The longitudinal structure function F_L

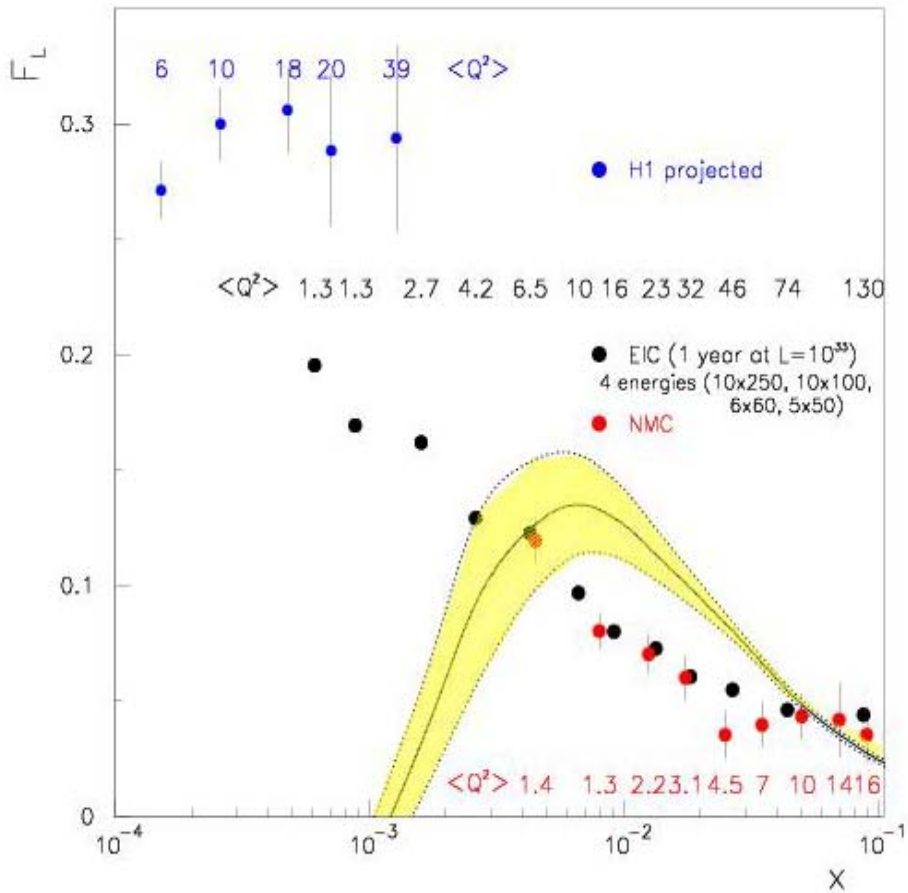
assumptions:

- **at least 3 energy measurements**

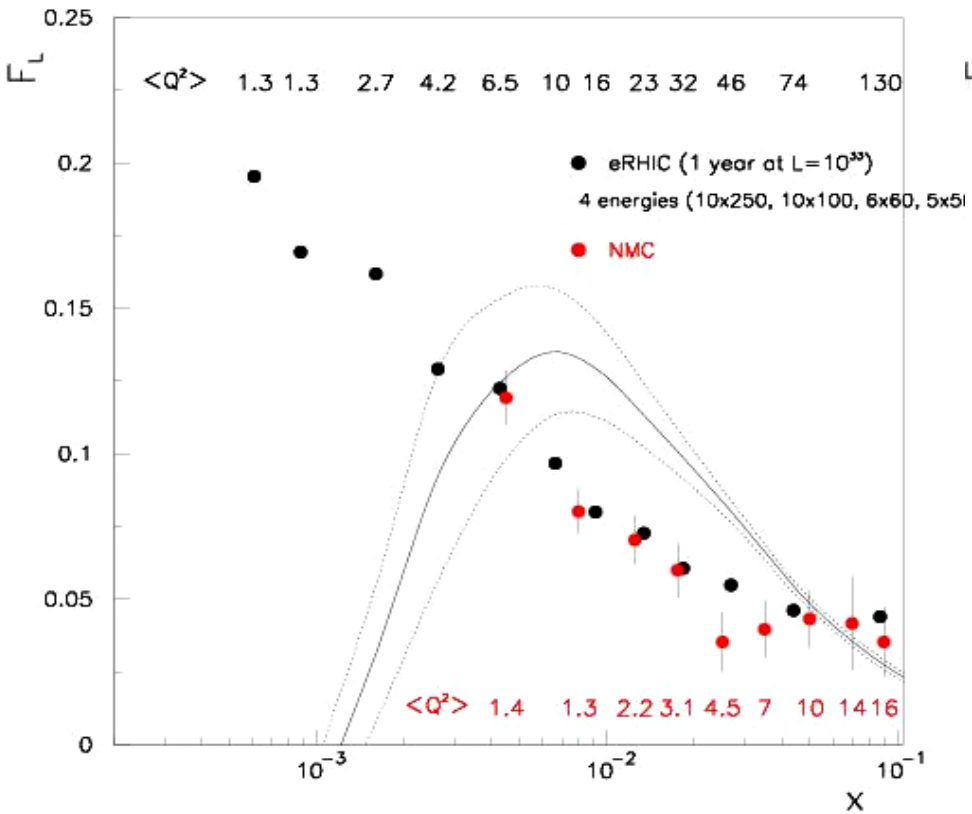
  eRHIC: 10x100, 6x60, 5x50 (plus 10x250 for proton)

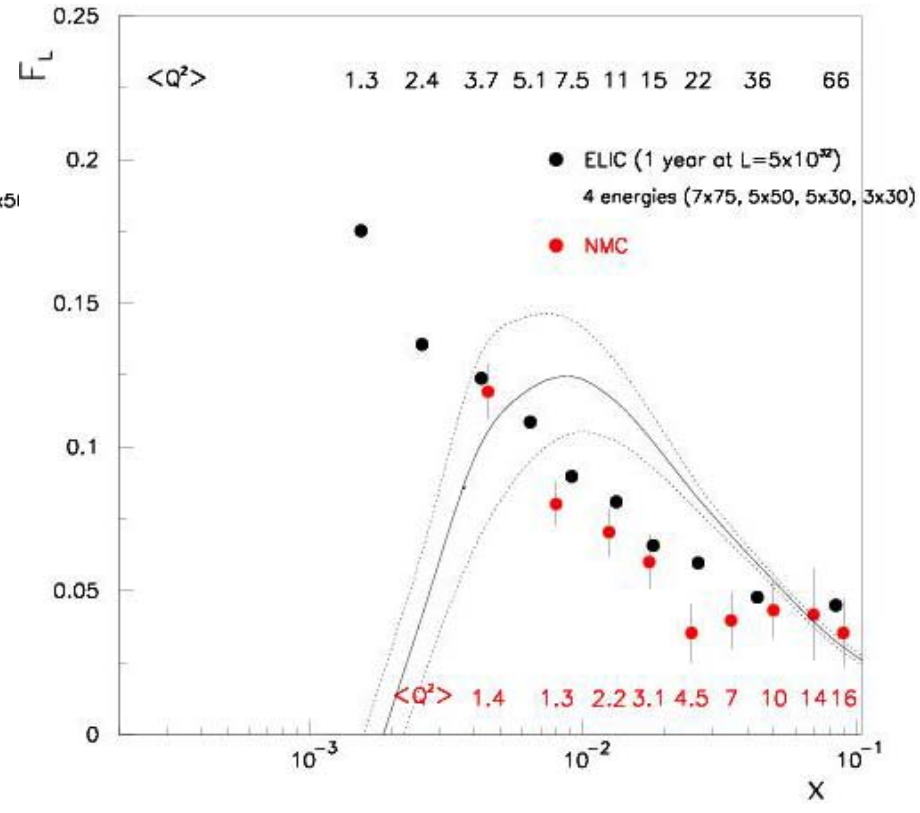
  ELIC: 7x75, 6x60, 5x50 (plus 7x150 for protons)

