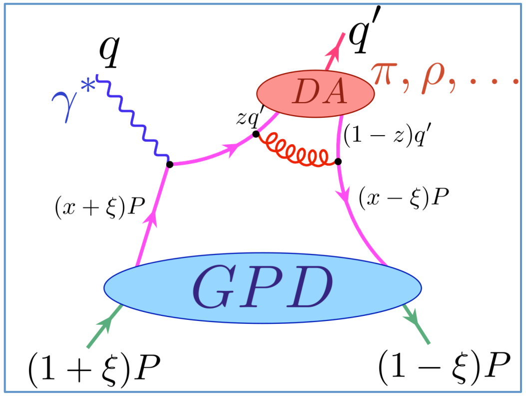
Tomographic transversity distributions and deeply exclusive meson production

Valery Kubarovsky

Jefferson Lab

Nucleon and resonance Structure with Hard Exclusive processes
May 29-31, 2017, Paris, France

Outline



- Physics motivation
- CLAS data on pseudoscalar meson electroproduction
- Transversity GPD and structure functions
- Flavor decomposition of the Transversity GPDs
- Conclusion

15 Years with Paul

2004-2006

Pentaquark Θ^+ and Θ^{++}

VOLUME 92, NUMBER 3 PHYSICAL REVIEW LETTERS week ending 23 JANUARY 2004

Observation of an Exotic Baryon with $S = +1$ in Photoproduction from the Proton

V. Kubarovsky,[1,3] L. Guo,[2] D. P. Weygand,[3] P. Stoler,[1] M. Battaglieri,[18] R. DeVita,[18] G. Adams,[1] Ji Li,[1] M. Nozar,[3]
C. Salgado,[26] P. Ambrozewicz,[13] E. Anciant,[5] M. Anghinolfi,[18] B. Asavapibhop,[24] G. Audit,[5] T. Auger,[5] H. Avakian,[3]

PRL 97, 102001 (2006) PHYSICAL REVIEW LETTERS week ending 8 SEPTEMBER 2006

Search for Θ^{++} Pentaquarks in the Exclusive Reaction $\gamma p \to K^+ K^- p$

V. Kubarovsky,[1,2] M. Battaglieri,[3] R. De Vita,[3] J. Goett,[1] L. Guo,[2] G. S. Mutchler,[6] P. Stoler,[1] D. P. Weygand,[2]
P. Ambrozewicz,[16] M. Anghinolfi,[3] G. Asryan,[39] H. Avakian,[2] H. Bagdasaryan,[33] N. Baillie,[38] J. P. Ball,[9] N. A. Baltzell,[4]

PHYSICAL REVIEW D 74, 032001 (2006)

Search for the Θ^+ pentaquark in the reactions $\gamma p \to \bar{K}^0 K^+ n$ and $\gamma p \to \bar{K}^0 K^0 p$

R. De Vita,[1] M. Battaglieri,[1] V. Kubarovsky,[2] N. A. Baltzell,[3] M. Bellis,[2,4] J. Goett,[2] L. Guo,[5] G. S. Mutchler,[6] P. Stoler,[2]

PRL 96, 042001 (2006) PHYSICAL REVIEW LETTERS week ending 3 FEBRUARY 2006

Search for $\Theta^+(1540)$ Pentaquark in High-Statistics Measurement of $\gamma p \to \bar{K}^0 K^+ n$ at CLAS

M. Battaglieri,[1] R. De Vita,[1] V. Kubarovsky,[2] L. Guo,[3] G. S. Mutchler,[4] P. Stoler,[2] D. P. Weygand,[3] P. Ambrozewicz,[14]

2008-2017

DVCS

PRL **100,** 162002 (2008) PHYSICAL REVIEW LETTERS week ending 25 APRIL 2008

Measurement of Deeply Virtual Compton Scattering Beam-Spin Asymmetries

F. X. Girod,[1,2] R. A. Niyazov,[2,32] H. Avakian,[2] J. Ball,[1] I. Bedlinskiy,[3] V. D. Burkert,[2] R. De Masi,[1,4] L. Elouadrhiri,[2] M. Garçon,[1,*] M. Guidal,[4] H. S. Jo,[4] K. Joo,[12] V. Kubarovsky,[2,32] S. V. Kuleshov,[3] M. MacCormick,[4] S. Niccolai,[4] O. Pogorelko,[3] F. Sabatié,[1] S. Stepanyan,[2] P. Stoler,[32] M. Ungaro,[12] B. Zhao,[12] M. J. Amaryan,[31] P. Ambrozewicz,[15]

PRL **115,** 212003 (2015) PHYSICAL REVIEW LETTERS week ending 20 NOVEMBER 2015

Cross Sections for the Exclusive Photon Electroproduction on the Proton and Generalized Parton Distributions

H. S. Jo,[1,*] F. X. Girod,[2,3] H. Avakian,[2] V. D. Burkert,[2] M. Garçon,[3] M. Guidal,[1] V. Kubarovsky,[2,4] S. Niccolai,[1] P. Stoler,[4] K. P. Adhikari,[27] D. Adikaram,[27,†] M. J. Amaryan,[27] M. D. Anderson,[35] S. Anefalos Pereira,[17] J. Ball,[3] N. A. Baltzell,[5,31]

Cross sections for the Deeply Virtual Compton Scattering (DVCS) on the proton at Jefferson Laboratory

N. Hirlinger Saylor, B. Guegan, M. Guidal, P. Stoler, F-X. Girod, H-S. Jo, V. Kubarovsky, S. Niccolai, et al.*
Rensselaer Polytechnic Institute and Institut de Physique Nucléaire

2006-2013

π^0 in Resonance Region

PRL **97,** 112003 (2006) PHYSICAL REVIEW LETTERS week ending 15 SEPTEMBER 2006

Measurement of the $N \to \Delta^+(1232)$ Transition at High-Momentum Transfer by π^0 Electroproduction

M. Ungaro,[1,2,3] P. Stoler,[1] I. Aznauryan,[3,40] V. D. Burkert,[3] K. Joo,[2] L. C. Smith,[38] G. Adams,[1] M. Amarian,[31]
P. Ambrozewicz,[13] M. Anghinolfi,[19] G. Asryan,[40] G. Audit,[9] H. Avakian,[3] H. Bagdasaryan,[40,31] J. P. Ball,[4] N. A. Baltzell,[35]

PHYSICAL REVIEW C **80**, 035203 (2009)

Neutral pion electroproduction in the resonance region at high Q^2

A. N. Villano,[1,*] P. Stoler,[1] P. E. Bosted,[2] S. H. Connell,[3] M. M. Dalton,[4] M. K. Jones,[2] V. Kubarovsky,[1] G. S. Adams,[1]
A. Ahmidouch,[5] J. Arrington,[6] R. Asaturyan,[7,†] O. K. Baker,[2,8] H. Breuer,[9] M. E. Christy,[8] S. Danagoulian,[5] D. Day,[10]

PHYSICAL REVIEW C **87**, 045205 (2013)

Near-threshold neutral pion electroproduction at high momentum transfers and generalized form factors

P. Khetarpal,[30,12] P. Stoler,[30] I. G. Aznauryan,[35,40] V. Kubarovsky,[35,30] K. P. Adhikari,[29] D. Adikaram,[29] M. Aghasyan,[18]
M. J. Amaryan,[29] M. D. Anderson,[37] S. Anefalos Pereira,[18] M. Anghinolfi,[19] H. Avakian,[35] H. Baghdasaryan,[38,29] J. Ball,[7]

2012-2017

π^0/η Exclusive Electroproduction

PRL **109,** 112001 (2012) PHYSICAL REVIEW LETTERS week ending 14 SEPTEMBER 2012

Measurement of Exclusive π^0 Electroproduction Structure Functions and their Relationship to Transverse Generalized Parton Distributions

I. Bedlinskiy,[22] V. Kubarovsky,[35,30] S. Niccolai,[21] P. Stoler,[30] K. P. Adhikari,[29] M. Aghasyan,[18] M. J. Amaryan,[29] M. Anghinolfi,[19] H. Avakian,[35] H. Baghdasaryan,[39,41] J. Ball,[7] N. A. Baltzell,[1] M. Battaglieri,[19] R. P. Bennett,[29]

PHYSICAL REVIEW C **90**, 025205 (2014)

Exclusive π^0 electroproduction at $W > 2$ GeV with CLAS

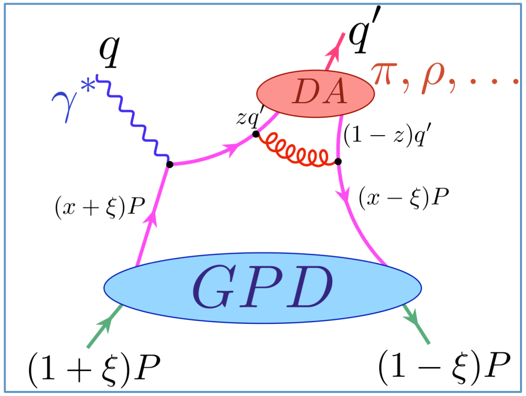
I. Bedlinskiy,[19] V. Kubarovsky,[32,27] S. Niccolai,[18,12] P. Stoler,[27] K. P. Adhikari,[26] M. D. Anderson,[35] S. Anefalos Pereira,[15] H. Avakian,[32] J. Ball,[6] N. A. Baltzell,[1,31] M. Battaglieri,[16] V. Batourine,[32,21] A. S. Biselli,[9] S. Boiarinov,[32] J. Bono,[10]

PHYSICAL REVIEW C **95**, 035202 (2017)

Exclusive η electroproduction at $W > 2$ GeV with CLAS and transversity generalized parton distributions

I. Bedlinskiy,[22] V. Kubarovsky,[36,31] P. Stoler,[31] K. P. Adhikari,[25] Z. Akbar,[12] S. Anefalos Pereira,[17] H. Avakian,[36] J. Ball,[7] N. A. Baltzell,[36,34] M. Battaglieri,[18] V. Batourine,[36,24] A. S. Biselli,[10,5] S. Boiarinov,[36] W. J. Briscoe,[14] V. D. Burkert,[36]

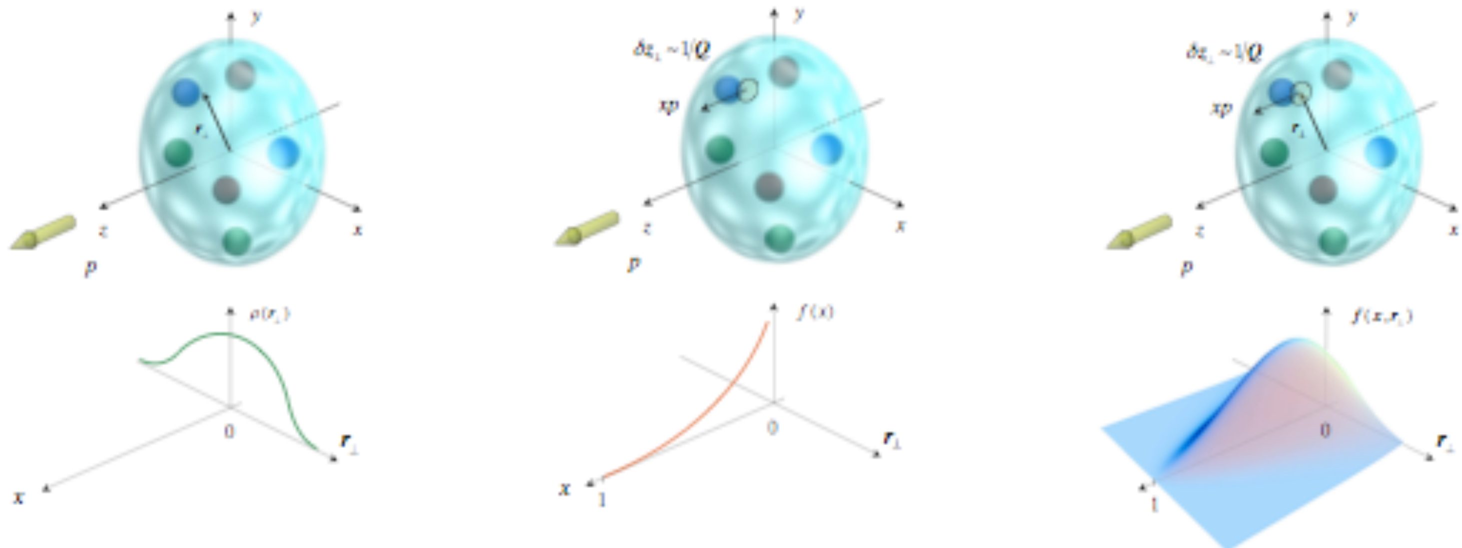
Outline



- Physics motivation
- CLAS data on pseudoscalar meson electroproduction
- Transversity GPD and structure functions
- Flavor decomposition of the Transversity GPDs
- Conclusion

