Summary
Working Group F
Spin Physics

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(with Ed Kinney and Bo-Qiang Ma)

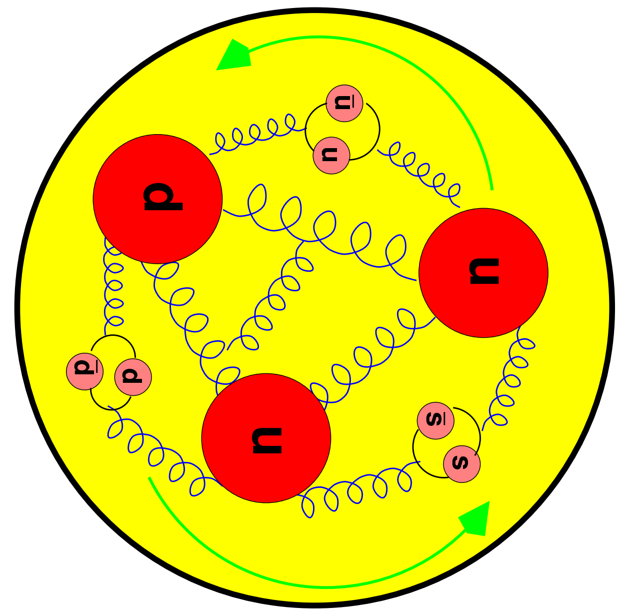
Sessions

- Inclusive Asymmetries (4 talks)
- PDFs, global fits (joint session with WG A) (4 talks, WG A)
- PDFs and inclusive measurements (4 talks)
- Gluon Polarisation (6 talks)
- Single Spin Asymmetries and Transversity (8 talks)
- Vector meson production and DVCS (joint session with WG B) (2(9) talks)
- Exclusive reactions and GPDF (4 talks)
- Future plans (1 talk)

Main topic: Nucleon (spin) structure

- **Distribution functions**

unpolarised	q,g	F_2, R, form factors
long. pol.	Δq, Δg	g_1, g_2
transv. pol.	δq	h_1, Sivers DF



- **Generalised distribution functions**

unpolarised	$H^{q,g}$, $E^{q,g}$
polarised	$\tilde{H}^{g,q}$, $\tilde{E}^{g,q}$

- **Fragmentation functions**

D_1
Collins FF
Two Hadron FF H_1, D_1

Experiments

- **Fixed Target**

HERMES	27 GeV pol. e^+, e^-	pol. H,D (L/T)	DIS
COMPASS	160 GeV pol. μ^+	pol. LiD (L/T)	DIS, quasi-real Photons
JLAB Hall A	6 GeV pol. e^-	pol. ^{3}He	DIS (high x)
Hall B CLAS	6 GeV pol. e^-	pol. H,D	Resonance region
Hall C RSS	6 GeV pol. e^-	pol. H,D	Resonance region
SAMPLE Bates	200 MeV pol. e^-	unpol. H,D	Elastic
MAMI A4	855 MeV pol. e^-	unpol. H,D	Elastic
JLAB G0	6 GeV pol. e^-	unpol. H,D	Elastic
Jlab HAPPEX	6 GeV pol. e^-	unpol. H,D	Elastic

- **Collider**

STAR	200 GeV pol. p	Jetproduction, direct Photons...
PHENIX	200 GeV pol. p	Jetproduction, direct Photons...
BELLE	8 GeV e^-, 3.5 GeV e^+	Fragmentation..

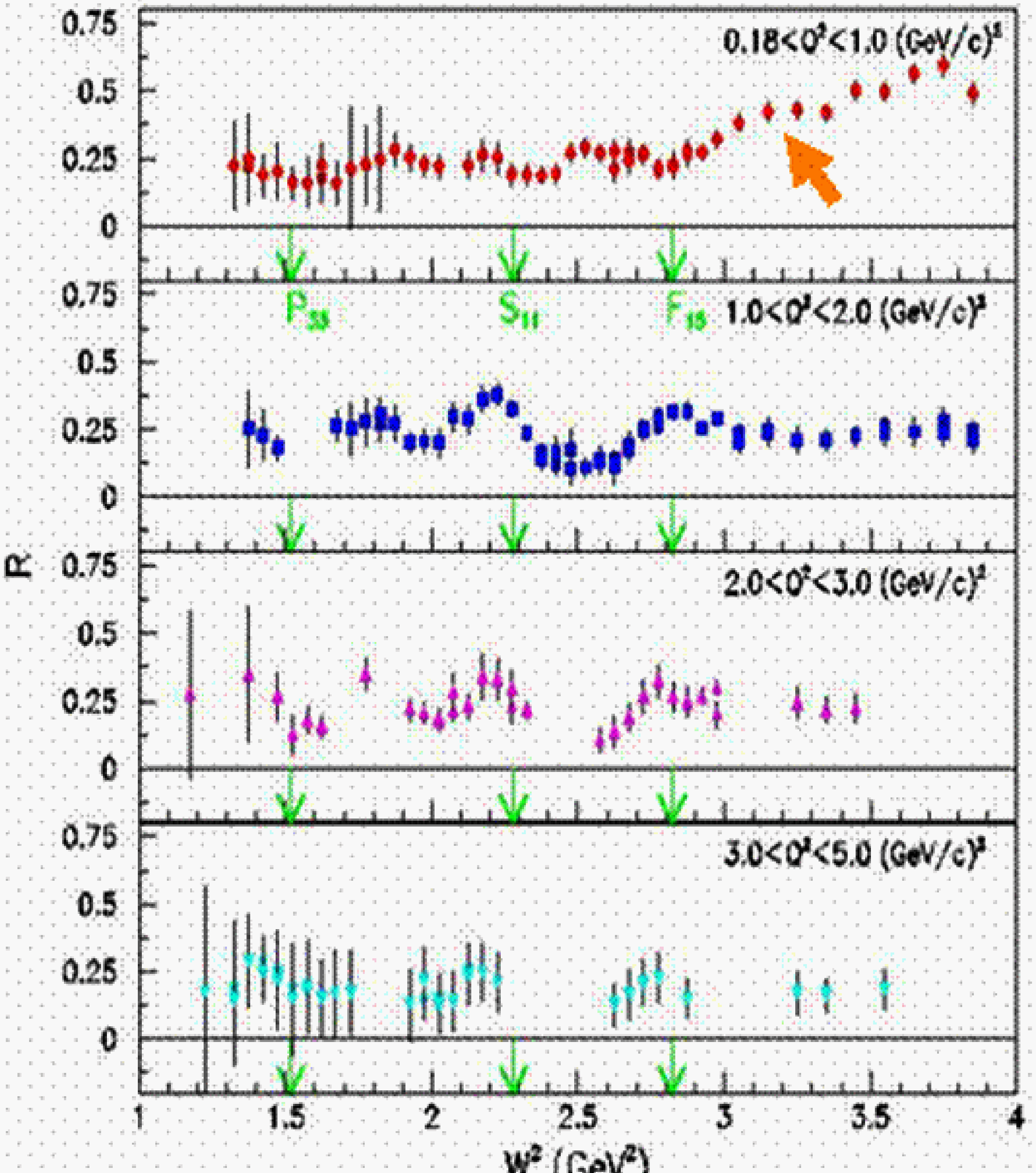
Inclusive Asymmetries and PDFs

- Spin results from JLAB Hall B and C (Khandaker)
- New High-Precision Neutron (^{3}He) Spin Structure Results from Jefferson Lab (Kramer)
- Inclusive and semi-inclusive asymmetries (Leberig)
- Parity violating electron scattering (Maas)
- AAC analysis of polarised parton distributions with uncertainties (Kumano)
- The role of higher twists in determining polarised parton densities (Sidorov)
- Proton Spin structure and intrinsic motion of constituent (Zavada)
- Measurements of R and the Longitudinal and Transverse Structure Functions in the Nucleon Resonance Region and Quark-Hadron Duality (Ent)

Inclusive measurements at JLAB

- E-94-110
  - precise unpolarised measurement (%) in resonance region
  - L/T separation with 2 methods: precise determination of R at low Q^2
  - test of quark-hadron duality
- E-01-006 (RSS)
  - A_1, A_2 for p and d at $Q^2 \approx 1.3$ GeV^2 for $0.8 \leq W \leq 2$ GeV
  - prelim. results for exp. asymmetries
  - W dep., onset of duality, twist-3 effects, extended GHD
- E-99-117
  - precise A_1^n at high x (0.3 – 0.6) at $Q^2 \approx 4$ GeV^2
- E-03-109 (SANE)
  - approved Hall C exp., new electron detector
  - A_1, g_2 for p at and $0.3 \leq x \leq 0.8$ and $2.5 \leq Q^2 \leq 6.5$ GeV^2
  - x, Q^2 dependence, moments, duality
- CLAS EG1
  - high statistics g_1 for p and d in resonance region, large range in Q^2 and W
  - $\Gamma_1(Q^2)$ at low Q^2
  - polarised duality
- E-97-103
  - high statistics g_2^n at $x = 0.2$ for low Q^2
  - search for higher twists

E94-110 Rosenbluth Extractions of R



- Clear resonant behaviour is observed in R for the first time!

→ Resonance longitudinal component NON-ZERO.

→ Transition form factor extractions should be revisited.

- Longitudinal peak in second resonance region at lower mass than S_{11}(1535 MeV)

→ D_{13}(1520 MeV) ? P_{11}(1440 MeV)?

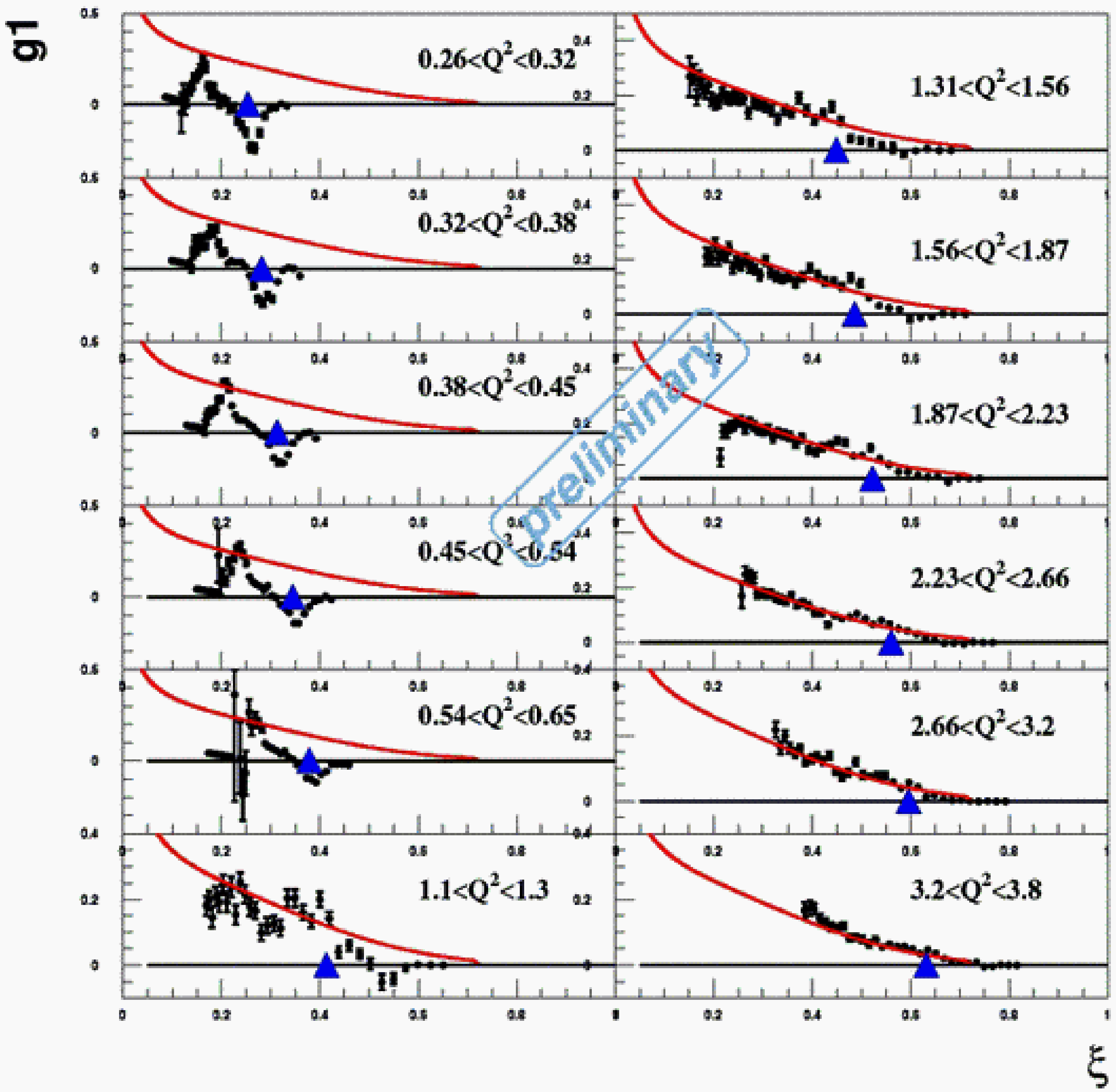
- R is large at low Q high W (low x)

→ Was expected R → 0 as Q^2 → 0

→ R → 0 also not seen in recent SLAC DIS analysis (R1998)