- **$\Delta\varepsilon > 0.25$**
- **statistical errors only**



The longitudinal structure function F_L





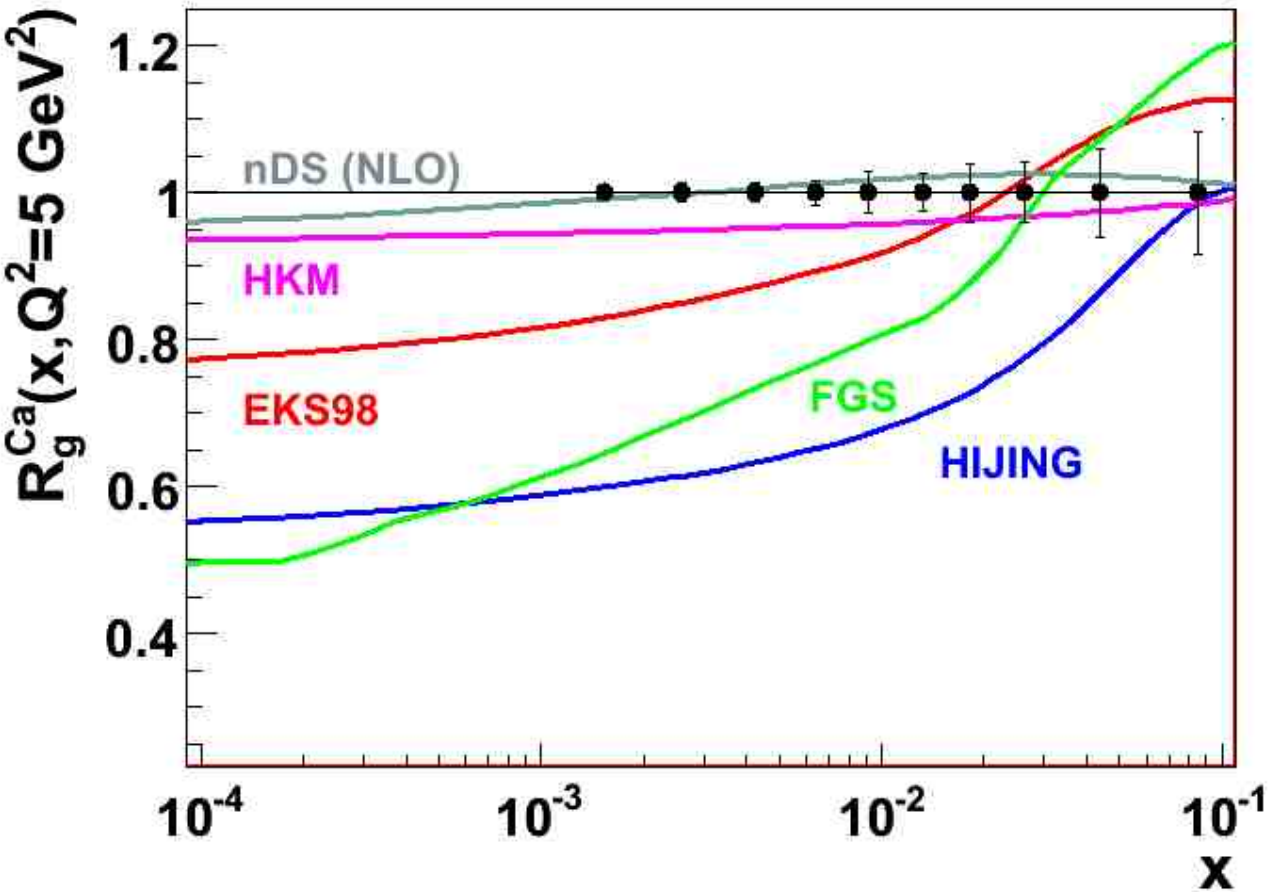
- very precise measurement with L ~ $5x10^{32}$ nucleons/cm^2/s
- interesting kinematic domain (low x, relatively low Q^2)
- similar kinematic range for eRHIC and ELIC
- systematic errors to be estimated

Nuclear modifications of the gluon distribution

ELIC

1 year of running

10 days @ 7on75
(L_{Ca}=8x10^{32})
20 days @ 5on50
(L_{Ca}=5x10^{32})
70 days @ 5on30
(L_{Ca}=1x10^{32})



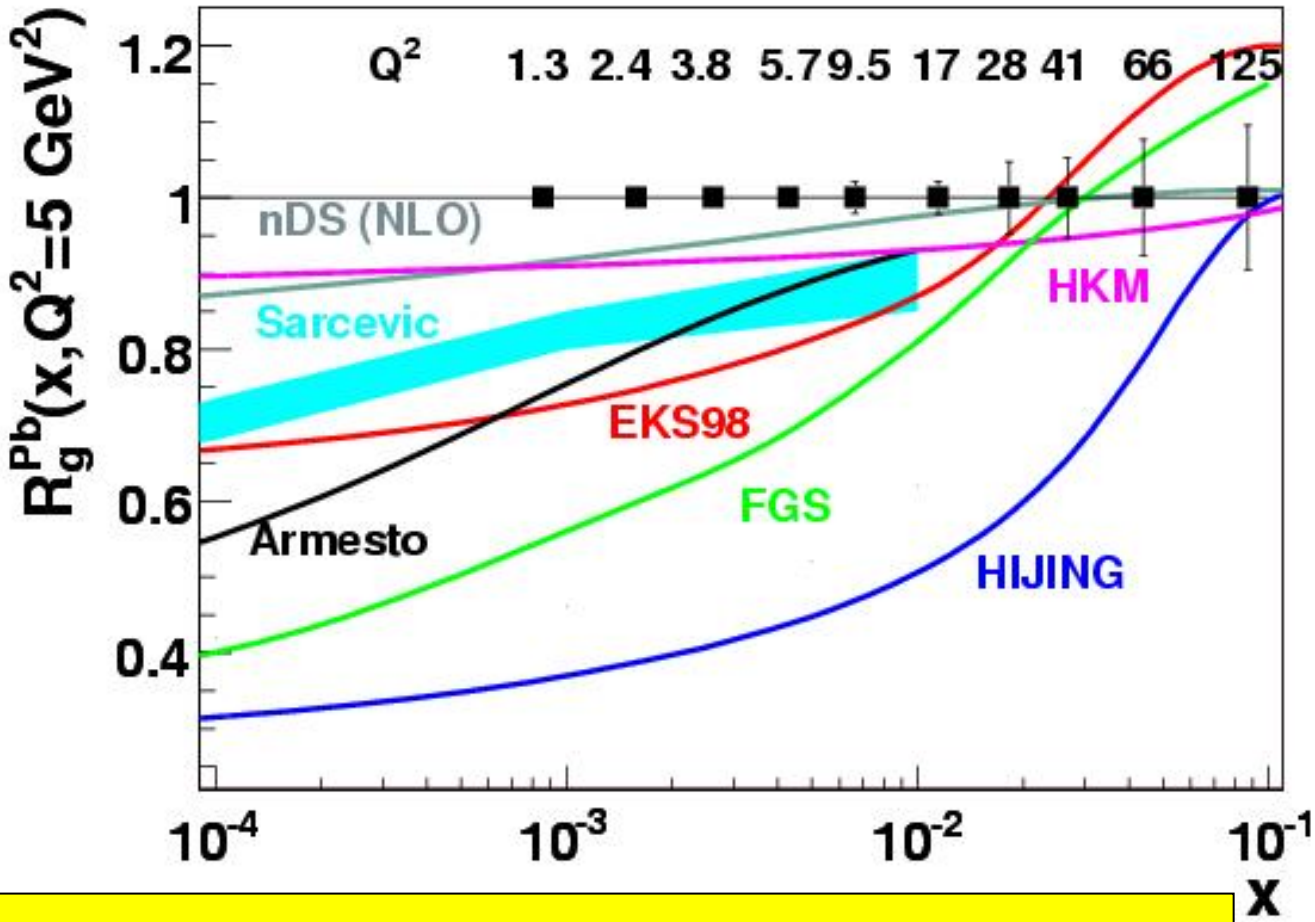
- **high luminosity highly desirable (here L ~ 5x10^{32} nuclei/cm^2/s)**
- **Q^2 range not sufficient to clearly separate between "traditional" shadowing models and effects of CGC**