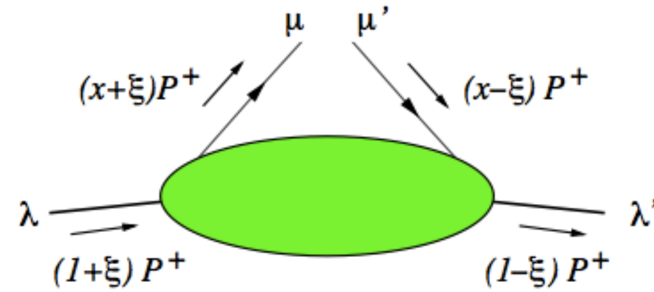
Description of hadron structure in terms of GPDs

D. Mu¨ller ’,X. Ji, A. Radyushkin



Nucleon form factors	*Structure functions*	*GPDs*
transverse charge & current densities Nobel prize 1961- R. Hofstadter	quark longitudinal momentum (polarized and unpolarized) distributions Nobel prize 1990 –J.Friedman, H. Kendall, R. Taylor	correlated quark momentum distributions (polarized and unpolarized) in transverse space

Generalized Parton Distributions



- GPDs are the functions of three kinematic variables: x, ξ and t
- There are 4 chiral even GPDs where partons do not flip helicity $H, \tilde{H}, E, \tilde{E}$
- 4 chiral odd GPDs flip the parton helicity

  $H_T, \tilde{H}_T, E_T, \tilde{E}_T$
- The chiral-odd GPDs are difficult to access since subprocesses with quark helicity-flip are suppressed

Chiral-odd GPDs

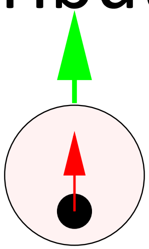
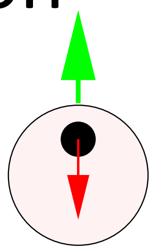
- Very little known about the chiral-odd GPDs
- Anomalous tensor magnetic moment

$$\kappa_T = \int_{-1}^{+1} dx\ \bar{E}_T(x, \xi, t=0)$$

- (Compare with anomalous magnetic moment)

$$\kappa = \int_{-1}^{+1} dx\ E(x, \xi, t=0) = F_2(t=0)$$

- Transversity distribution $H_T^q(x,0,0) = h_1^q(x)$

$h_1 =$  - 

The transversity describes the distribution of transversely polarized quarks in a transversely polarized nucleon

$ep \to ep\pi^0$

Structure functions and GPDs

$$\frac{d^4\sigma}{dQ^2 dx_B dt d\phi_\pi} = \Gamma(Q^2, x_B, E)\frac{1}{2\pi}(\sigma_T + \epsilon\sigma_L + \epsilon\cos 2\phi_\pi \sigma_{TT} + \sqrt{2\epsilon(1+\epsilon)}\cos\phi_\pi \sigma_{LT})$$

Leading twist σ_L

$$\sigma_L = \frac{4\pi\alpha_e}{\kappa Q^2}[(1-\xi^2)|\langle\tilde{H}\rangle|^2 - 2\xi^2 Re(\langle\tilde{H}\rangle|\langle\tilde{E}\rangle) - \frac{t}{4m^2}\xi^2|\langle\tilde{E}\rangle|^2]$$

σ_L suppressed by a factor coming from:

$$\tilde{H}^\pi = \frac{1}{3\sqrt{2}}[2\tilde{H}^u + \tilde{H}^d]$$

$\tilde{H}^u$ and $\tilde{H}^d$ have opposite signes

S. Goloskokov and P. Kroll
S. Liuti and G. Goldstein

$$\langle\tilde{H}\rangle = \sum_\lambda \int_{-1}^{1} dx M(x,\xi,Q^2,\lambda)\tilde{H}(x,\xi,t)$$

$$\langle\tilde{E}\rangle = \sum_\lambda \int_{-1}^{1} dx M(x,\xi,Q^2,\lambda)\tilde{E}(x,\xi,t)$$

The brackets <F> denote the convolution of the elementary process with the GPD F (generalized form factors)

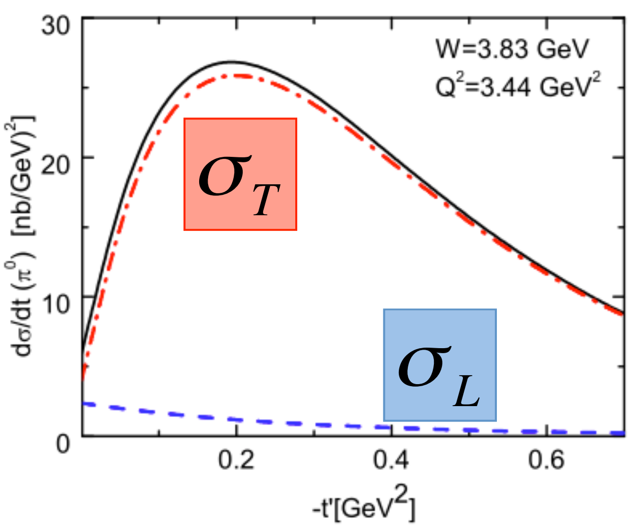
$$ep \to ep\pi^0$$

Structure functions and GPDs

$$\frac{d^4\sigma}{dQ^2 dx_B dt d\phi_\pi} = \Gamma(Q^2, x_B, E)\frac{1}{2\pi}(\sigma_T + \epsilon\sigma_L + \epsilon\cos 2\phi_\pi \sigma_{TT} + \sqrt{2\epsilon(1+\epsilon)}\cos\phi_\pi \sigma_{LT})$$

$$\sigma_T = \frac{4\pi\alpha_e}{2\kappa}\frac{\mu_\pi^2}{Q^4}[(1-\xi^2)|\langle H_T\rangle|^2 - \frac{t'}{8m^2}|\langle \bar{E}_T\rangle|^2]$$

$$\sigma_{TT} = \frac{4\pi\alpha_e}{2\kappa}\frac{\mu_\pi^2}{Q^4}\frac{t'}{8m^2}|\langle \bar{E}_T\rangle|^2$$



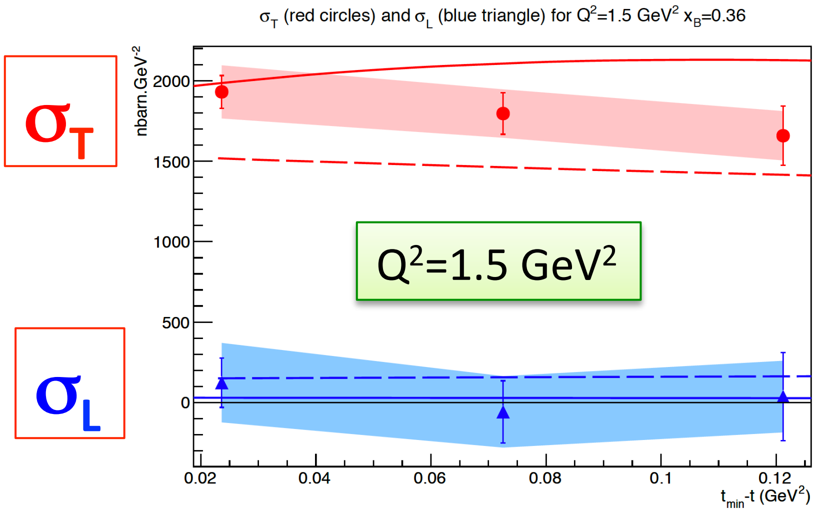
Transversity GPD model

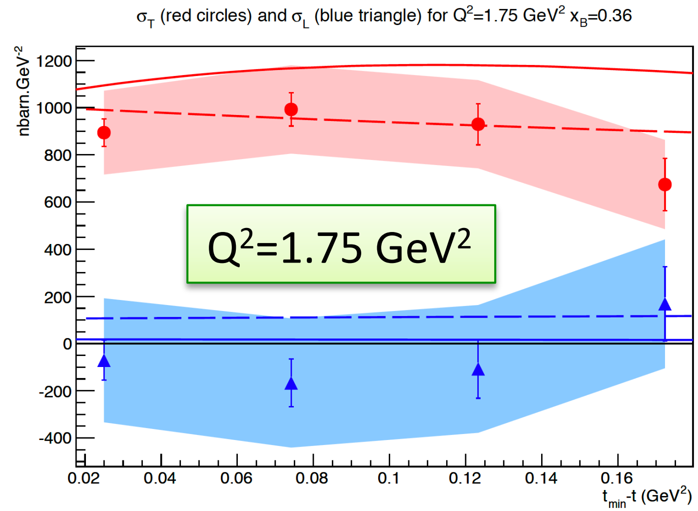
S. Goloskokov and P. Kroll

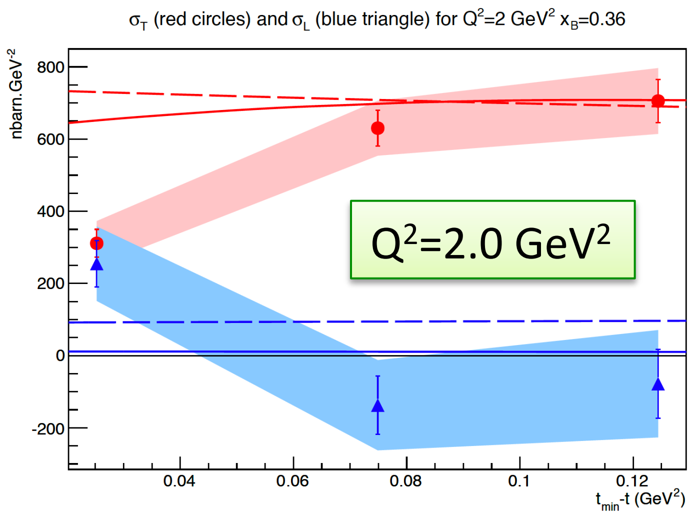
S. Liuti and G. Goldstein

- $\sigma_L \ll \sigma_T$
- t-dependence at $t=t_{min}$ is determined by the interplay between H_T and $\bar{E}_T = 2\tilde{H}_T + E_T$

Rosenbluth separation σ_T and σ_L
Hall-A Jefferson Lab





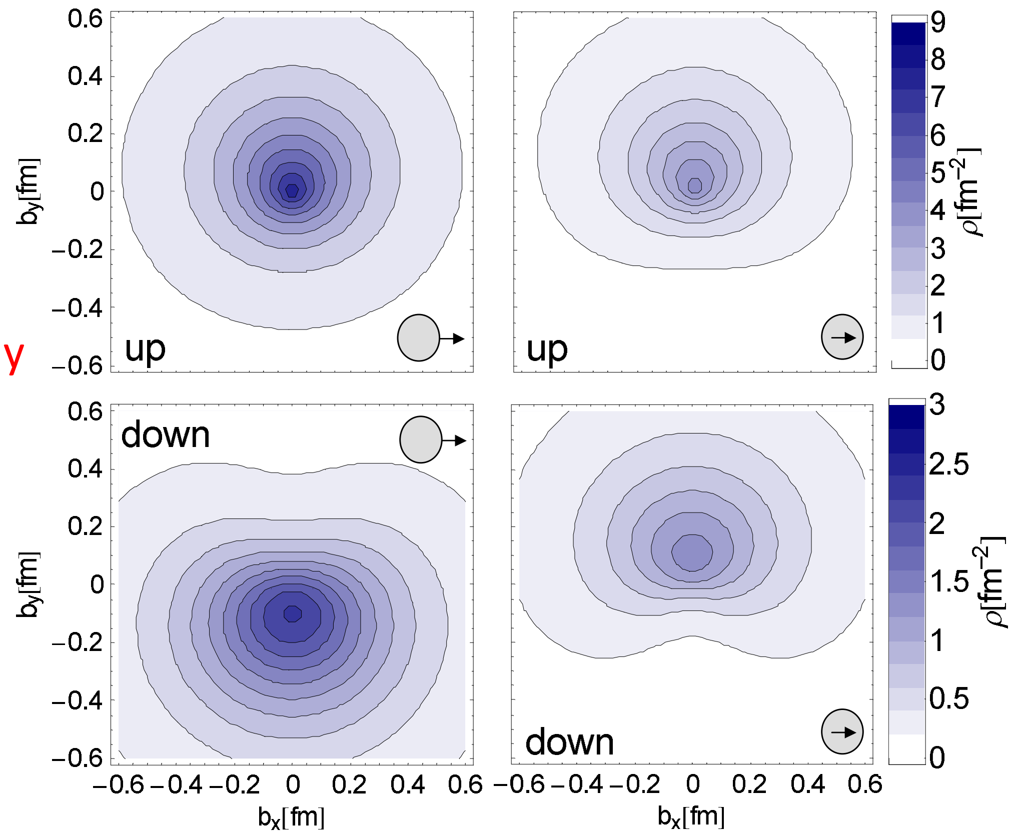


- Experimental **proof** that the transverse π^0 cross section is dominant!
- It opens the direct way to study the transversity GPDs in pseudoscalar exclusive production

