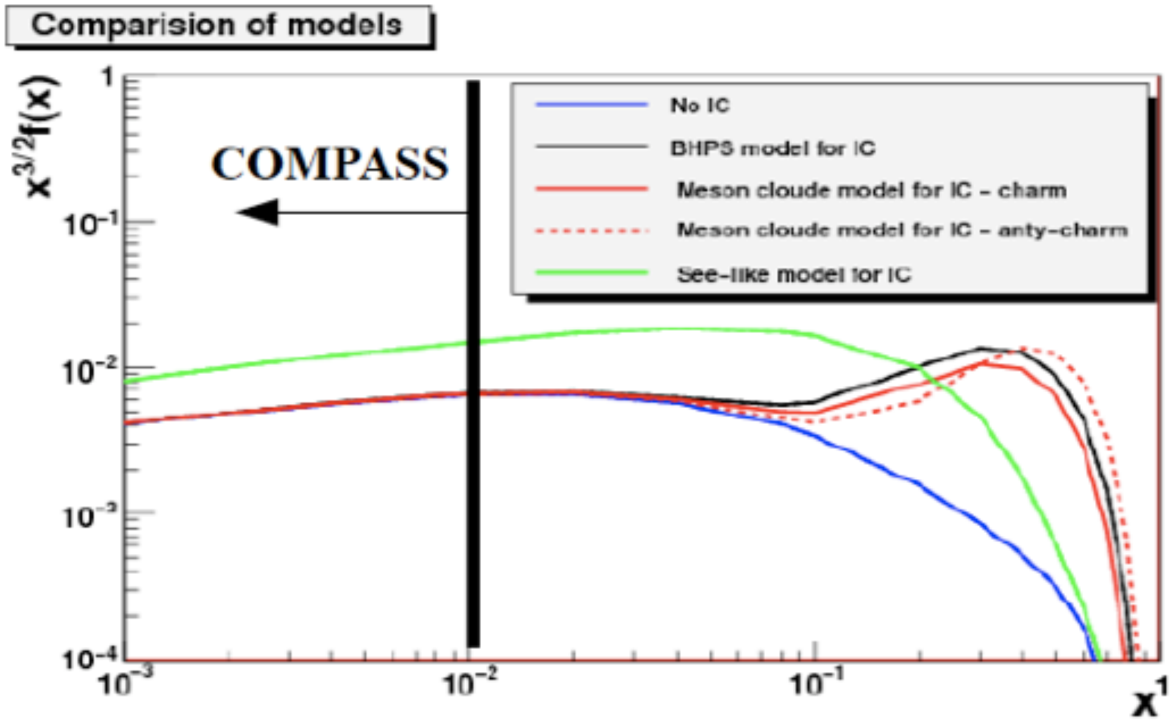
virtual photon energy fraction carried by D^0 meson



Ref. Hep-ph/0508126 and hep-ph/9508403
Phys. Lett. B93 (1980) 451
Data from EMC:Nucl.Phys.B213, 31(1983)

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)***



Validation of parameterization *(2006 example)*