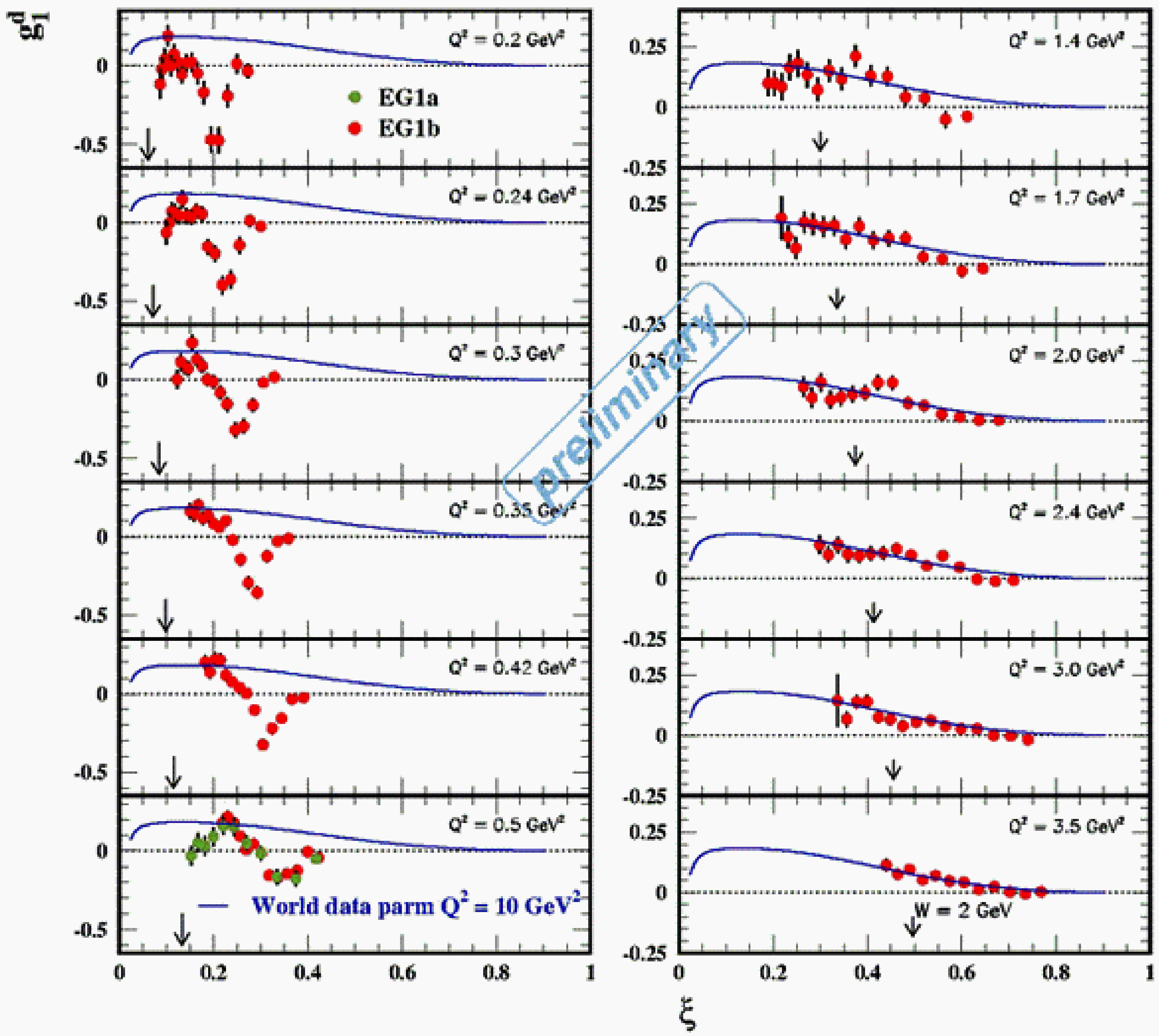
$g_1(\xi)$ Duality for the Proton

$g_1^p(\xi)$ for E=1.6 and E=5.6 GeV



$g_1(\xi)$ Duality for the Deuteron

$g_1^d(\xi)$ for E=1.6 and E=5.6 GeV

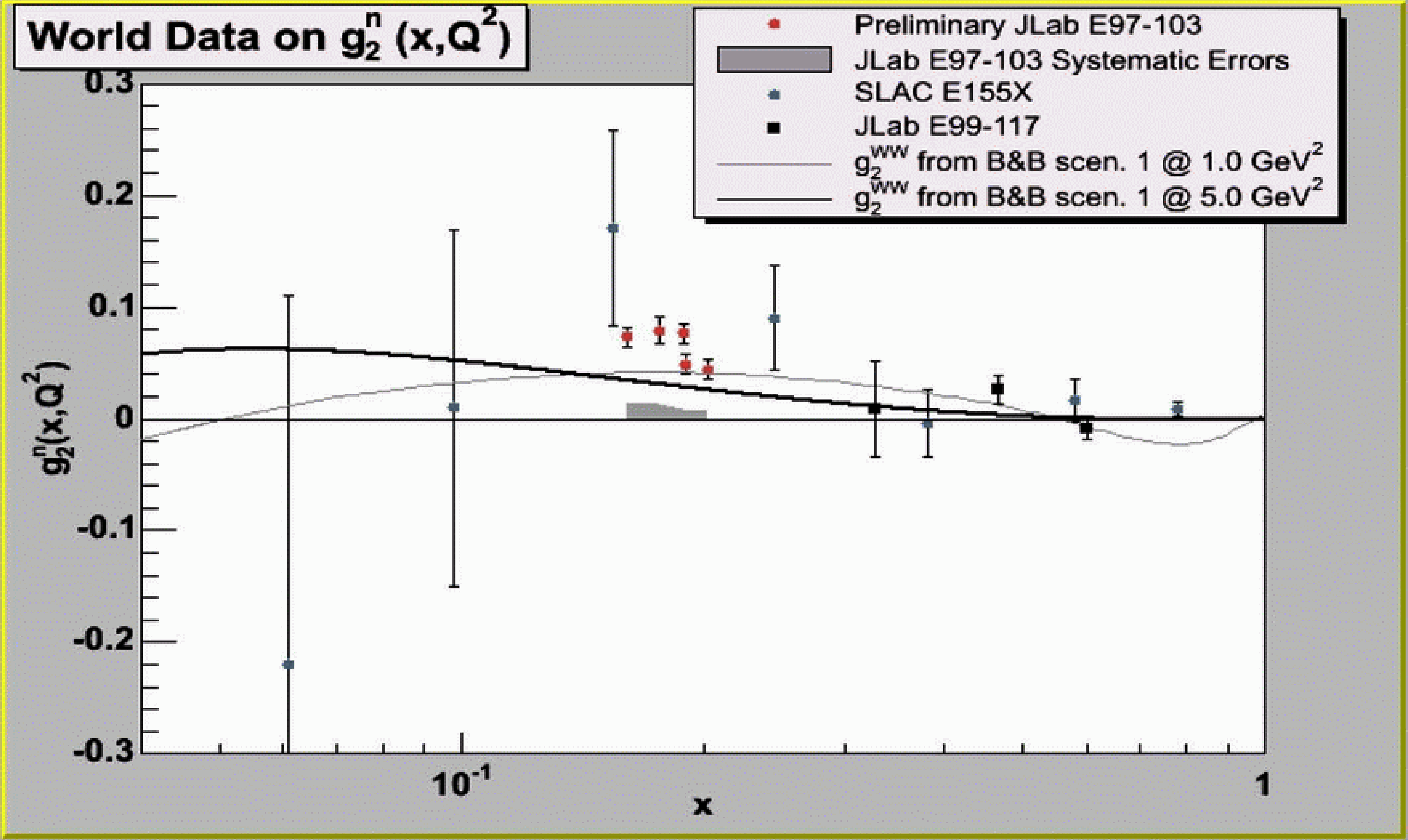


- *Nachtmann* variable, $\xi = \frac{2x}{1+\sqrt{1+4M^2x^2/Q^2}}$ ($\sim 0.2 < Q^2 < 3.5$ GeV^2)
- Curves are global fit to world data at $Q^2 = 10$ GeV^2
- Δ causes g_1 to deviate strongly from DIS scaling curves

- *Duality* seems to be *valid* for *proton* and *deuteron* g_1 for as low as $Q^2 \sim 1.4$ GeV^2 (excluding Δ region)

Kevin M. Kramer
Duke University

g_2^n versus x



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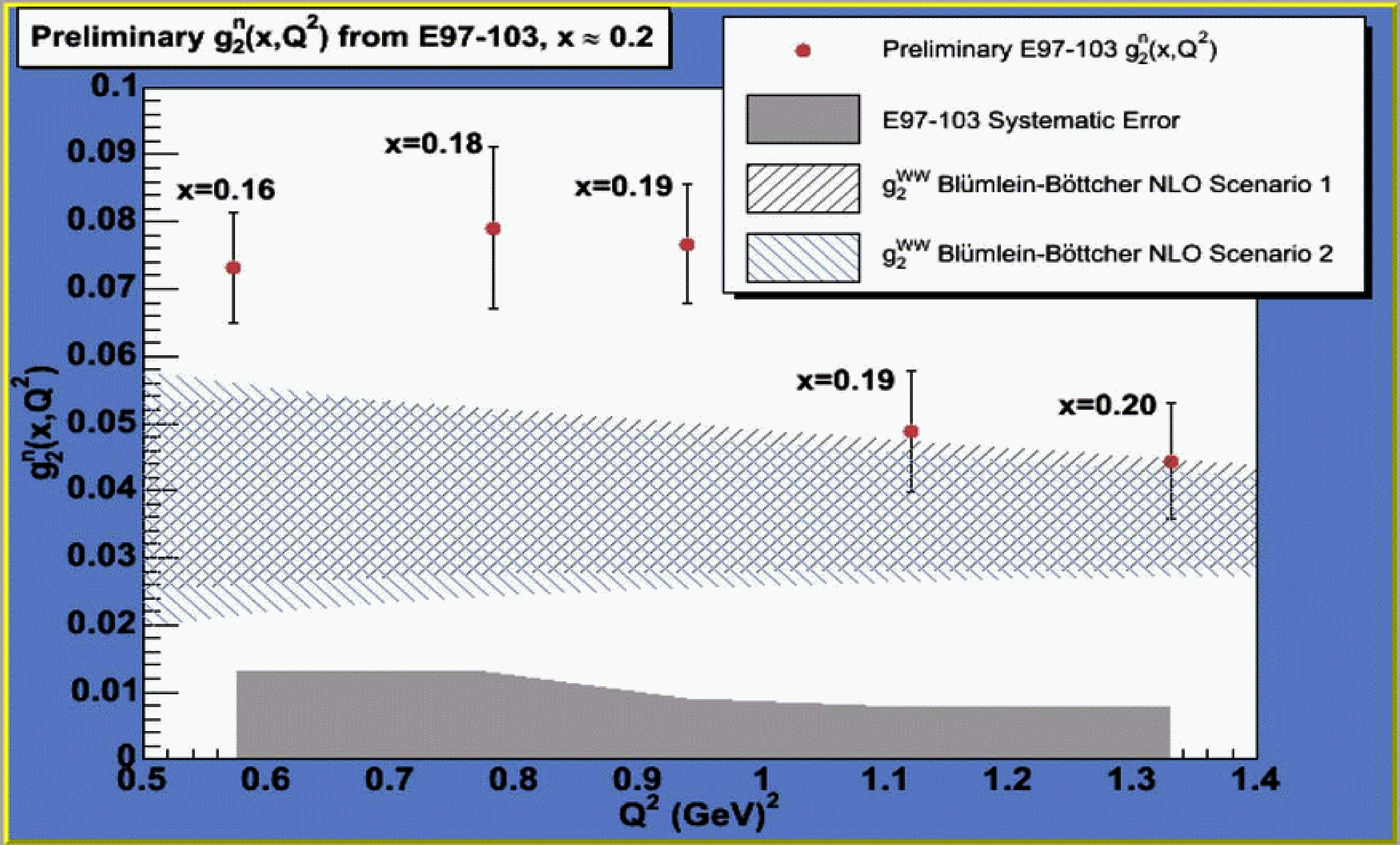
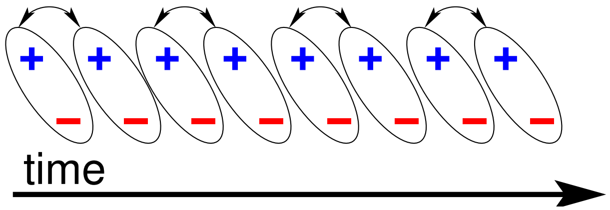
Duke University

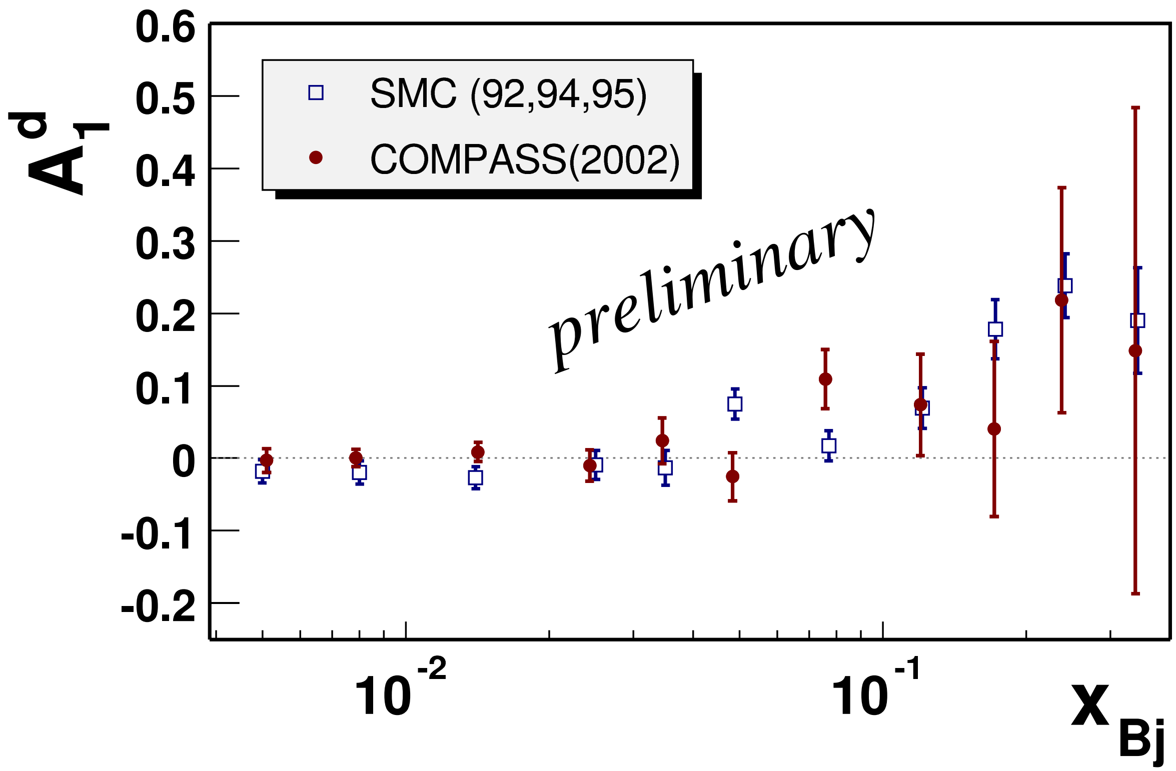
g_2^n vs. Q^2



Inclusive Result A_1

- **Combine Configurations:**





- 1st year data taking

  $\approx$ 3 years of SMC for $x < 0.04$

  – 5 times higher beam rate
  – 2 times higher f
- large uncertainty for $x > 0.04$

  $\Rightarrow$ trigger upgrade for 2003
  $\Rightarrow$ large Q^2
- 2003 + 2004 data $\Rightarrow$ four time the statistics

Parity violating electron scattering

- measurement of strange contribution to nucleon vector form factor
- only possible if $s(x) \neq \bar{s}(x)$
- needed: electromagnetic proton and neutron FF plus asymmetry from electro-weak interference
- $A_0(\mathrm{nostrangecontribution}) \sim 10^{-6}$ for $Q^2 \sim 0.3$ GeV^2
- requirements
  - high luminosity
  - polarised electron beam, unpolarised target
  - inelastic background suppression
- experiments use either low energy, magnetic spectrometer, high resolution electromagnetic calorimeter
- false asymmetries: control of all beam parameter needed
- results from MAMI A4 and HAPPEX show deviations from A_0
- indication that $s(x) \neq \bar{s}(x)$

Analysis of polarised PDF

- new AAC analysis including SLAC E155 data
  - analysis also with $\Delta g = 0$
  - investigation of error correlation between Δg and $\Delta \bar{q}$
  - improved sea determination, Δg not constrained

- analysis with higher twists
  - $(g_1/F_1)_{\rm exp}$ with $F_2(\rm NMC)$ and $R(\rm SLAC)$
  - additive HT for g_1 used
  - dependence on factorisation scheme studied
  - moments of HT studied
  - sea determined quite well, Δg unconstrained

- analysis in terms of a valence quark model
  - quarks as quasifree fermions with mass, intrinsic quark motion with spherical symmetry and J=1/2 constraint
  - relates unpol. valence distribution to g_1 and g_2
  - sum rules, predictions for transversity

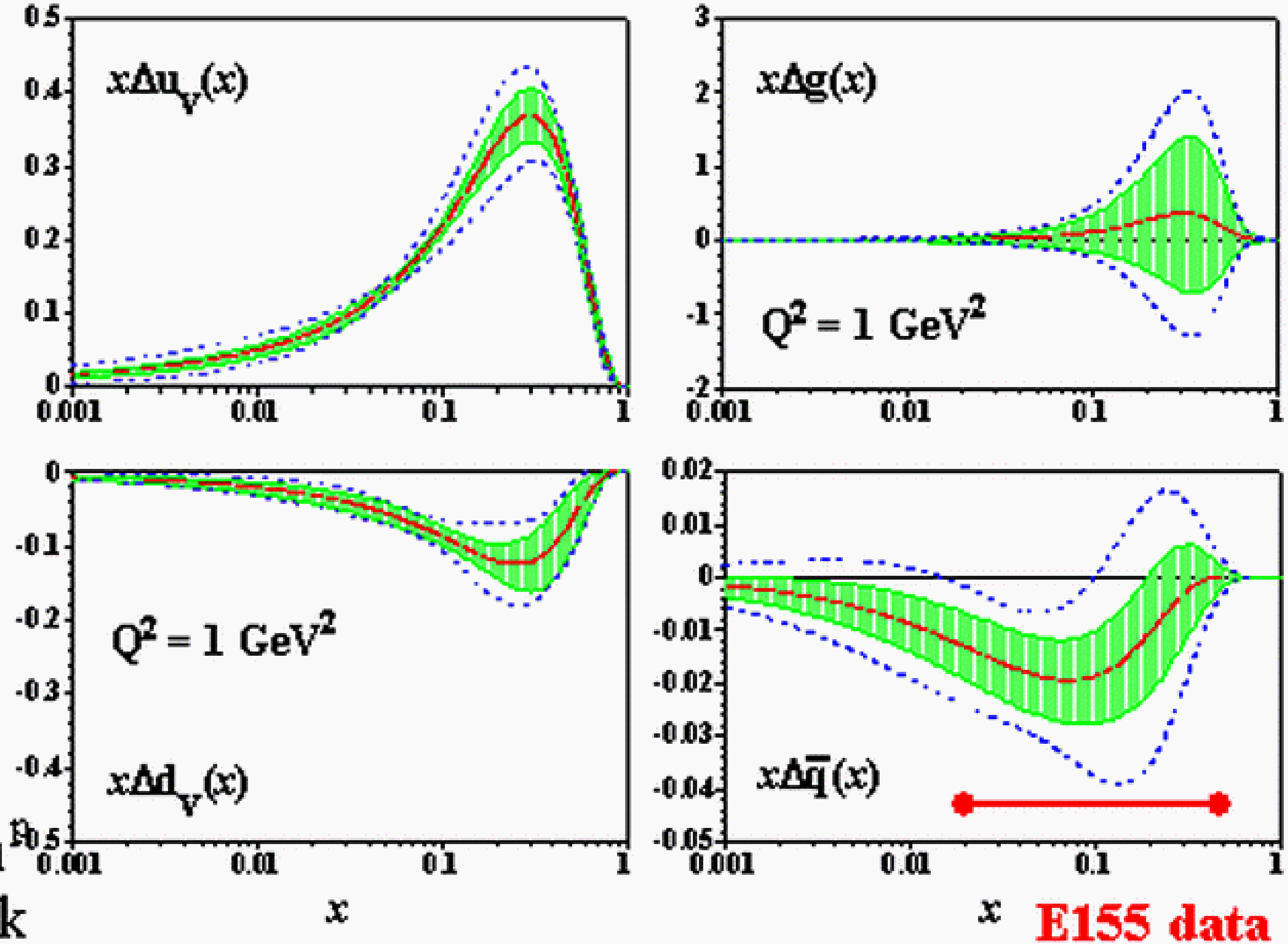
Polarized PDFs (AAC03)