Hall-A, Phys.Rev.Lett. **117**,262001(2016)

Transverse Densities for u and d Quarks in the Nucleon

Strong distortions for unpolarized quarks in transversely polarized nucleon



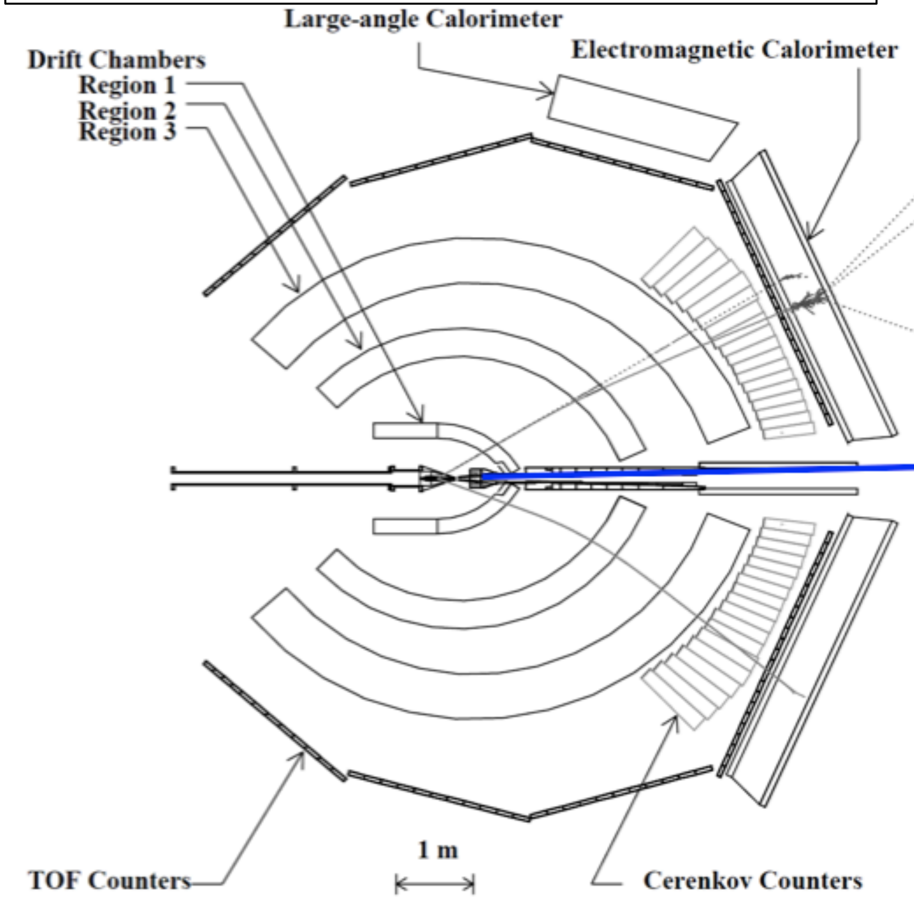
Strong distortions for transversely polarized quarks in an unpolarized nucleon

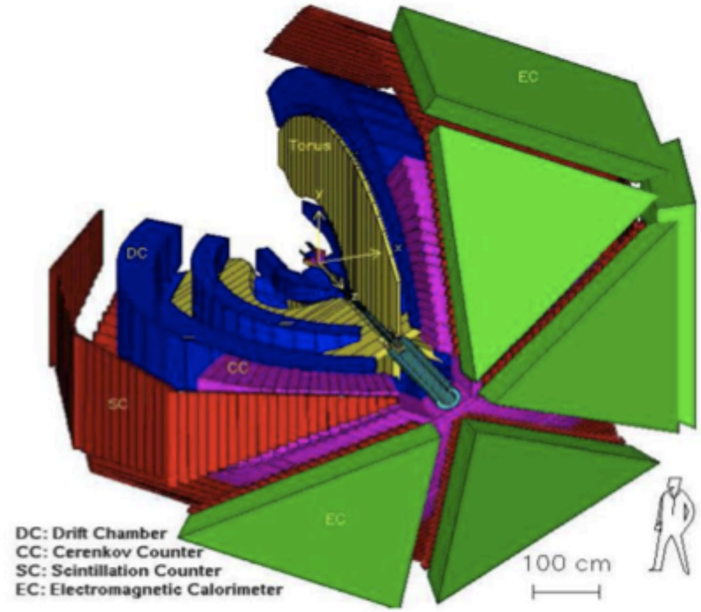
Described by E

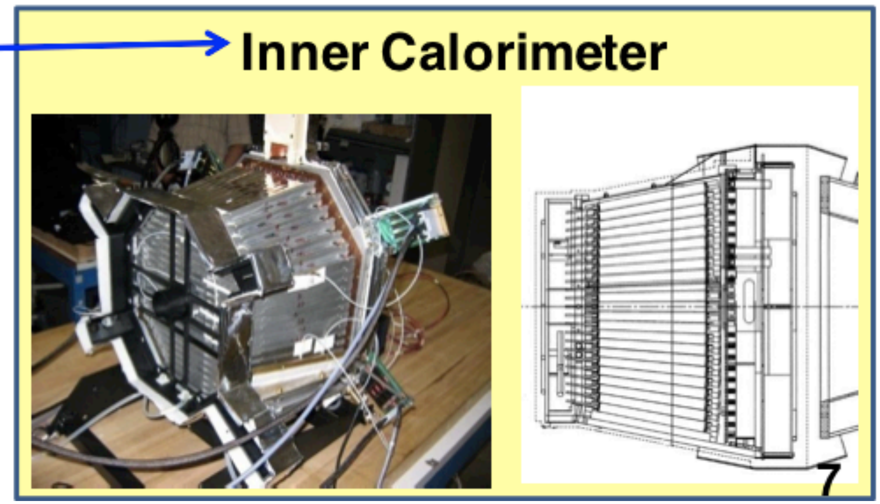
Described by $\bar{E}_T = 2\tilde{H}_T + E_T$

Gockeler et al, Phys. Rev. Lett. 98, 222001 (2007), lattice

CEBAF Large Acceptance Spectrometer CLAS







CLAS Lead Tungstate Electromagnetic Calorimeter

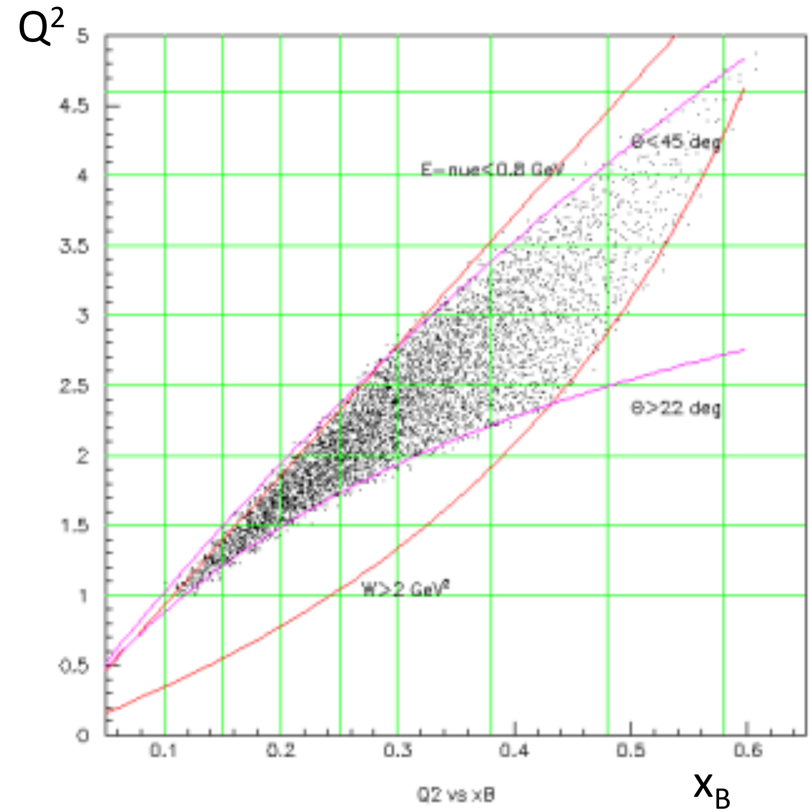
424 crystals, 18 RL,
Pointing geometry,
APD readout

4 Dimensional Grid

$ep \to ep\pi^0$

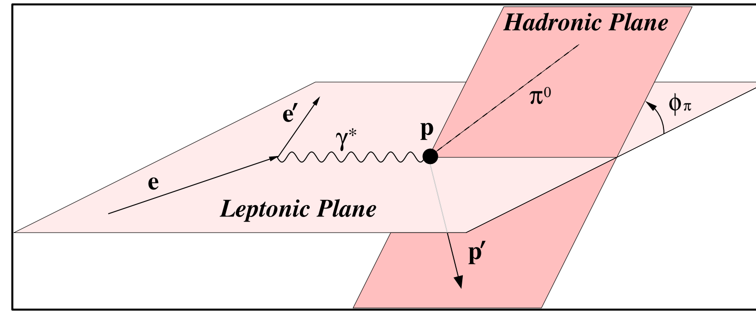
Rectangular bins are used.

- Q^2 7 bins(1.-4.5GeV^2)
- x_B 7 bins(0.1-0.58)
- t 8 bins(0.09-2.0GeV)
- ϕ 20 bins(0-360°)
- π^0 data ~2000 points
- η data ~1000 points

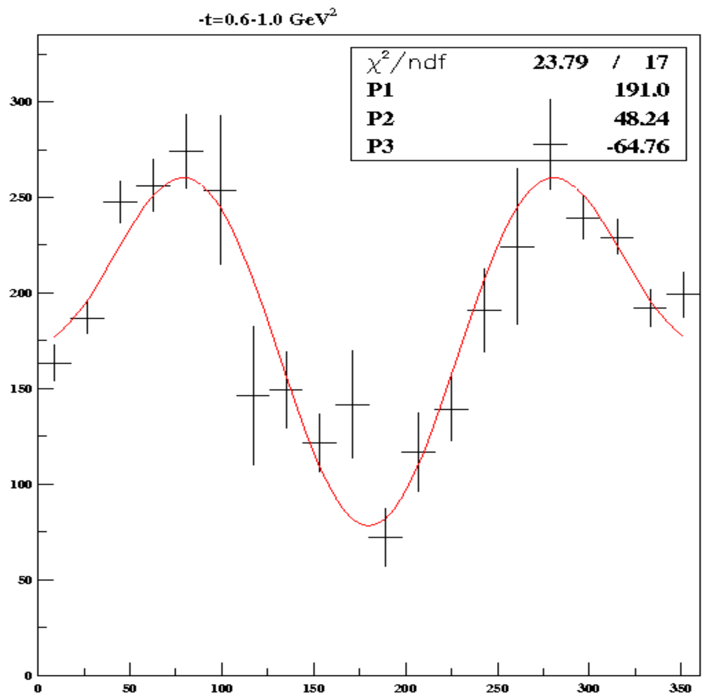


Structure Functions

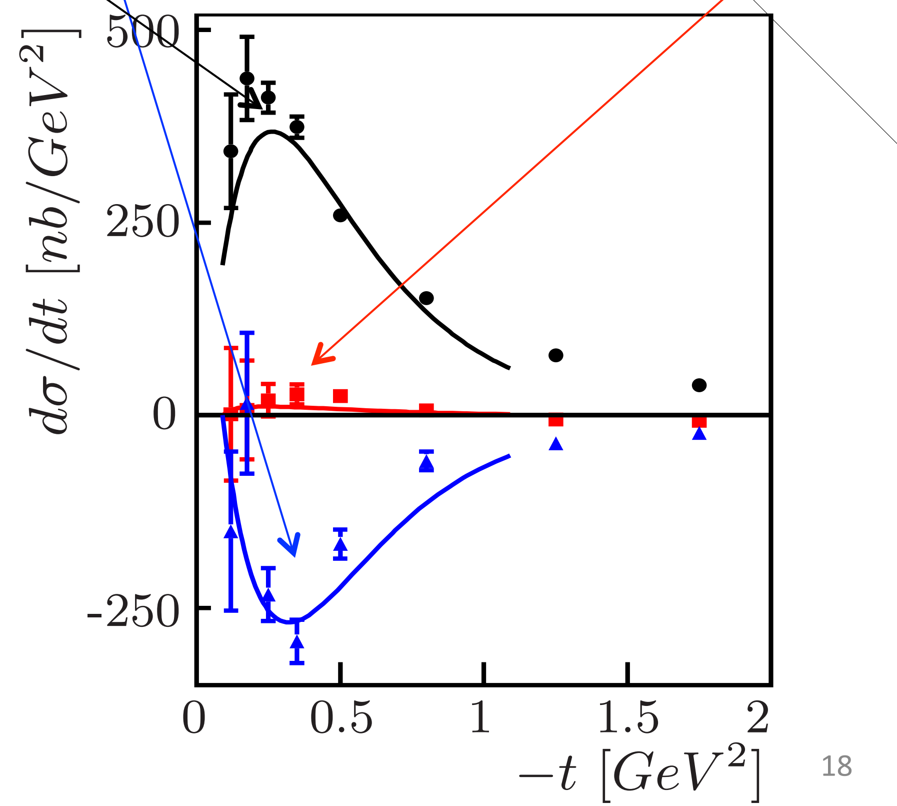
$\sigma_U = \sigma_T + \varepsilon\sigma_L \quad \sigma_{TT} \quad \sigma_{LT}$