Nuclear modifications of the gluon distribution

eRHIC

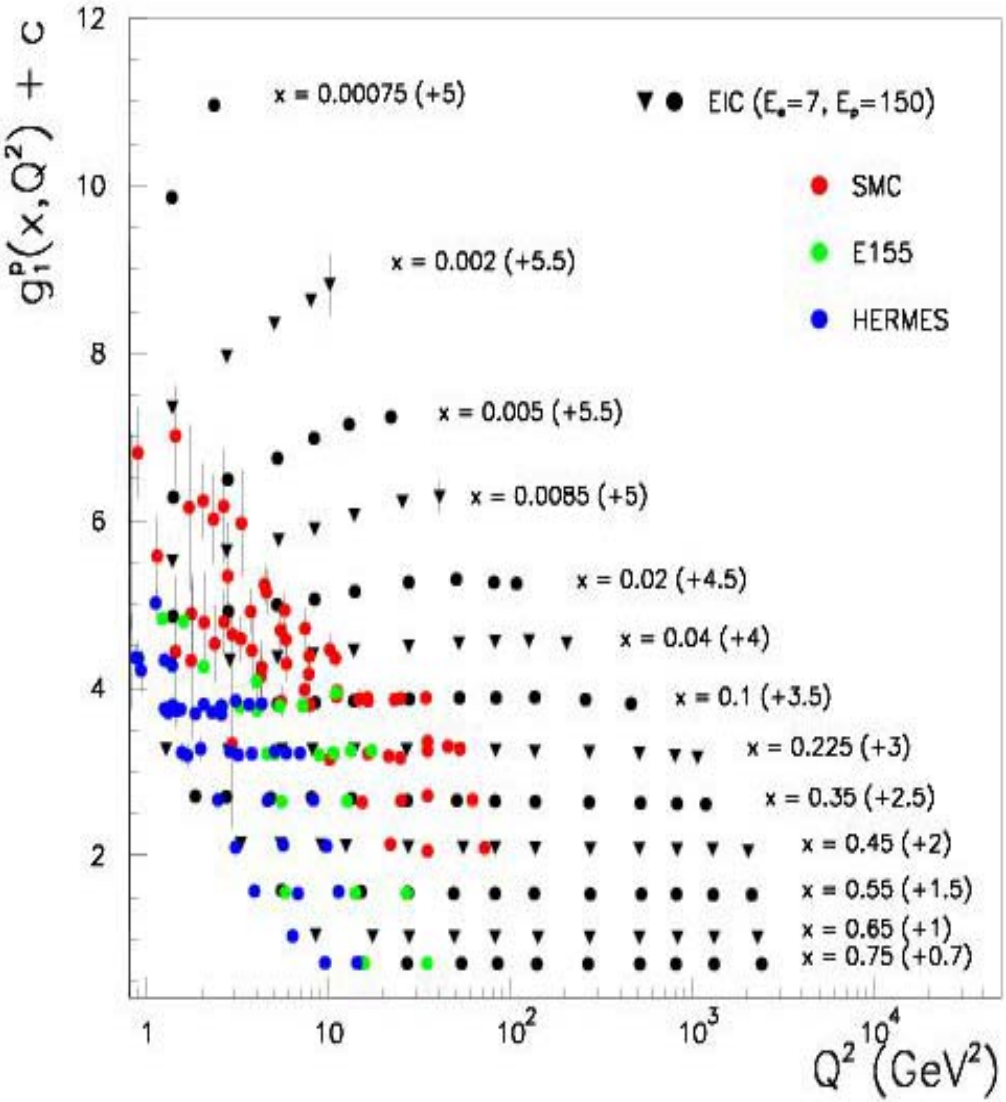
1 year of running

10 days @ 10on100
(L_{Pb}=1x10^{31})
40 days @ 6on60
(L_{Pb}=3x10^{30})
50 days @ 5on30
(L_{Pb}=2.5x10^{30})