- PDF uncertainties reduced by including precise (E155-p) data
- Valence-quark distributions are well determined
  - Small uncertainty of Δu_v, Δd_v
- Antiquark uncertainty is significantly reduced
  - $g_1^p \propto 4\Delta u_v + \Delta d_v + 12\Delta\bar{q}$
- $\Delta g(x)$ is not determined
  - Large uncertainty
  - Indirect contribution to g_1^p
  - Correlation with antiquark

AAC03 uncertainties

AAC00 uncertainties

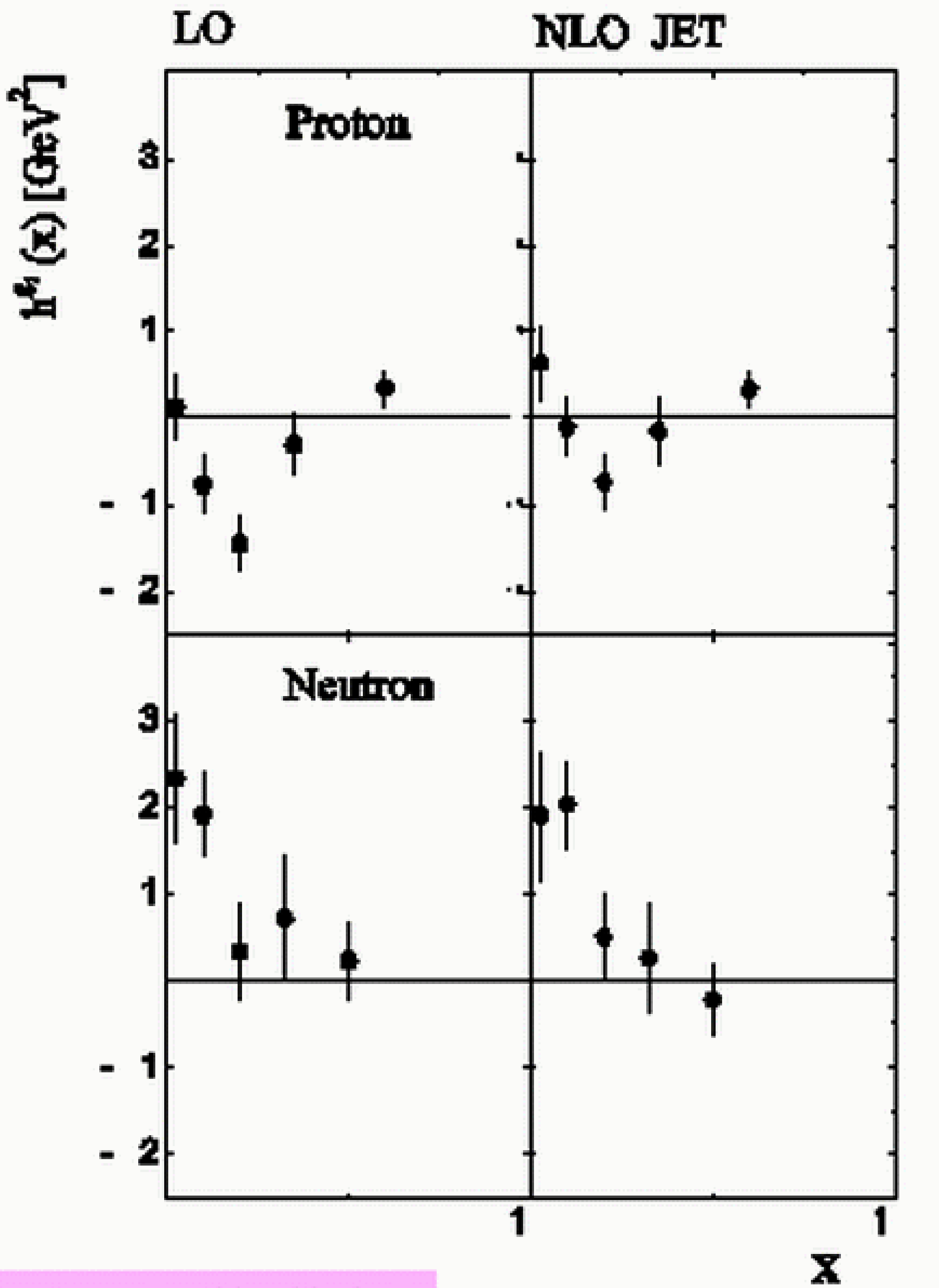
AAC00 ↔ AAC03 (with E155-p)



Higher twist effects

Dependence of χ^2 on HT corrections

Fit	LO HT=0	NLO HT=0	LO+HT	NLO+HT
χ^2	244.5	218.8	150.7	145.0
DF	185-6	185-6	185-16	185-16
χ^2 / DF	1.36	1.22	0.892	0.858

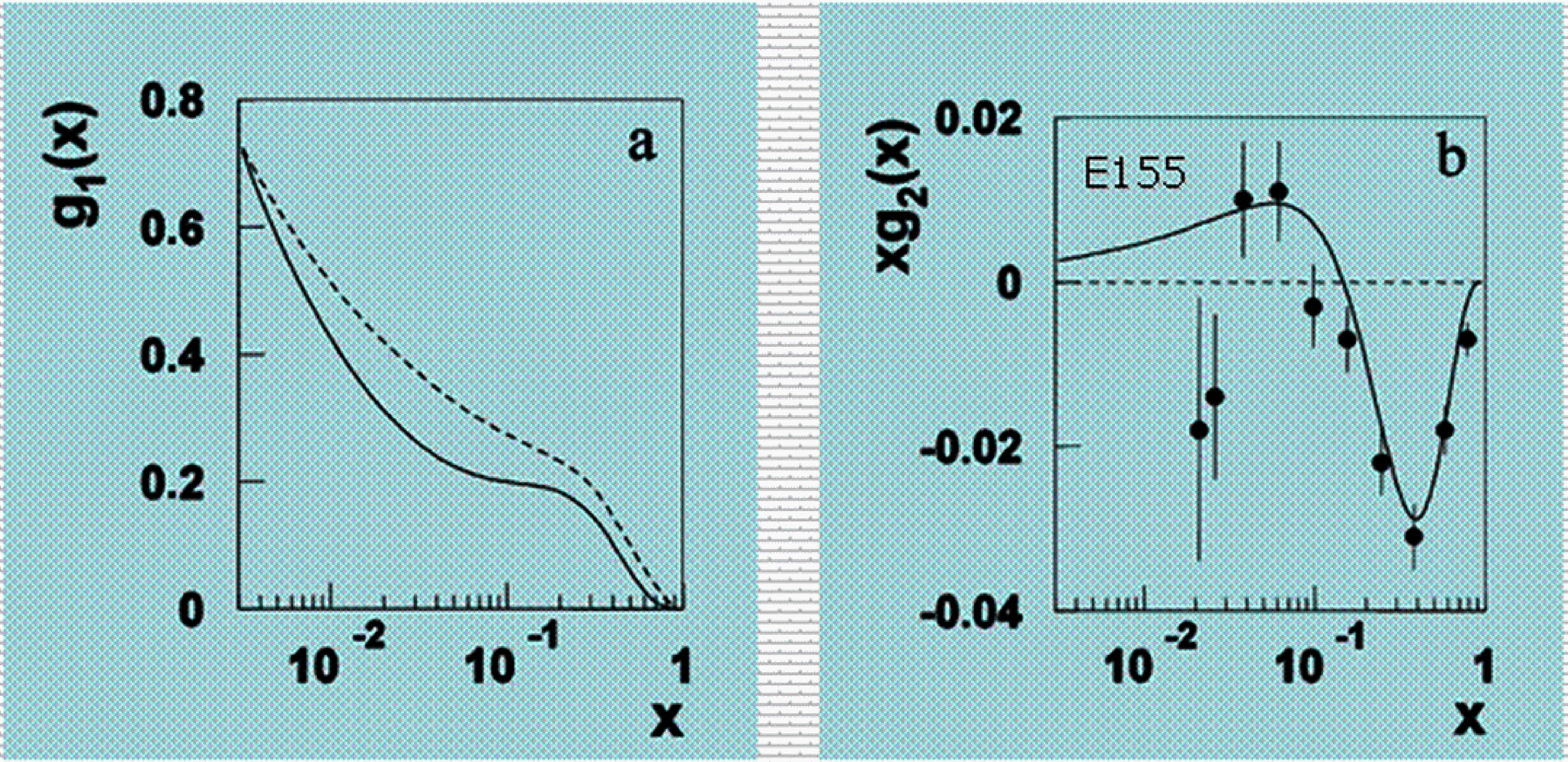


The size of HT corrections to g_1 is NOT negligible

The shape of HT depends on the target

$$g_1(x,Q^2) = g_1(x,Q^2)_{LT} + h^N(x)/Q^2$$

Valence quarks



Calculation - solid line, data - dashed line (left) and circles (right)

Gluon Polarisation

- SMC high p_{T} analysis (Kowalik)
- Gluon polarisation measurement at COMPASS (Heinsius)
- Longitudinal Gluon Polarization in RHIC Double-Spin Asymmetries (Kretzer)
- Longitudinal Double Spin Asymmetries in Neutral Pion Production at PHENIX (Bauer)
- A_{LL} for jets at mid-y (Trentalange)
- Effect of $\Delta g(x)$ on the π^0 spin asymmetry at RHIC (Sudoh)

Methods(1)

DIS: Photon-Gluon-Fusion

- High p_{T} hadron pairs

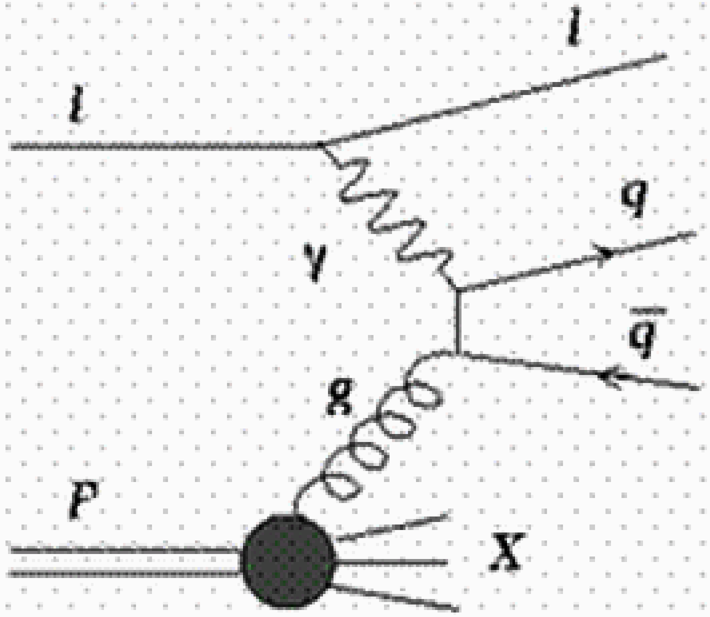
SMC p,d (93 –96) $Q^2 > 1$ GeV^2 $\quad A_p^{\mathrm{lN}\to\mathrm{lhhX}} = 0.030 \pm 0.057(stat) \pm 0.010(syst)$

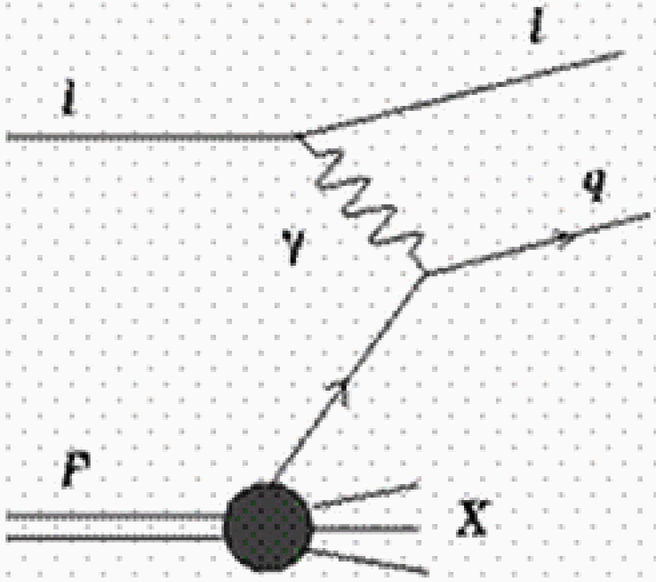
$A_d^{\mathrm{lN}\to\mathrm{lhhX}} = 0.070 \pm 0.077(stat) \pm 0.010(syst)$

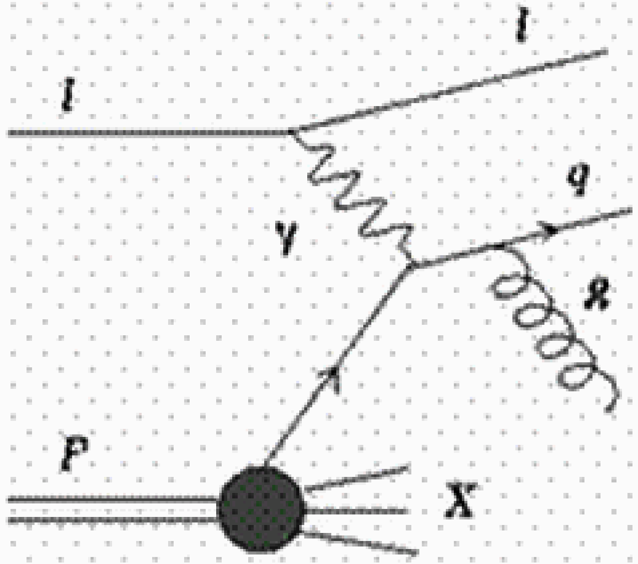
COMPASS d (2002) all Q^2 $\quad A_d^{\gamma\mathrm{N}\to\mathrm{lhhX}} = -0.065 \pm 0.036(stat) \pm 0.010(false)$

- Open charm production
  - $\mathrm{D}^* \to \mathrm{D}^0\pi$, $\mathrm{D}^0 \to \mathrm{K}\pi$
  - COMPASS d (2002) all Q^2
  - prospects for 2002 – 2004: $\delta(\Delta G/G) \approx 0.24$

PGF with high-p_T hadrons







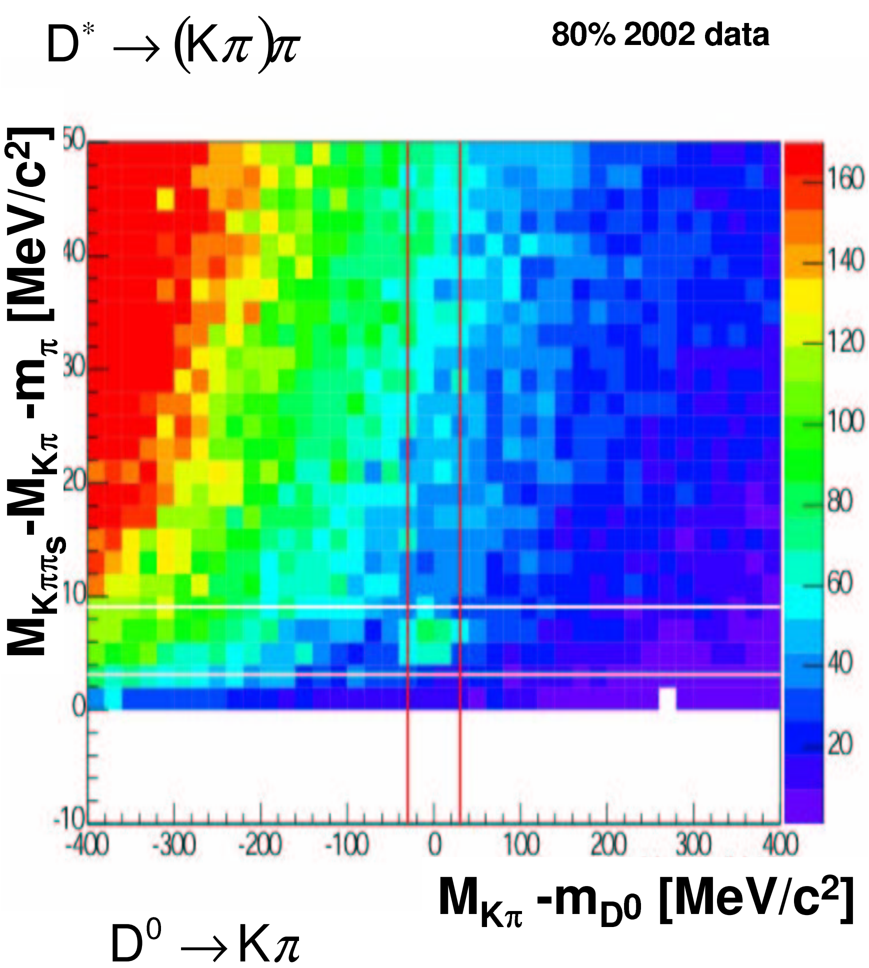
Photon Gluon Fusion (PGF) $\propto \frac{\Delta G}{G}$