$$\frac{d\sigma}{dtd\phi}(Q^2,x,t,\phi) = \frac{1}{2\pi}\left(\left(\frac{d\sigma_T}{dt} + \varepsilon\frac{d\sigma_L}{dt}\right) + \varepsilon\frac{d\sigma_{TT}}{dt}\cos 2\phi + \sqrt{2\varepsilon(\varepsilon+1)}\frac{d\sigma_{LT}}{dt}\cos\phi\right)$$



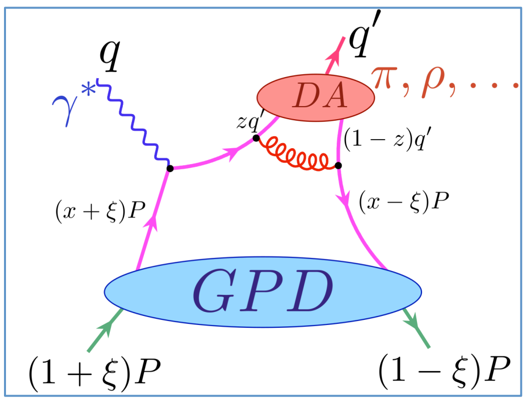
φ distribution

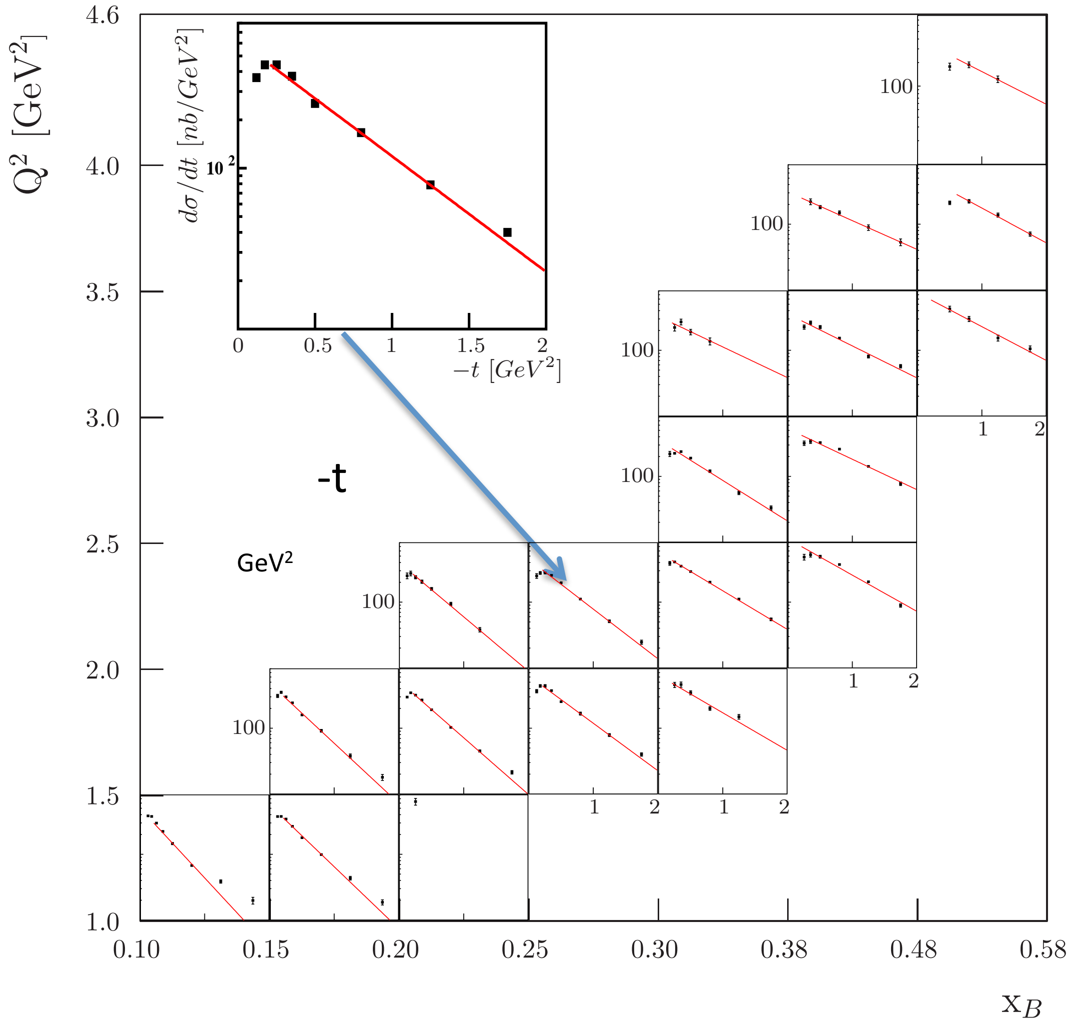


-t

$d\sigma_U/dt$

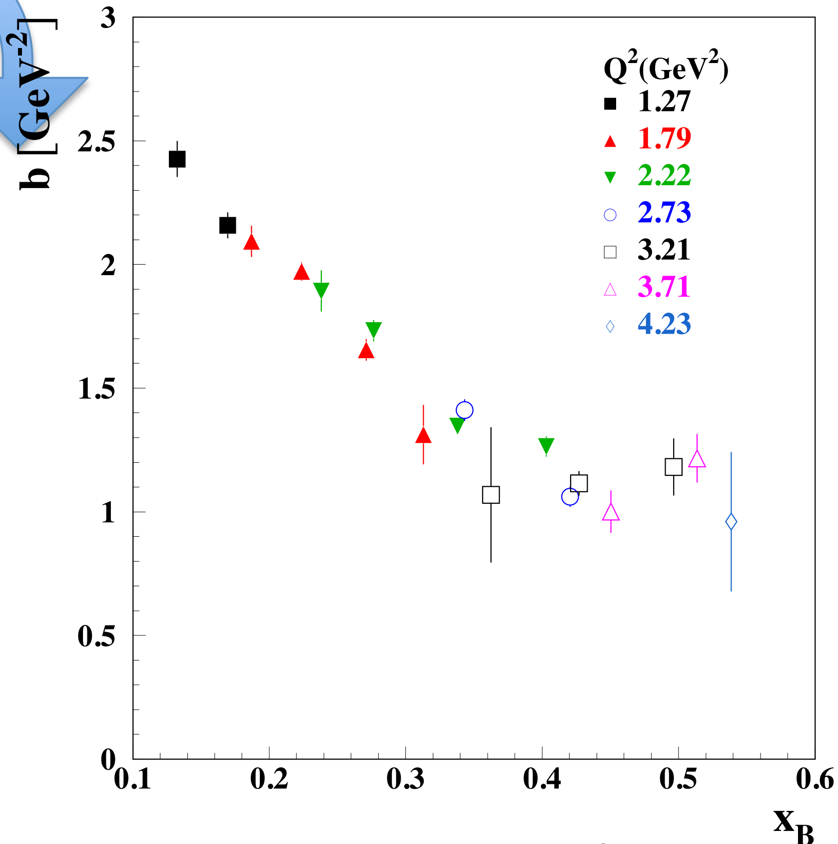
$$\frac{d\sigma}{dt}(\gamma^* p \to ep\pi^0) \propto e^{bt}$$





t-slope parameter: x_B dependence

$$\frac{d\sigma}{dt} \propto e^{bt}$$

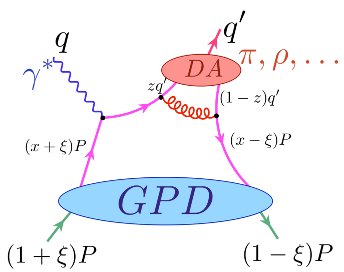


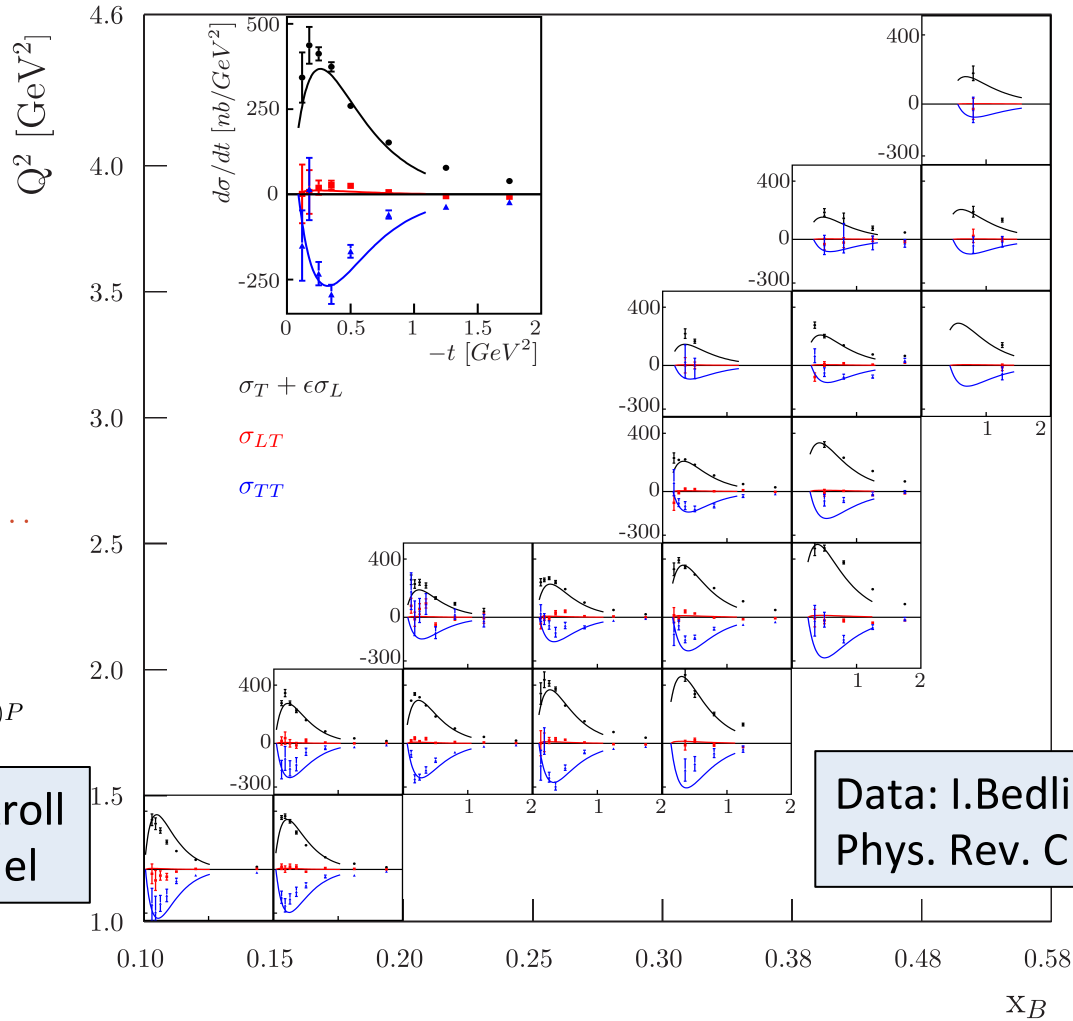
The slope parameter is decreasing with increasing x_B. The Q^2 dependence is weak. Looking to this picture we can say that the perp width of the partons with x→1 goes to zero.

