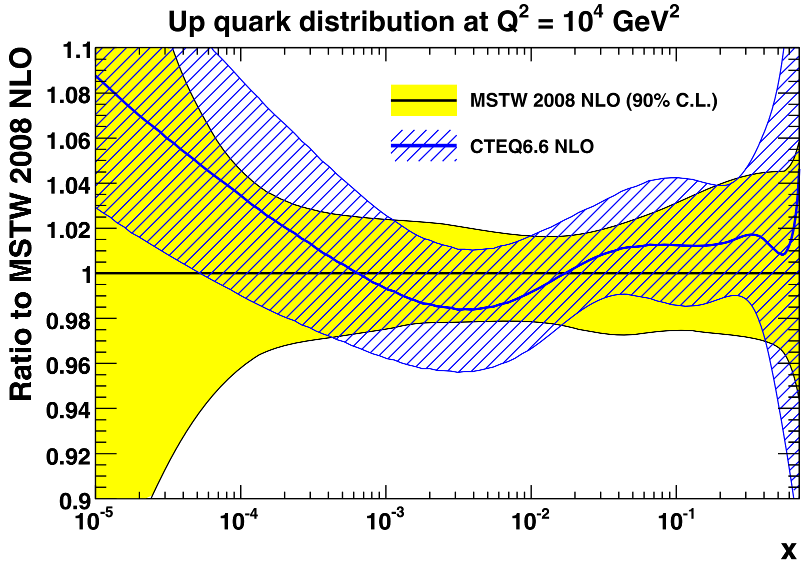
Probing strangeness in hard processes: a (partial) theory summary

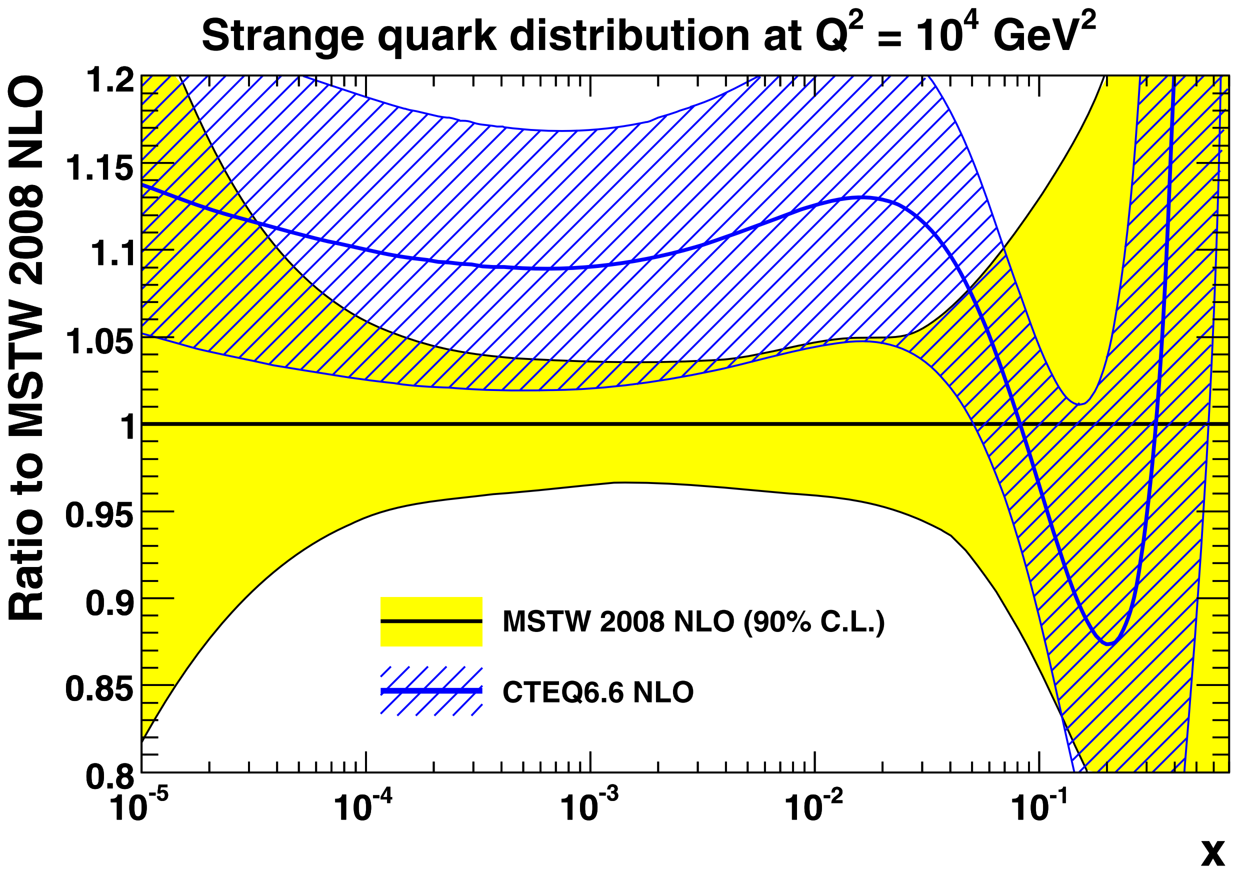
A. Bacchetta

- Strange unpolarized PDF
- Strange fragmentation functions
- Strange dihadron fragmentation functions
- Strange in-medium effects
- Strange helicity distribution
- Strange TMDs
- Strange GPDs
- Strange fracture functions


WANTED
strange quark
s
REWARD

Strange unpolarized PDFs



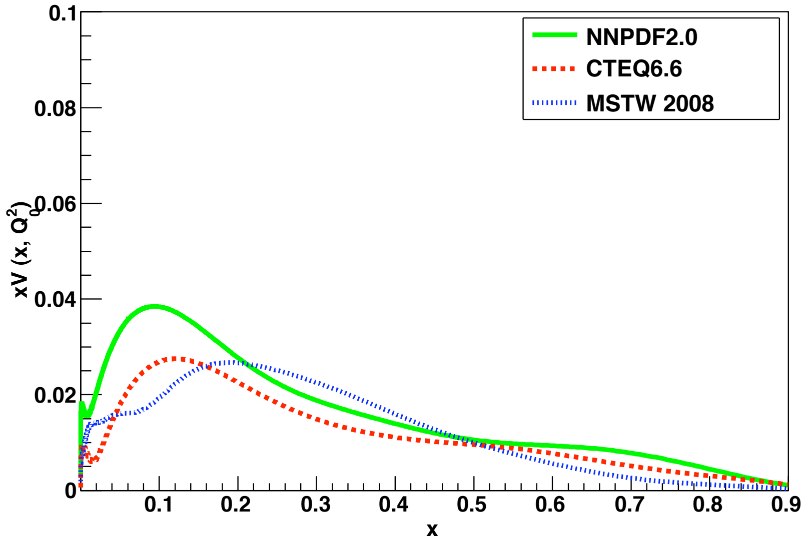


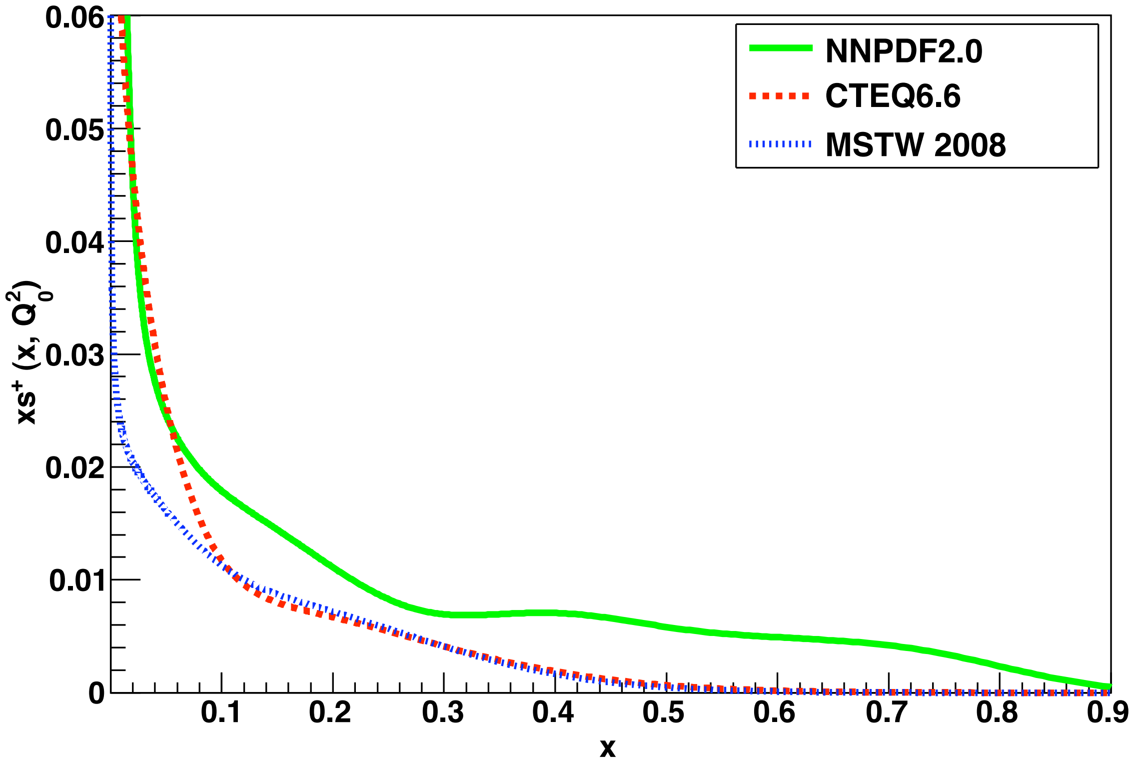
The strange distribution is poorly constrained

F. Kunne's talk and Martin, Stirling, Thorne, Watt, EPJ C63 (09)

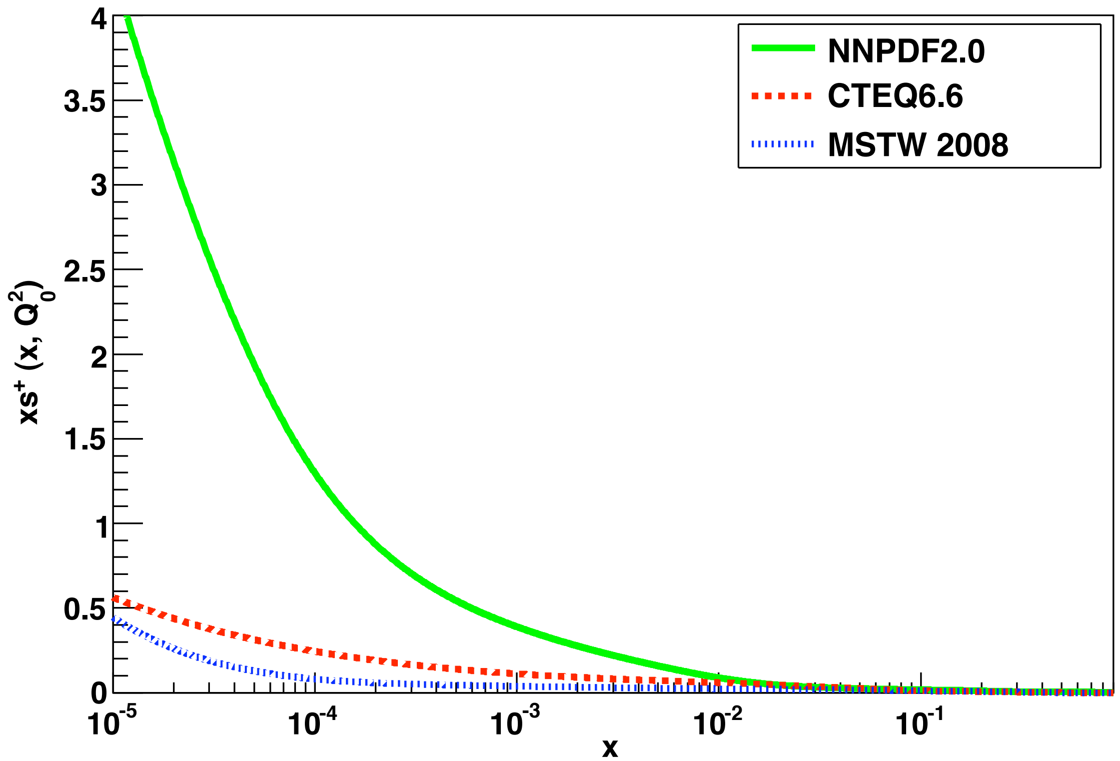
Absolute PDF uncertainties

valence distr





Linear scale

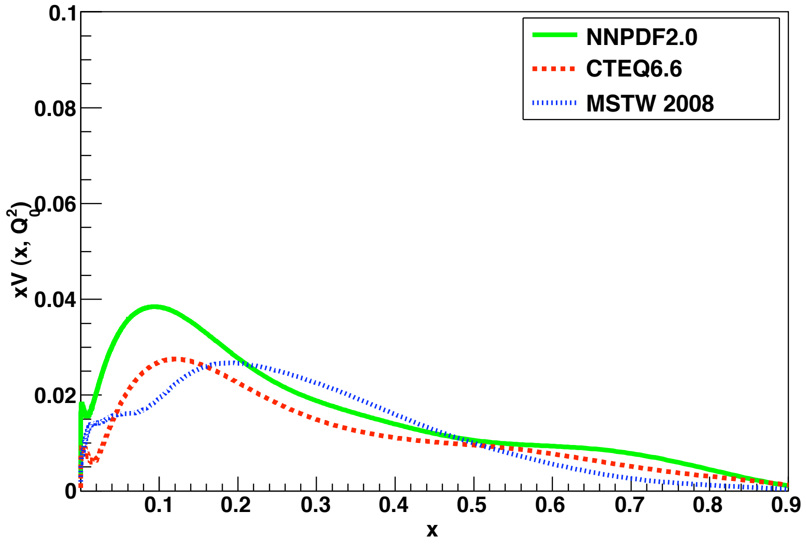


Log scale

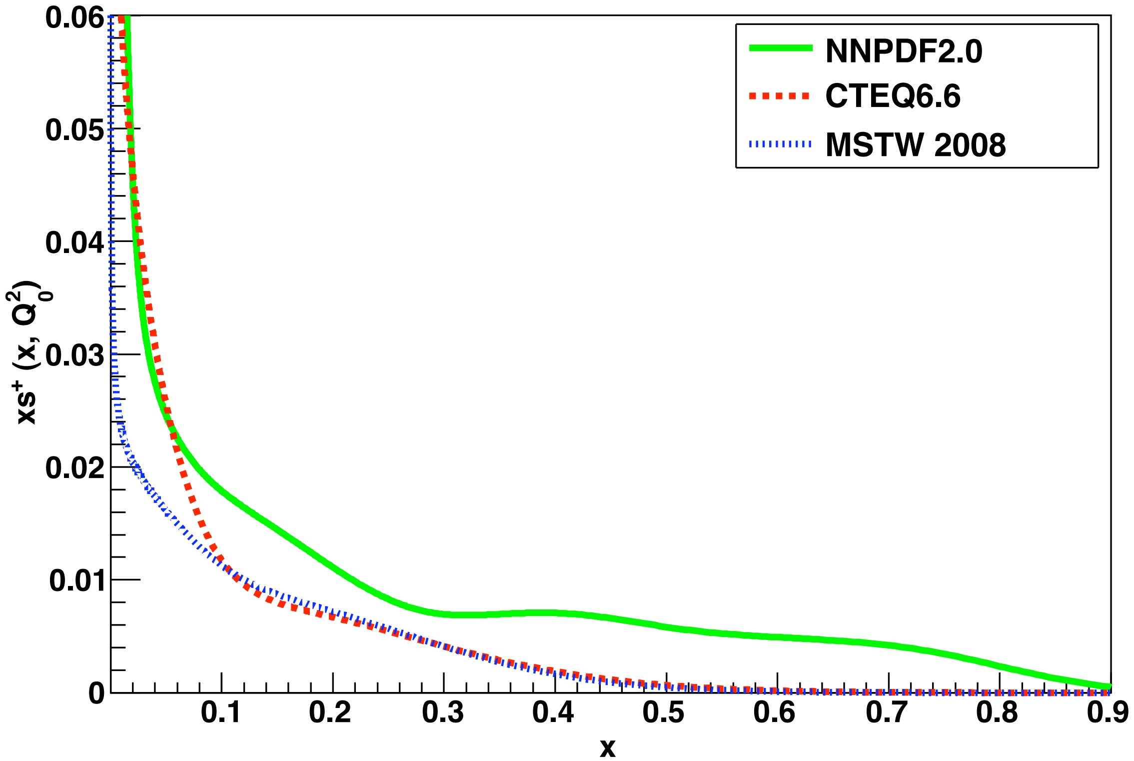
J. Rojo's talk and NNPDF Coll, NPB 838 (10)