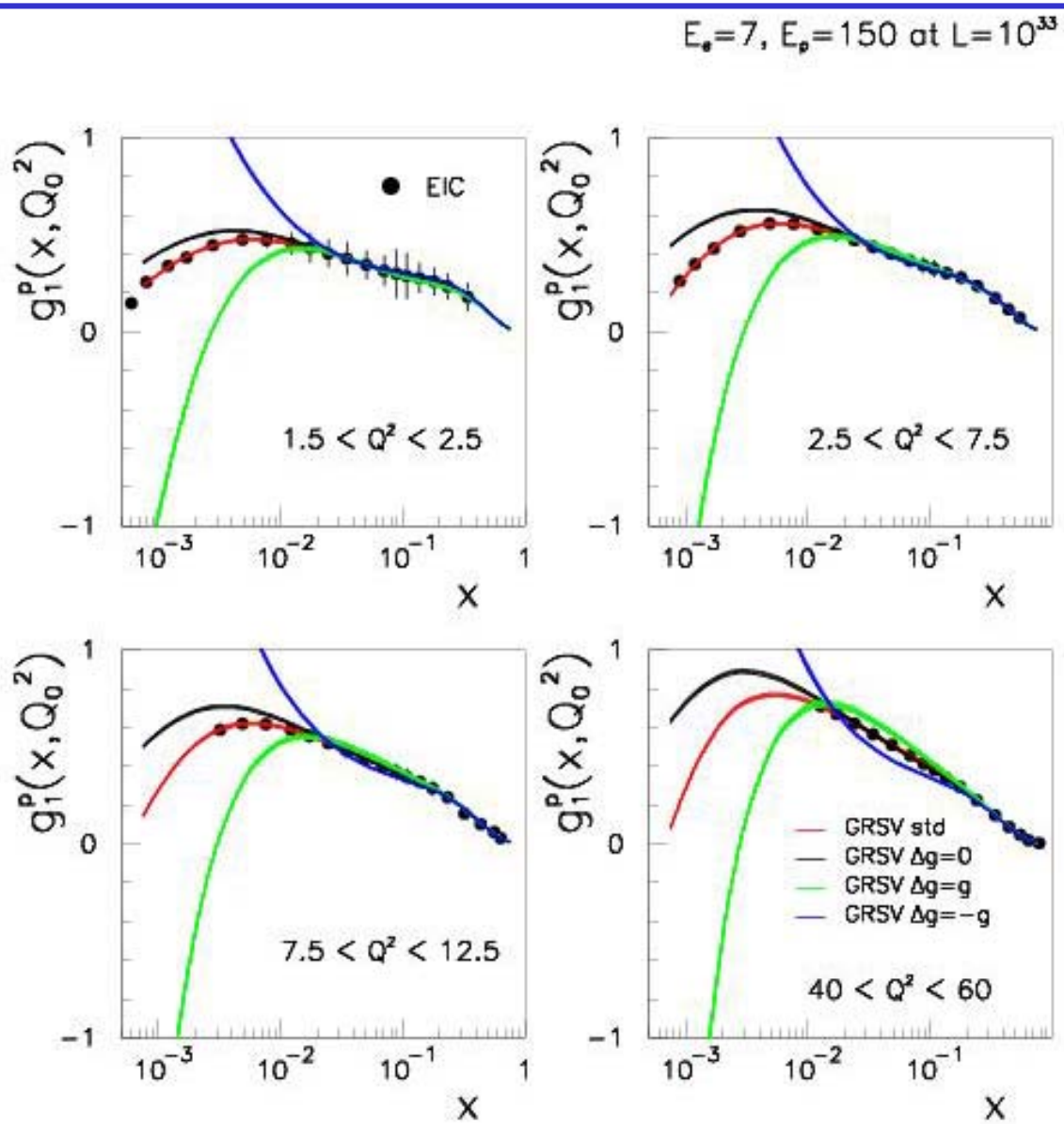
- **heavy nucleus (lead) enlarges expected effects**
- **statistical precision sufficient to separate between models**
- **Q^2 range not sufficient to clearly separate between "traditional" shadowing models and effects of CGC**

The polarised structure function g_1

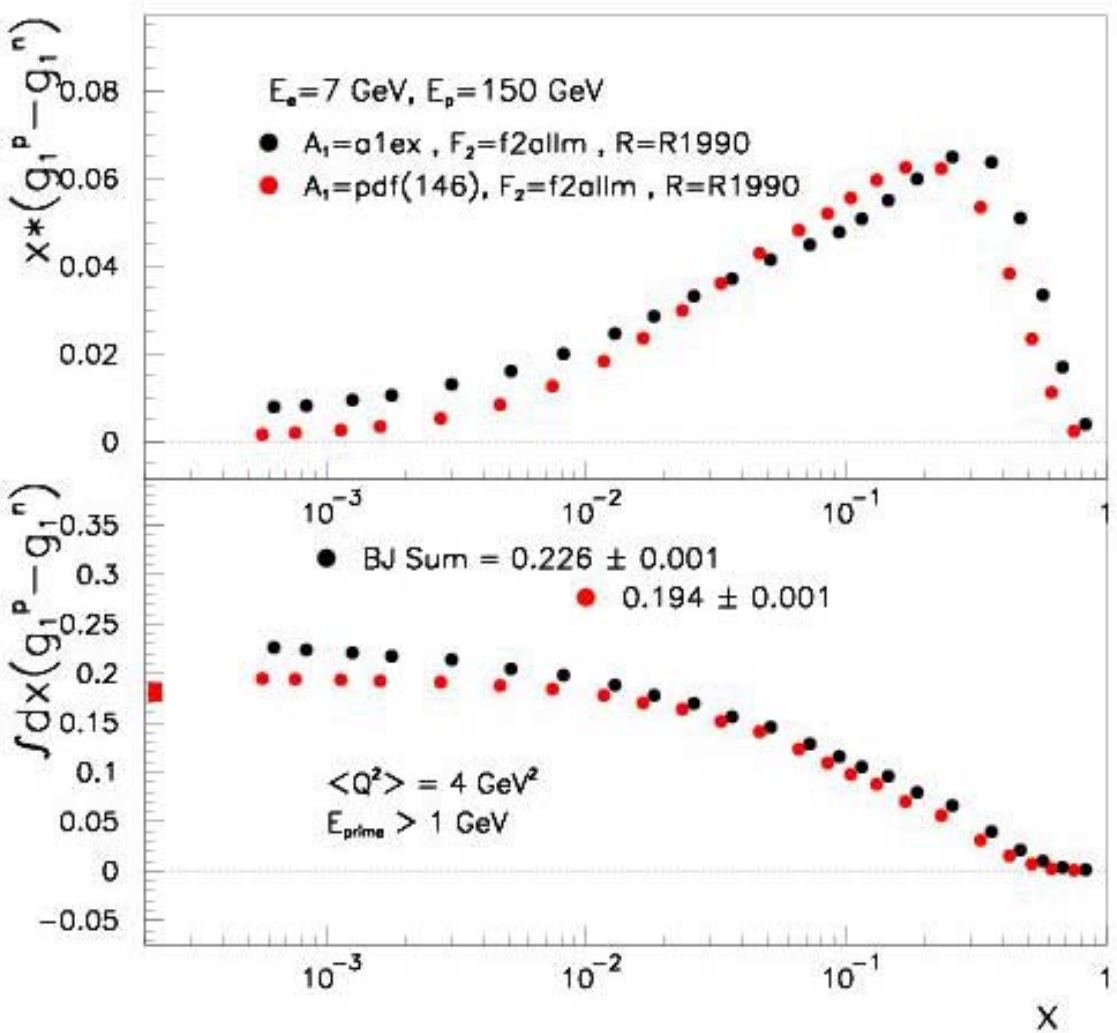


- **great coverage in x and Q^2**
- **$0.001 < x < 0.9$**
- **> 2 decades in Q^2 for $x>0.01$**
- **statistical precision and kinematic range sufficient to determine ΔG**