Structure Functions

$(\sigma_T + \varepsilon\sigma_L)$ σ_{TT} σ_{LT}

$\gamma^* p \rightarrow p\pi^0$





Curves: Goloskokov, Kroll
Transversity GPD model

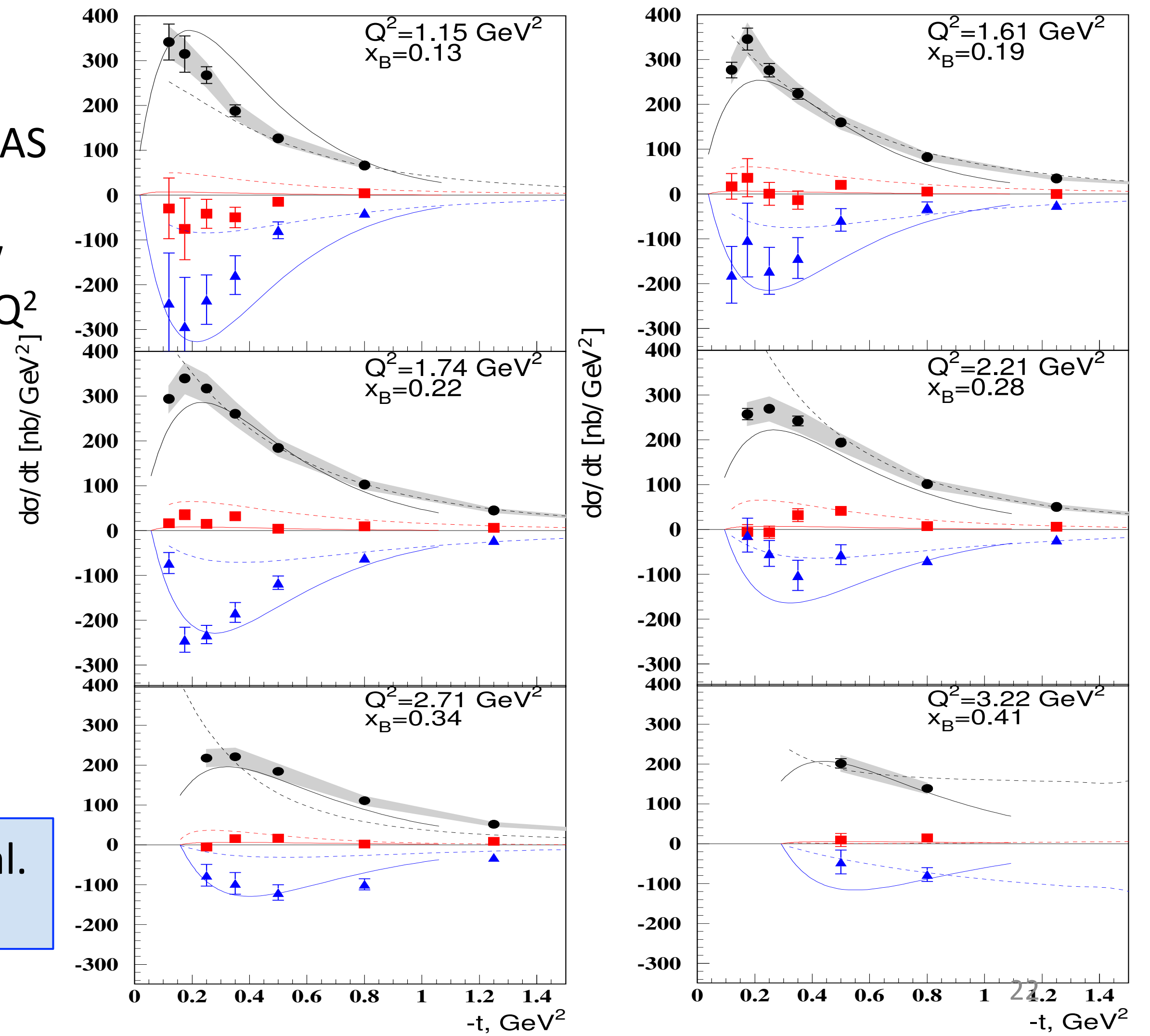
Data: I.Bedlinskiy et al. (CLAS)
Phys. Rev. C 90, 039901 (2014)

CLAS data and GPD theory predictions

Solid: S. Goloskokov and P. Kroll

Dots: S. Liuti and G. Goldstein

- ***Transversity* GPDs** H_T and $\bar{E}_T = 2\tilde{H}_T + E_T$ dominate in CLAS kinematics.
- The model was optimized for low x_B and high Q^2. The corrections t/Q^2 were omitted
- The model successfully describes CLAS data even at low Q^2
- Pseudoscalar meson production [provides unique possibility to access the transversity GPDs.]

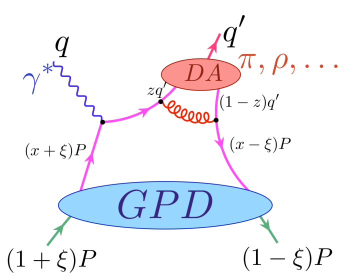


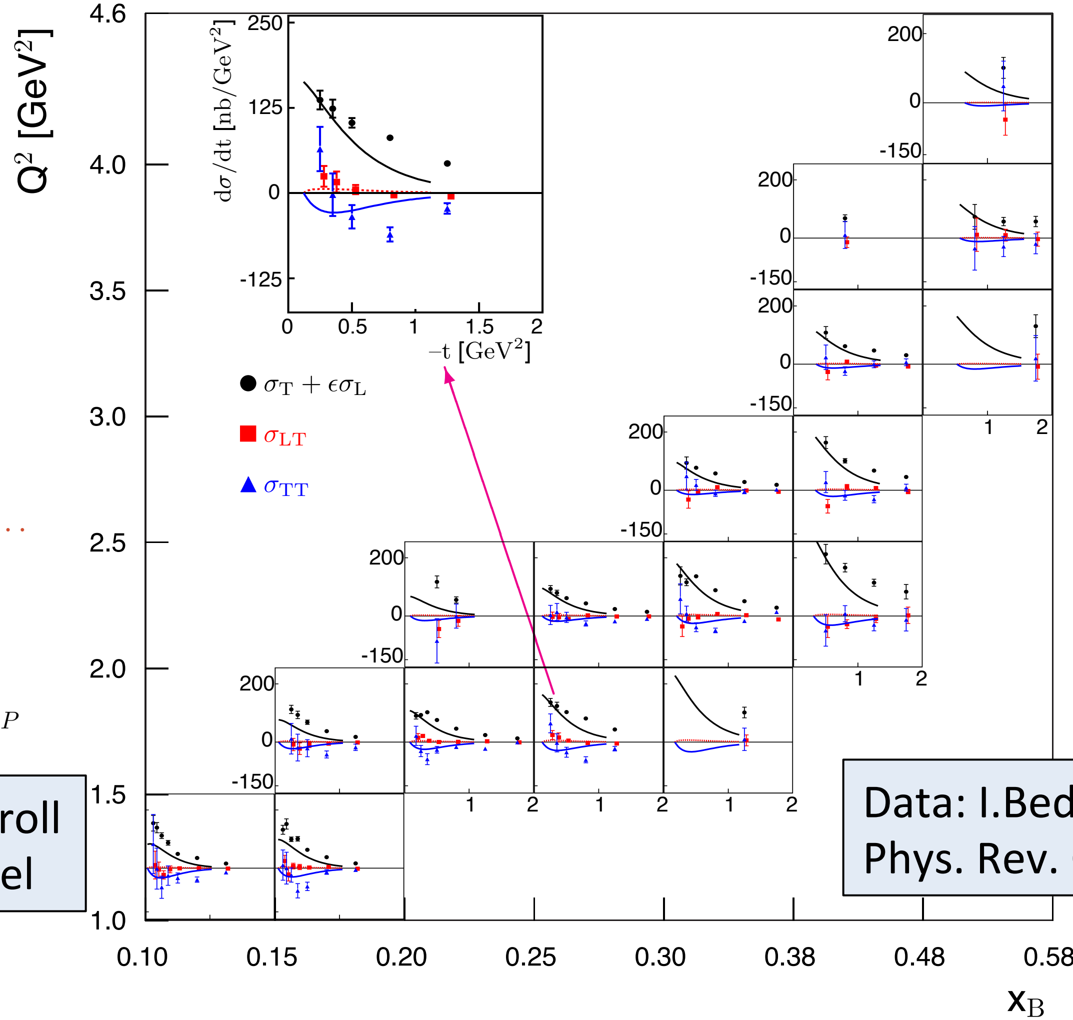
CLAS collaboration. I Bedlinskiy et al. Phys.Rev.Lett. 109 (2012) 112001

η Structure Functions

$(\sigma_T + \varepsilon\sigma_L)$ σ_{TT} σ_{LT}

$\gamma^* p \to p\eta$

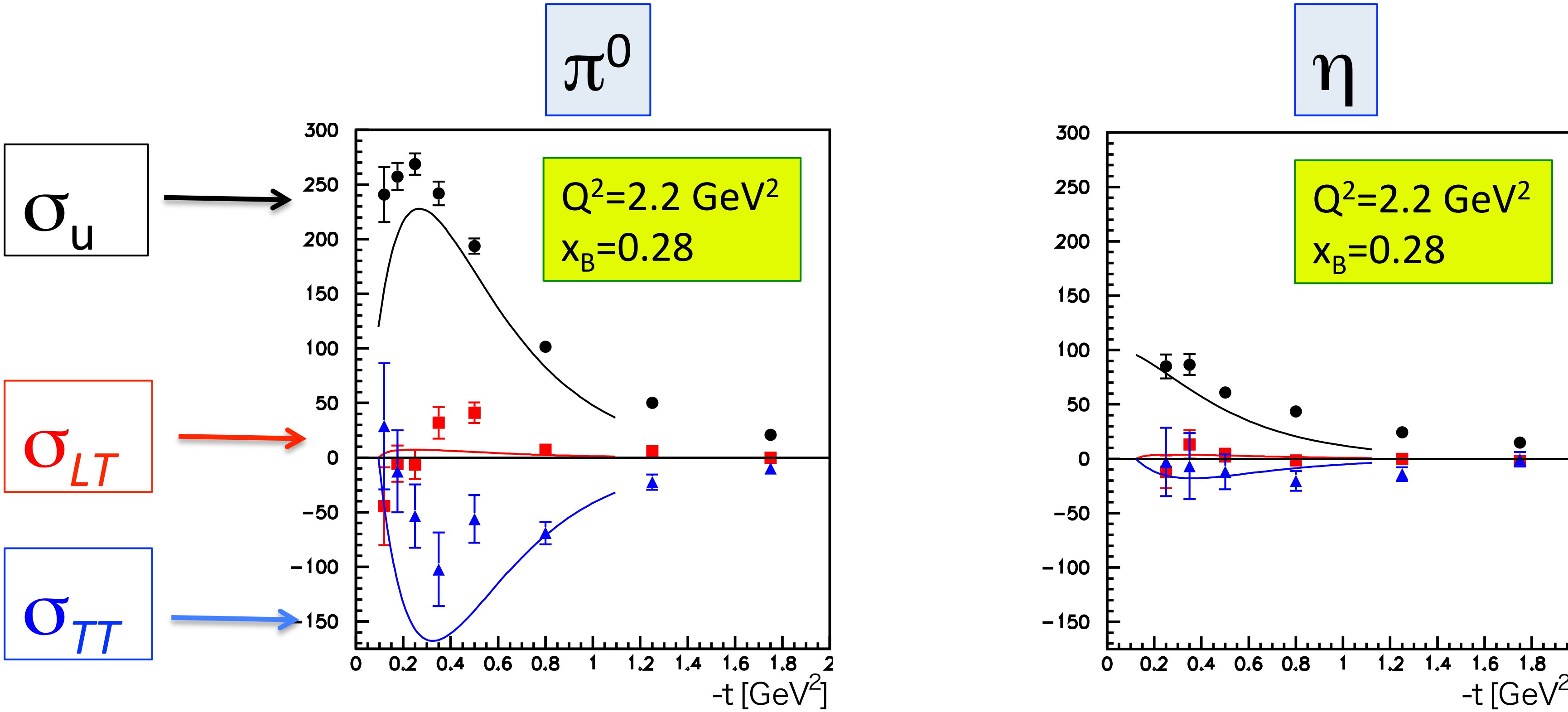




Curves: Goloskokov, Kroll
Transversity GPD model

Data: I.Bedlinskiy et al. (CLAS)
Phys. Rev. C **95**, 035202 (2017)