Absolute PDF uncertainties

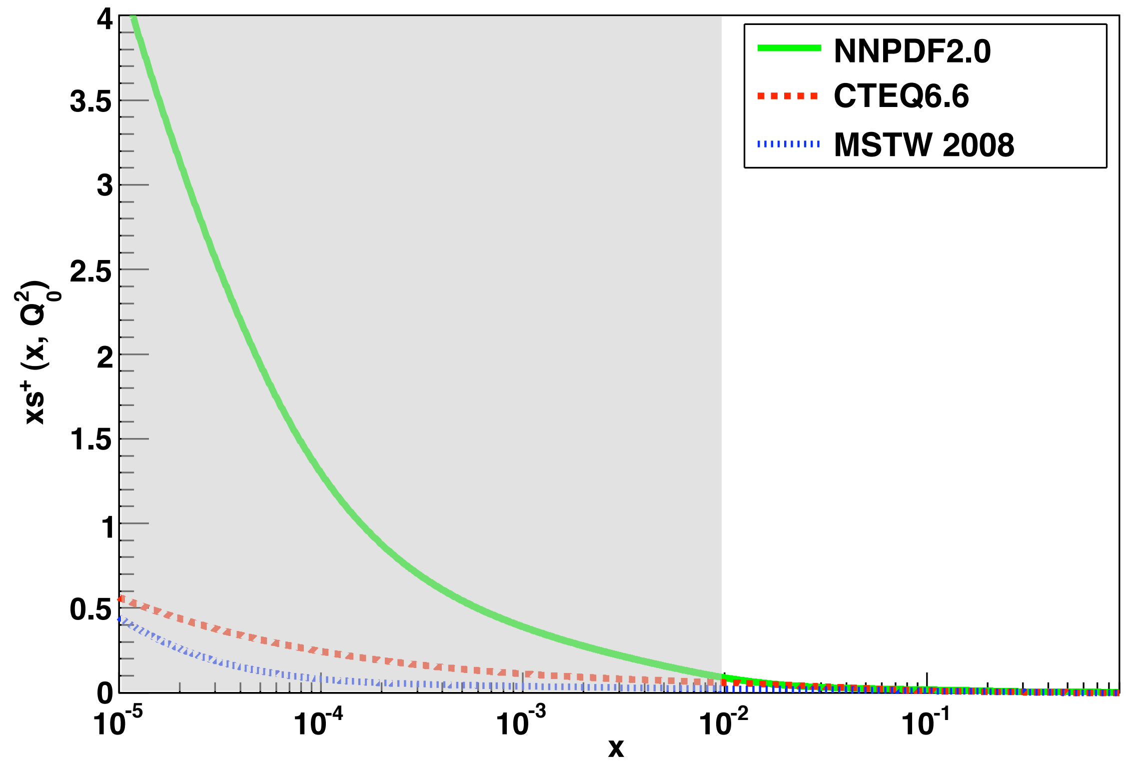
valence distr



Functional bias below 10^{-2}:
no constraint from data



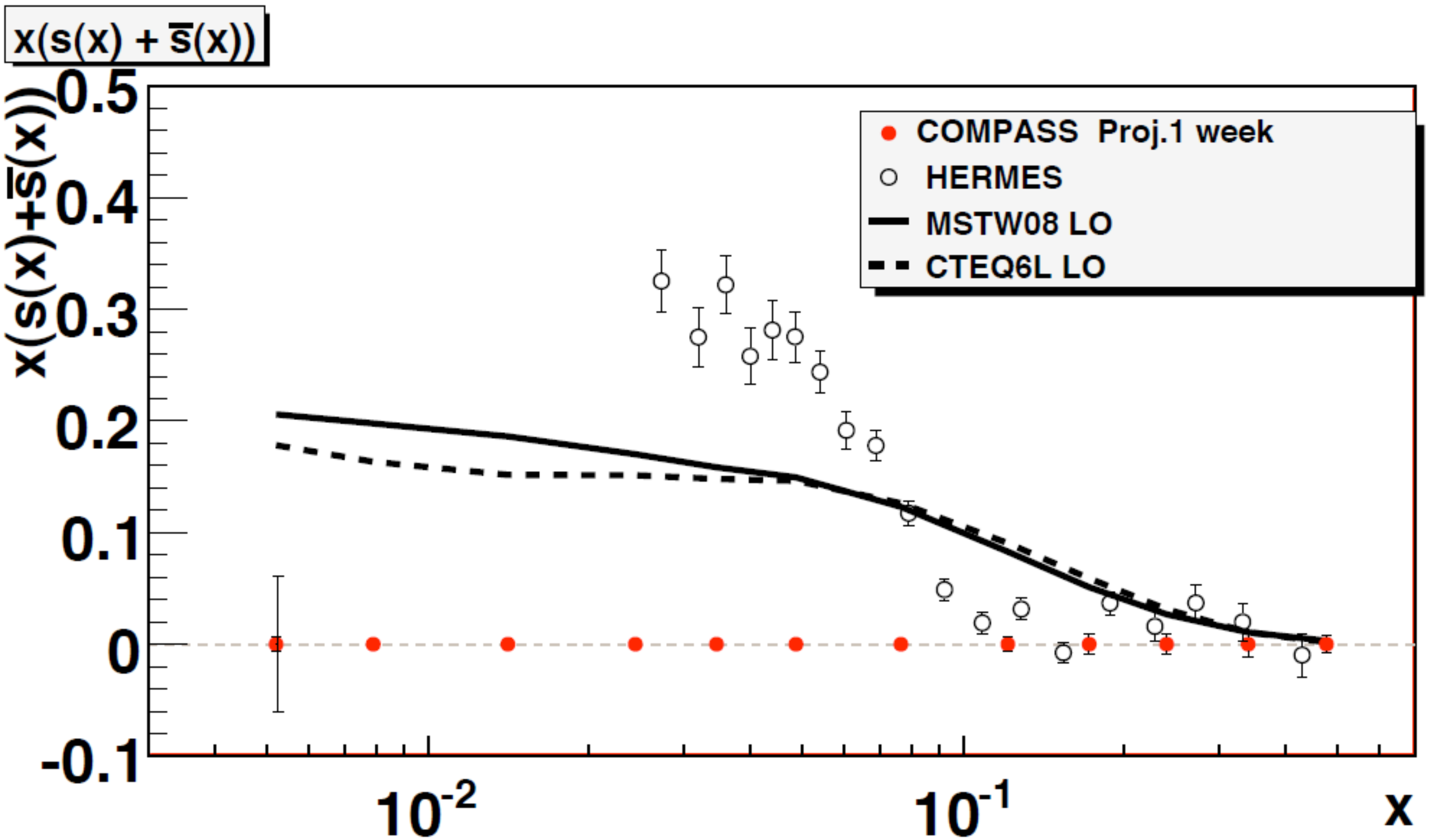
Linear scale



Log scale

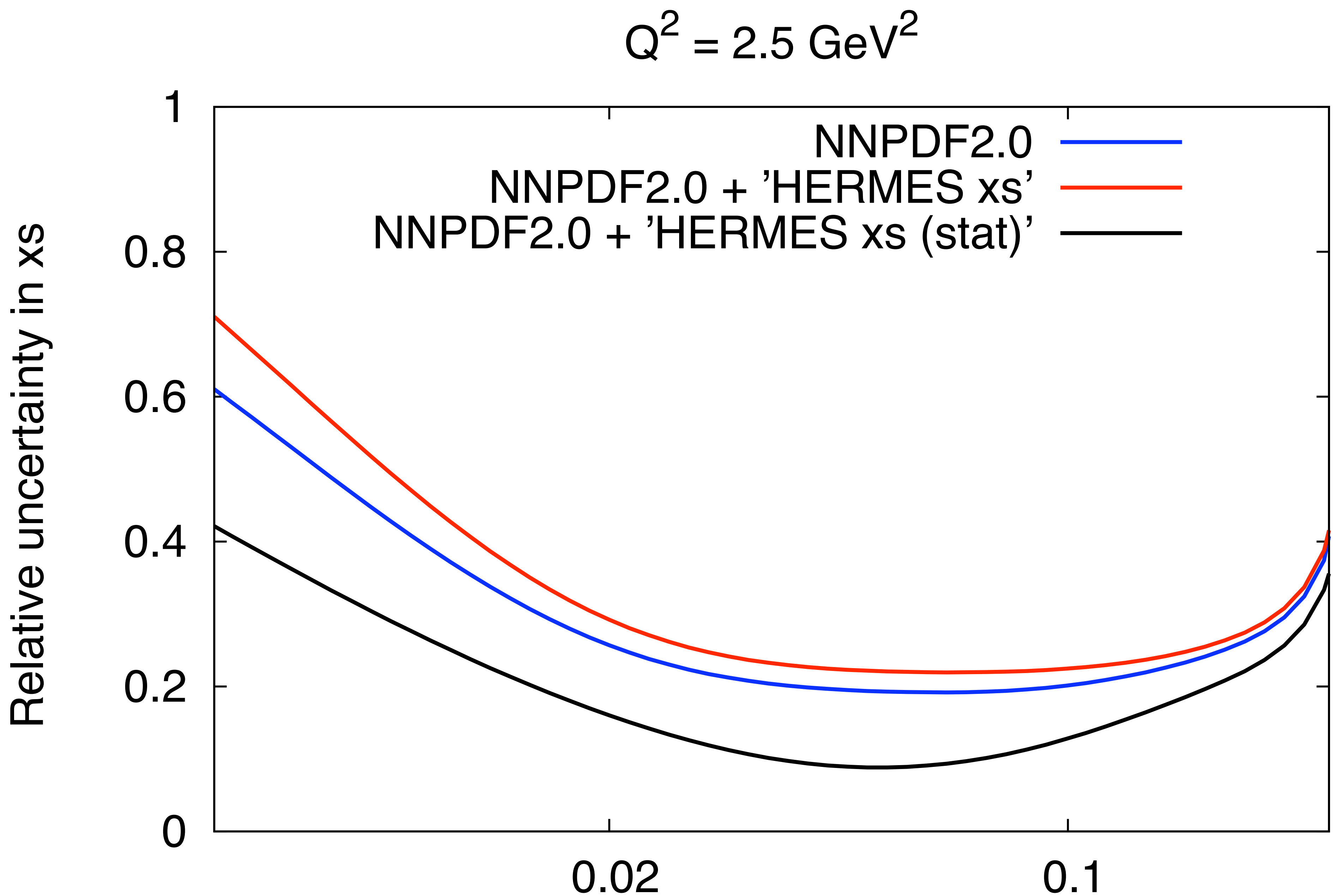
J. Rojo's talk and NNPDF Coll, NPB 838 (10)