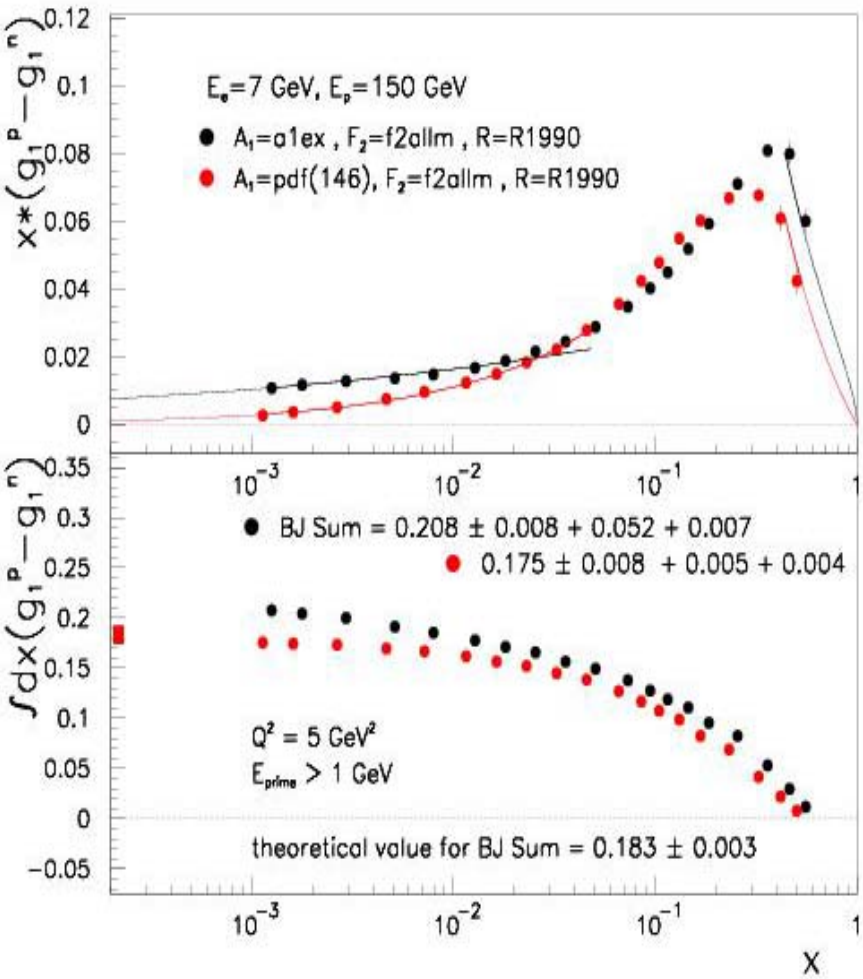
The polarised structure function g_1

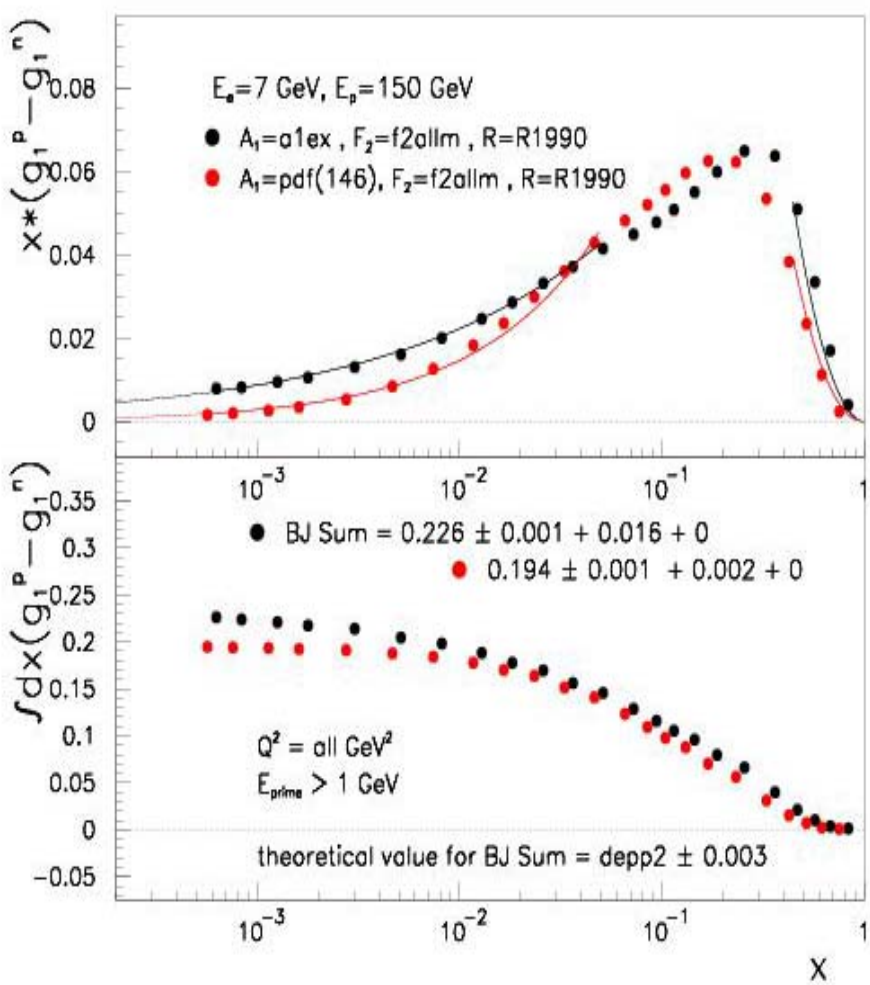


g_1 and the Bjorken Sum Rule



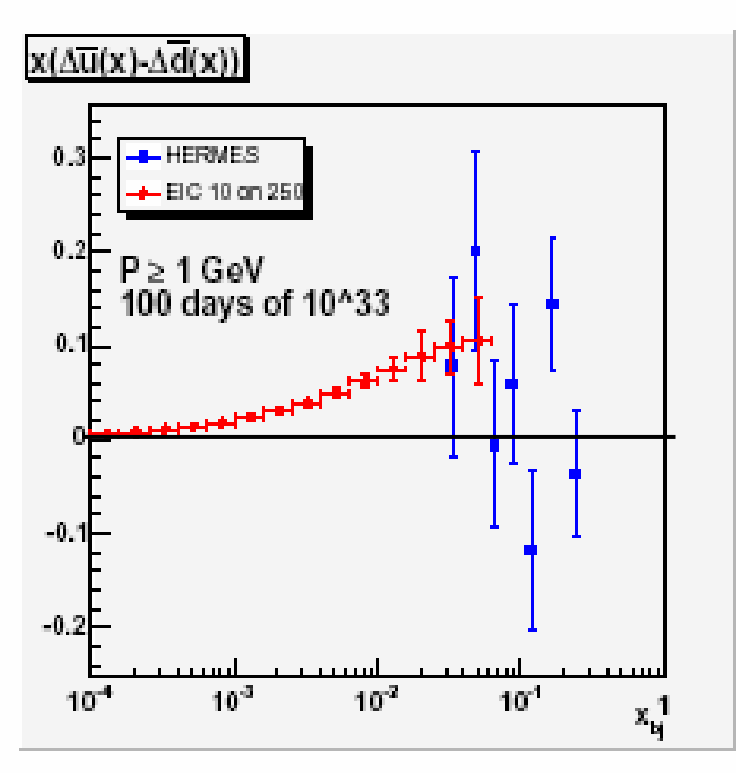
g_1 and the Bjorken Sum Rule

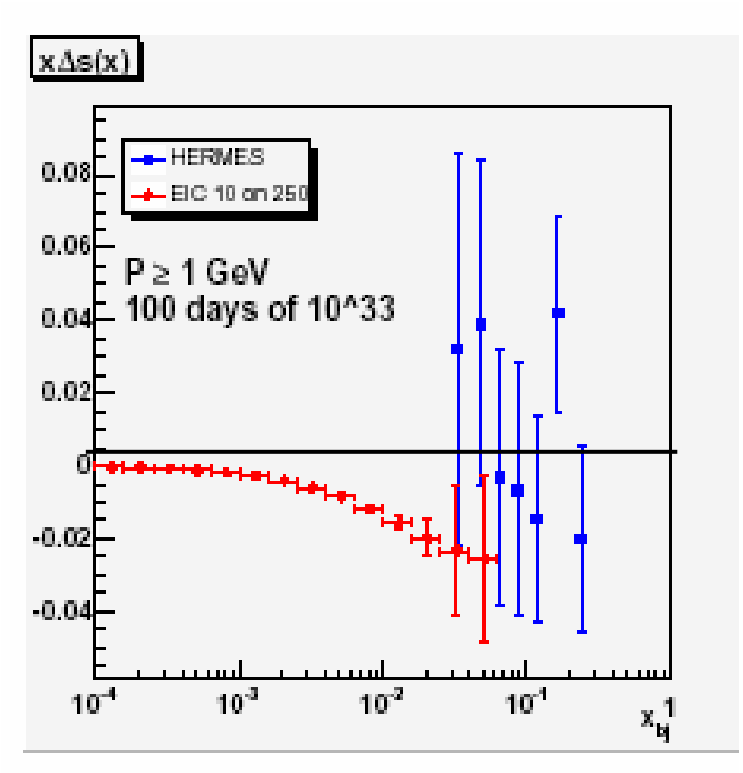




Polarisation of sea quarks

Joe Seele (Colorado)





Polarised gluon distribution via charm production

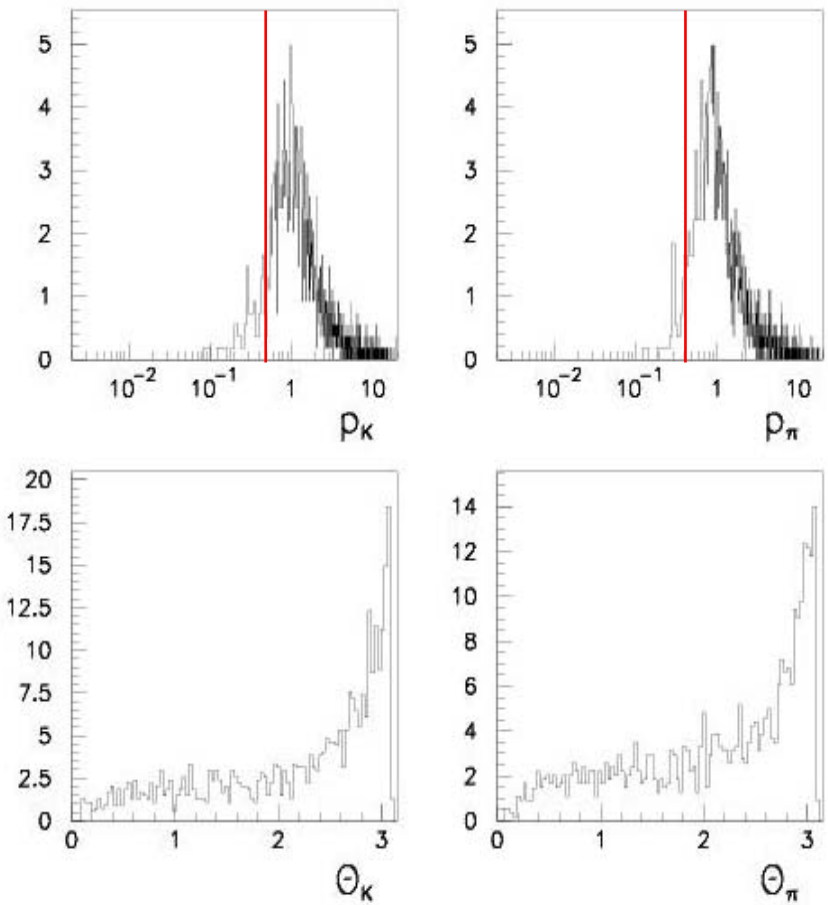