Comparison π^0/η



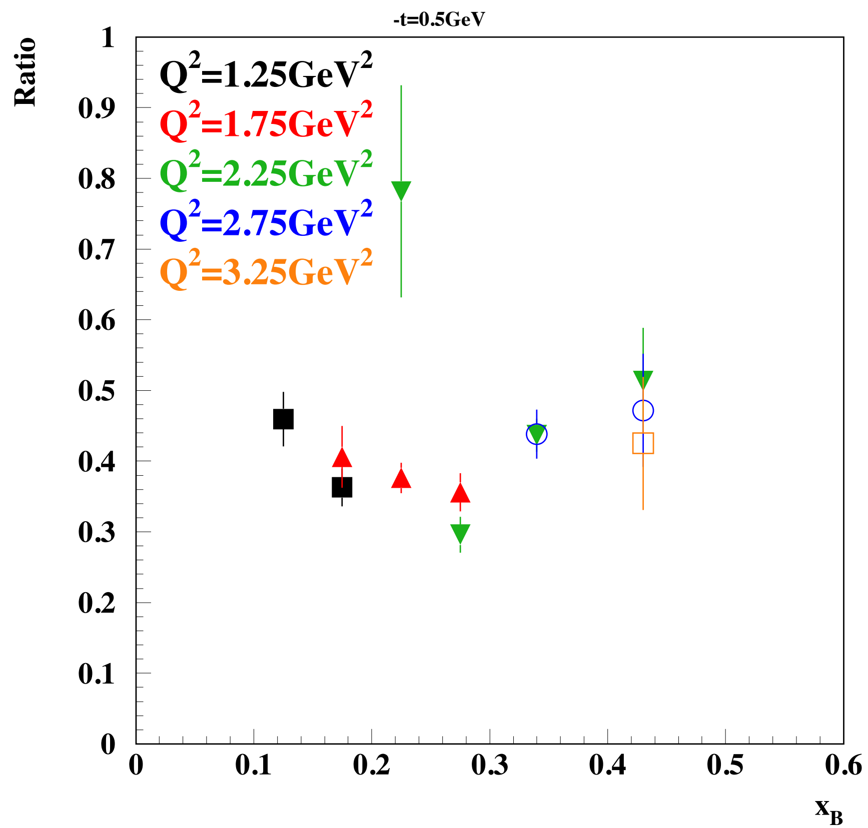
- $\sigma_U = \sigma_T + \varepsilon\sigma_L$ drops by a factor of 2.5 for η
- σ_{TT} drops by a factor of 10
- The GK GPD model (curves) follows the experimental data
- The statement about the ability of transversity GPD model to describe the pseudoscalar electroproduction becomes more solid with the inclusion of η data

CLAS-Phys.Rev.C95(2017)

η/π^0 ratio

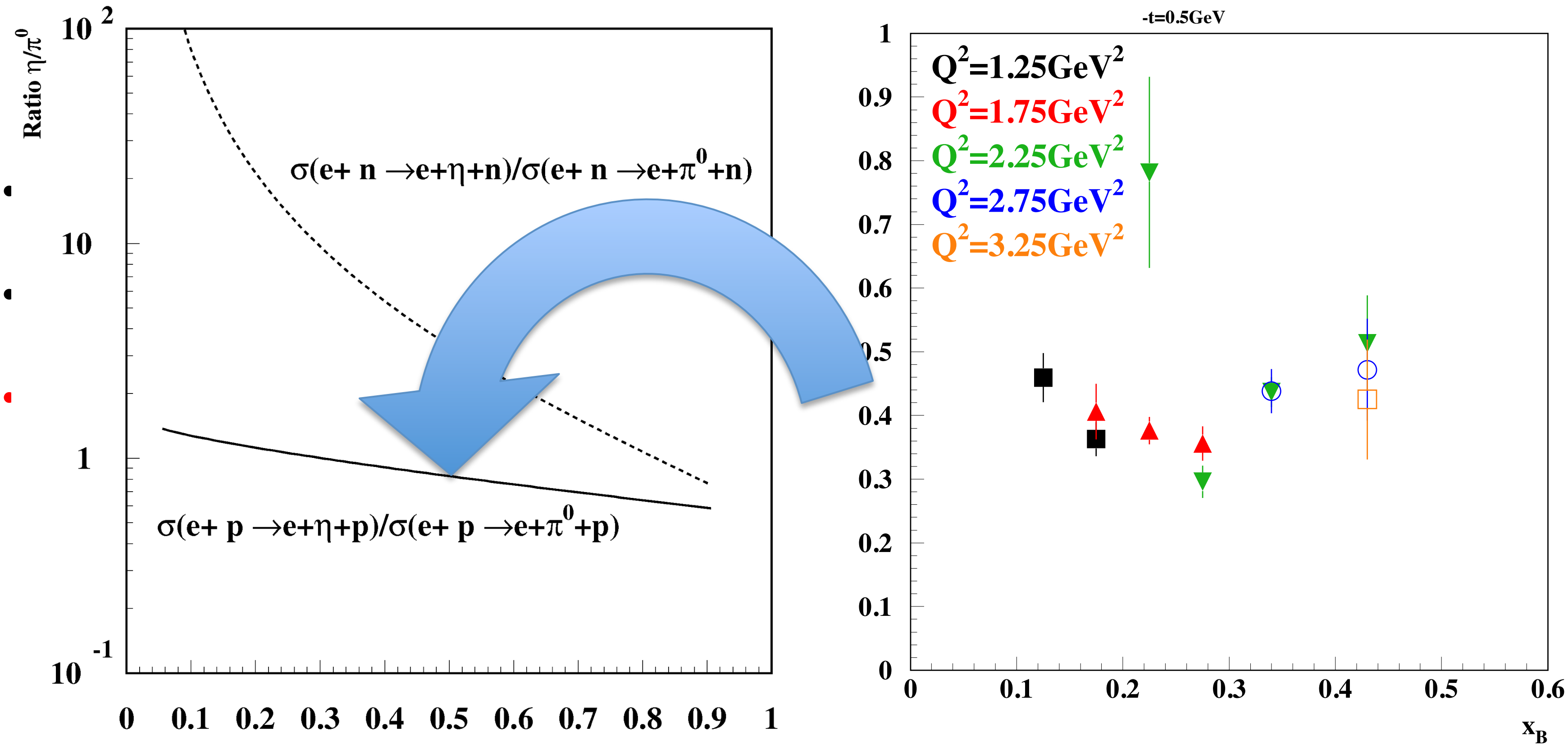
$$\frac{\sigma(ep \to ep\eta)}{\sigma(ep \to ep\pi^0)}$$

- The dependence on x_B and Q^2 is very weak.
- Chiral odd GPD models predict this ratio to be ~1/3 at CLAS kinematics
- Chiral even GPD models predict this ratio to be around 1 (at low –t).



η/π^0 ratio

$$\frac{\sigma(ep \to ep\eta)}{\sigma(ep \to ep\pi^0)}$$



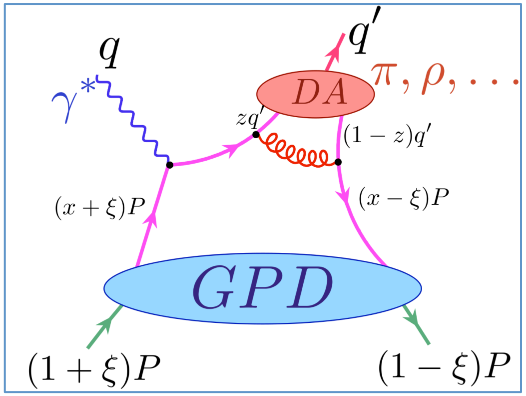
Theoretical prediction R=1 for the Chiral-even GPD models ($\sigma_L >> \sigma_T$)

CLAS-Phys.Rev.C95(2017)

Structure functions and GPDs

$$\frac{d\sigma_T}{dt} = \frac{4\pi\alpha}{2k'}\frac{\mu_P^2}{Q^8}\left[(1-\xi^2)\,|\langle H_T\rangle|^2 - \frac{t'}{8m^2}|\langle \bar{E}_T\rangle|^2\right]$$

$$\frac{d\sigma_{TT}}{dt} = \frac{4\pi\alpha}{k'}\frac{\mu_P^2}{Q^8}\frac{t'}{16m^2}|\langle \bar{E}_T\rangle|^2$$



Goloskokov, Kroll
Transversity GPD model

$$|\langle \bar{E}_T\rangle^{\pi,\eta}|^2 = \frac{k'}{4\pi\alpha}\frac{Q^8}{\mu_P^2}\frac{16m^2}{t'}\frac{d\sigma_{TT}^{\pi,\eta}}{dt}$$

$$|\langle H_T\rangle^{\pi,\eta}|^2 = \frac{2k'}{4\pi\alpha}\frac{Q^8}{\mu_P^2}\frac{1}{1-\xi^2}\left[\frac{d\sigma_T^{\pi,\eta}}{dt} + \frac{d\sigma_{TT}^{\pi,\eta}}{dt}\right]$$

$$\langle H_T\rangle = \Sigma_\lambda \int_{-1}^{1} dx M(x,\xi,Q^2,\lambda) H_T(x,\xi,t)$$

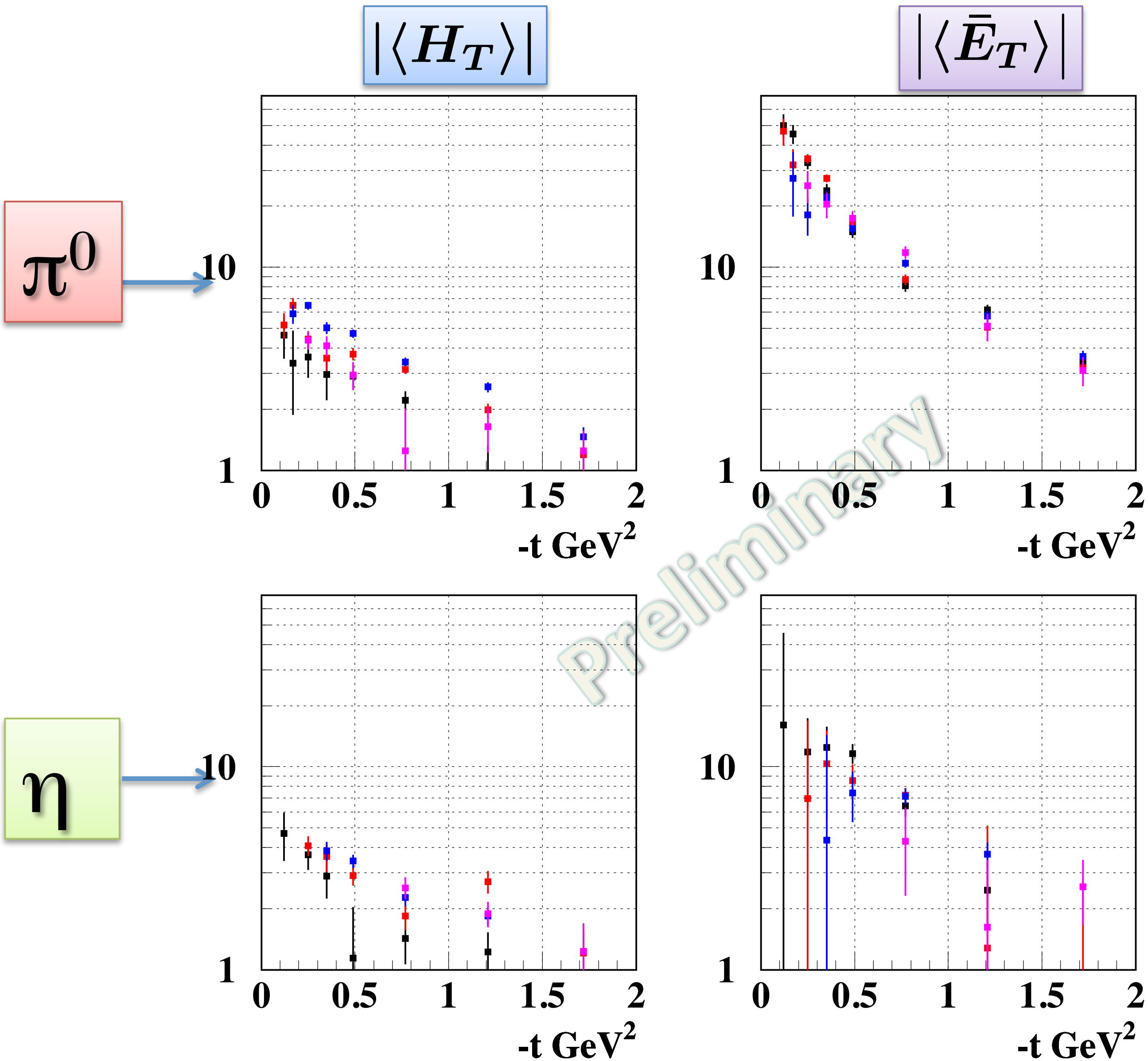
$$\langle \bar{E}_T\rangle = \Sigma_\lambda \int_{-1}^{1} dx M(x,\xi,Q^2,\lambda) \bar{E}_T(x,\xi,t)$$

The brackets <F> denote the convolution of the elementary process with the GPD F (generalized form factors)

- We did not separate σ_T and σ_L
- However *in the approximation* of the transversity GPDs dominance, that is supported by Jlab data, $\sigma_L \ll \sigma_T$ we have direct access to the generalized form factors for π and η production.