The shape of the strange distribution used in fits seems to be wrong

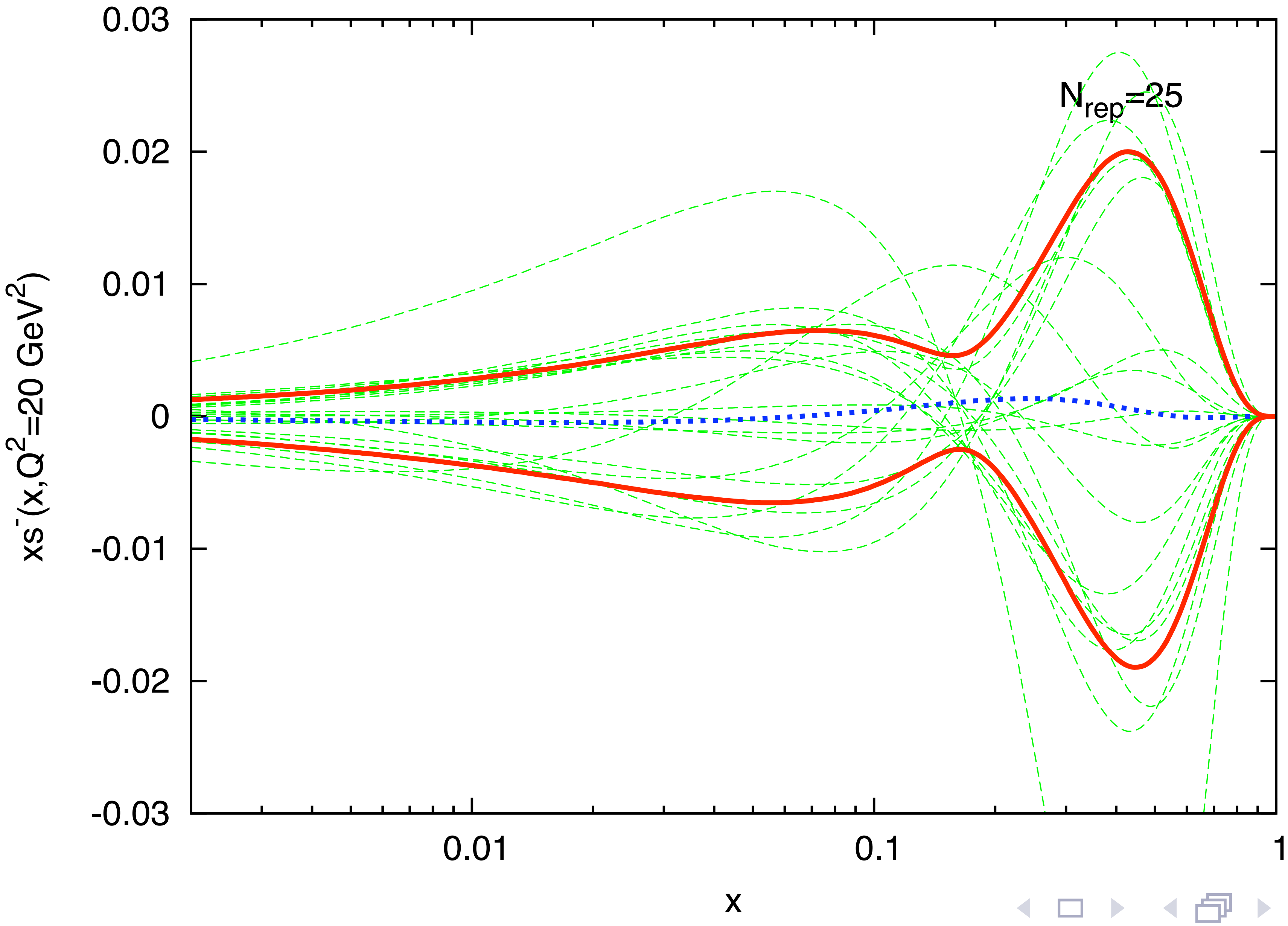


F. Kunne's talk and HERMES

More data can have a significant impact on constraining the strange distribution



J. Rojo's talk



The $s - \bar{s}$ distribution is poorly known

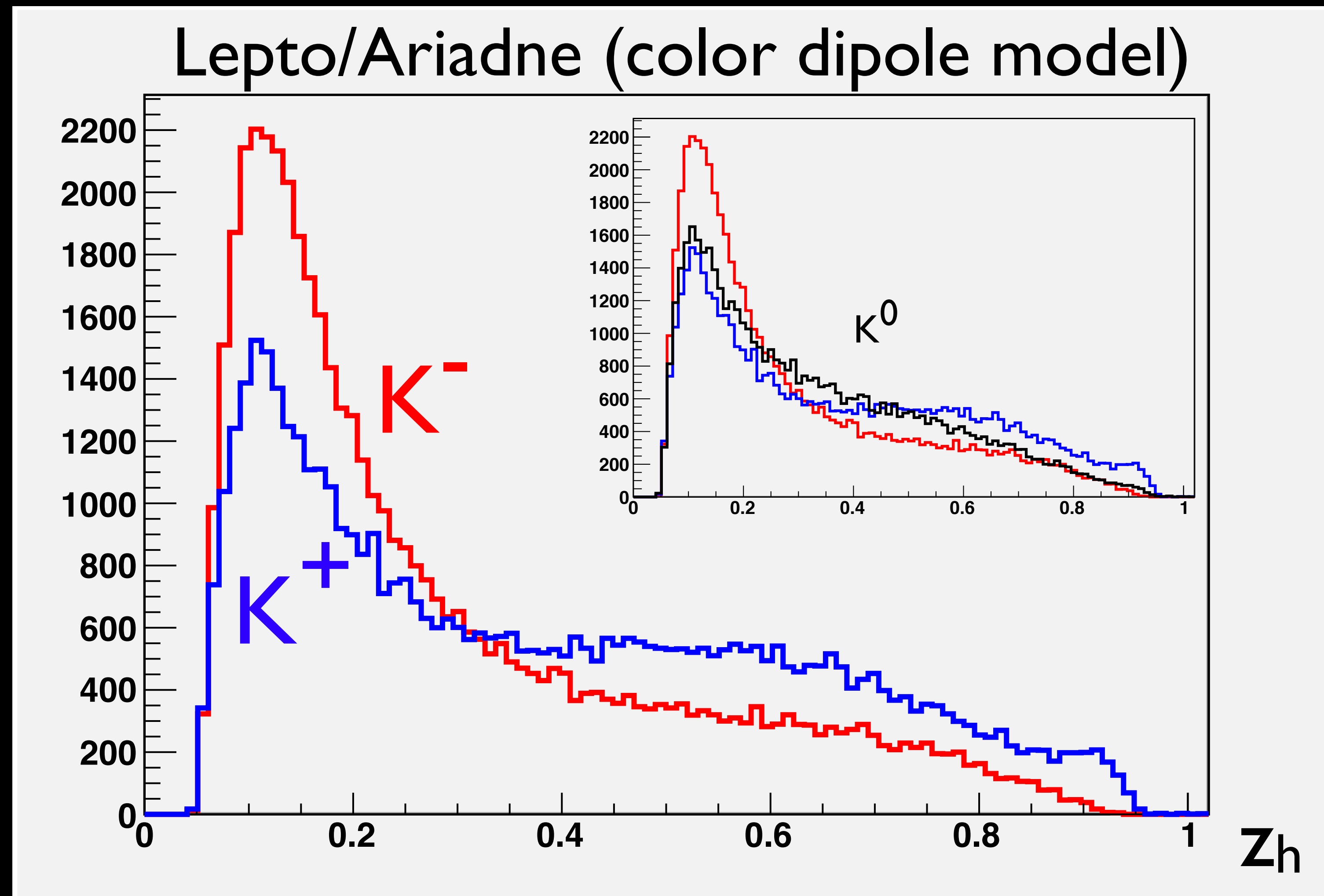
J. Rojo's talk

Strange fragmentation functions

K^+	$u\bar{s}$
K^-	$\bar{u}s$
K^0	$d\bar{s}$
$\bar{K}^0$	$\bar{d}s$

W. Brooks's talk

K^+	$u\bar{s}$
K^-	$\bar{u}s$
K^0	$d\bar{s}$
$\bar{K}^0$	$\bar{d}s$

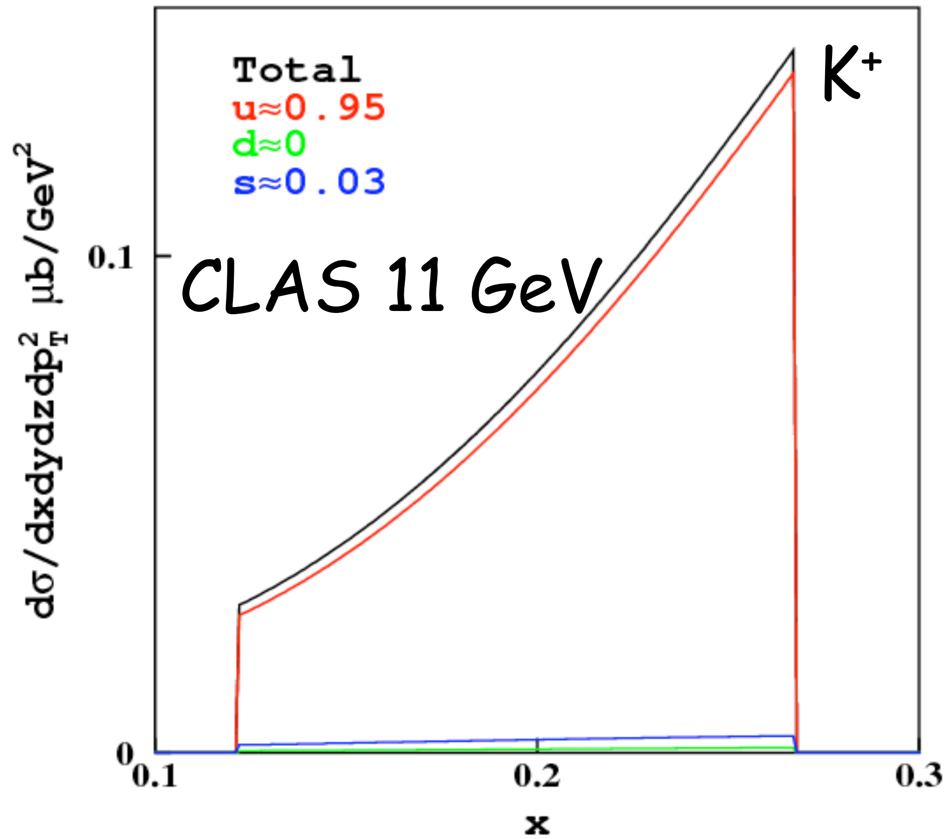


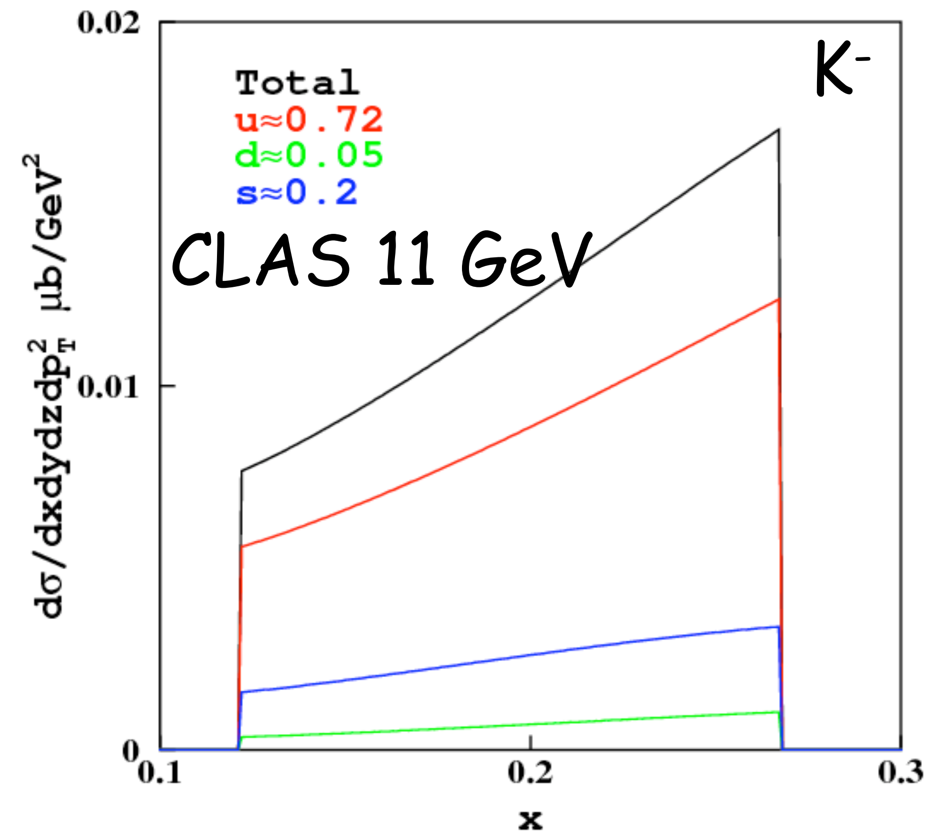
Naively, K^- comes more from mid-string than K^+:

......$\bar{q}$--q::$\bar{q}$--u::$\bar{u}$--s::$\bar{s}$--u vs. *......$\bar{q}$--u::$\bar{u}$--s::$\bar{s}$--q::$\bar{q}$--u*