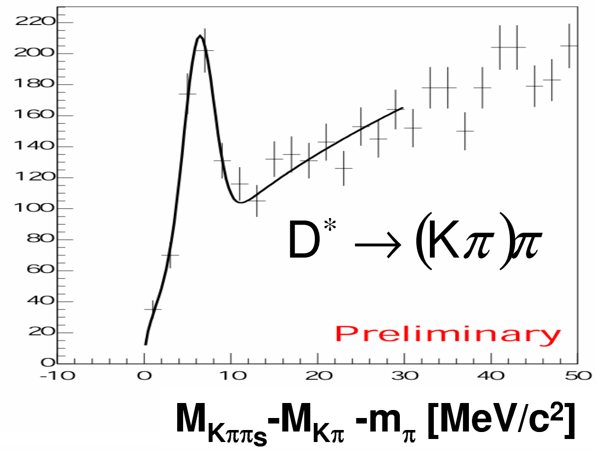
Leading Process (LP)

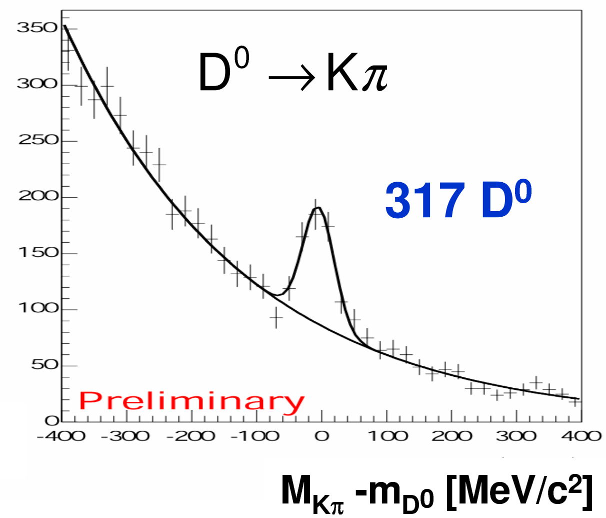
QCD Compton (QCD-C)

Pairs of high-p_T hadrons more likely in QCD-C and PGF

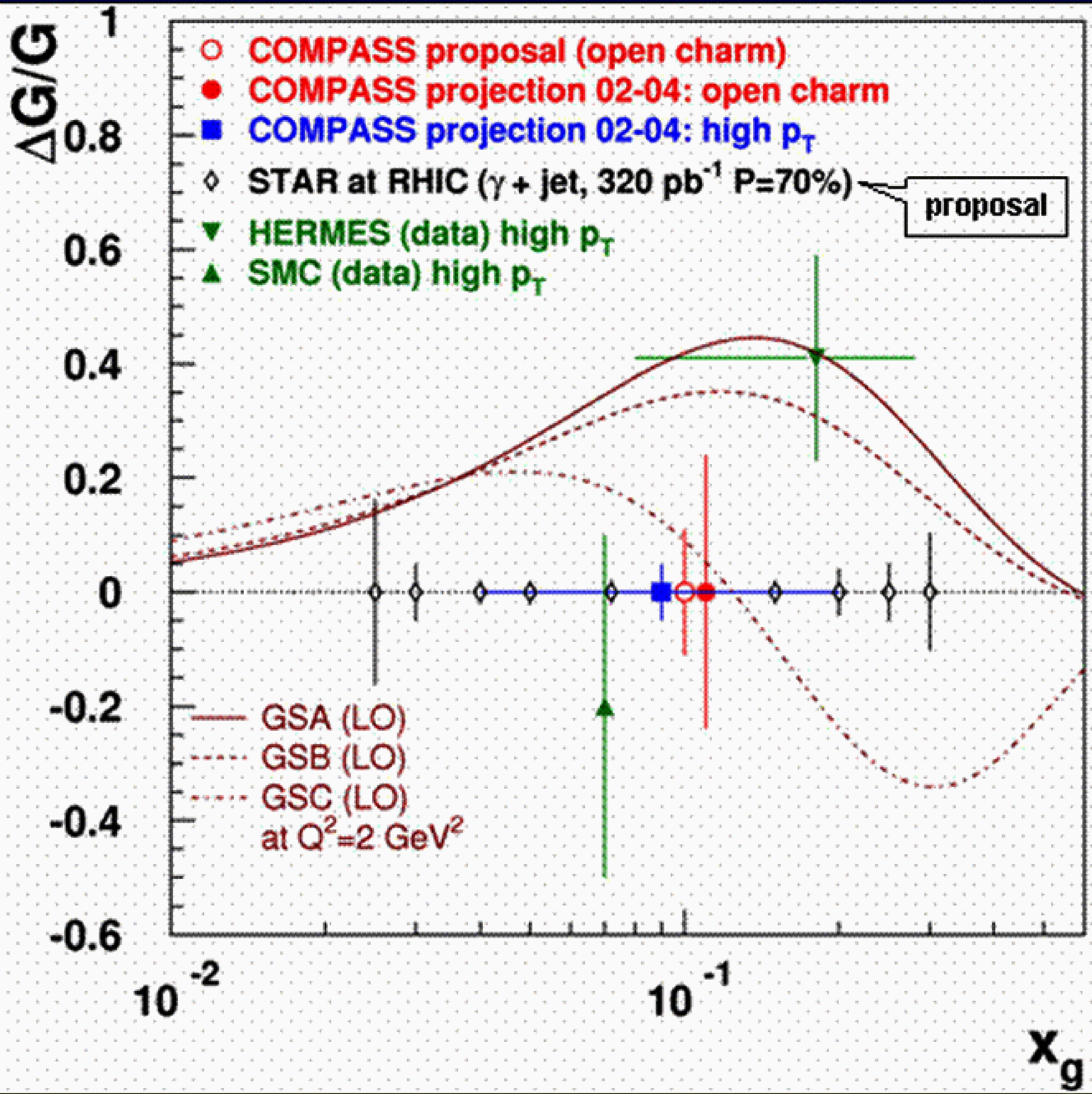
D* tagging : $D^* \rightarrow D^0 \pi$, $D^0 \rightarrow K \pi$







Expected error on ΔG/G



COMPASS Summary

First glance at open charm PGF with polarised target and beam

Good perspectives for ΔG from high-p_T hadron pairs

More COMPASS physics

- Inclusive and semi-inclusive asymmetries *M. Leberig*
- Transverse asymmetry A_{UT} for charged pions *H. Fischer*

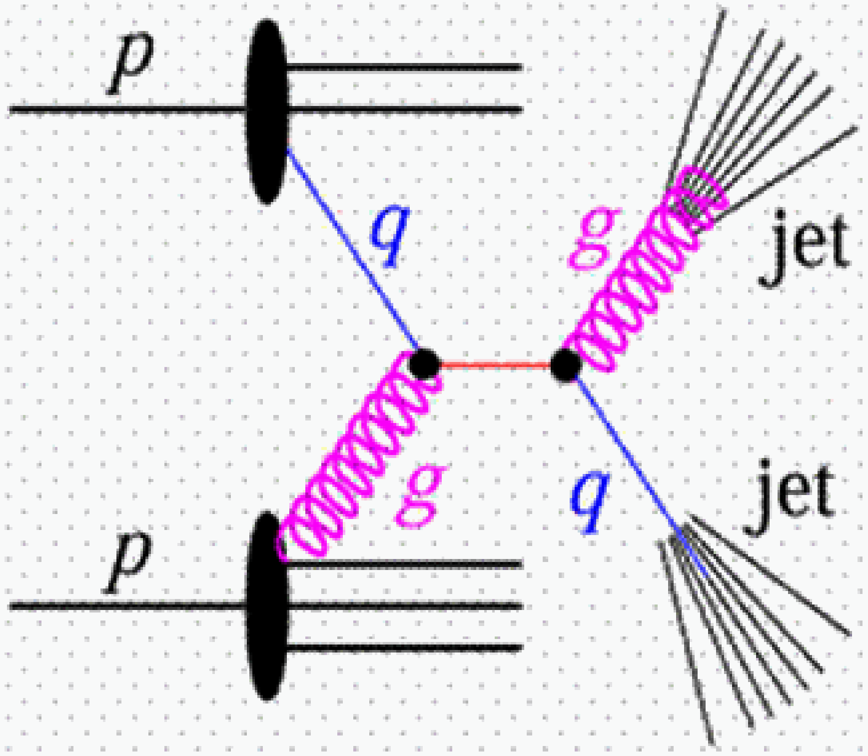
Methods(2)

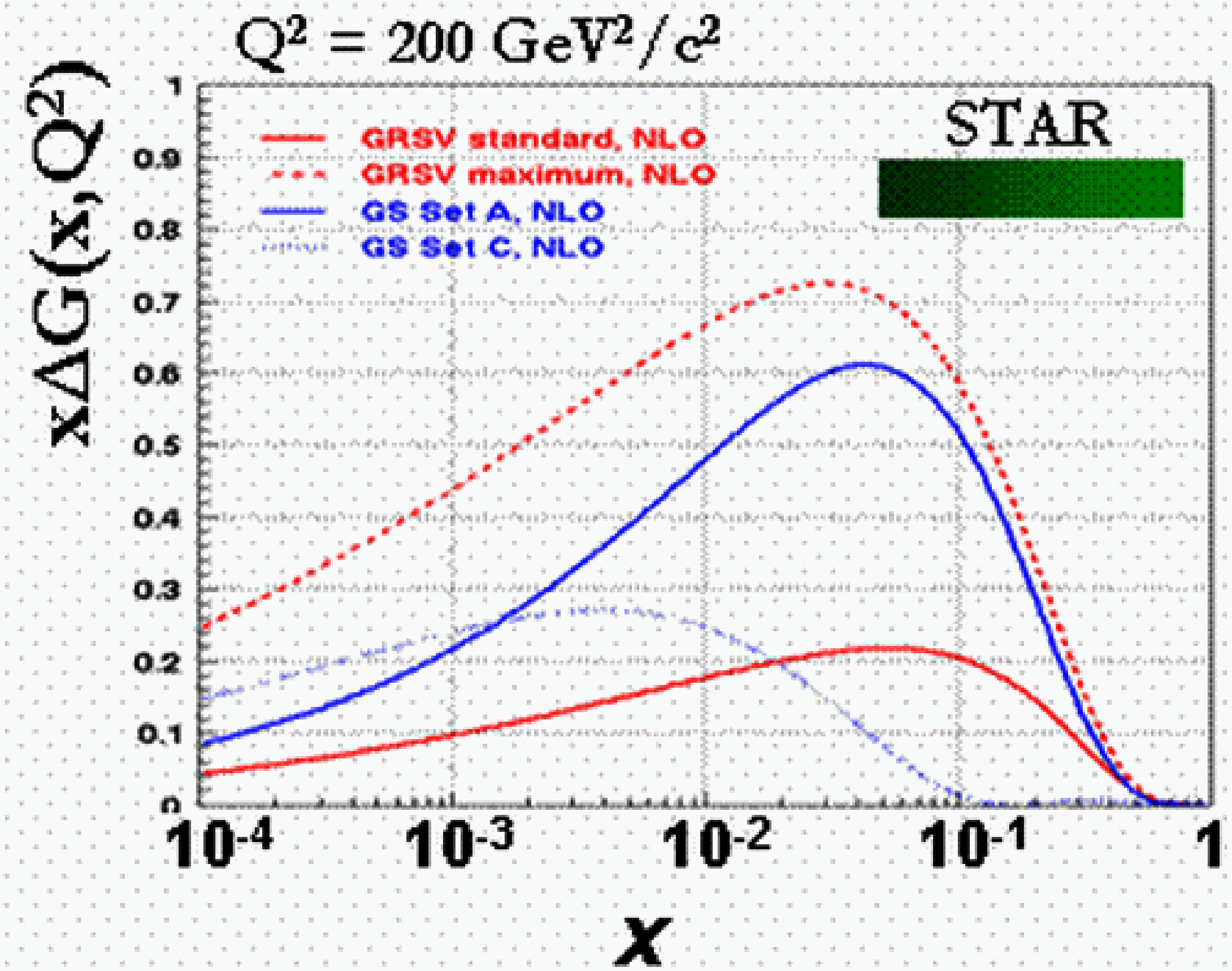
Quark-gluon scattering at pp collider

- RHIC
  - longitudinal polarisation in 2003 about 30%
  - luminosity 0.2 pb^{-1}
- STAR
  - jets at mid rapidity
  - analysis in progress
  - expected statistical precision for A_{LL}: ~ 0.030
- PHENIX
  - π^0 production
  - π^0 cross section well described by NLO pQCD
  - observed asymmetry A_{LL} is small
- Interpretation of PHENIX results
  - $\mathrm{qg} \to \mathrm{qgX}$ at small p_{T}
    $\mathrm{gg} \to \mathrm{qgX}$ at large p_{T}
  - pQCD predicts positive asymmetry
  - correlation between Δd and π^0 asymmetry studied
  - more precise data needed

Kinematic Range

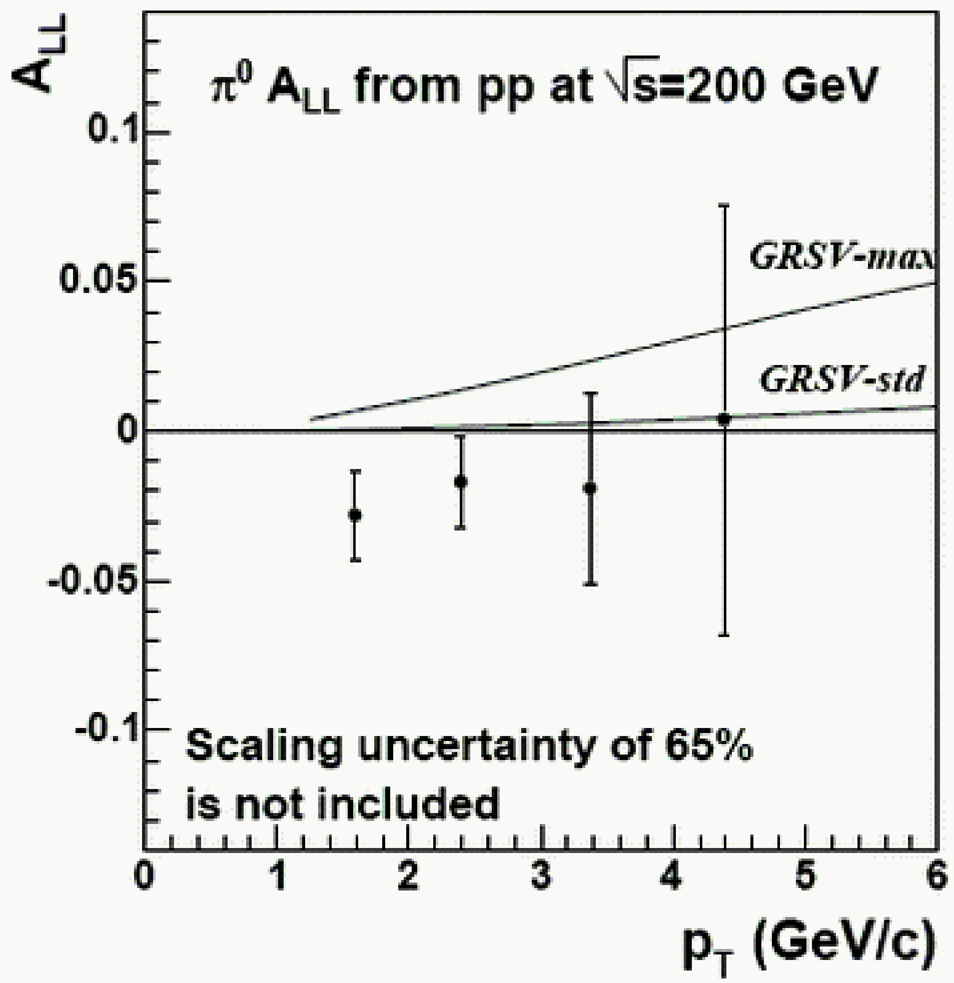
- Polarized proton collisions
- $\sqrt{s}$ = 200 GeV
- Jet E_T 5-50 GeV
- Pseudorapidity $0 < \eta < 1$





- Large Asymmetry
- Sensitivity to Large ΔG
- Dominant Reaction Mechanism

Results



Comparison with two NLO calculations:
Phys. Rev. **D63**(2001), 094005

Consistency with data:

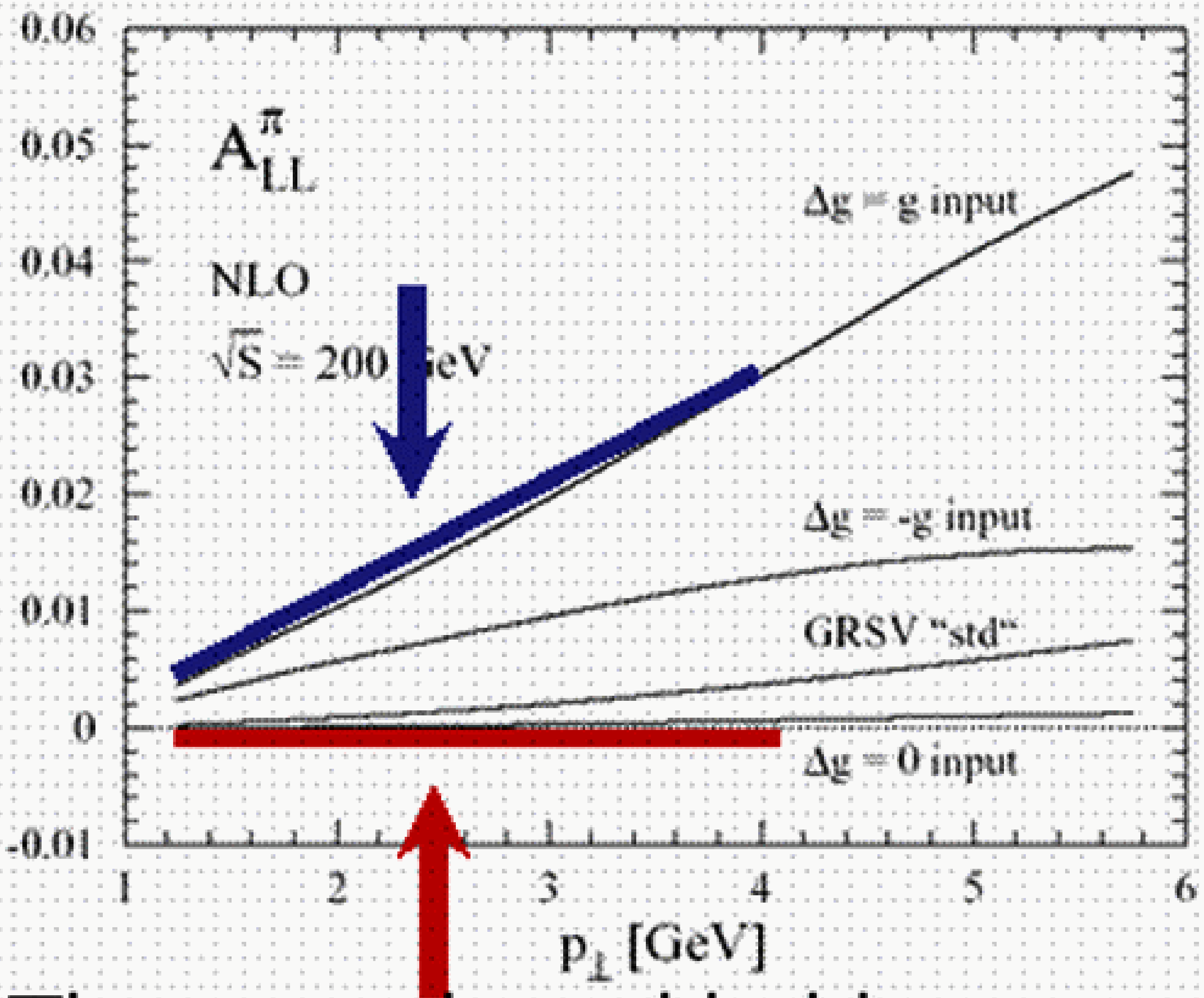
- GRSV-std: CL 21-25%
- GRSV-max: CL 0.1-8%

(no theoretical uncertainty included)

$p_T(GeV/c)$	Bckg. contr.	$A_{LL}^{\pi^0+bckg}$	A_{LL}^{bckg}	$A_{LL}^{\pi^0}$
1-2	27%	-0.015 ± 0.010	-0.018 ± 0.016	-0.028 ± 0.015
2-3	15%	-0.019 ± 0.013	-0.031 ± 0.028	-0.017 ± 0.015
3-4	9%	-0.018 ± 0.029	-0.008 ± 0.079	-0.019 ± 0.032
4-5	8%	0.025 ± 0.066	0.26 ± 0.20	0.004 ± 0.072

PHENIX

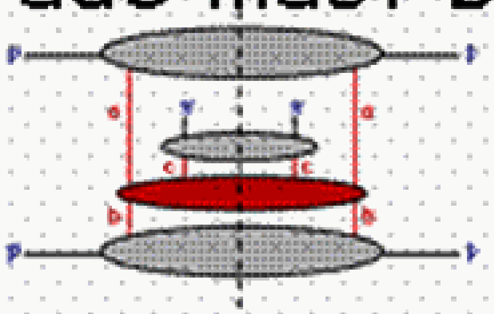
A_{LL}^{π} is bounded by:



✓ Positivity

✓ Underlying parton dynamics

The upper bound holds up to dependence on the scale where positivity is saturated. The lower bound is obtained under low $p_?$ approximations. The order of magnitude must be correct in both cases if the dynamics are:

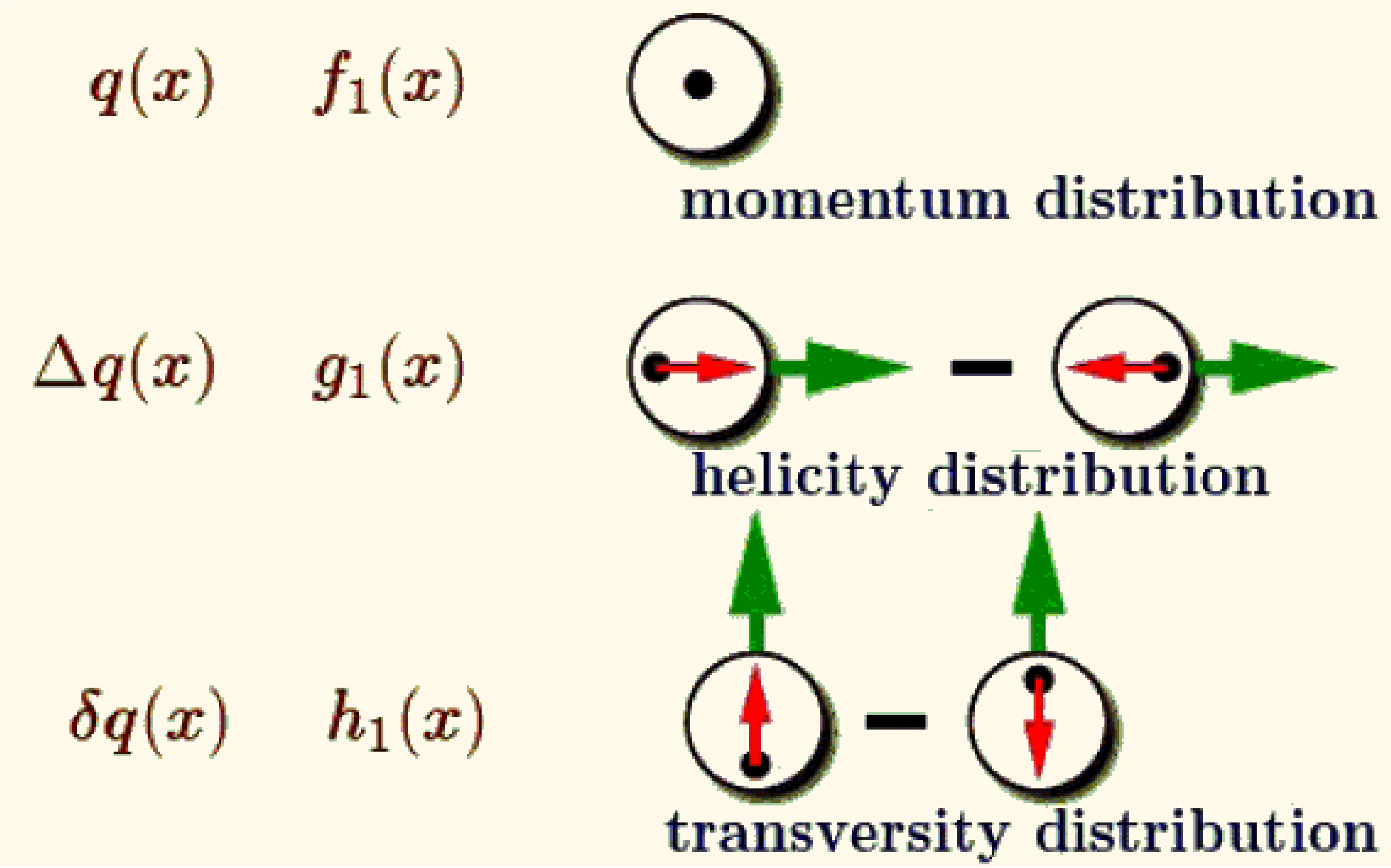


SSA and Transversity

- Measurement of transversity at HERMES (Seidl)
- Transverse asymmetry A_{UT} for charged pions (Fischer)
- Understanding the transverse target single spin asymmetries at HERMES (Schweitzer)
- Status of the Belle Spin Dependent Fragmentation Function Analysis (Grosse-Perdekamp)
- Single-spin asymmetries with two-hadron fragmentation functions (Bacchetta)
- Constraining the Sivers functions using Transverse Spin asymmetries at STAR (Fatemi)
- Single-Spin Transverse Asymmetry in Neutral Pion and Charged Hadron Production at PHENIX (Aidala)
- Measurement of single beam-spin asymmetry in electroproduction of pions at HERMES (Avetisyan)

Transverse Spin Physics

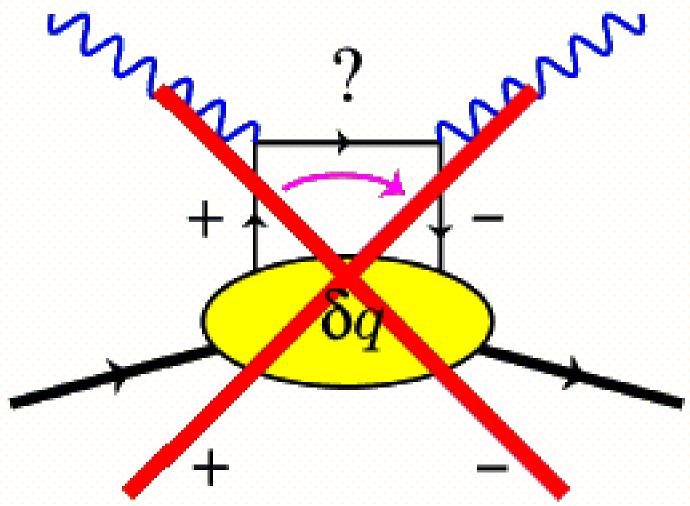
3 distribution functions are necessary to describe the spin structure of the nucleon at LO:



All of equal importance!

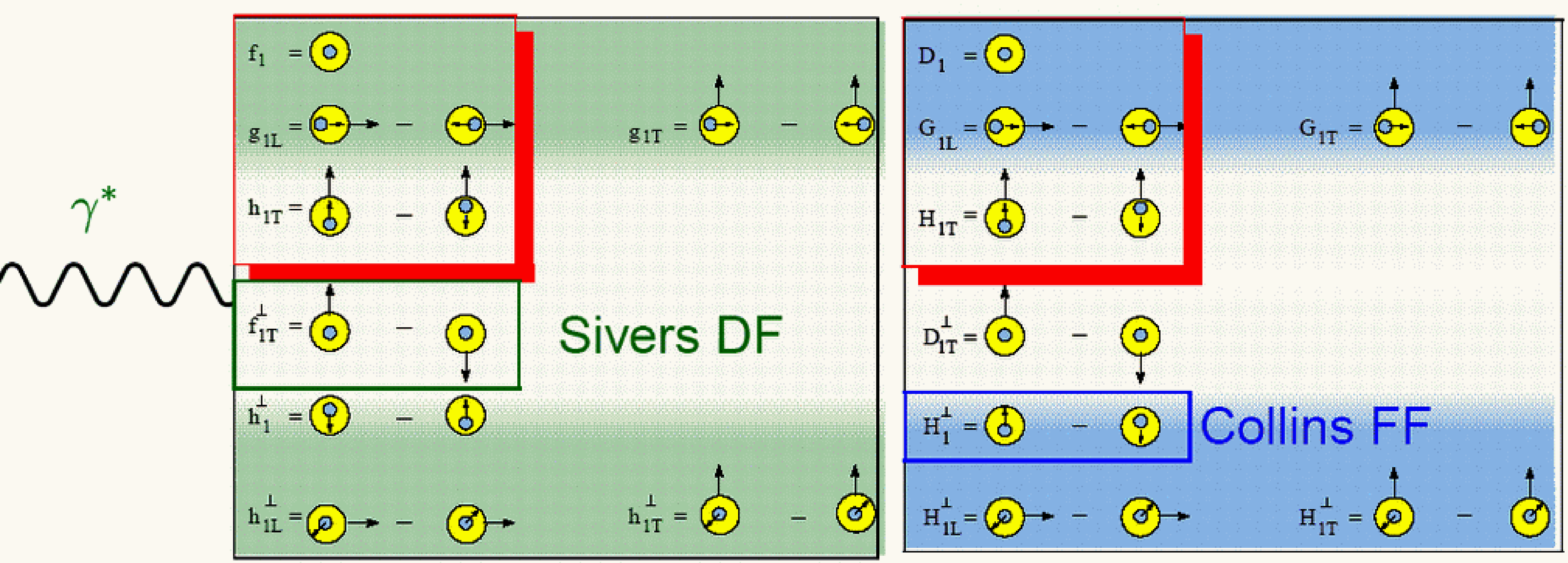
$h_1(x)$ decouples from leading twist DIS because helicity of quark must flip

No mixture with Gluons in evolution
- Valence like behavior



Transverse momentum dependent DFs and FFs

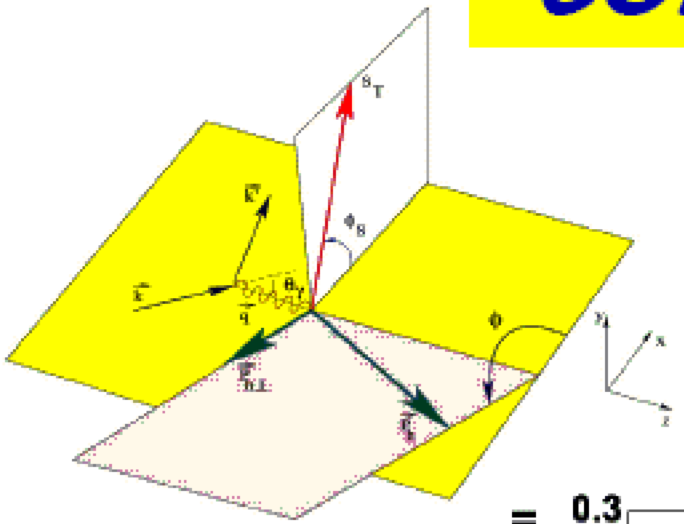
$$\sigma^{eH\to ehX} = \sum_q f^{H\to q} \otimes \sigma^{eq\to eq} \otimes D^{q\to h}$$



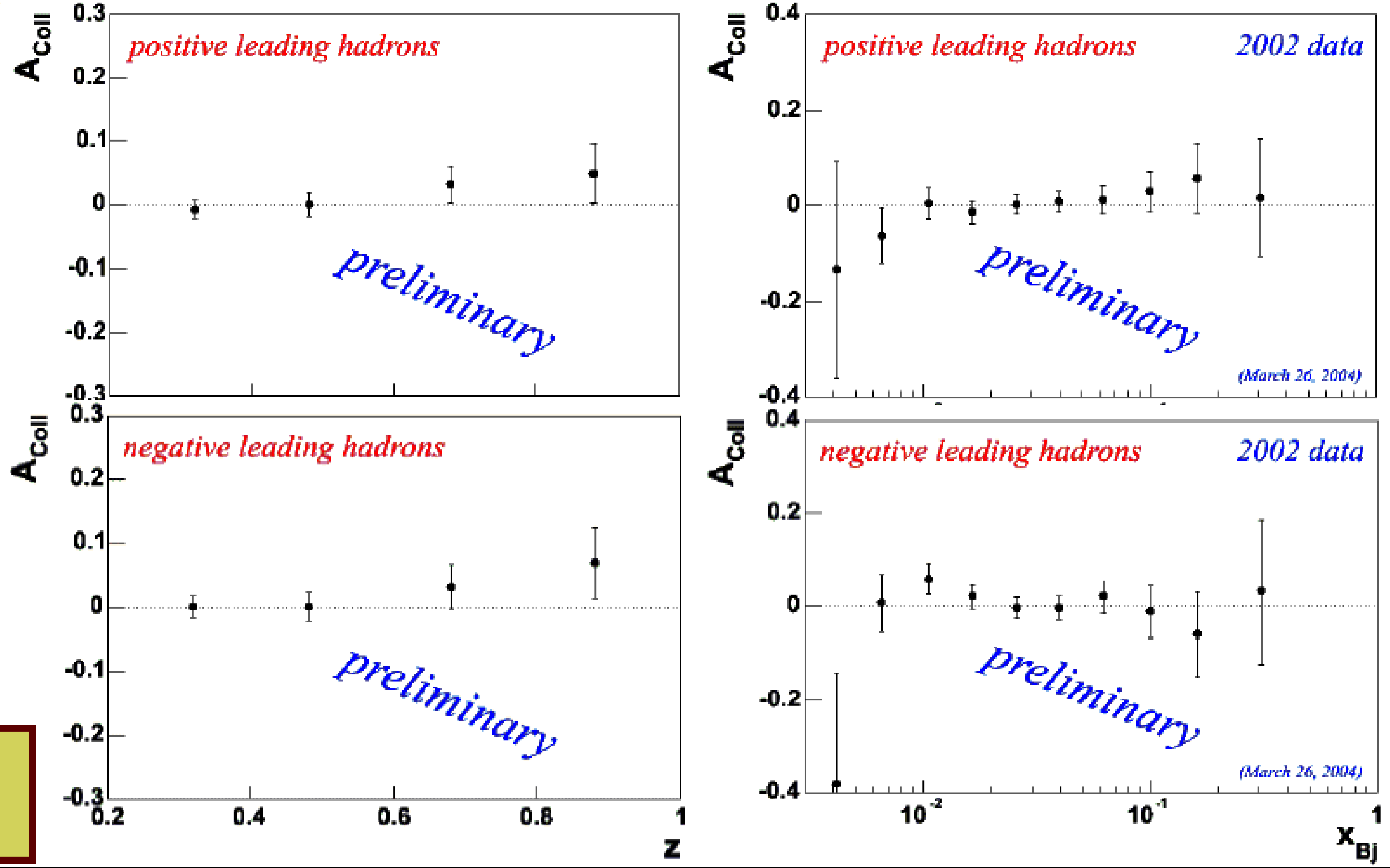
- "survive" integration over p_T(quarks) or k_T (fragmentation)
- T-odd and T-even functions
- chiral-odd and chiral-even functions