$\bar{E}_T = 2\tilde{H}_T + E_T$

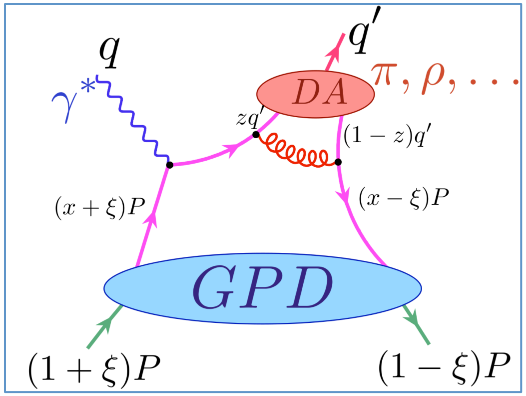
Generalized Form factors

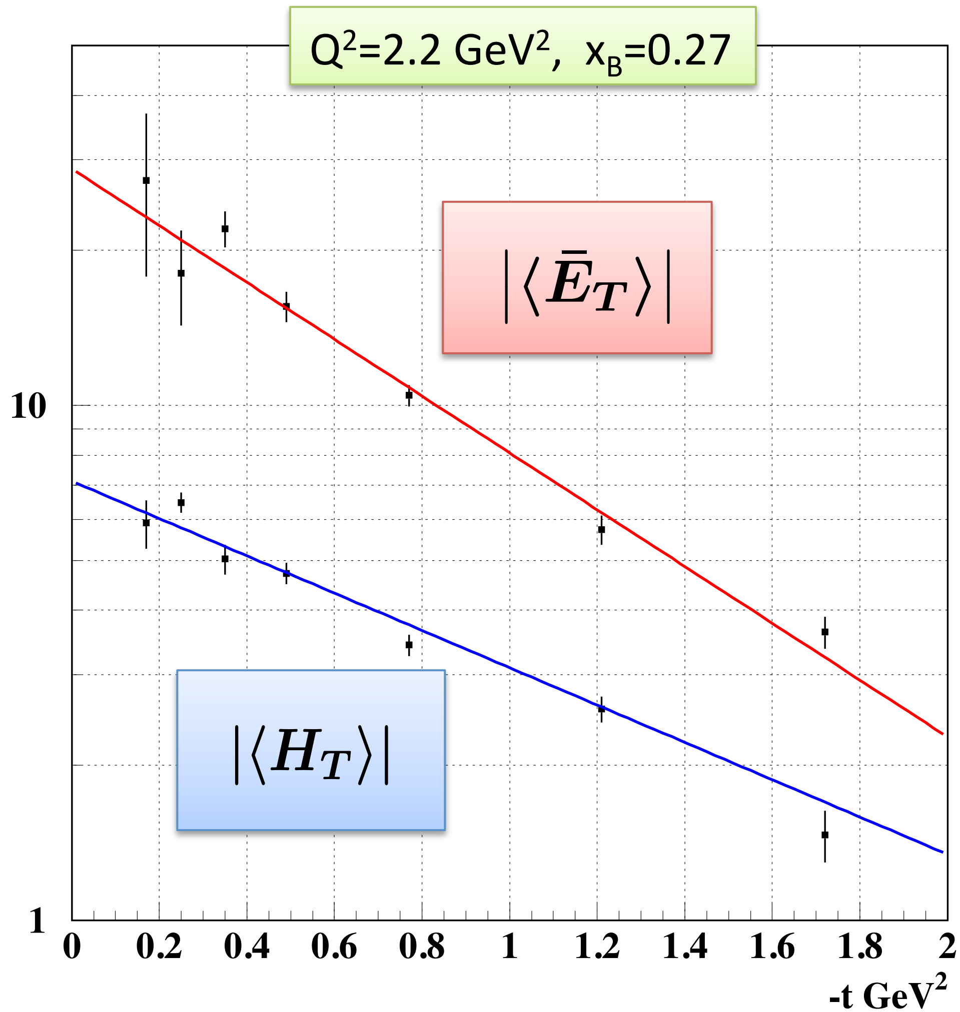


Q^2 GeV^2	x_B
1.2	0.15
1.8	0.22
2.2	0.27
2.7	0.34

- $\bar{E}_T$ > H_T for π^0 and η
- t-dependence is steeper for $\bar{E}_T$ than for H_T
- Estimation of the systematic uncertainties connected with the used approximation is in progress

π^0 Generalized Form Factors





- $\bar{E}_T$ > H_T
- t-dependence is steeper for $\bar{E}_T$ than for H_T

- $|\langle E_T, H_T \rangle| \sim \exp(bt)$
- $b(E_T)$=1.27 GeV^{-2}
- $b(H_T)$=0.98 GeV^{-2}

VK, arXiv:1601.04367

GPD Flavor Decomposition

$$H_T^{\pi} = \frac{1}{3\sqrt{2}}[2H_T^u + H_T^d]$$

$$H_T^{\eta} = \frac{1}{\sqrt{6}}[2H_T^u - H_T^d]$$

$$H_T^u = \frac{3}{2\sqrt{2}}[H_T^{\pi} + \sqrt{3}H_T^{\eta}]$$

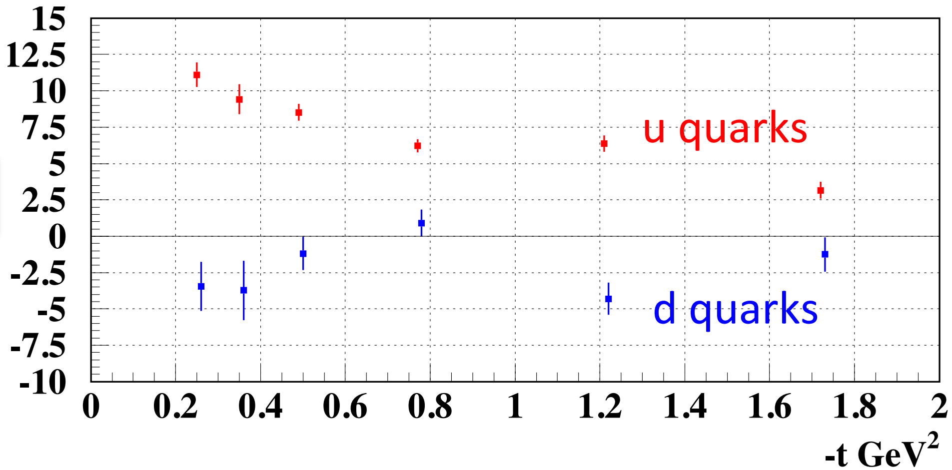
$$H_T^d = \frac{3}{\sqrt{2}}[H_T^{\pi} - \sqrt{3}H_T^{\eta}]$$

Similar expressions for $\bar{E}_T$

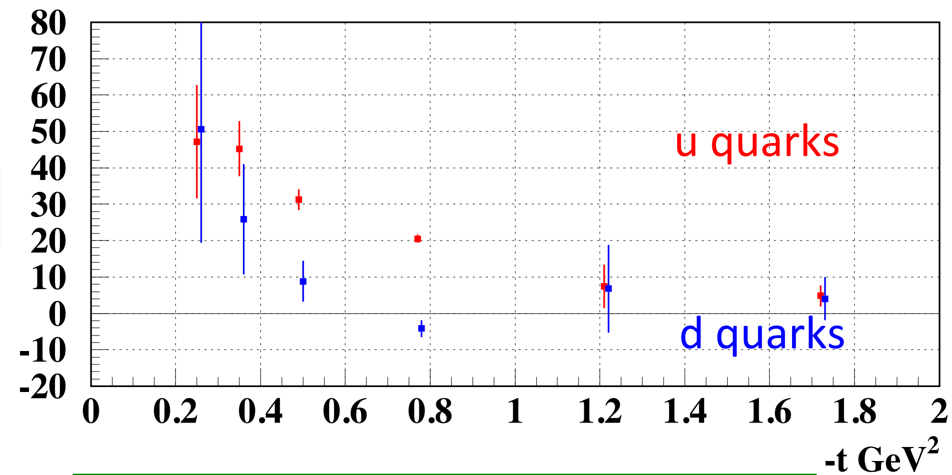
- GPDs appear in different flavor combinations for π^0 and η
- The combined π^0 and η data permit the flavor (u and d) decomposition for GPDs H_T and $\bar{E}_T$
- The u/d decomposition was done under simple assumption that the relative phase between u and d is 0 or 180 degrees.

Flavor Decomposition of the Transversity GPDs

$<H_T>$



$<\bar{E}_T>$



VK arXiv: 1601.04367 [hep-ex] 2016

Q^2=1.8 GeV^2, x_B=0.22

- $<H_T>^u$ and $<H_T>^d$ have different signs for u and d-quarks in accordance with the transversity function h_1 (Anselmino et al.)
- $|<\bar{E}_T>|^d$ and $|<\bar{E}_T>|^u$ seem to have the same signs
- Decisions shown with positive values of u-quark's GPDs only

π^0 Electroproduction off *Neutron*

Neutron

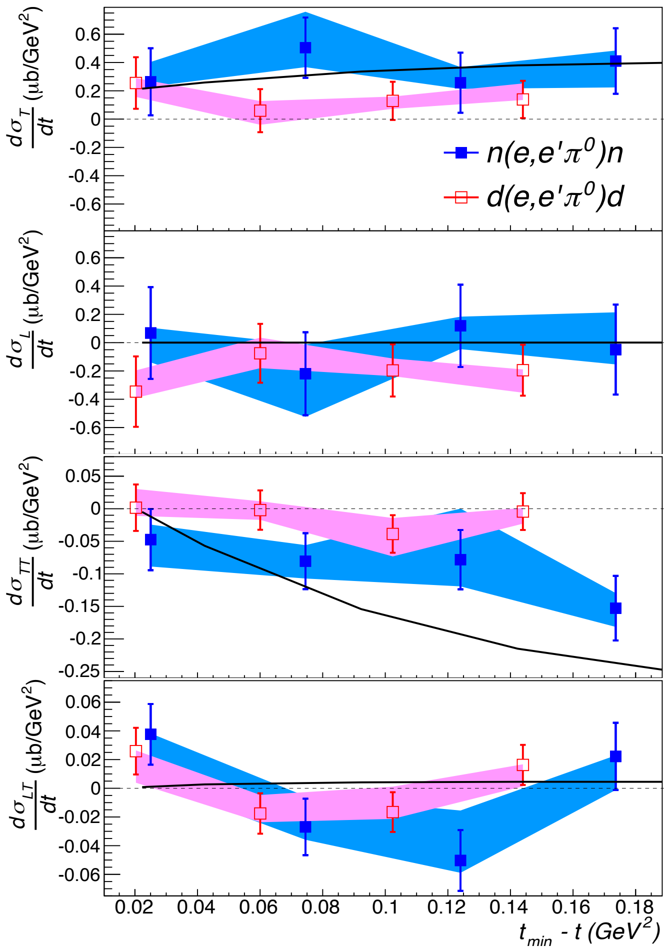
Deutron

σ_T

σ_L

σ_{TT}

σ_{LT}



The neutron cross sections

- dominated by σ_T and σ_{TT}
- σ_L and σ_{LT} are compatible with zero
- It is in good agreement with the previous measurement off a proton
- The data are I na a fair agreement with the theoretical expectations based on the helicity-flip (transversity) GPDs