W. Brooks's talk

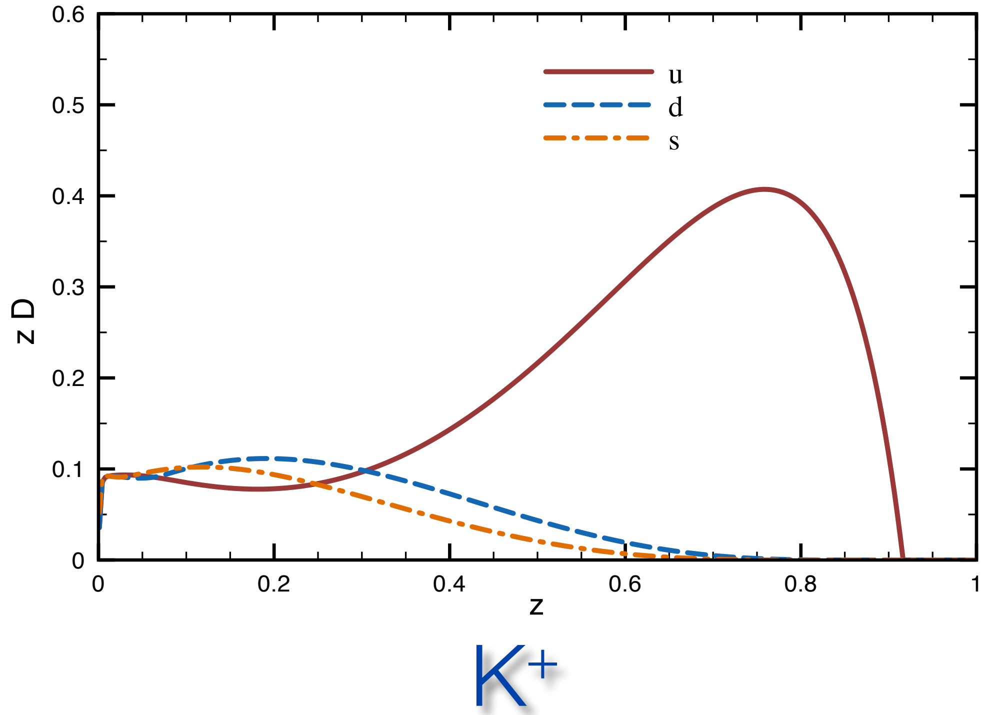
Q^2=2.5 GeV^2
z=0.5

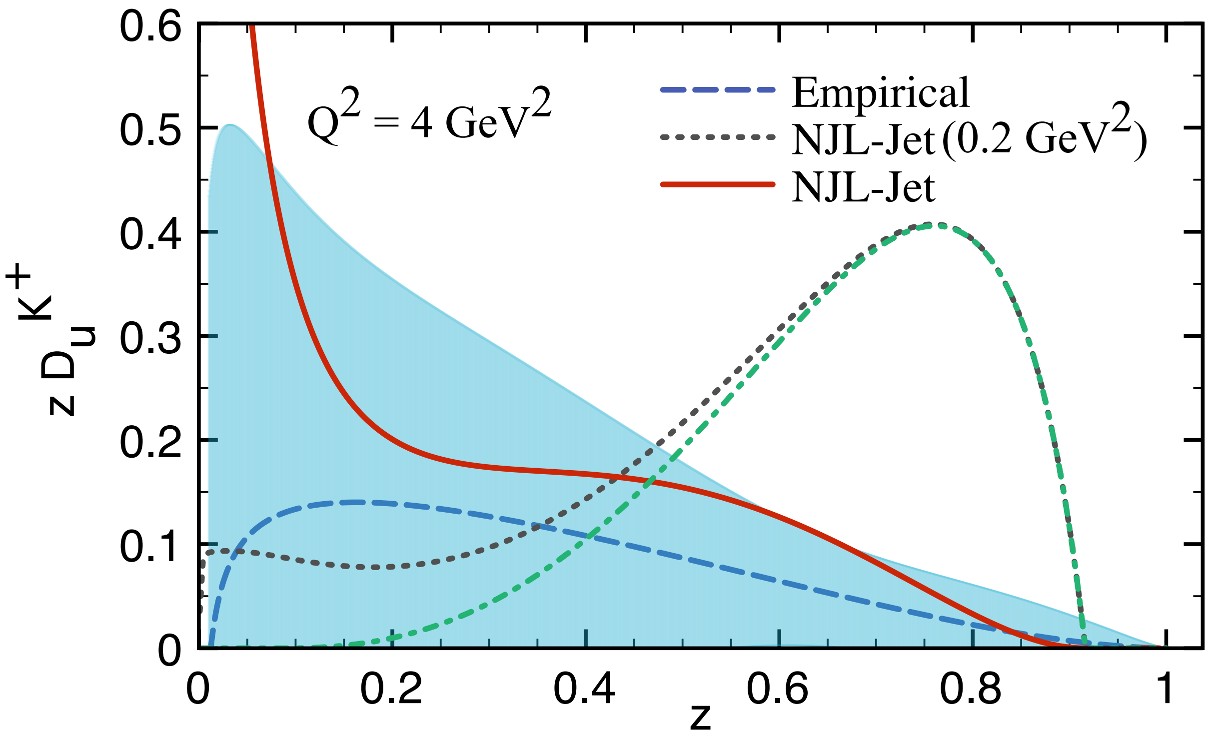


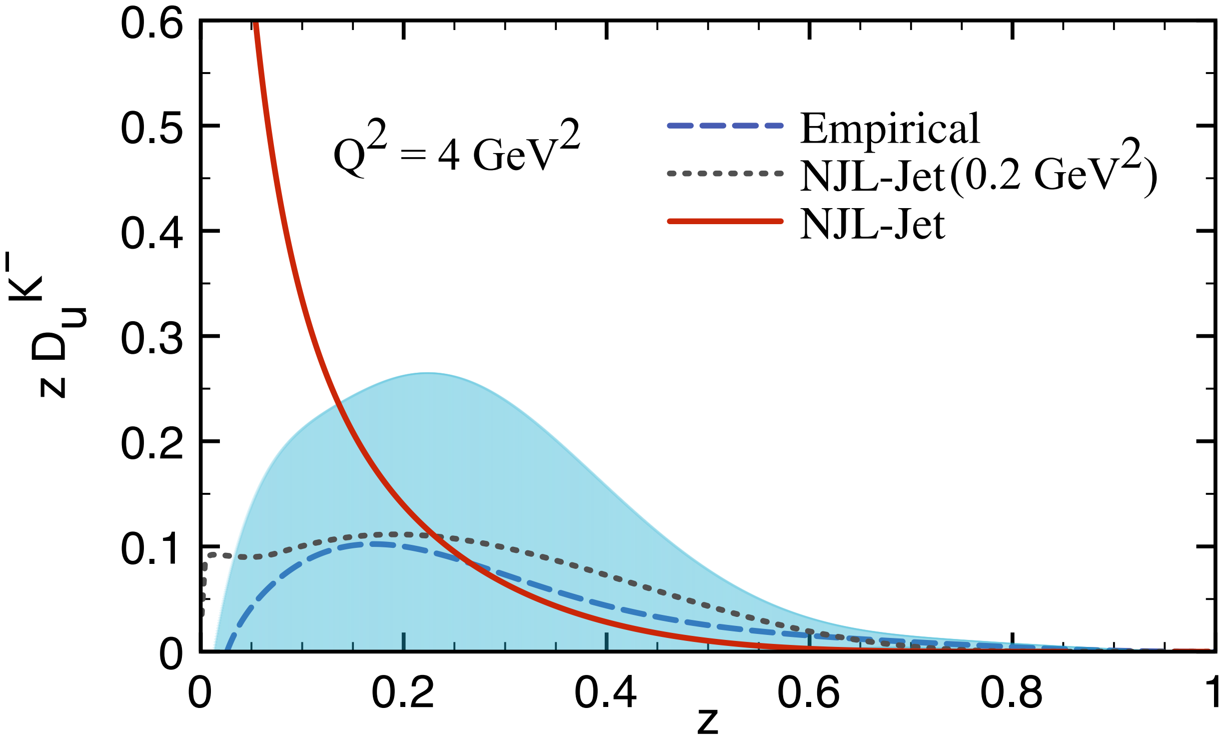


The strange can be probed
mainly by K$^-$ production

M. Osipenko's talk

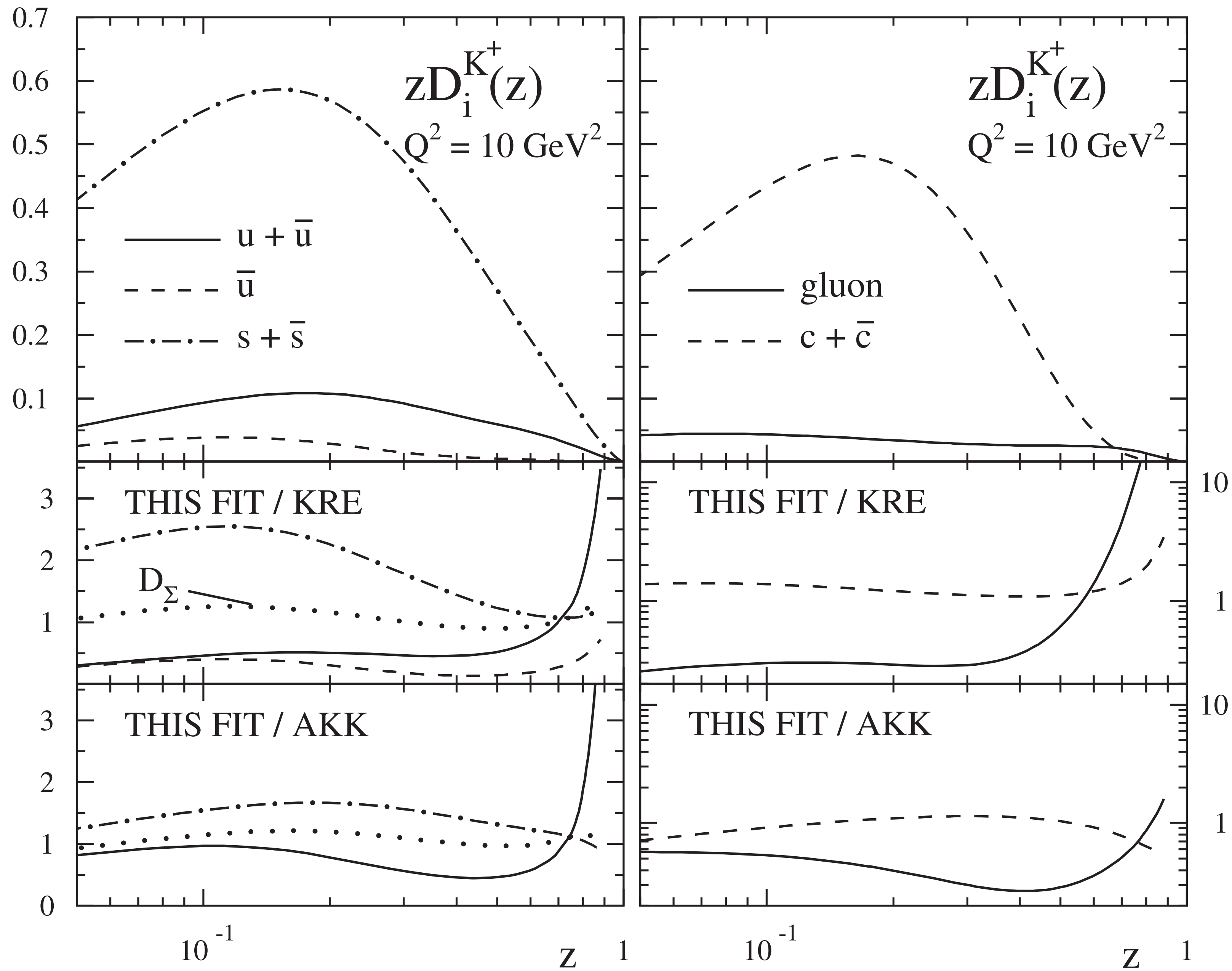






Shape of fragmentation function can be predicted by, e.g., NJL-jet model

H. Matevosyan's talk



Large differences between different fits

E. Christova's talk and DSS, PRD75 (07)

I) all fav. FFs and all unfav. FFs are equal $\Rightarrow$ 2 FFs (BKK)

$$\begin{aligned} D_u^{K^+} &= D_{\bar{s}}^{K^+} \Leftarrow fav. \\ D_{\bar{u}}^{K^+} &= D_s^{K^+} = D_d^{K^+} = D_{\bar{d}}^{K^+} \Leftarrow unfav. \end{aligned}$$

II) fav. FFs are not equal, all unfav. FFs equal $\Rightarrow$ 3 FFs (DSS)

$$\begin{aligned} D_u^{K^+}, \quad & D_{\bar{s}}^{K^+} \quad \Leftarrow \quad m_s >> m_{u,d} \\ D_{\bar{u}}^{K^+} &= D_s^{K^+} = D_d^{K^+} = D_{\bar{d}}^{K^+} \end{aligned}$$

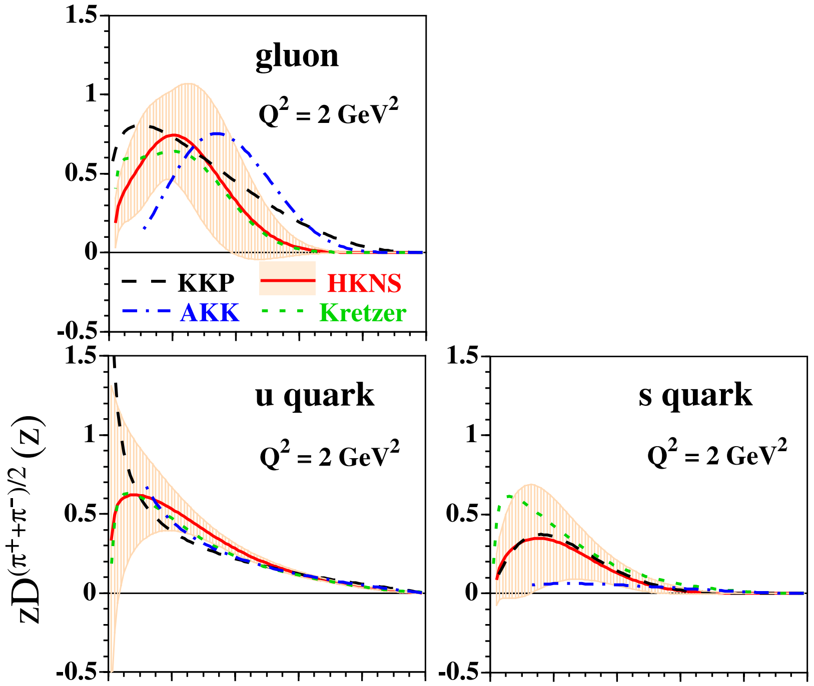
III) fav. FFs and unfav. FFs are power suppressed (Kre):

$$\begin{aligned} D_u^{K^+}, \quad & D_{\bar{s}}^{K^+} \quad \Leftarrow \quad m_s >> m_{u,d} \\ D_u^{K^+} &= (1-z) D_{\bar{s}}^{K^+}, \end{aligned}$$

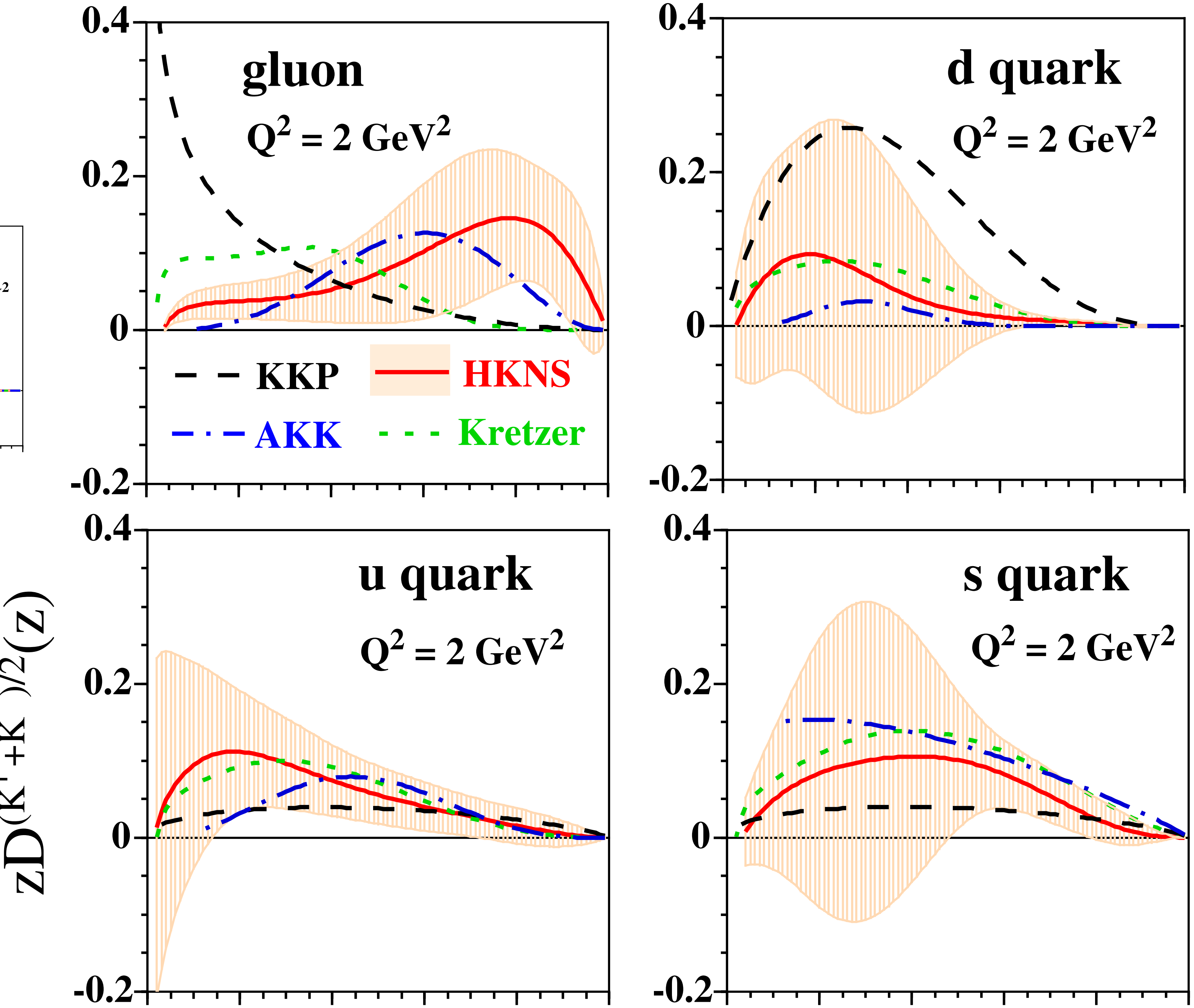
IV) fav. FFs are not equal and unfav. FFs are not equal

$\Rightarrow$ 5 FFs (AKK)

$$\begin{aligned} D_u^{K^+}, \quad & D_{\bar{s}}^{K^+} \Leftarrow fav. \\ D_{\bar{u}}^{K^+}, \quad & D_s^{K^+} \\ D_d^{K^+} &= D_{\bar{d}}^{K^+} \end{aligned}$$



pions



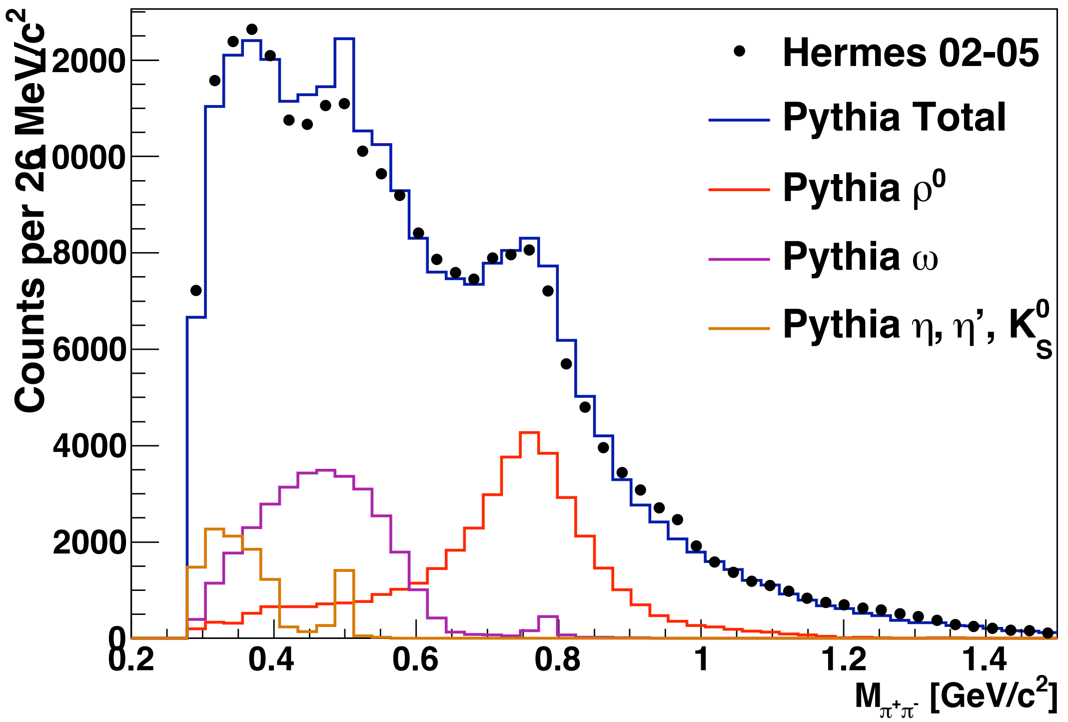
kaons

Large discrepancies and errors

E. Christova's talk and HKNS, PRD75 (07)

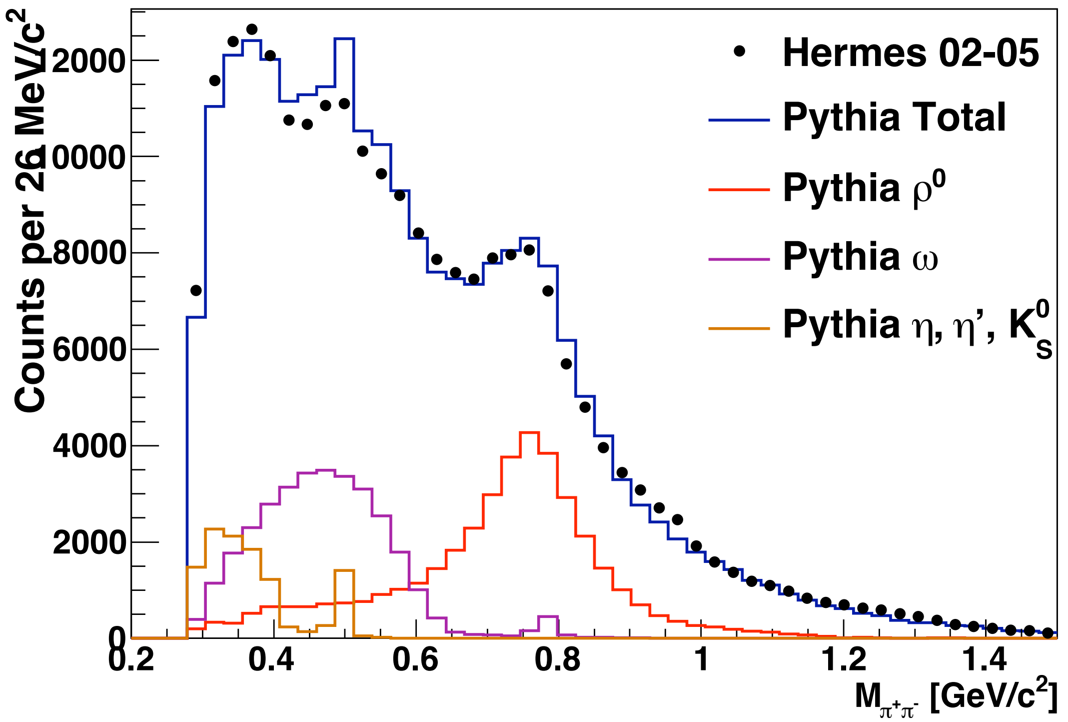
Strange dihadron fragmentation functions