COMPASS: Collins-Asymmetrie

Horst Fischer
DIS2004



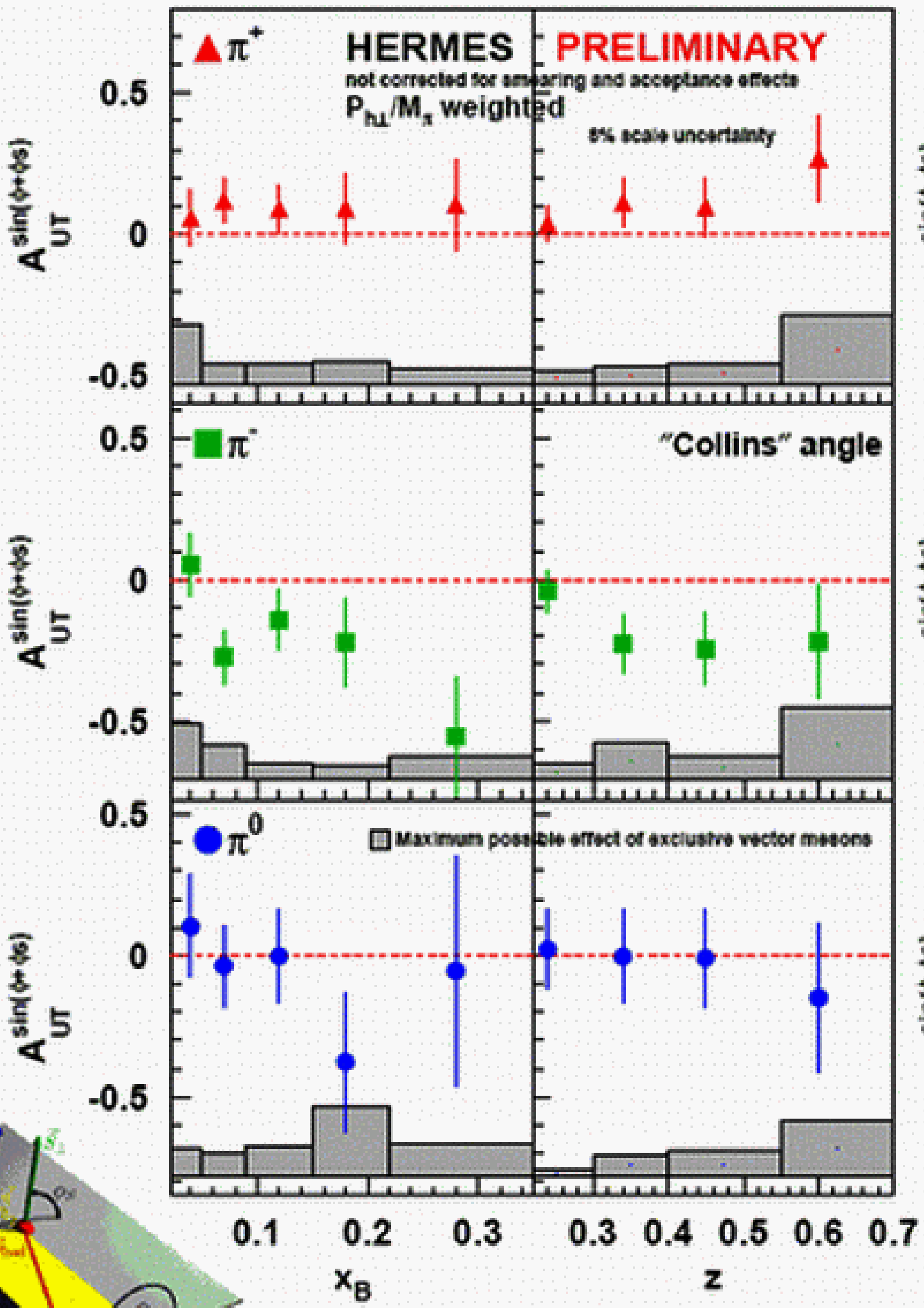
$$A_{Coll} \stackrel{c}{=} \frac{A_{UT}^{\sin\phi}}{D_{NN}\cdot f\cdot P} \propto \frac{\sum_q e_q^2 h_1^q(x,Q^2)\cdot H_1^{\perp(1)q}(z,Q^2)}{\sum_q e_q^2 f_1^q(x,Q^2)\cdot D_1^q(z,Q^2)}$$



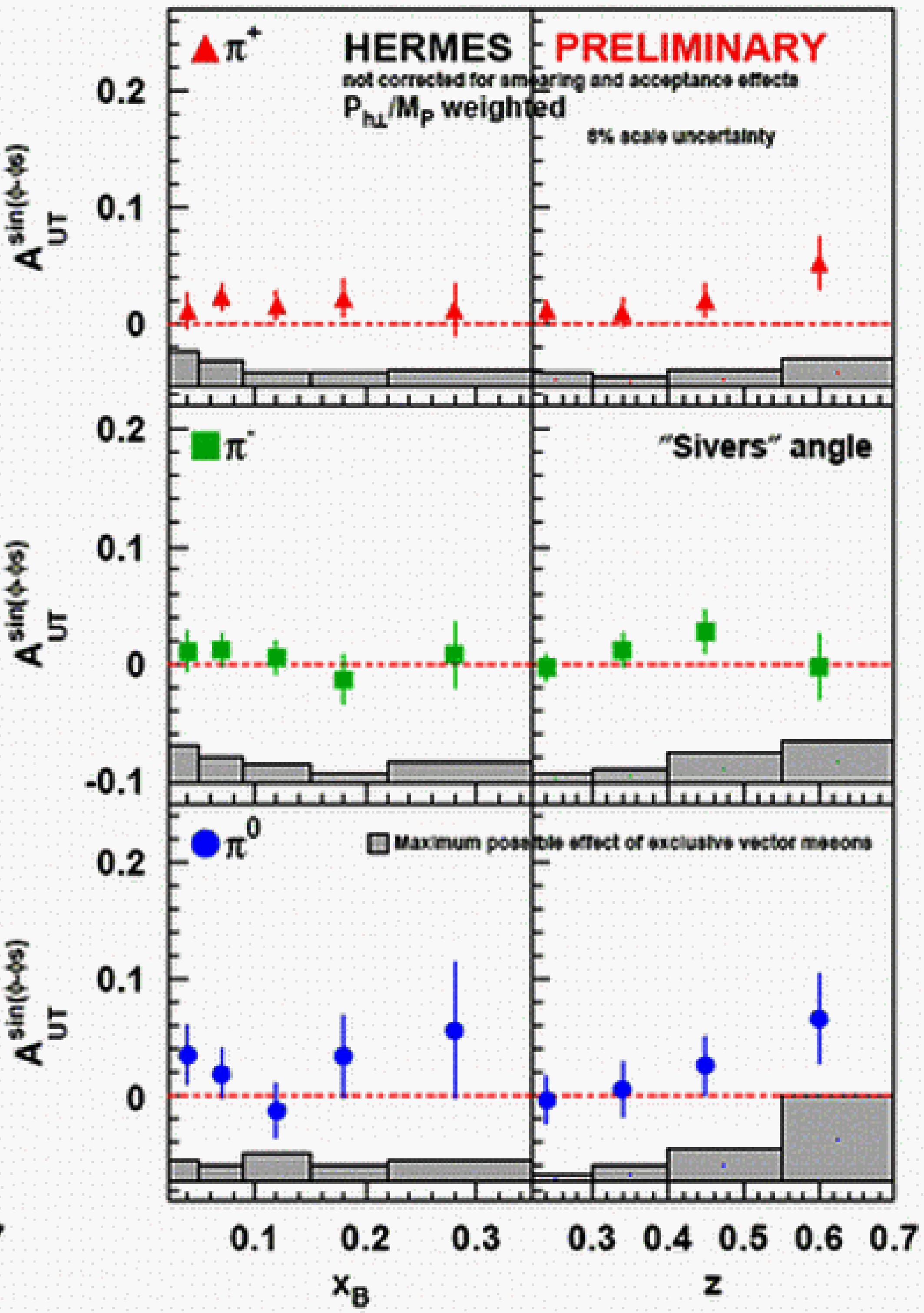
polarized
^{6}LiD-Target

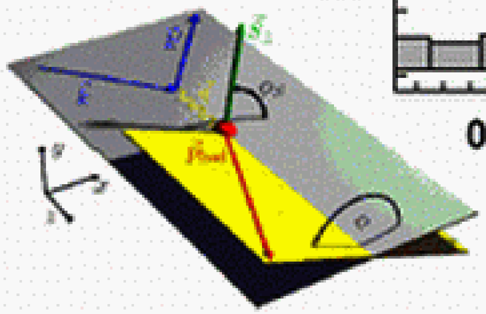
$P_{h\perp}/M_h$ weighted asymmetries

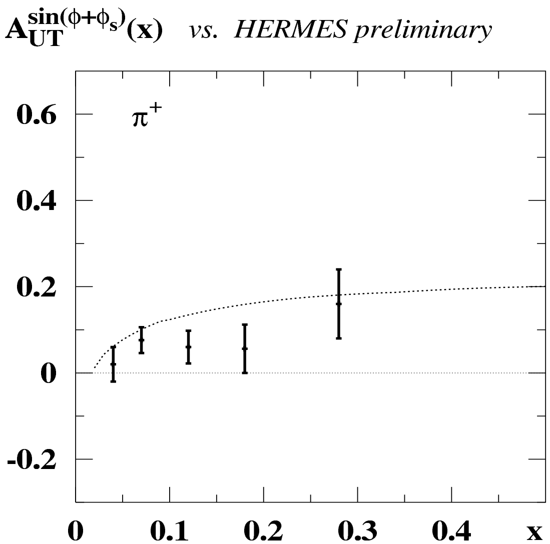
'Collins' Moments

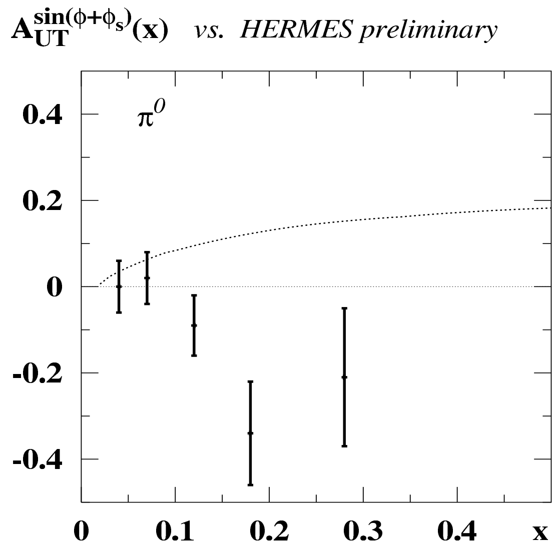


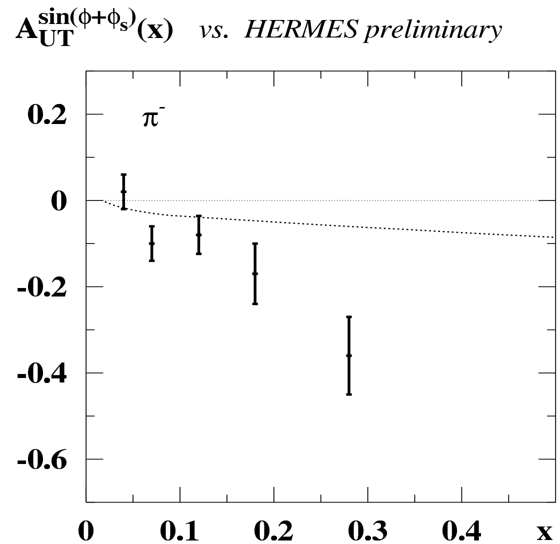
'Sivers' Moments











π^+

- Ok!

π^0

- No unfavoured fragm.!
- Requires $4h_1^u \ll -h_1^d$

  in contradiction to models

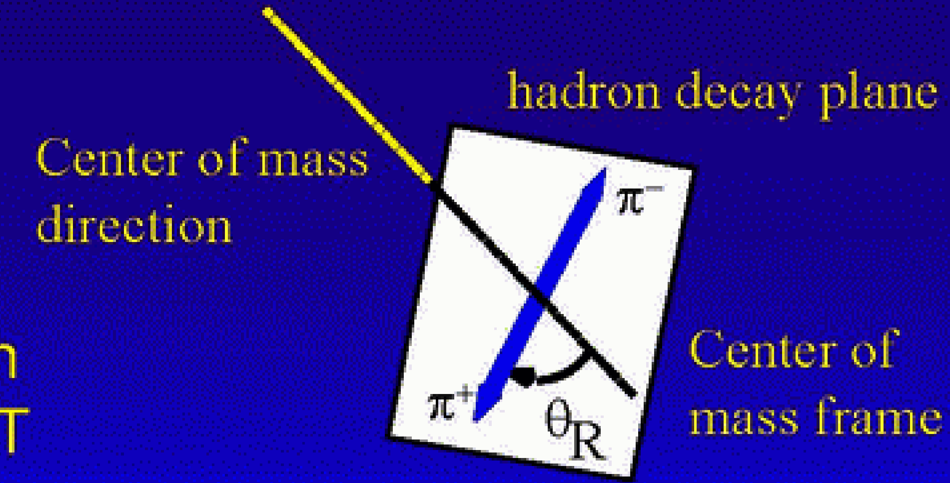
π^-

- Not unexpected!
  Here unfavoured
  fragmentation
  can change a lot

Due to u-quark dominance (in all models) one would expect $A_{UT\,\pi^+}^{\sin(\phi+\phi_s)} \approx A_{UT\,\pi^0}^{\sin(\phi+\phi_s)}$ (as for $A_{UL}^{\sin\phi}$). Why not here?

Results quite puzzling!