assumptions:

- **vertex separation of 100μm**
- **full angular coverage (3<Θ<177 degrees)**
- **perfect particle identification for pions and kaons (over full momentum range)**
- **detection of low momenta particles (p>0.5 GeV)**
- **measurement of scattered electron (even at very small scattering angles)**
- **100% efficiency**

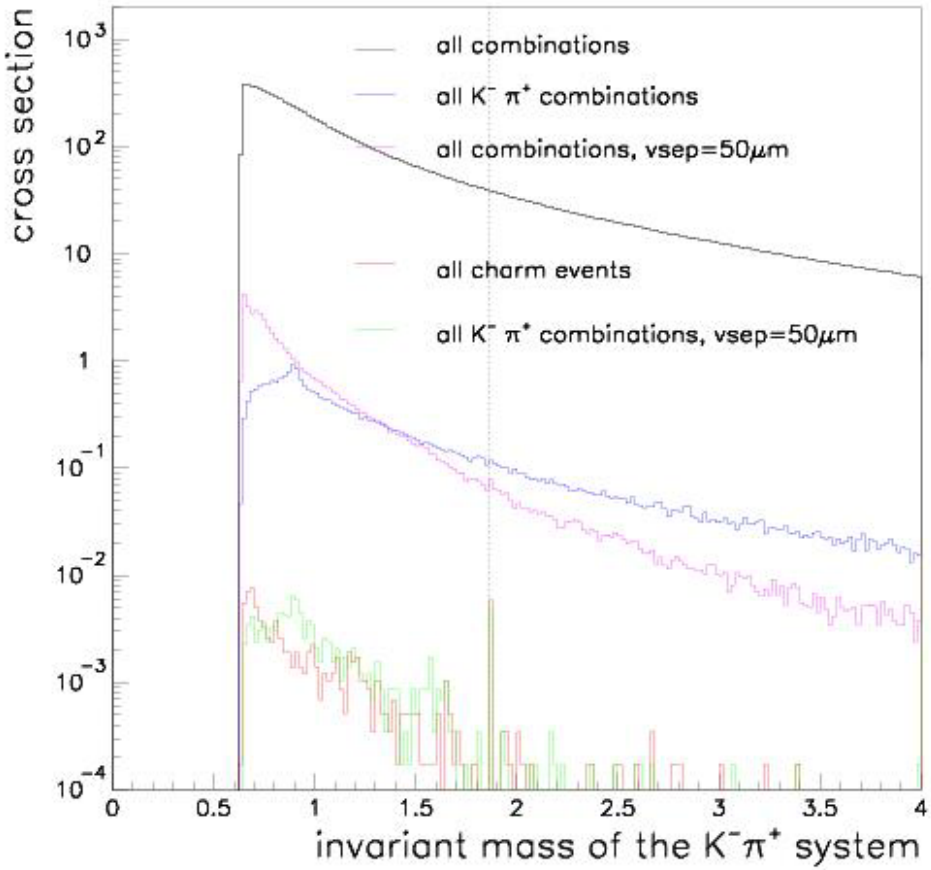
very demanding detector requirements !