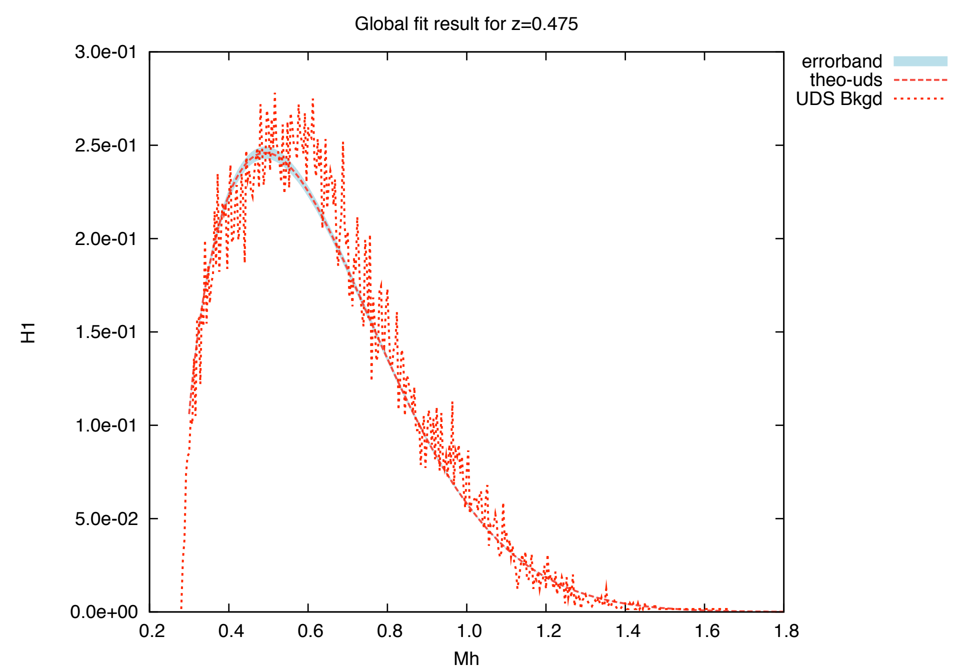
First problem: identify different channels



S. Gliske's and A. Courtoy's talks

First problem: identify different channels





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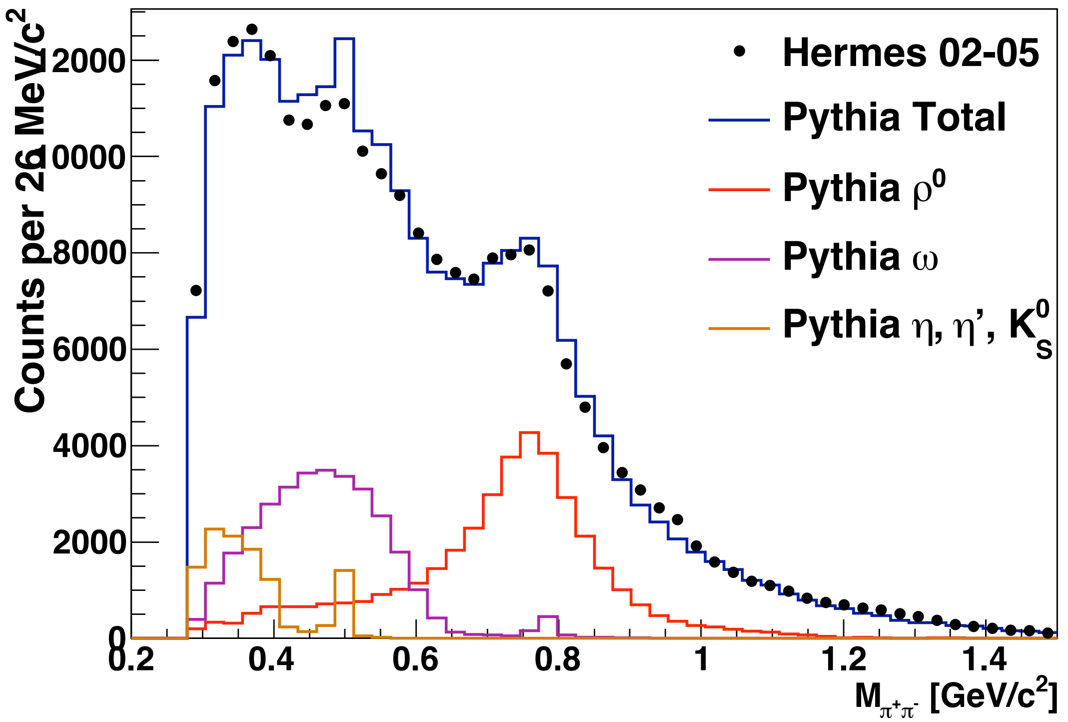
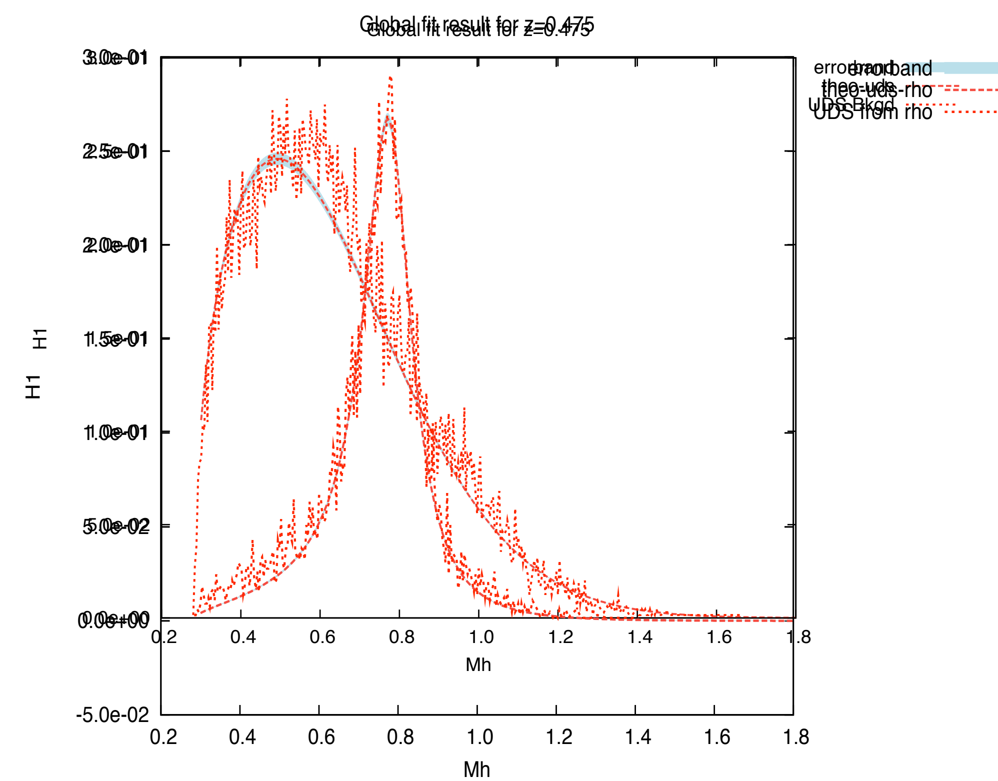




S. Gliske's and A. Courtoy's talks

Second problem: understand flavor content

$\pi^+\pi^-$	$u\bar{d}d\bar{u}$
K^+K^-	$u\bar{s}s\bar{u}$

A. Courtoy's talks

Second problem: understand flavor content

$\pi^+\pi^-$	$u\bar{d}d\bar{u}$
K^+K^-	$u\bar{s}s\bar{u}$

For $\pi^+\pi^-$

A. Courtoy's talks

Second problem: understand flavor content

$\pi^+\pi^-$	$u\bar{d}d\bar{u}$
K^+K^-	$u\bar{s}s\bar{u}$

For $\pi^+\pi^-$

$$D_1^u(z,M_h) = D_1^{\bar{u}}(z,M_h) = D_1^d(z,M_h) = D_1^{\bar{d}}(z,M_h)$$
$$D_1^s(z,M_h) = D_1^{\bar{s}}(z,M_h)$$
$$D_1^c(z,M_h) = D_1^{\bar{c}}(z,M_h)$$

A. Courtoy's talks

Second problem: understand flavor content

$\pi^+\pi^-$	$u\bar{d}d\bar{u}$
K^+K^-	$u\bar{s}s\bar{u}$

For $\pi^+\pi^-$

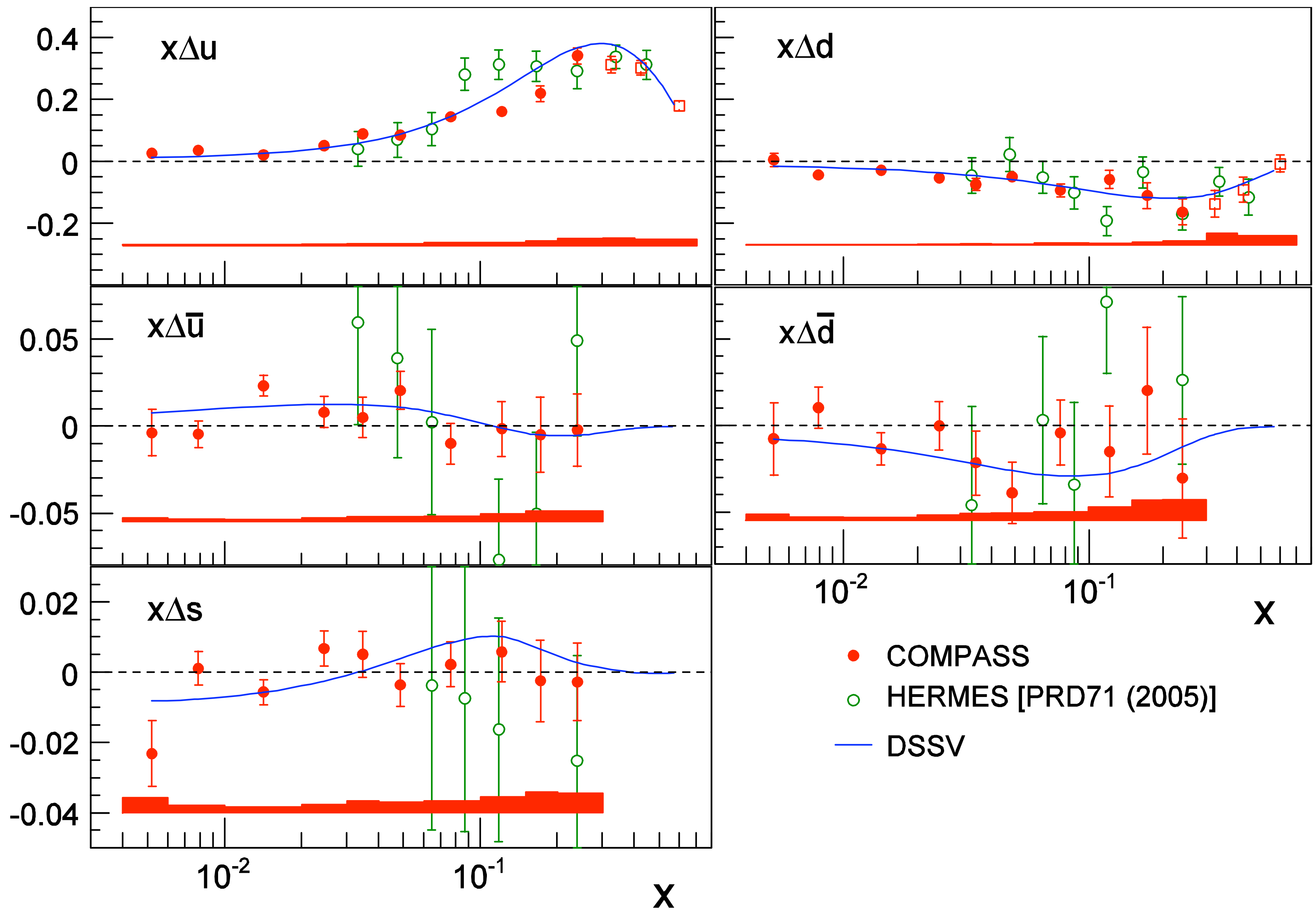
$$D_1^u(z, M_h) = D_1^{\bar{u}}(z, M_h) = D_1^d(z, M_h) = D_1^{d}(z, M_h)$$
$$D_1^s(z, M_h) = D_1^{\bar{s}}(z, M_h)$$
$$D_1^c(z, M_h) = D_1^{\bar{c}}(z, M_h)$$