- Data, Hall-A arXiv:1702.00835 (2017)
- Theory, S. Goloskokov and P. Kroll, Eur. Phys. J. A47, 112

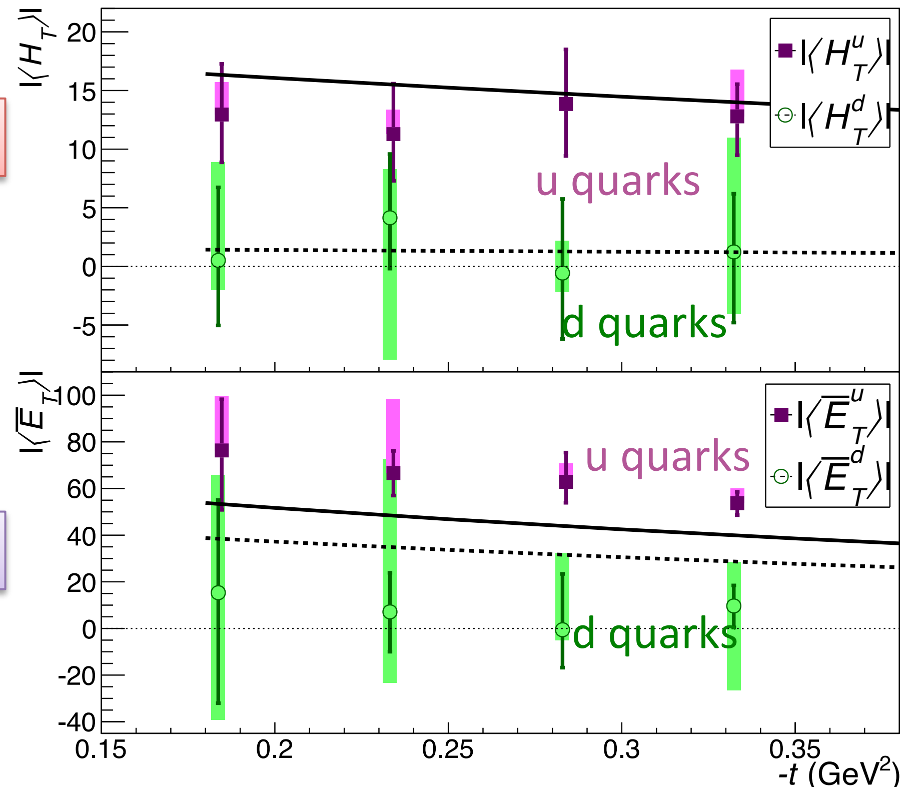
Flavor decomposition:n and p

|<H$_T$>|

$$H_T^p = \frac{1}{3\sqrt{2}}(2H_T^u + H_T^d)$$
$$H_T^n = \frac{1}{3\sqrt{2}}(H_T^u + 2H_T^d)$$

|<E$_T$>|

$$H_T^p = \frac{1}{3\sqrt{2}}(2H_T^u + H_T^d)$$
$$H_T^n = \frac{1}{3\sqrt{2}}(H_T^u + 2H_T^d)$$
$$H_T^\eta = \frac{1}{\sqrt{6}}(2H_T^u - H_T^d)$$



Proton, neutron and η data Will solve the problem of unknown phase between u and d GFF

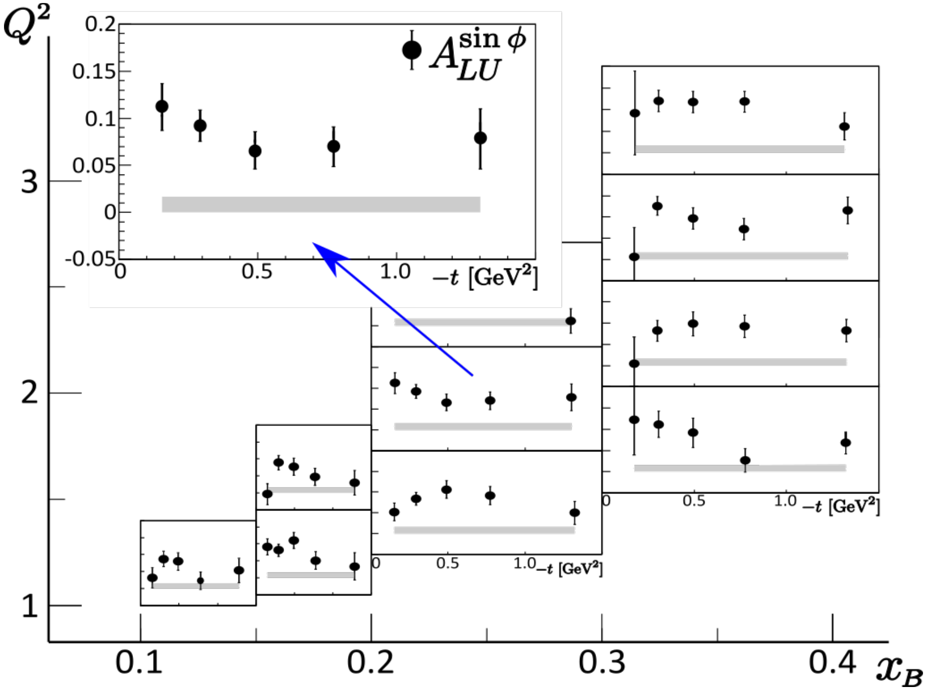
- $< E_T^u >$ is larger than $< H_T^u >$
- Good agreement with GK model

$ep \to ep\pi^0$

beam, target and double spin asymmetries

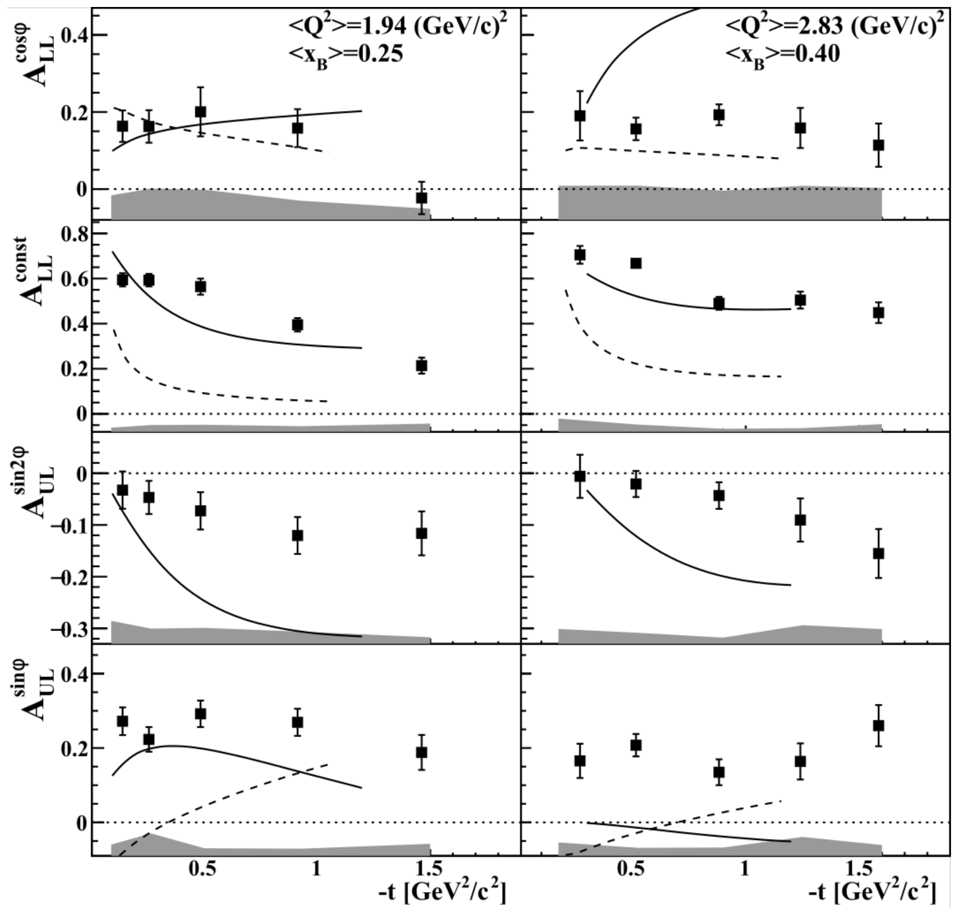
Beam spin asymmetries

R. De Masi *et al.* (CLAS collaboration) PRC**77**: 042201 (2008)



Target and double spin asymmetries

A. Kim *et al.* (CLAS collaboration) PLB**768**, 168 (2016)



Polarized observables:

$$A_{LU}^{\sin\phi}\sigma_0 \sim \text{Im}\left[\langle H_T\rangle^*\langle\tilde{E}\rangle\right]$$

$$A_{UL}^{\sin\phi}\sigma_0 \sim \text{Im}\left[\langle\bar{E}_T\rangle^*\langle\tilde{H}\rangle + \xi\langle H_T\rangle^*\langle\tilde{E}\rangle\right]$$

$$A_{LL}^{\cos 0\phi}\sigma_0 \sim |\langle H_T\rangle|^2$$

$$A_{LL}^{\cos\phi}\sigma_0 \sim \text{Re}\left[\langle\bar{E}_T\rangle^*\langle\tilde{H}\rangle + \xi\langle H_T\rangle^*\langle\tilde{E}\rangle\right]$$

Dominated by transverse virtual photons contribution

Future developments

- CLAS12 first experiments will take data with proton and neutron targets
- Cross sections:

$$ep \to ep(\pi^0, \eta)$$
$$en \to en(\pi^0, \eta)$$

- Asymmetries:

$$\mathcal{A}_{LU} \ - \ beam\ spin$$
$$\mathcal{A}_{UL} \ - \ target\ spin$$
$$\mathcal{A}_{LL} \ - \ beam\ target$$

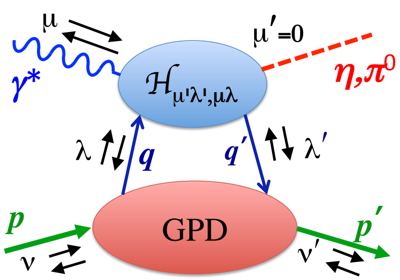
Summary

- Jlab π^0 and η data supports the dominance of the transversity GPDs H_T and $\bar{E}_T$ in the processes of the pseudoscalar meson electroproduction

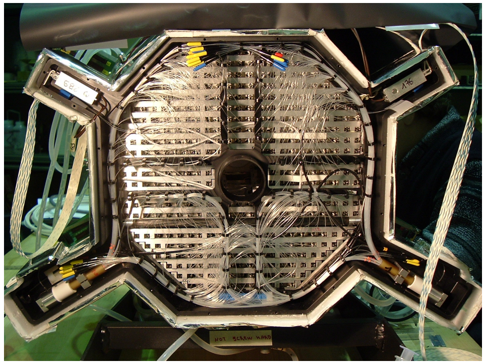
- The generalized form factors $\langle H_T \rangle$ and $\langle \bar{E}_T \rangle$ are directly connected to the structure functions σ_T and σ_{TT} within handbag approach

- The combined π^0 and η proton and neutron data will provide the way for the flavor decomposition of transversity GPD

The End


μ
μ′=0
γ*
η,π⁰
$\mathcal{H}_{\mu'\lambda',\mu\lambda}$
λ
q
q′
λ′
p
GPD
p′
ν
ν′

+



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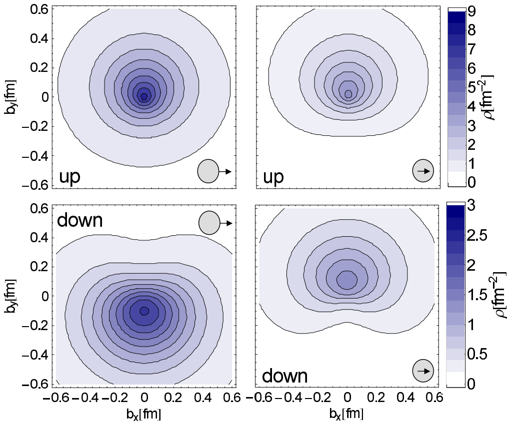
up
up
down
down
b_y[fm]
b_x[fm]
ρ[fm⁻²]