Polarised gluon distribution via charm production

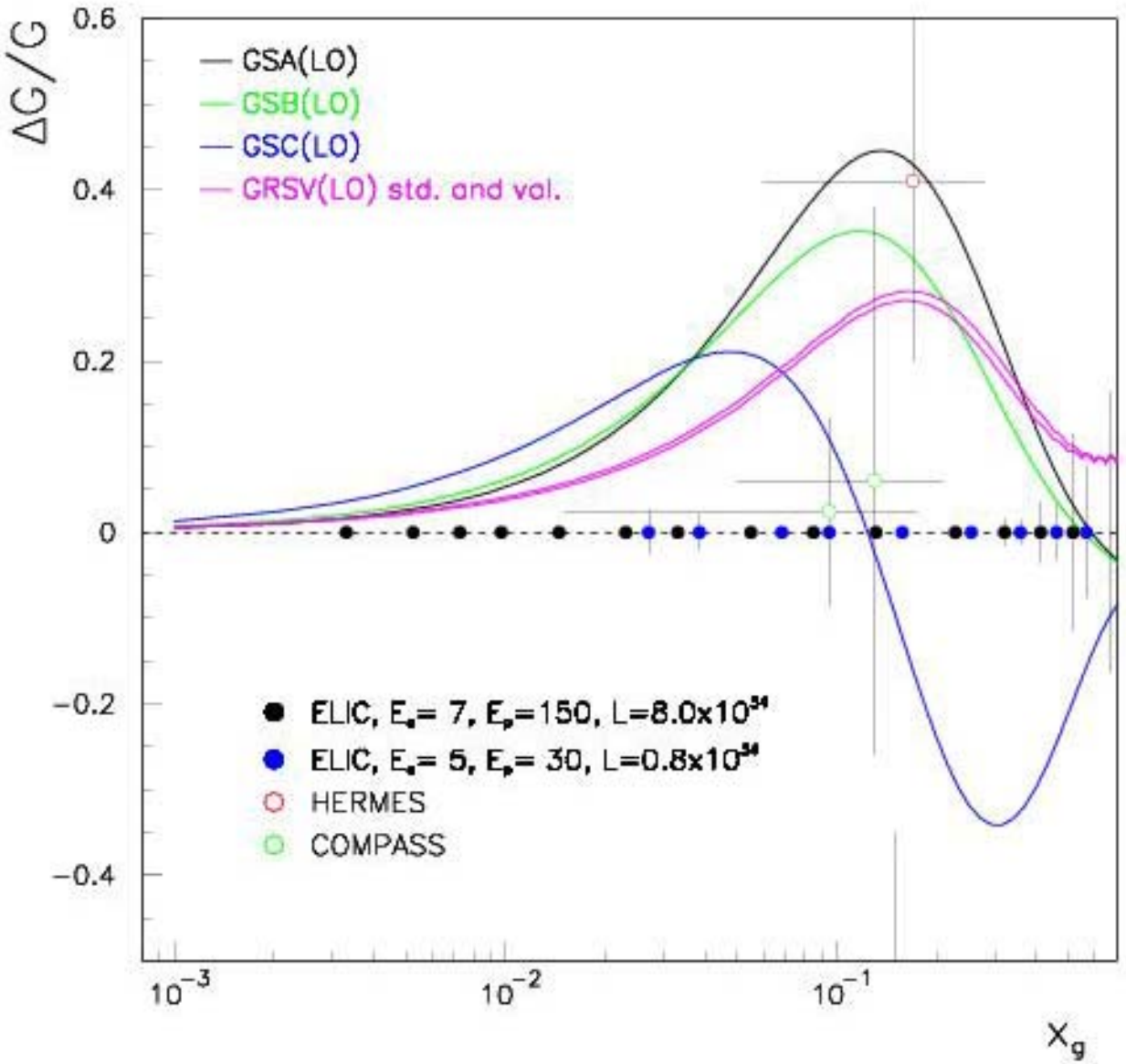
aroma – kinematics of decay particles



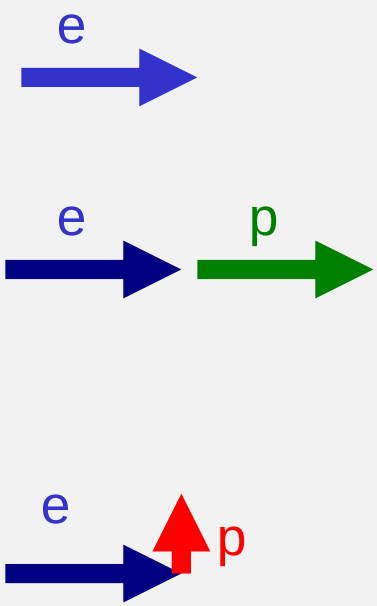
PYTHIA – hadronic D0 decays



Polarised gluon distribution via charm production



SIDIS at leading twist



N \ q	U	L	T
U	f_1		$h_1^\perp$
L		g_1	$h_{1L}^\perp$
T	$f_{1T}^\perp$	g_{1T}	h_1 $h_{1T}^\perp$