I. . $D_1^s(z, M_h) = 0$

II. . $D_1^s(z, M_h) = D_1^u(z, M_h)$

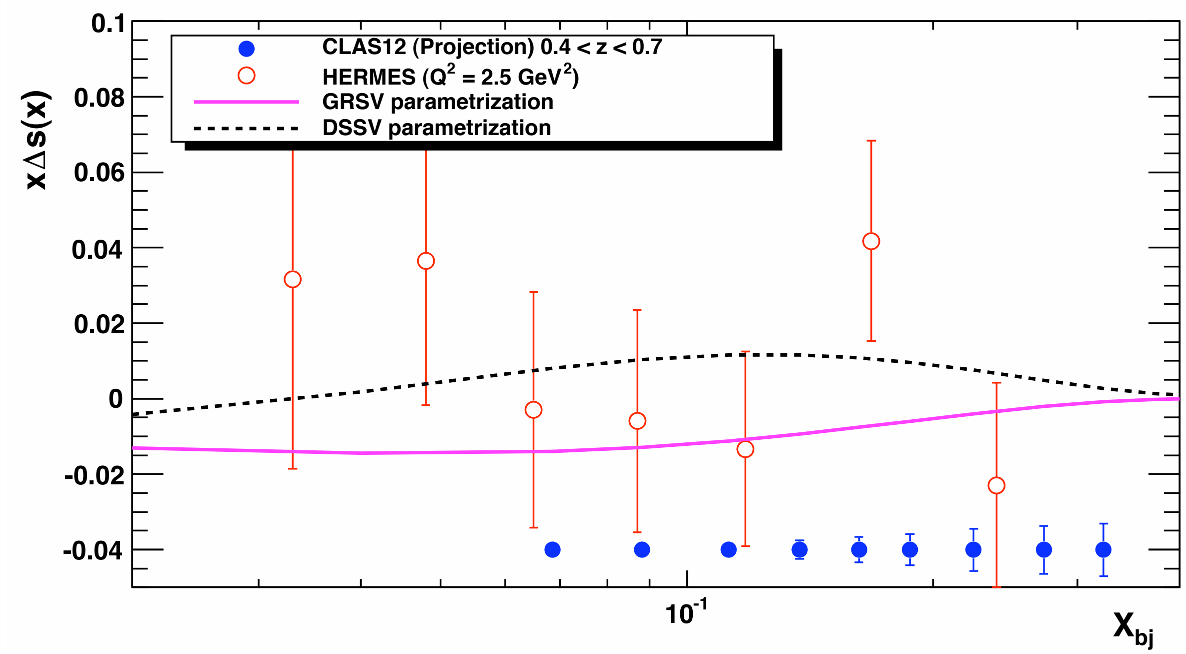
A. Courtoy's talks

Strange helicity distribution



F. Kunne's talk

Isoscalar extraction of Δs



F. Kunne's talk and HERMES

Δs puzzle

Inclusive data (g_1^N & a_8 from hyperon decay +SU(3))
→ $\int \Delta s = -0.08$

While semi inclusive data → $\Delta s(x) \approx 0$

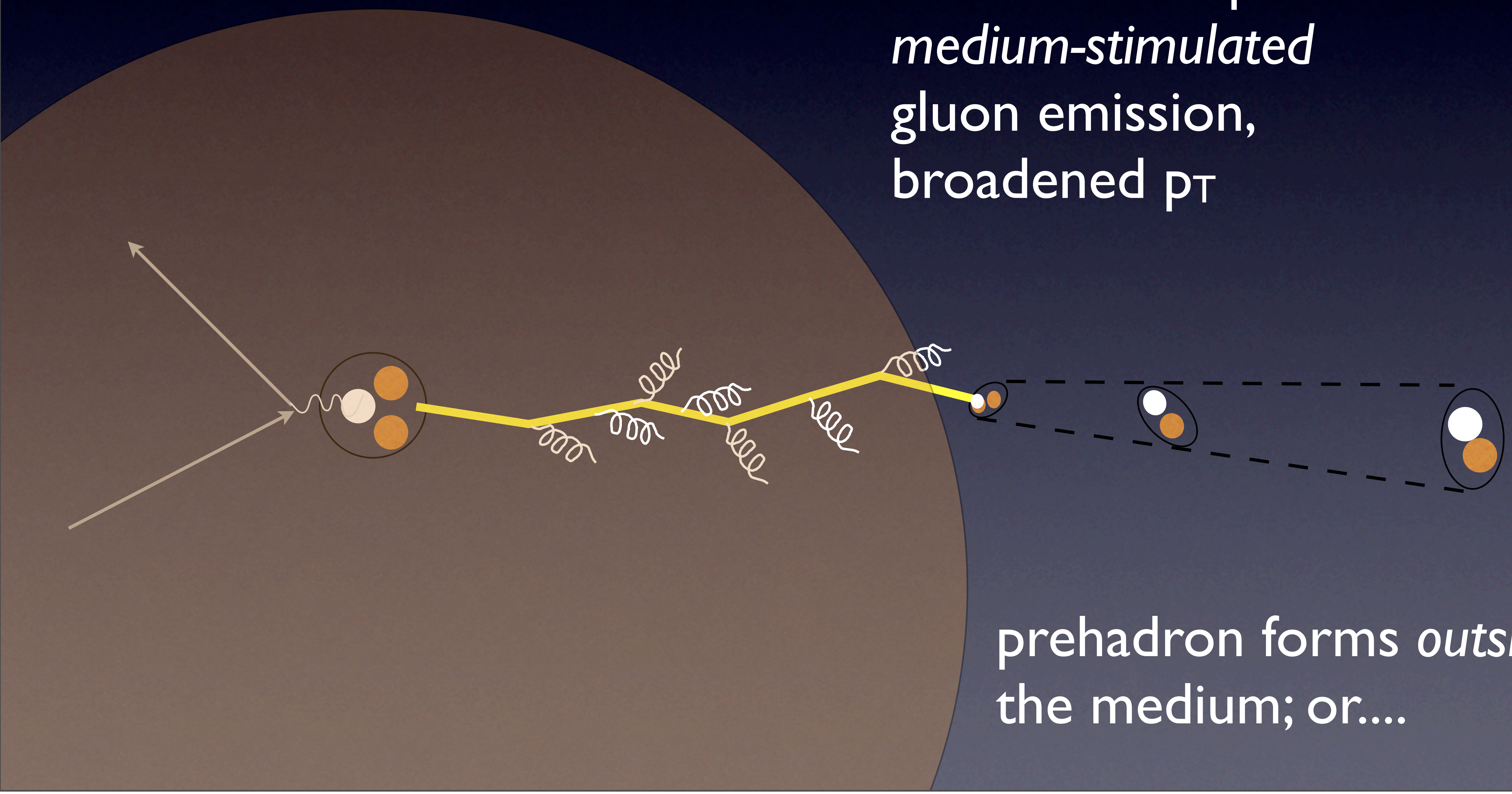
- Uncertainty on quark fragmentation functions (s-quark to K)
  - would need a factor of ~2 from DSS value of FF
- Global fits (DSSV, LSS) suggest negative Δs at low x
  - reconciles the two approaches
  - indeed COMPASS SIDIS : Δs=-0.01 with linear extrap.
    Δs=-0.05 with DSSV extrap.
- Assume SU(3) violation a_8 from0.58 to 0.42 → Δs=-0.02

Bass &Thomas, PLB684(2010) 216

Strange in-medium modifications

DIS in Cold Nuclear Medium

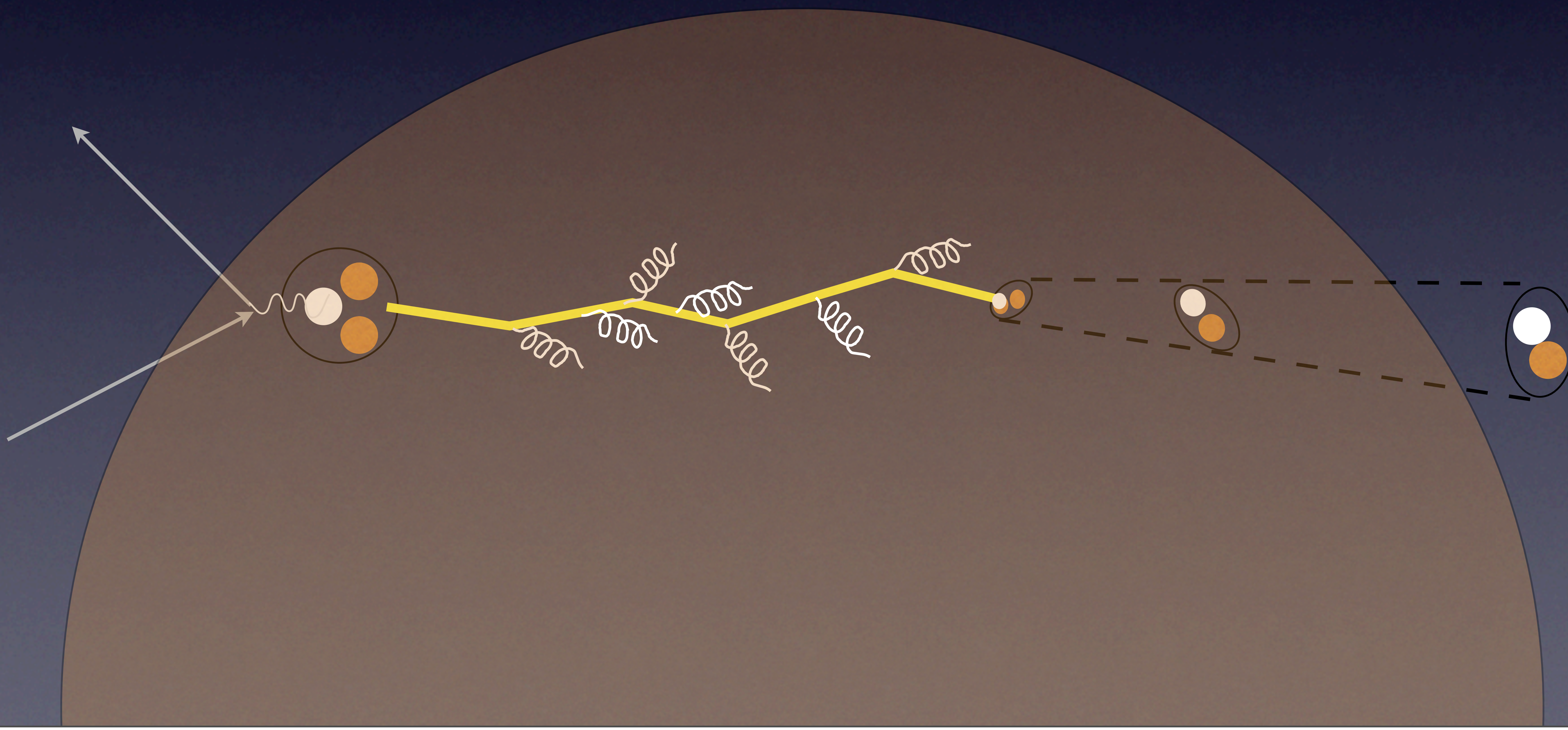
Partonic multiple scattering:
medium-stimulated
gluon emission,
broadened p_T

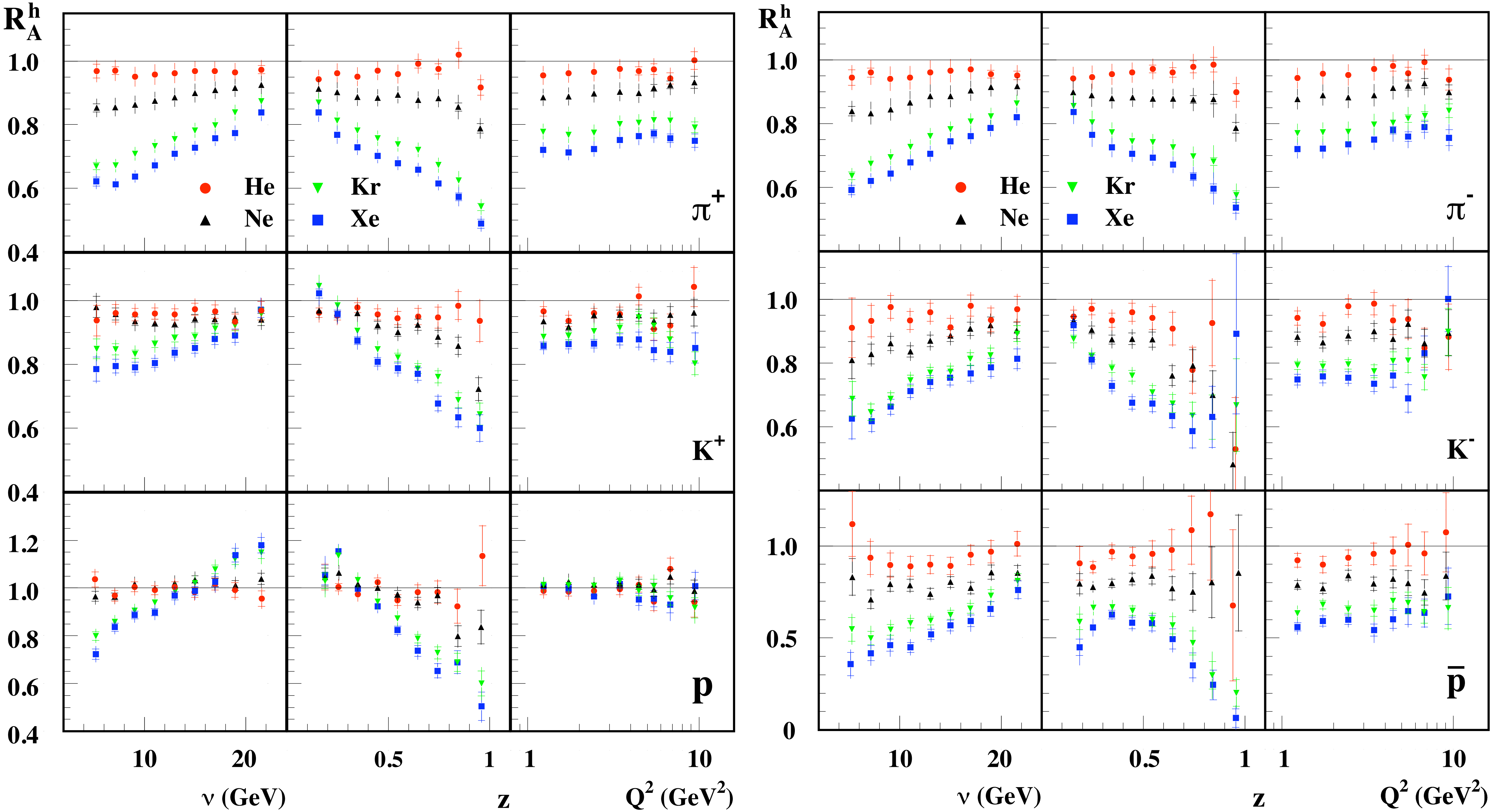


prehadron forms *outside*
the medium; or....