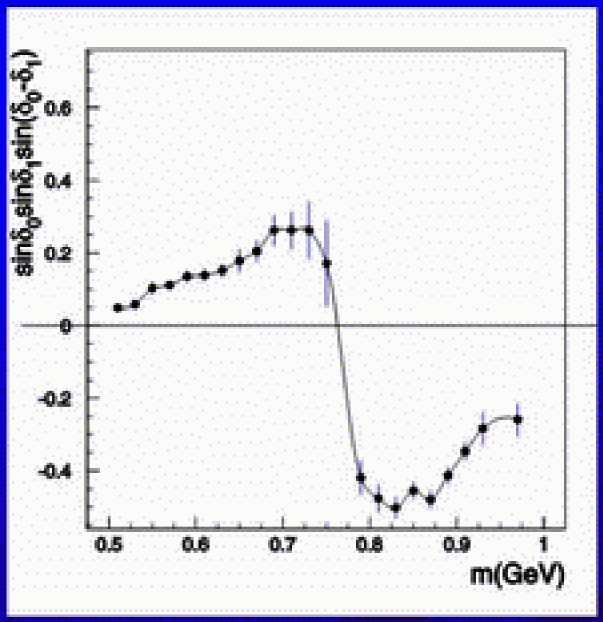
$D_1(z, \cos\theta_R, M^2_{\pi\pi})$ Probability of producing a pair with a given fractional momentum, polar angle and invariant mass



$H_1^{\sphericalangle}(z, \cos\theta_R, M^2_{\pi\pi})$ INTERFERENCE fragmentation function
Chiral odd and T-odd function WITHOUT transverse momentum

$$A_{UT}(x, y, z, \cos\theta_R, M^2_{\pi\pi}) \sim B(y)\sin(\phi_R + \phi_S)\,\sin\theta_R\, h_1\, H_1^{\sphericalangle}(z, \cos\theta_R, M^2_{\pi\pi})$$

$$H_1^{\sphericalangle}(z, \cos\theta_R, M^2_{\pi\pi}) \approx H_1^{\sphericalangle sp}(z, M^2_{\pi\pi}) + \cos\theta_R H_1^{\sphericalangle pp}(z, M^2_{\pi\pi})$$



R. Jaffe, X. Jin, J. Tang, PRL 80 (1997)

Resonance, Breit-Wigner shape

A. Bacchetta, M. Radici, PRD67, 094002

$$A_{UT} \sim B(y)\sin(\phi_R + \phi_S)\sin\theta_R\, h_1 H_1^{\sphericalangle}$$
$$+V(y)\sin\phi_S \sin\theta_R \frac{M}{Q}(\ldots)$$

A. Bacchetta, M. Radici, PRD69, 0740XX

$$A_{UT} \sim B(y)\sin(\phi_h + \phi_S)\; I[h_1 \otimes H_1^{\perp}]$$
$$+A(y)\sin(\phi_h - \phi_S)\; I[f_{1T}^{\perp} \otimes D_1]$$
$$+B(y)\sin(3\phi_h - \phi_S)\; I[h_{1T}^{\perp} \otimes H_1^{\perp}]$$
$$+V(y)\sin\phi_S \frac{M}{Q} I[\ldots]$$
$$+V(y)\sin(2\phi_h - \phi_S)\frac{M}{Q} I[\ldots]$$

Drawbacks:

- Several terms
- Convolutions
- Evolution unknown

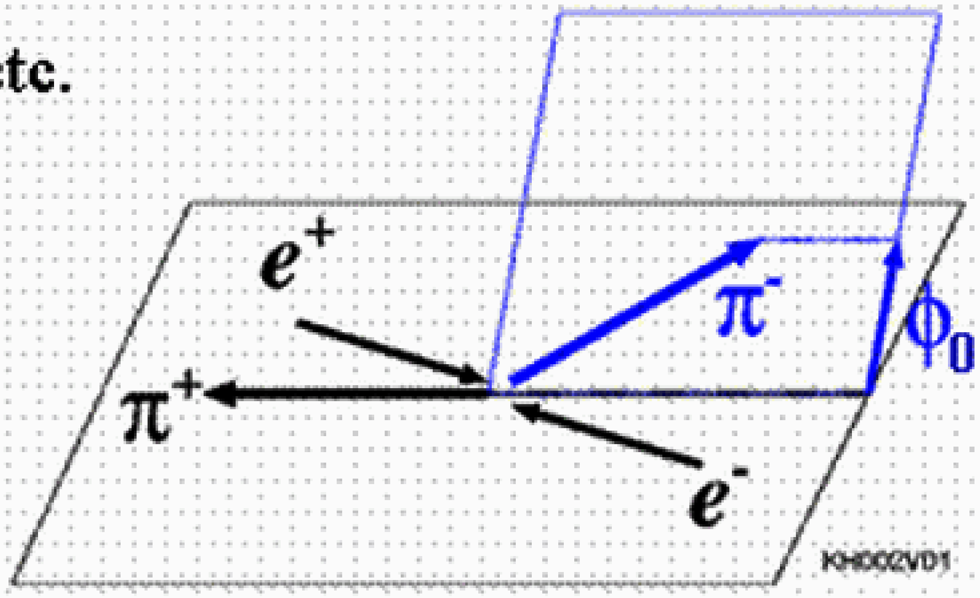
Analysis Procedure

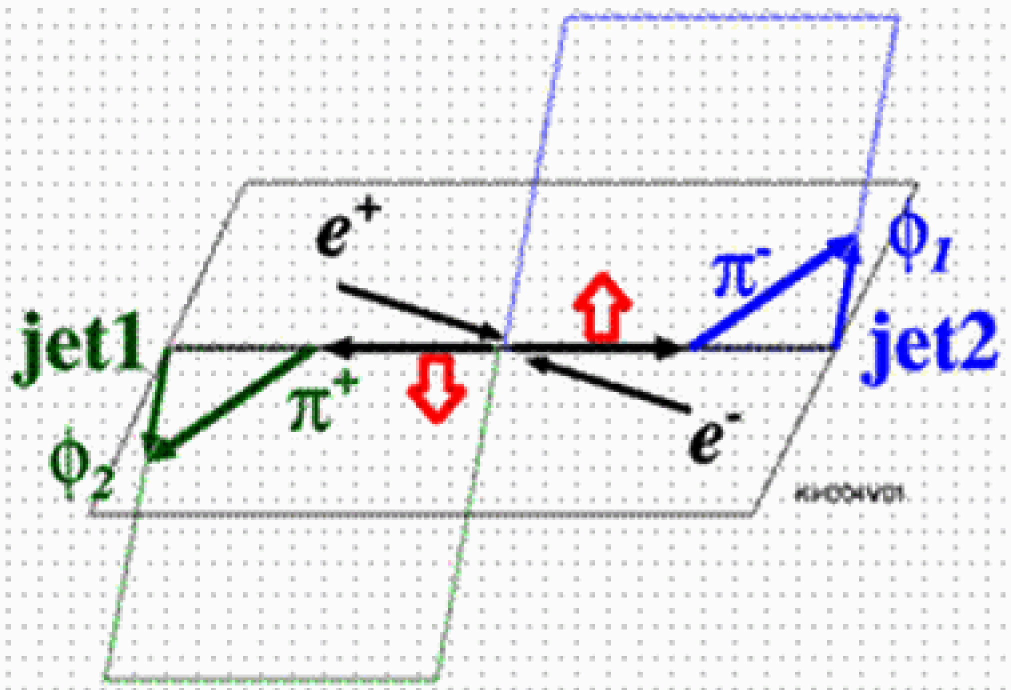
Collins-Heppelmann FF: $H_1^\perp(z)$ for $e^+e^- \to \pi^+_{jet1}\pi^-_{jet2}X$

- **Event Selection**
  - Light-quark events with event-shape, vertexing, etc.
  - 2-jet events with T>0.85
- **Track Selection**
  - Tracks from IP (vertex cut)
  - PID to select pions
- **Angle measurements**
  - Reaction plane defined with beam (z-axis) and jet axis
  - hadron planes defined with pions and jet axis
  - ϕ_i: angles between the planes
- **Asymmetry study**
  - Search azimuthal angle correlations

$A \propto H_1^\perp(z_1)H_1^\perp(z_2)\cos(2\phi_0)$ or
$A \propto H_1^\perp(z_1)H_1^\perp(z_2)\cos(\phi_1+\phi_2)$

as functions of z





Single Spin π^0 Asymmetry

$$A_N = \frac{1}{Pol} \times \frac{Y_{\pi^0}^{\uparrow} - Y_{\pi^0}^{\downarrow}}{Y_{\pi^0}^{\uparrow} + Y_{\pi^0}^{\downarrow}}$$

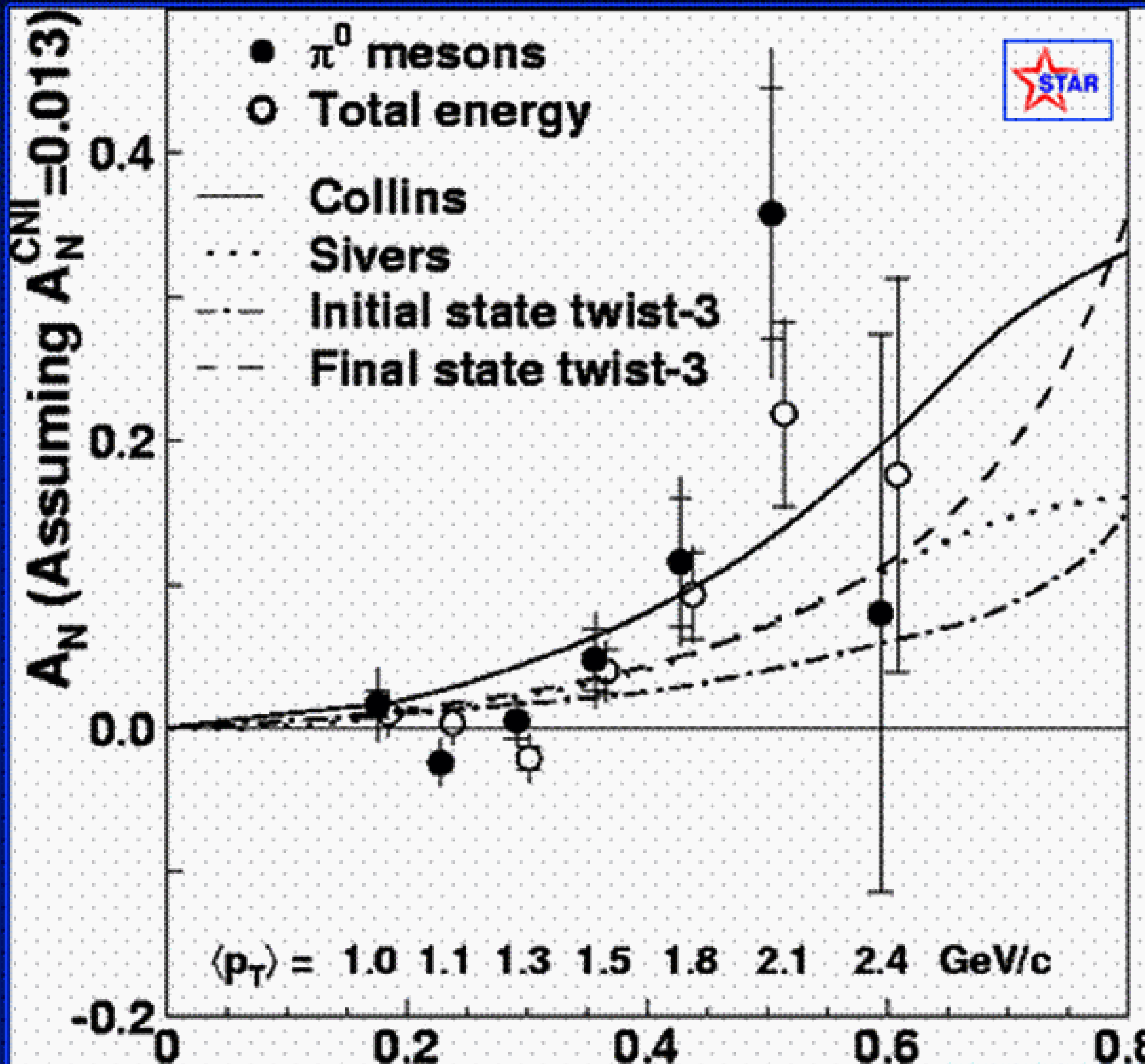
For $<\eta> = 3.7$ possible contributions to A_N are:

Sivers Effect – Spin dependent initial partonic transverse momentum

Collins Effect – Spin dependent transverse momentum kick in fragmentation

Sterman and Qiu – Initial State twist 3

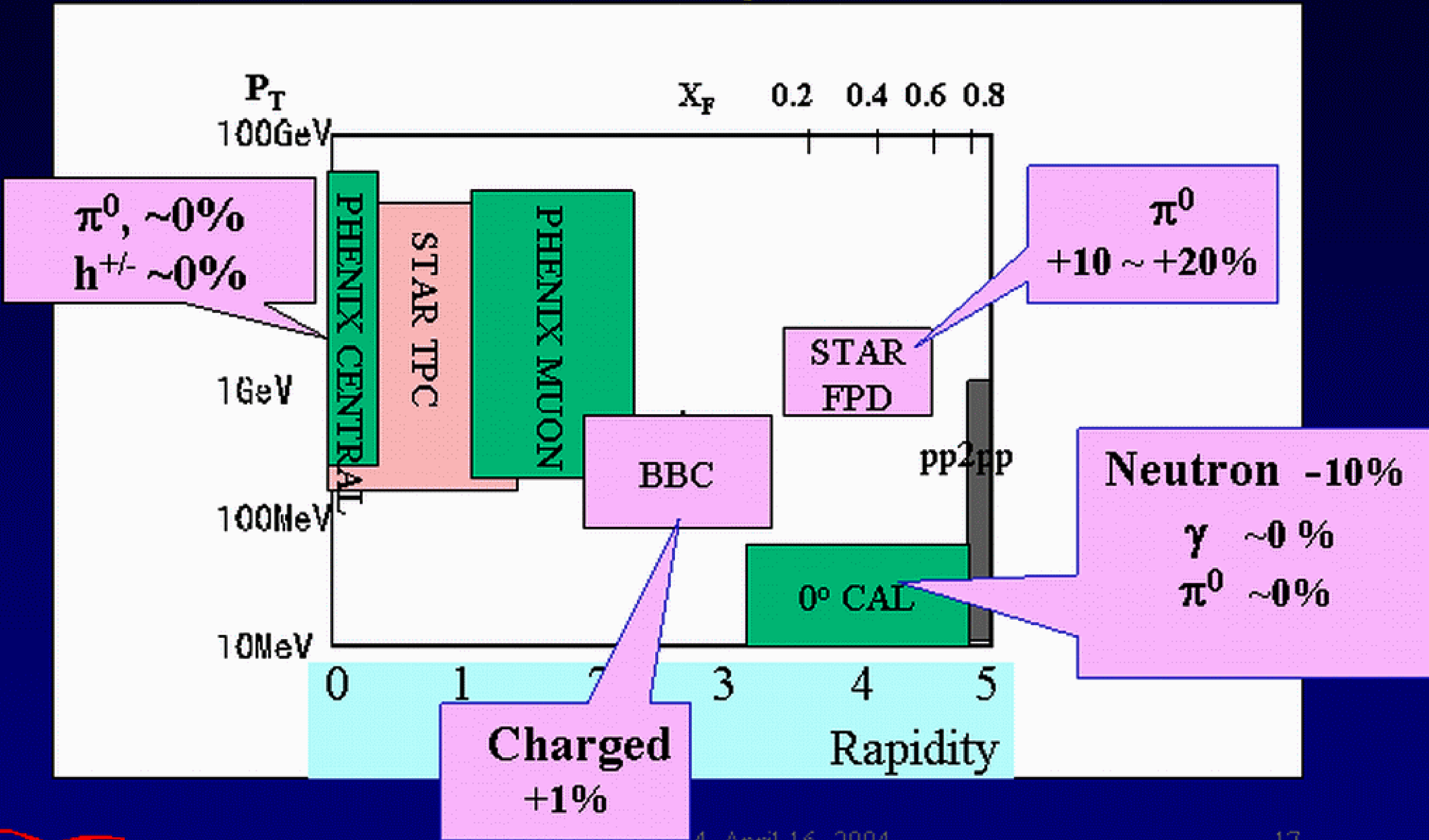
Koike – Final State twist 3



$$X_F = \frac{2E_{\pi^0}}{\sqrt{s}}$$

hep-ex/0310058

Single-spin asymmetries seen at RHIC so far…



Exlusive Reactions and GPDFs

Experiment

- Electroproduction of rho mesons (Borissov)
- The HERMES DVCS Roadmap (Ellinghaus)
- Electroproduction of exclusive $\pi^+\pi^-$ at HERMES (Fabbri)
- Exclusive π^+ production at HERMES (Hadjidakis)

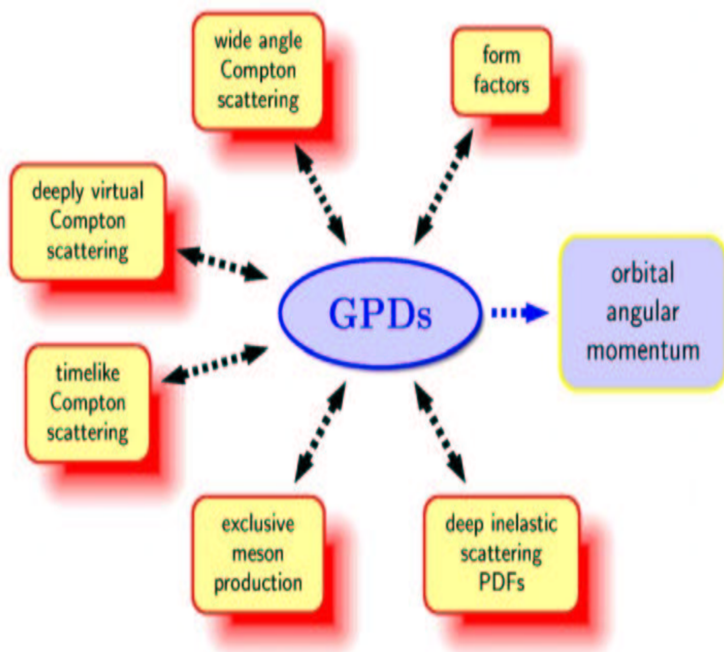
Theory

- Charge asymmetry in $\pi^+\pi^-$ electroproduction on proton at high energies as a test of σ, ρ mesons degeneration (Kuraev)
- A Simple Model for Generalised Parton Distributions of the Pion (Lansberg)

GPDs ⟷ Nucleon Structure

GPDs $(H, \tilde{H}, E, \tilde{E})$: Parameterization of the nucleon structure

GPDs: Description of inclusive and (hard) exclusive processes
→ Constraint by known quantities



GPDs accessible in exclusive reactions ⇒

- vector mesons: unpolarized GPD H, E
- pseudoscalar mesons: polarized GPD $\tilde{H}$,$\tilde{E}$