Boer

Mulders

Sivers

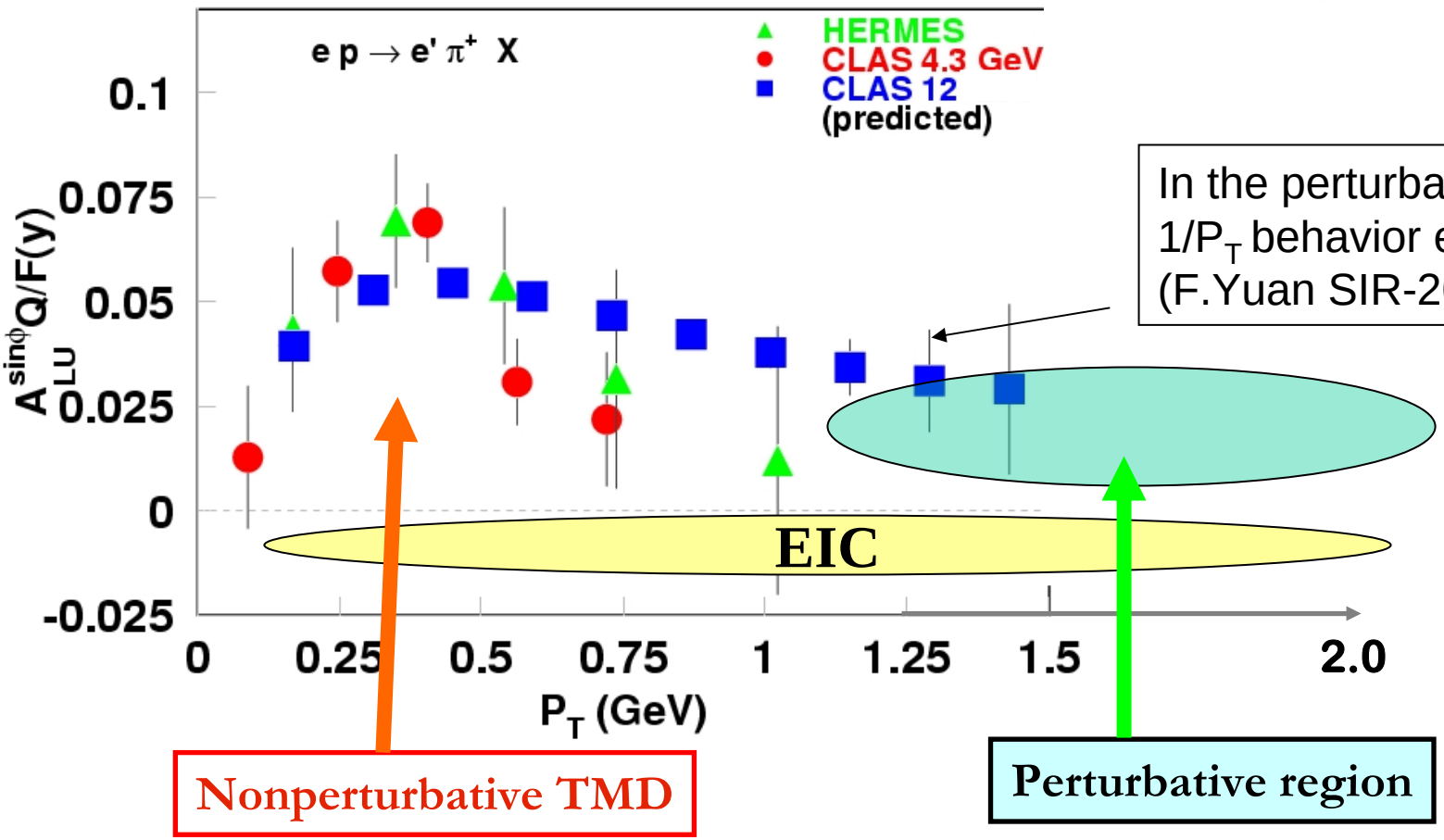
transversity

Off-diagonal PDFs vanish if quarks only in s-state! In addition T-odd PDFs require FSI (Brodsky et al., Collins, Ji et al. 2002)

P_T-dependence of beam SSA

$\sigma^{\sin\phi}_{LU(UL)} \sim F_{LU(UL)} \sim 1/Q$ (Twist-3)

$$A_{LU} \propto g^{\perp(1)}(x) D_1(z)$$



In the perturbative limit $1/P_T$ behavior expected (F.Yuan SIR-2005)

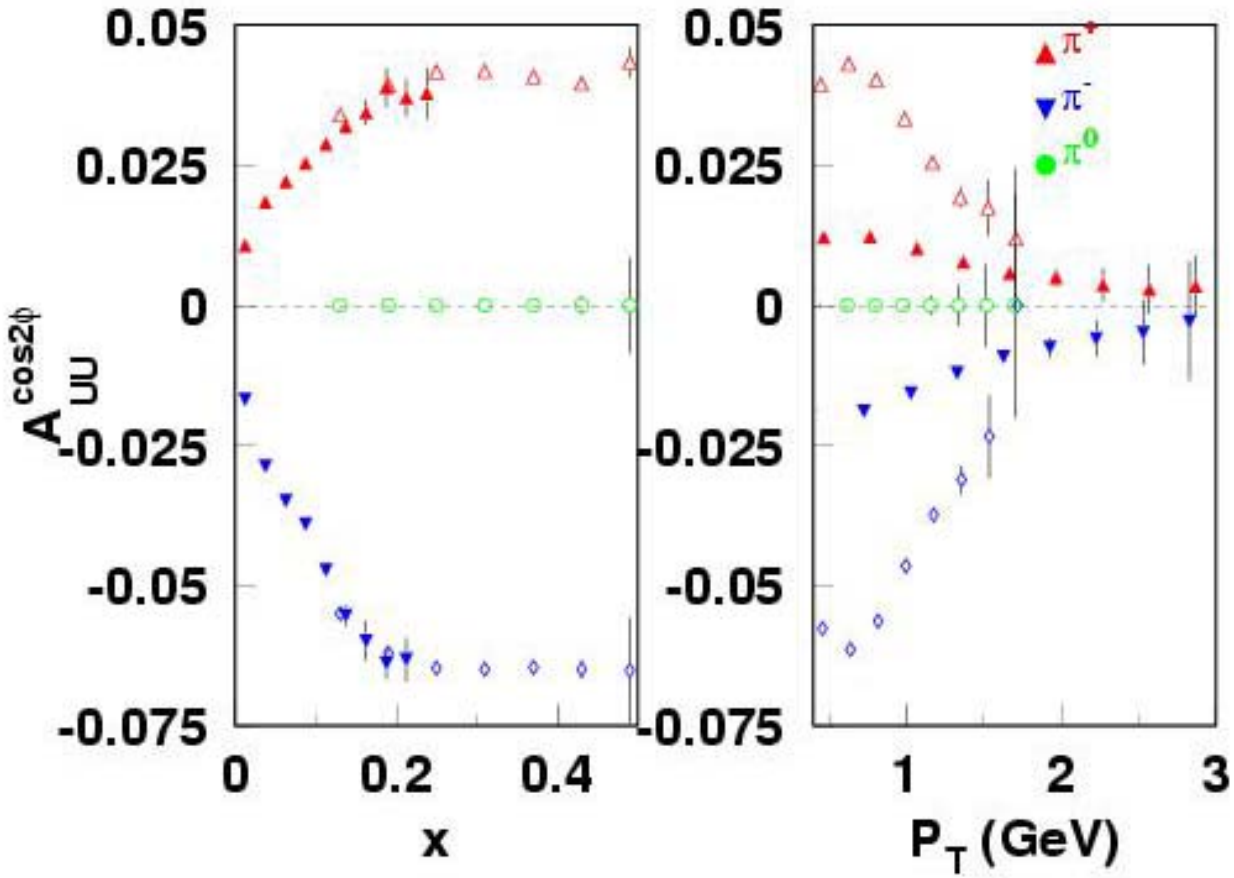
Nonperturbative TMD

Perturbative region

Study for SSA transition from non-perturbative to perturbative regime.
EIC will significantly increase the P_T range.

$A_{UU}^{\cos 2\Phi}$ (related to Boer function)

with H. Avakian



Complementary kinematic range of CLAS12 and EIC

Next Steps

- verify expected luminosities for nuclei
- get expected precision on $d(F_2^A/F_2^D)/d\ln Q^2$
- study fragmentation in charm production
- check "conversion" factor from charm cross section to ΔG
- include other charm decay channels (including D* tagging)
- **get first estimates of systematic uncertainties**
- **specify more clearly detector requirements for different processes**
- **get realistic estimates for selected exclusive processes**

Summary

Significant progress in simulations of some key measurements at EIC

• F_L measurements will give excellent determination of the gluon distribution for $0.001<x<0.1$ and at moderate Q^2

• nuclear modifications of the gluon distribution will allow a first direct experimental test of various shadowing models

• measurements of g1 will allow to address the question of its low x behaviour and a statistically very precise determination of the Bjorken Sur (systematics due to uncertainty in proton beam polarisation ??)

• measurements of the charm cross section will provide a precise determination of ΔG

• transverse momentum dependent PDFs will be accessible at much higher p_T and lower x than at CLAS12

Summary

Recent town meeting on QCD at Rutgers University (joined between Phases of QCD and Hadron Structure) recommended the EIC as the highest priority for new construction after the Jlab 12 GeV upgrade and the RHIC II upgrade

For more information:

- Zeroth order design report for the Electron-Light Ion Collider at CEBAF
- A high luminosity, high energy Electron Ion Collider: a new experimental quest to study the glue which binds us all