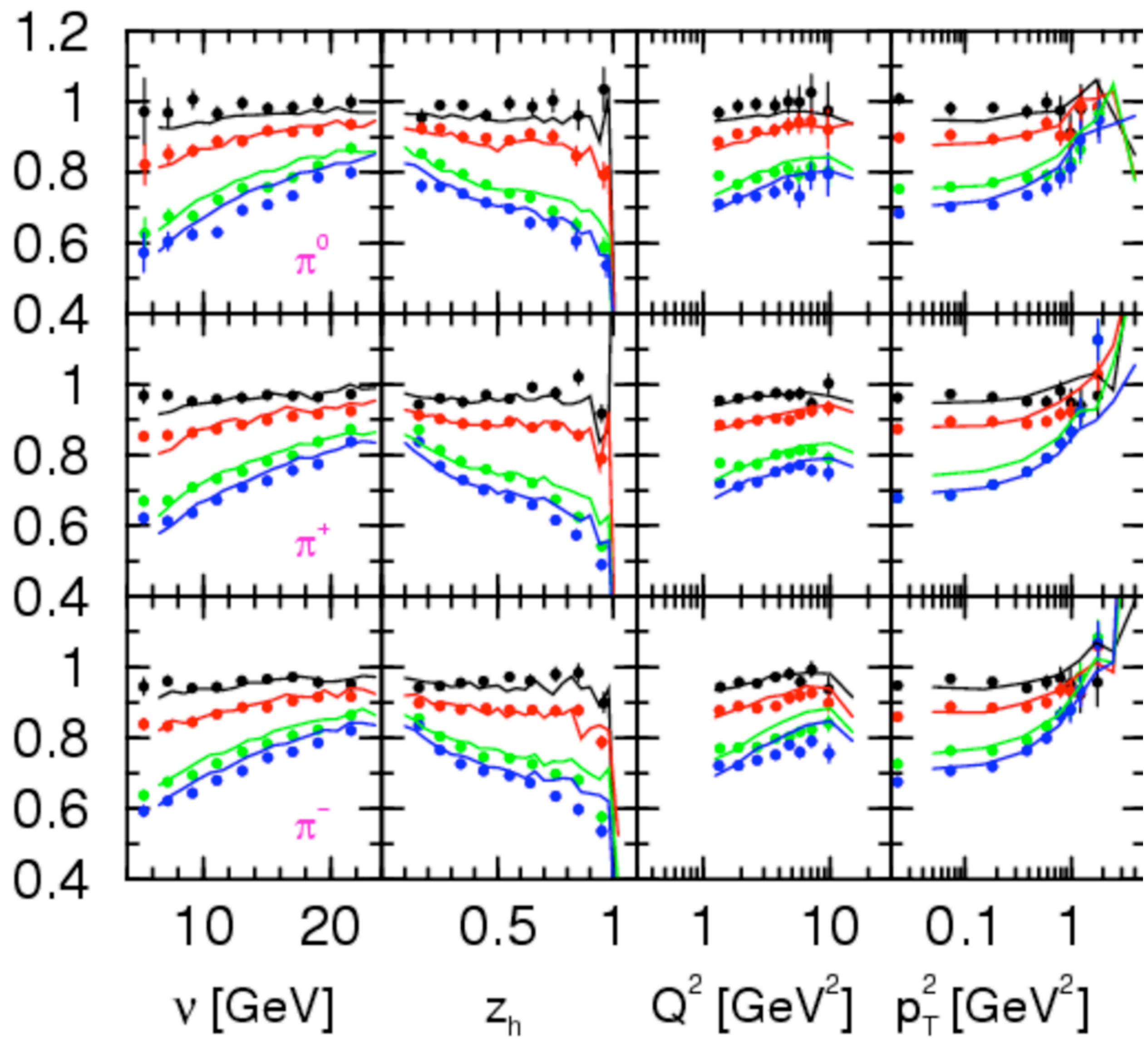
DIS in Cold Nuclear Medium

Hadron forms *inside* the medium; then also have prehadron/hadron interaction

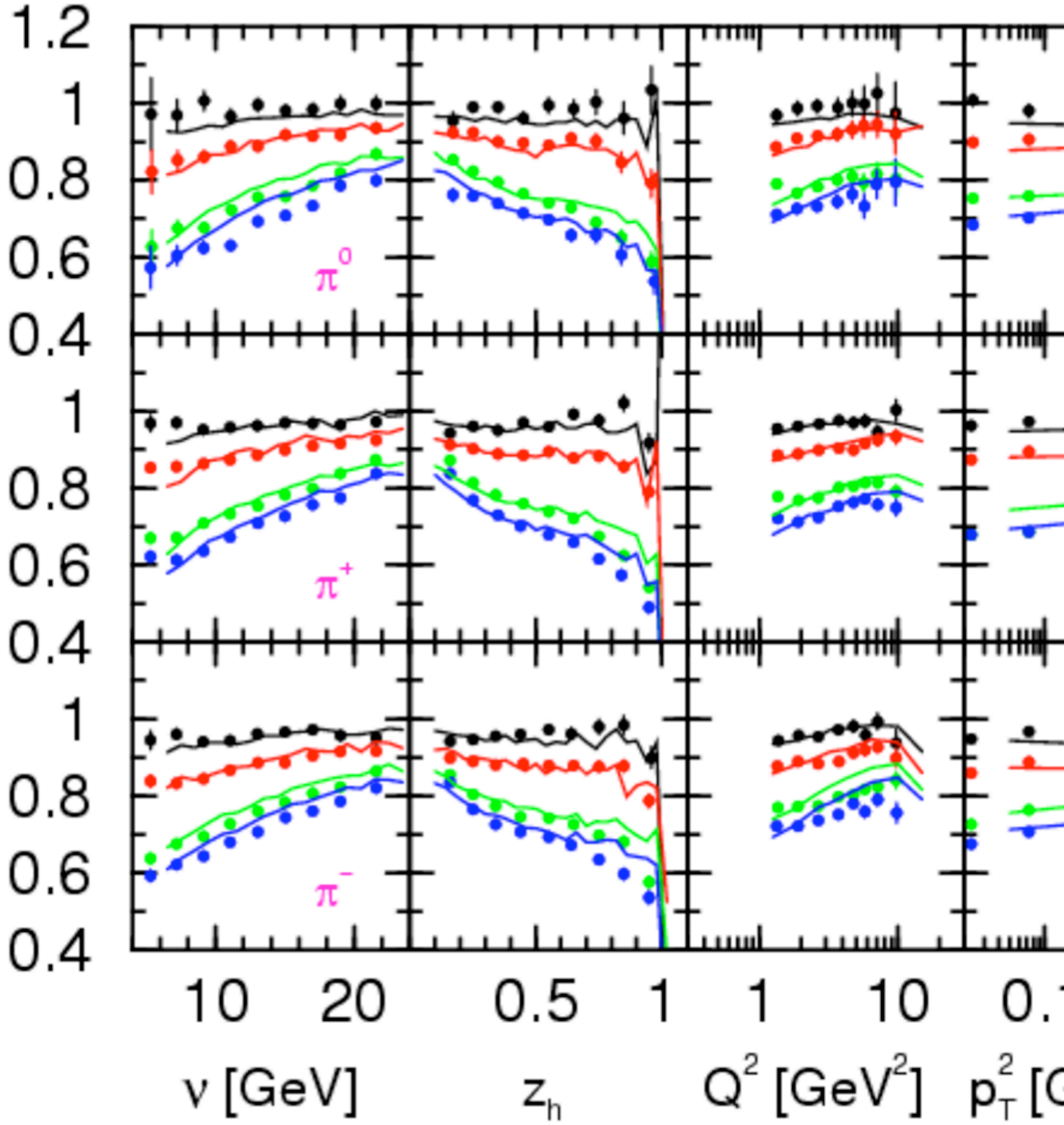




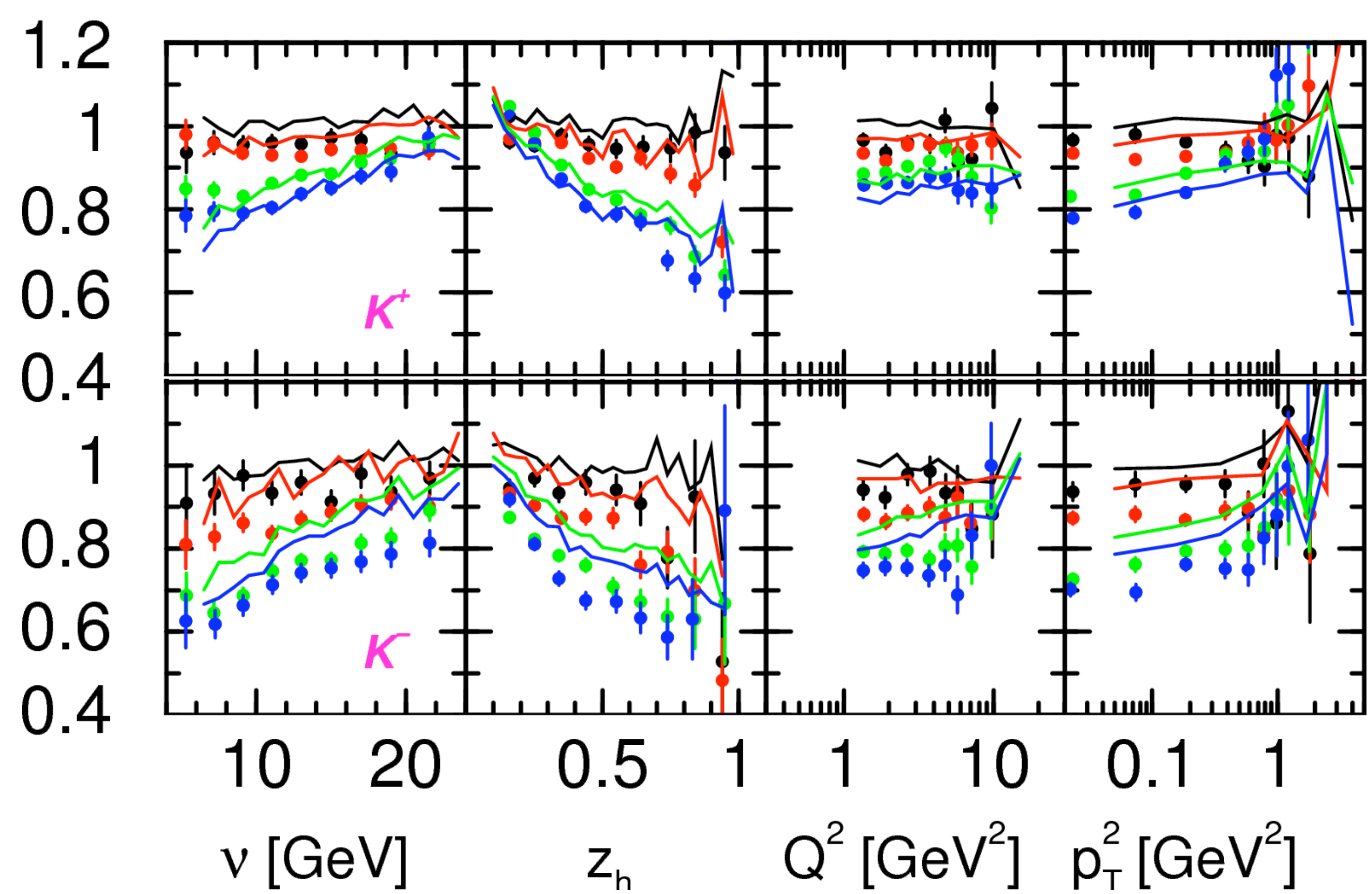
W. Brooks's talk and HERMES



K. Gallmeister's talk and HERMES



Kaon



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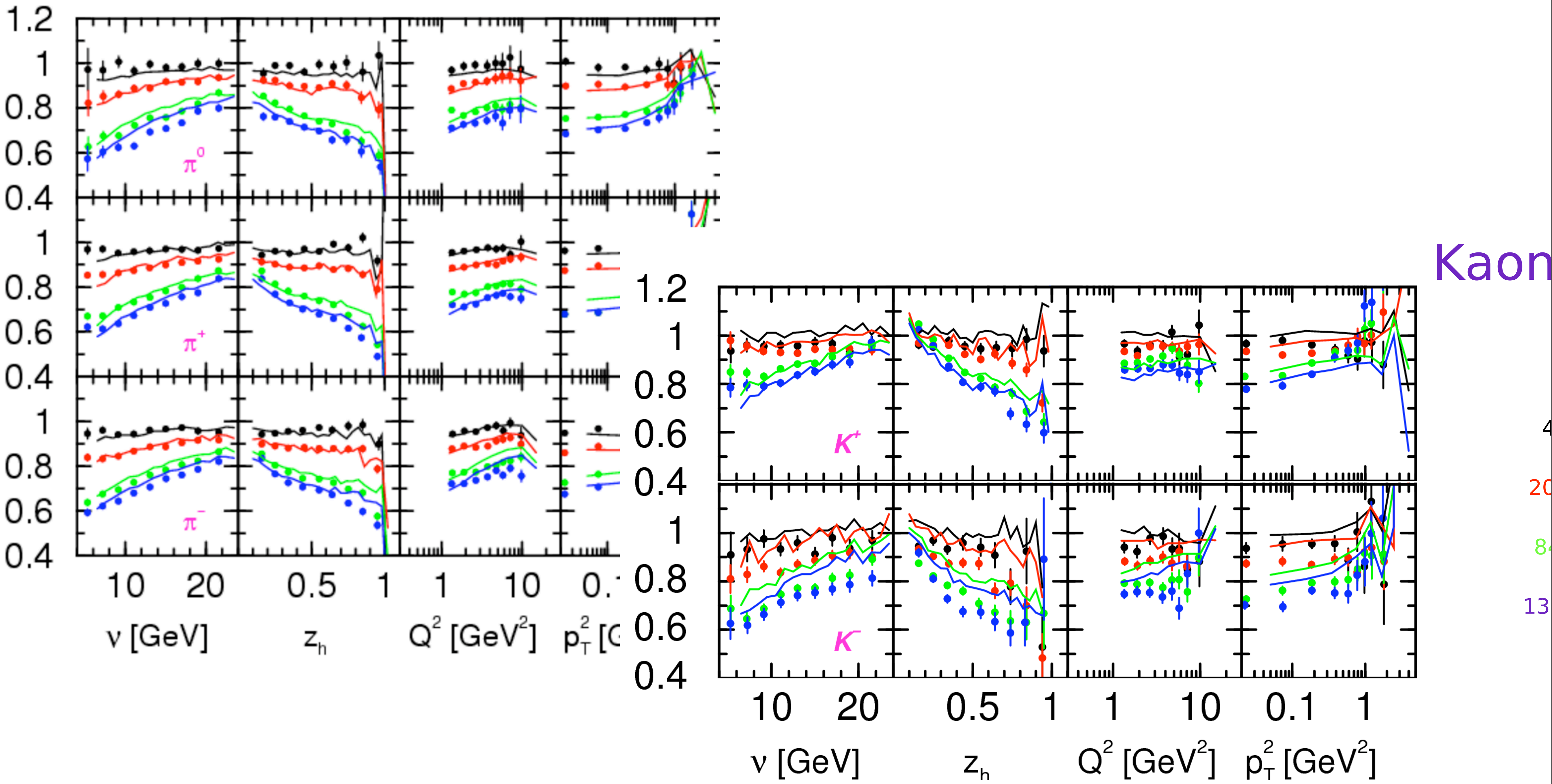
84
13

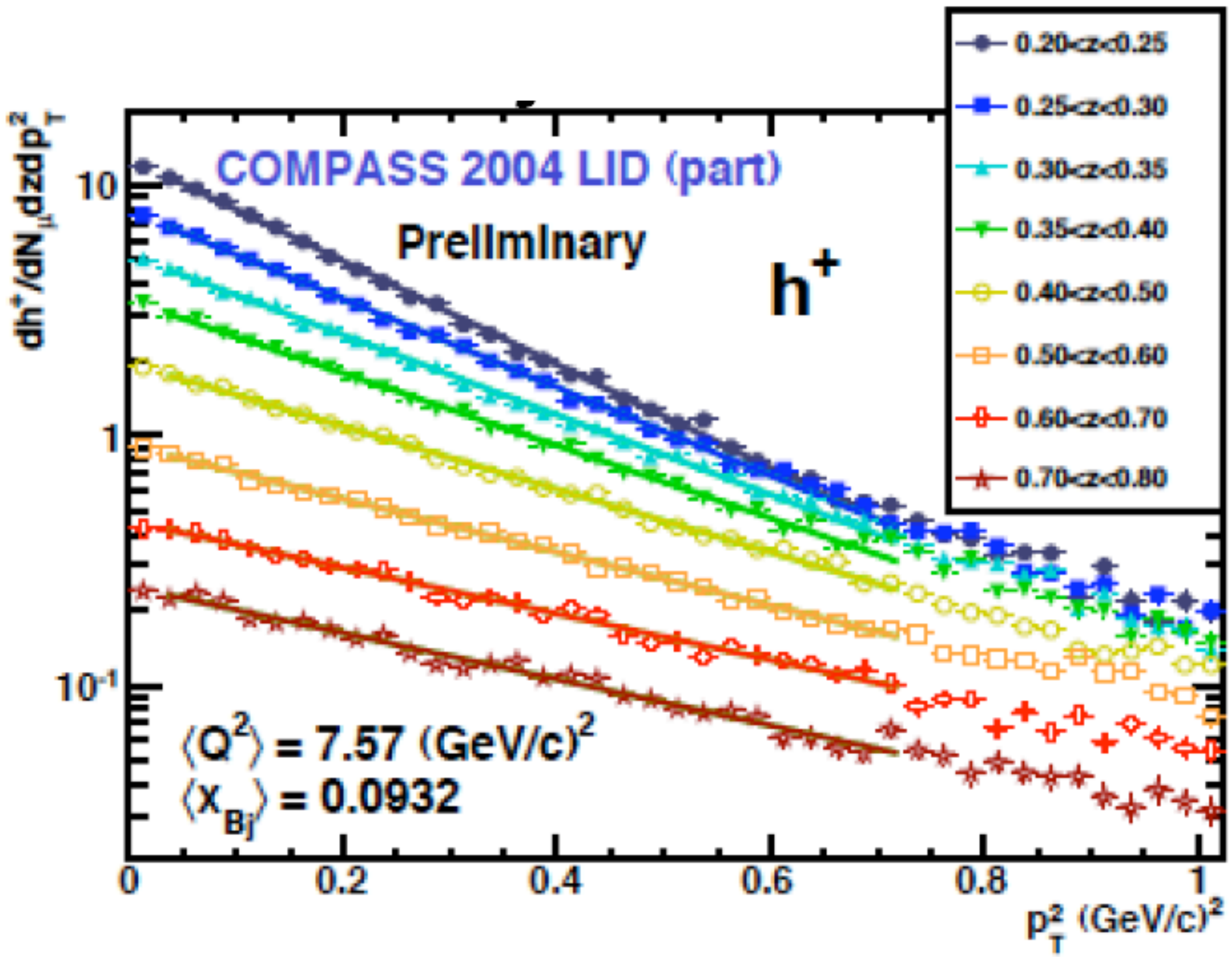
K. Gallmeister's talk and HERMES



- Kaons/Antikaons critical test of interaction scenario
  - Different production mechanism (leading/non-leading)
  - Different hadronic FSI cross section