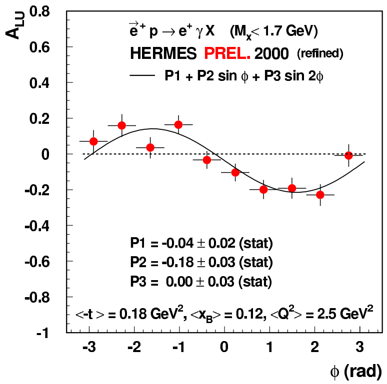
HERMES results

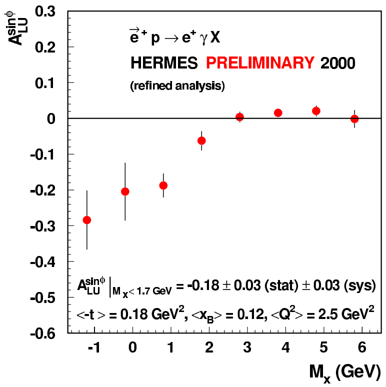
- Production of ρ,ω and ϕ
  - cross sections, Q^2-dependence
  - σ_L/σ_T,
  - ρ double spin asymmetries
  - diffrative slope
  - color tranparency studied at fixed coherence length supports factorisation
- DVCS
  - interference with BH measurable
  - azimuthal asymmtries: beam charge and beam spin
- Exclusive π^+ and $\pi^+\pi^-$ production
  - exclusive π^+ cross section results
  - transverse target spin asymmetries: 1000 exclusive π^+ expected for 2002 – 2004
  - interference between $\pi^+\pi^-$ isospin states
- Future:
  Recoil detector willimprove measurement of exclusive channels from 2005 onwards

Beam–Spin Asymmetry

Beam–Spin Asymmetry (BSA) $A_{\rm LU}(\phi)$:
(Beam pol. (L), Target unpol. (U))

$$A_{\rm LU}(\phi) = \frac{1}{<|P_b|>} \frac{\overrightarrow{N}(\phi) - \overleftarrow{N}(\phi)}{\overrightarrow{N}(\phi) + \overleftarrow{N}(\phi)}$$





$A_{\rm LU}$ in exclusive bin:
Expected $\sin(\phi)$ dependence $\Rightarrow {\rm Im}\, M^{1,1}$,
$\sin(2\phi)$ compatible with zero (higher twist)

$\sin(\phi)$–Moment in exclusive bin:

$$A_{\rm LU}^{\sin\phi} = 2 \sum_{i=1}^{\overrightarrow{N}+\overleftarrow{N}} \frac{\sin(\phi_i)}{(P_l)_i} = -0.18 \pm 0.03 \pm 0.03$$

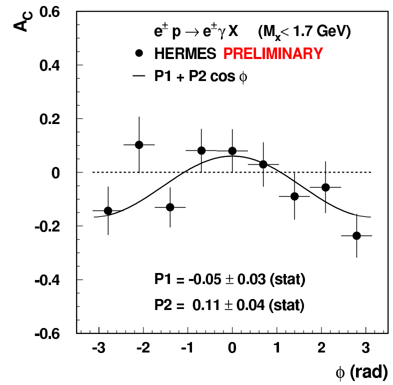
$\sin(\phi)$–Moment in non–exclusive region:
small and slightly positive ($\to \pi^0$)

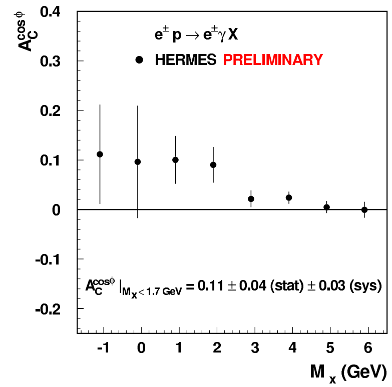
(Results from 1996/97 → PRL **87**, 182001 (2001))

Beam–Charge Asymmetry

$$A_{\rm C}(\phi) = \frac{N^+(\phi) - N^-(\phi)}{N^+(\phi) + N^-(\phi)} \propto I$$

$$I \propto \pm(c_0^I + \sum_{n=1}^3 c_n^I \cos(n\phi) + \lambda \sum_{n=1}^2 s_n^I \sin(n\phi))$$





$A_{\rm C}$ in exclusive bin:
Expected $\cos(\phi)$ dependence $\Rightarrow {\rm Re}\, M^{1,1}$

$\cos(\phi)$–Moment in exclusive bin:

$$A_C^{\cos\phi} = 2 \frac{\sum_{i=1}^{N^+} \cos\phi_i - \sum_{i=1}^{N^-} \cos\phi_i}{N^+ + N^-} = 0.11 \pm 0.04 \pm 0.03$$

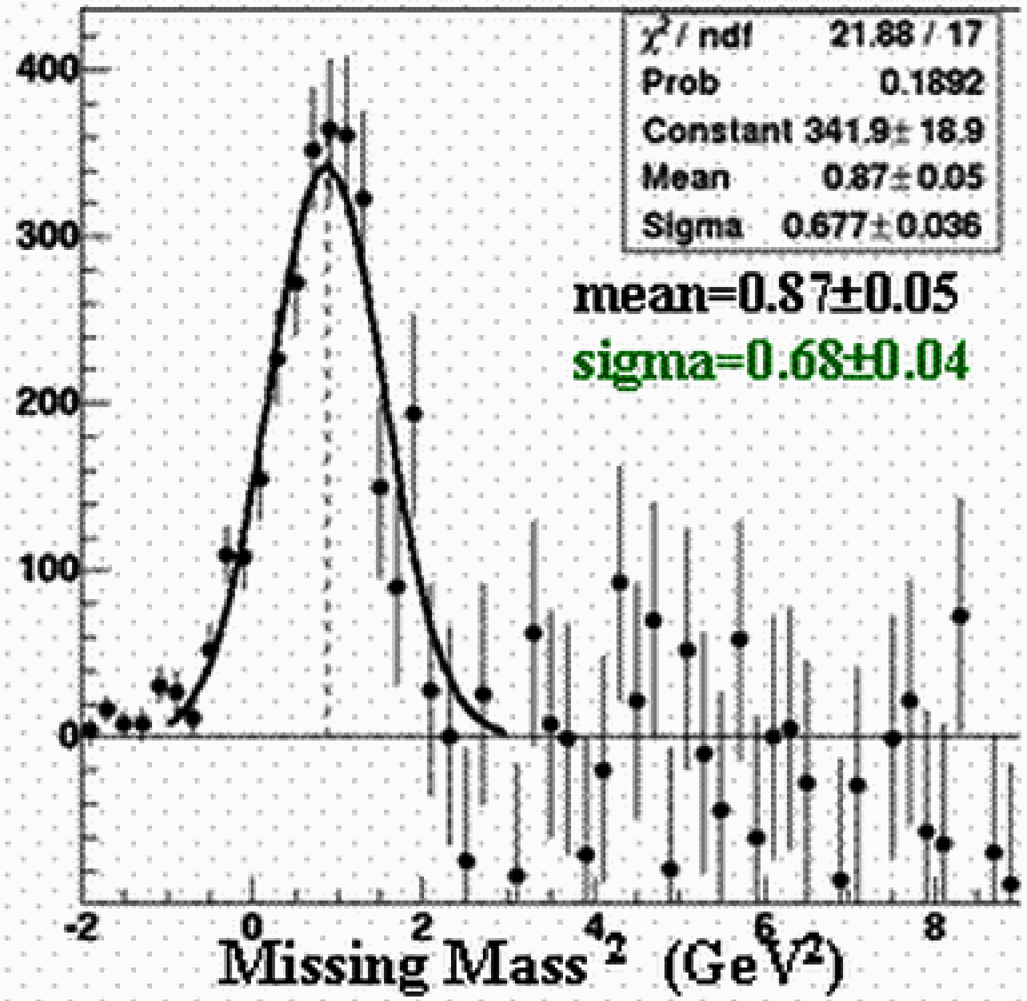
$(< Q^2 >= 2.8\ {\rm GeV}^2,\ < x >= 0.12,\ < -t >= 0.27\ {\rm GeV}^2)$

$\cos(\phi)$–Moments small at higher missing mass

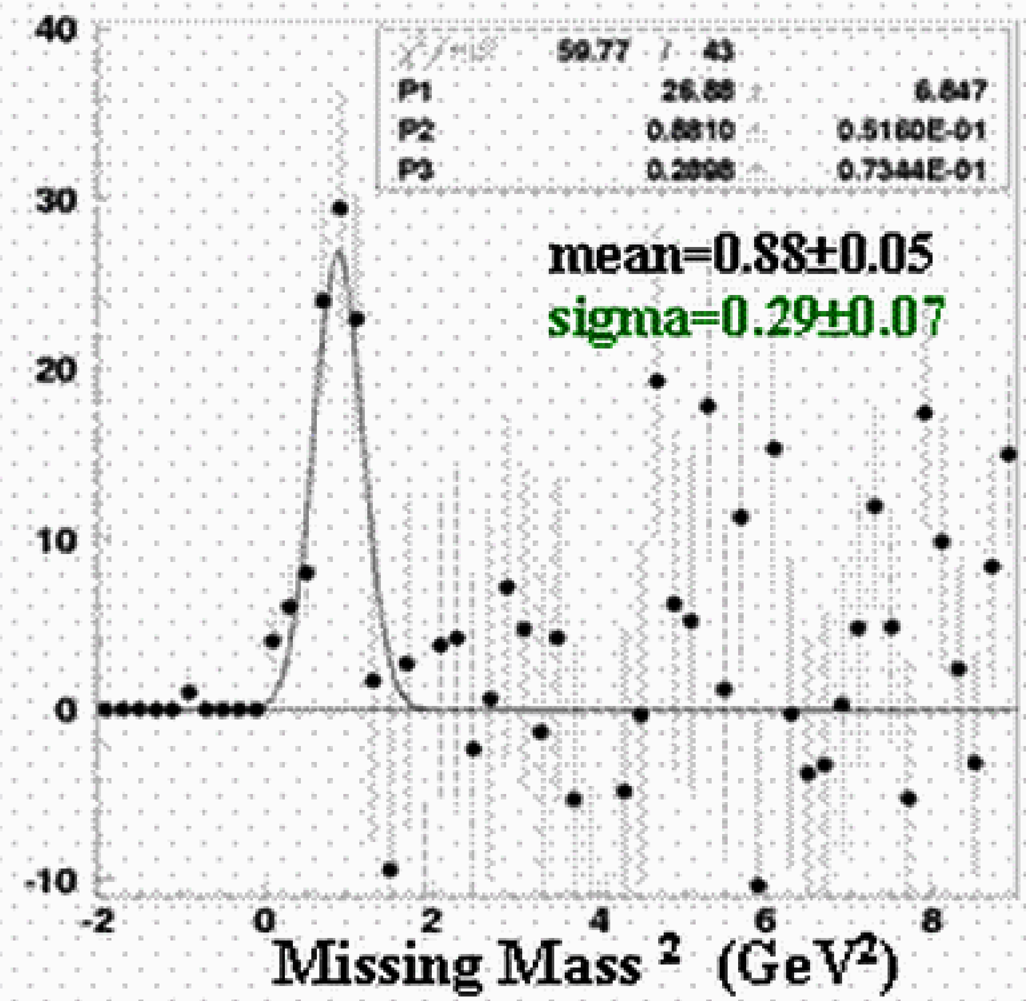
$\Rightarrow$ Basic concept seems to work !!!

Exclusivity for $e\,p \rightarrow e\,\pi^+(n)$

E_e=27.5 GeV



E_e=12 GeV



→ For different beam energy, same exclusive peak at the nucleon mass

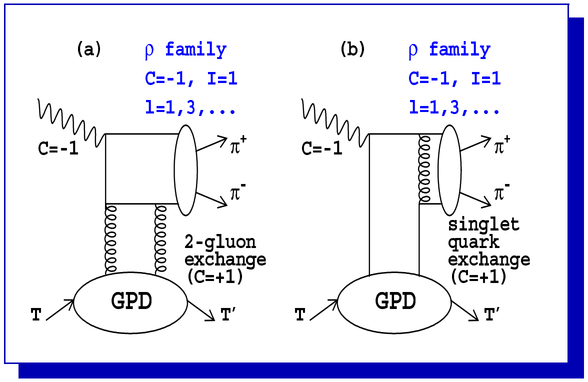
→ L/T separation not possible $\sigma_{tot} = \sigma_T + \varepsilon\,\sigma_L$

Hermes kinematics: $\varepsilon > 0.80$

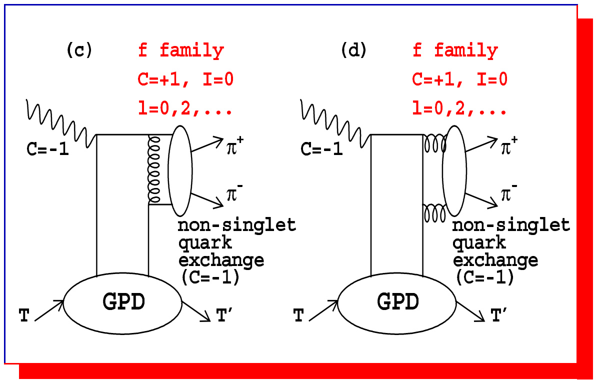
σ_T suppressed by $1/Q^2 \rightarrow$ at large Q^2, σ_L dominates

Hard Exclusive Production of $\pi^+\pi^-$

Which channels may contribute?

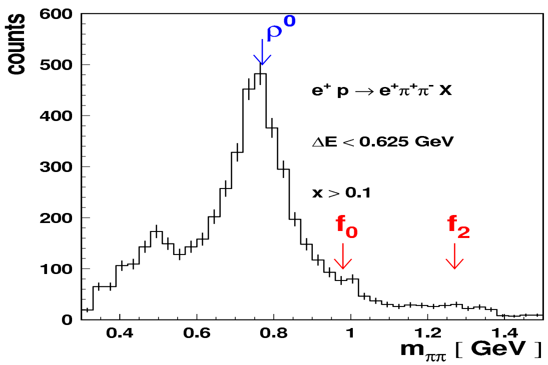


- ρ^0: $I(J^{PC})=1(1^{--})$



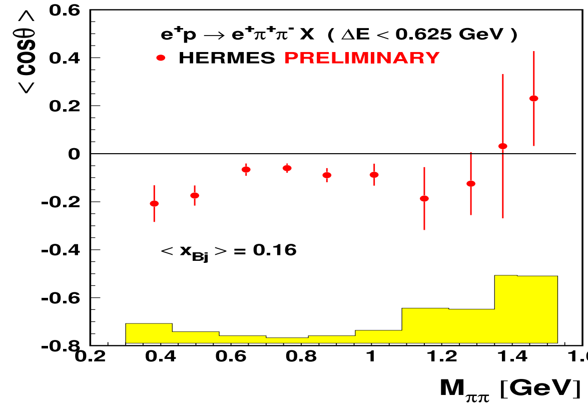
- non-resonant S-wave & f_0: $I(J^{PC})=0(0^{--})$
- f_2: $I(J^{PC})=0(2^{--})$

$m_{\pi\pi}$-region accessed at *HERMES*

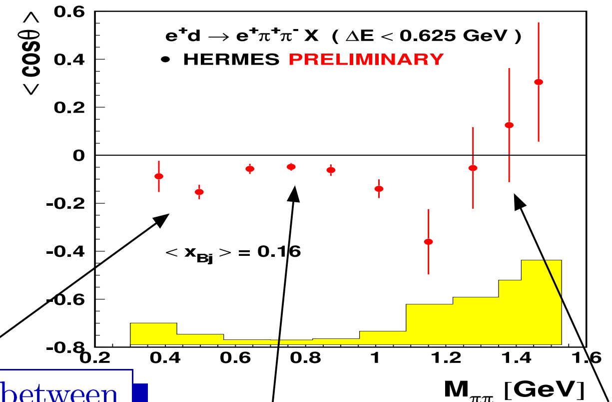


$m_{\pi\pi}$-dependence of $\langle\cos\theta\rangle$

Hydrogen:



Deuteron:



Interference between non-resonant S-wave and lower ρ^0 tail $m_{\pi\pi} < 0.6\,\mathrm{GeV}$

Minimum interference between S-P waves $m_{\pi\pi} \sim 0.77\,\mathrm{GeV}$

Indication of ρ^0-f_2 interference $m_{\pi\pi} \sim 1.3\,\mathrm{GeV}$

Future Plans

- Spin Physics with eRHIC (Kinney)
  - high precision spin structure functions $g1$ for p and n at low x
  - Bjorken sum rule
  - polarized gluon distribution from scaling violations and direct measurements
  - flavour separation
  - parity violating structure function g_5
  - photon spin structure
  - DVCS
  - transversity
  - GHD sum rule

- Spin physics is a very active field
- Many new data will be taken in the nearest future
- New projects are being discussed
- There are many interesting results with high precision and new measurements that weren't possible before
- Many new results are just around the corner
- We had stimulating discussions and everybody is going home with some homework and new ideas
- Thanks to all participants of the spin sessions