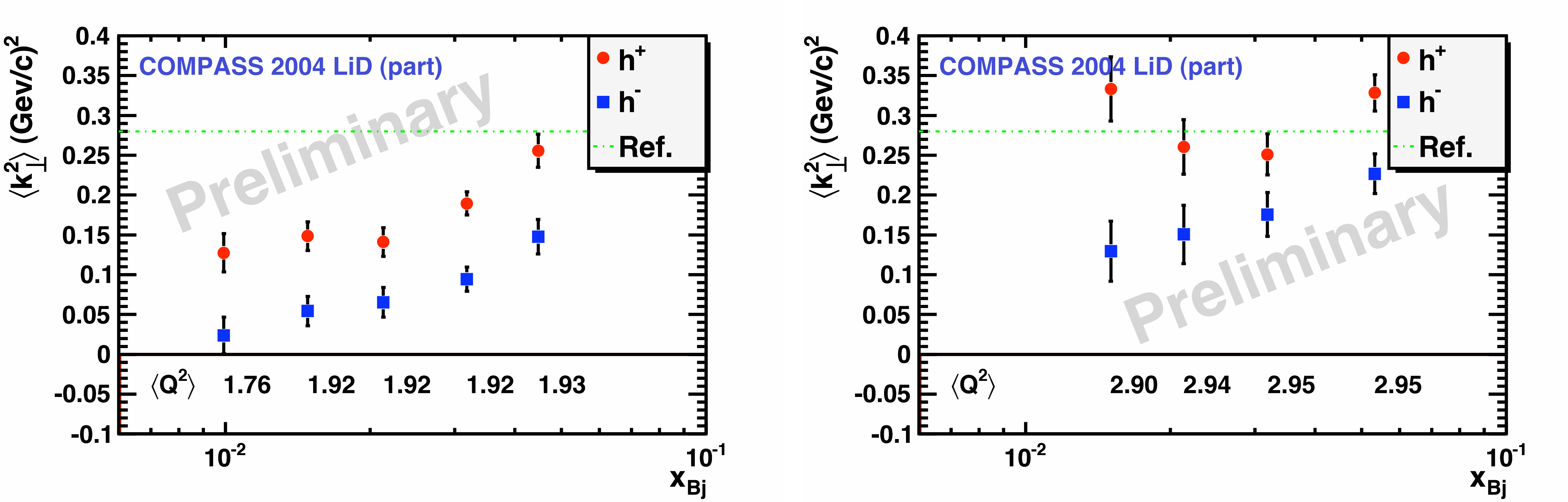
K. Gallmeister's talk and HERMES

Strange TMDs: unpolarized



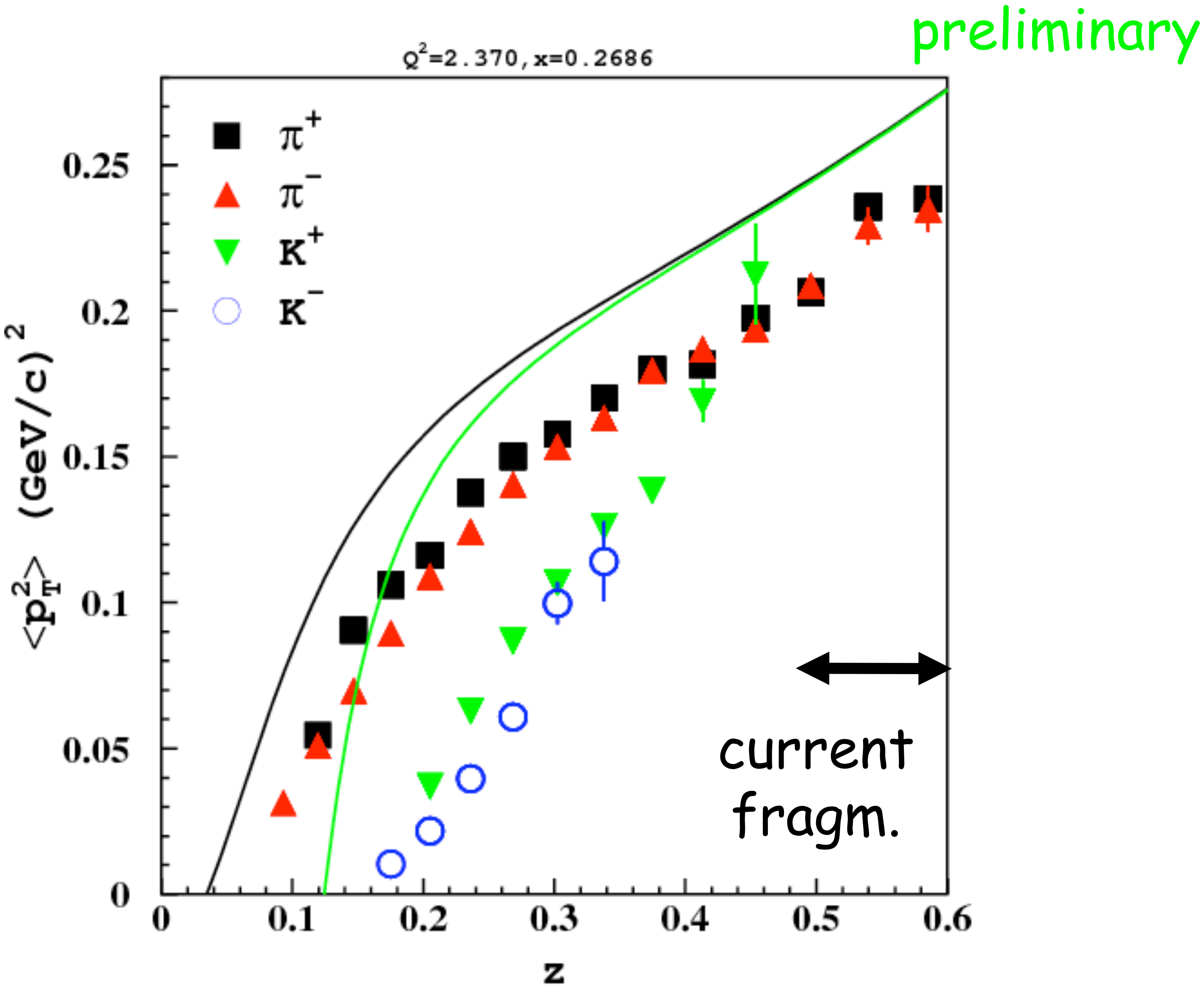
We have to understand the
unpolarized distributions first

A. Martin's talk and J.-F. Rajotte, Prague Spin 2010



There is some evidence
of flavor dependence

J.-F. Rajotte, Prague Spin 2010



There is some evidence

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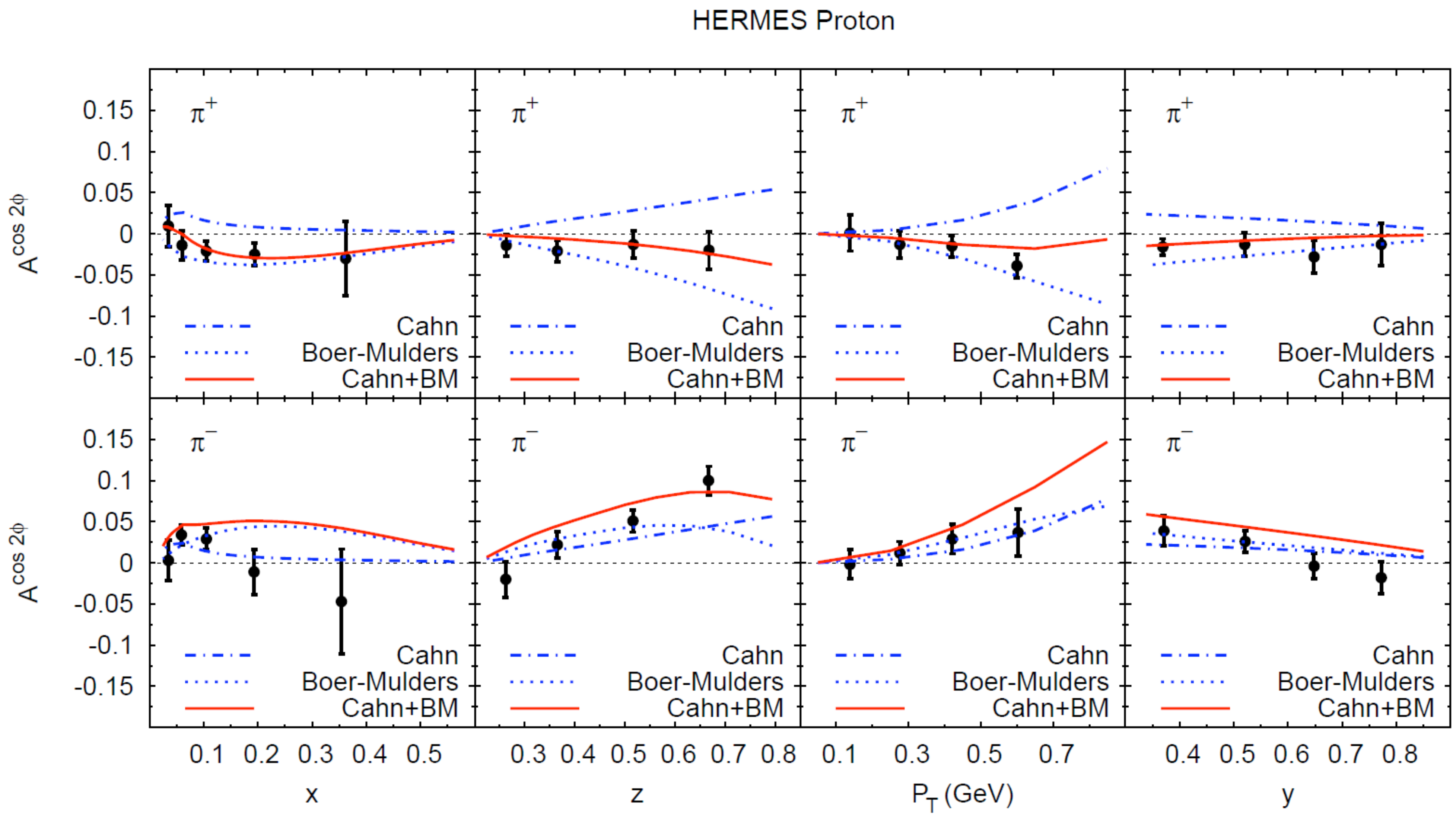
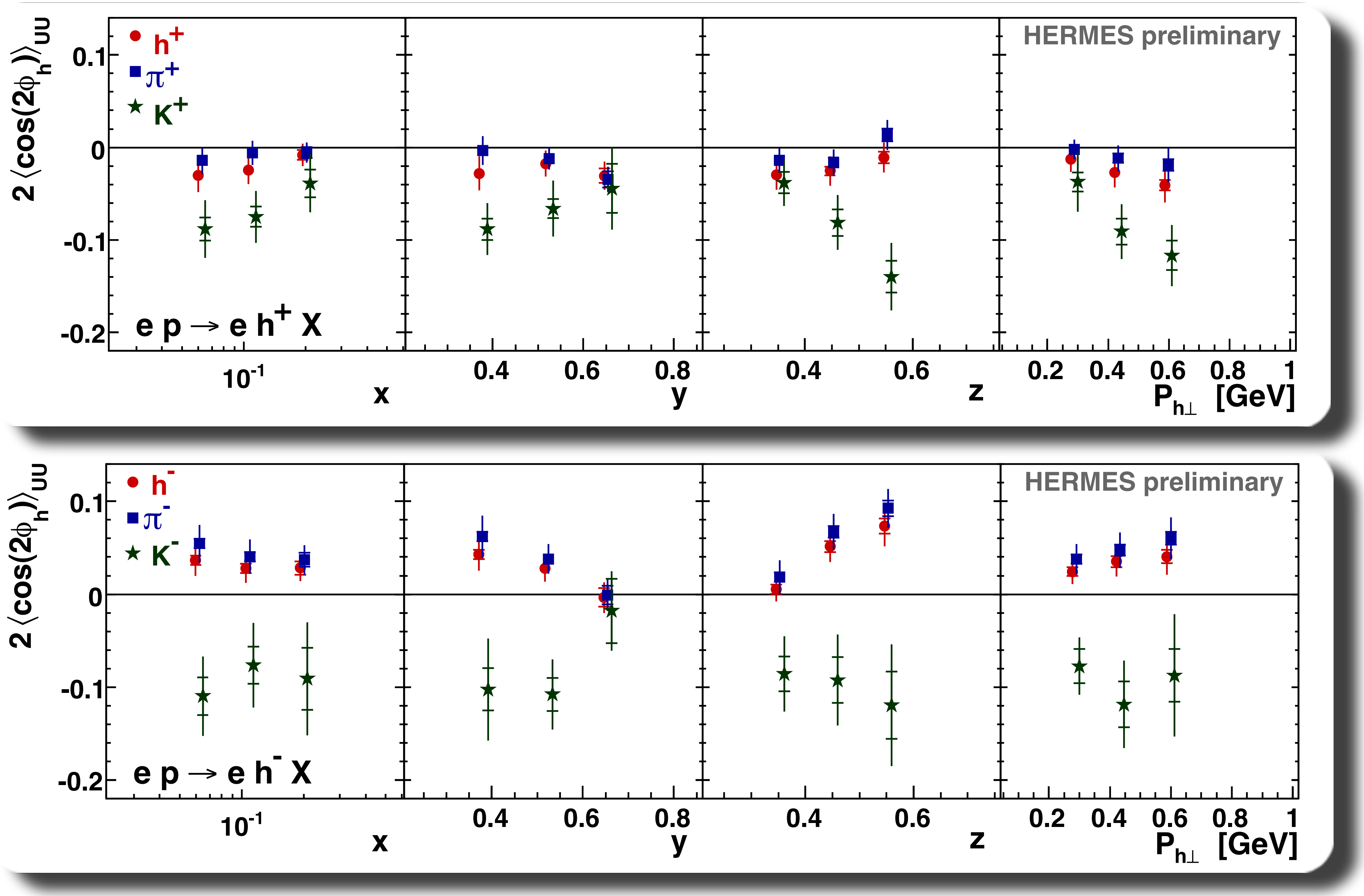
M. Osipenko's talk



We have to understand azimuthal asymmetries

S. Melis's talk



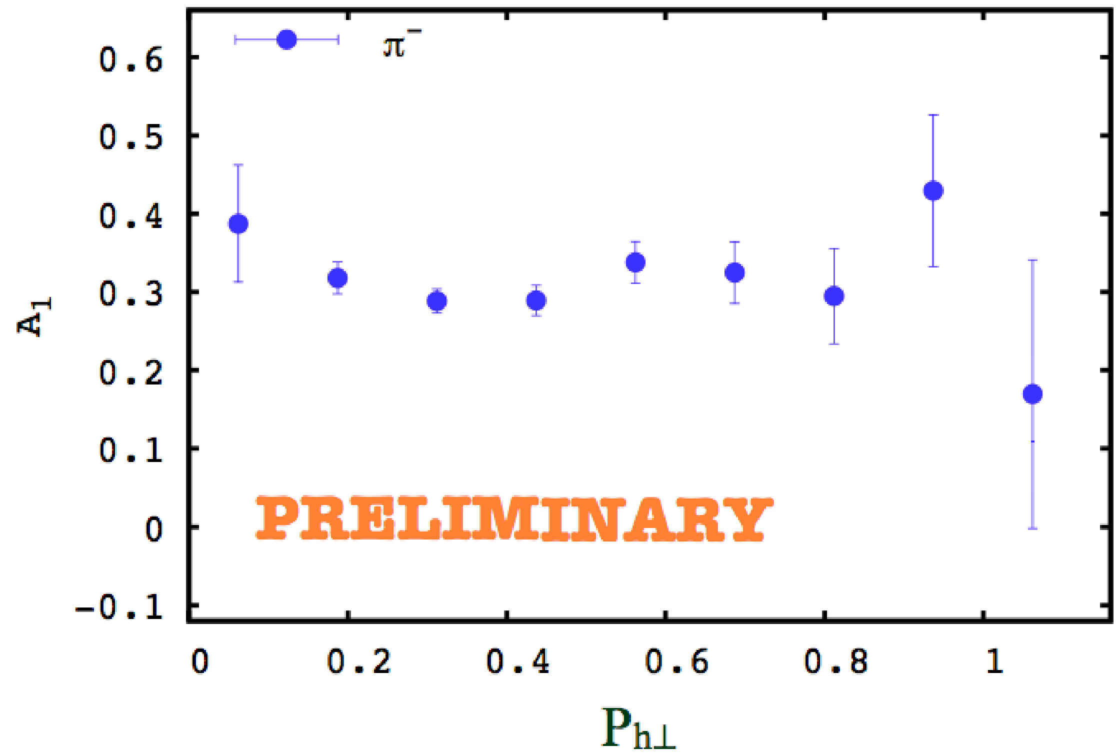
Striking differences

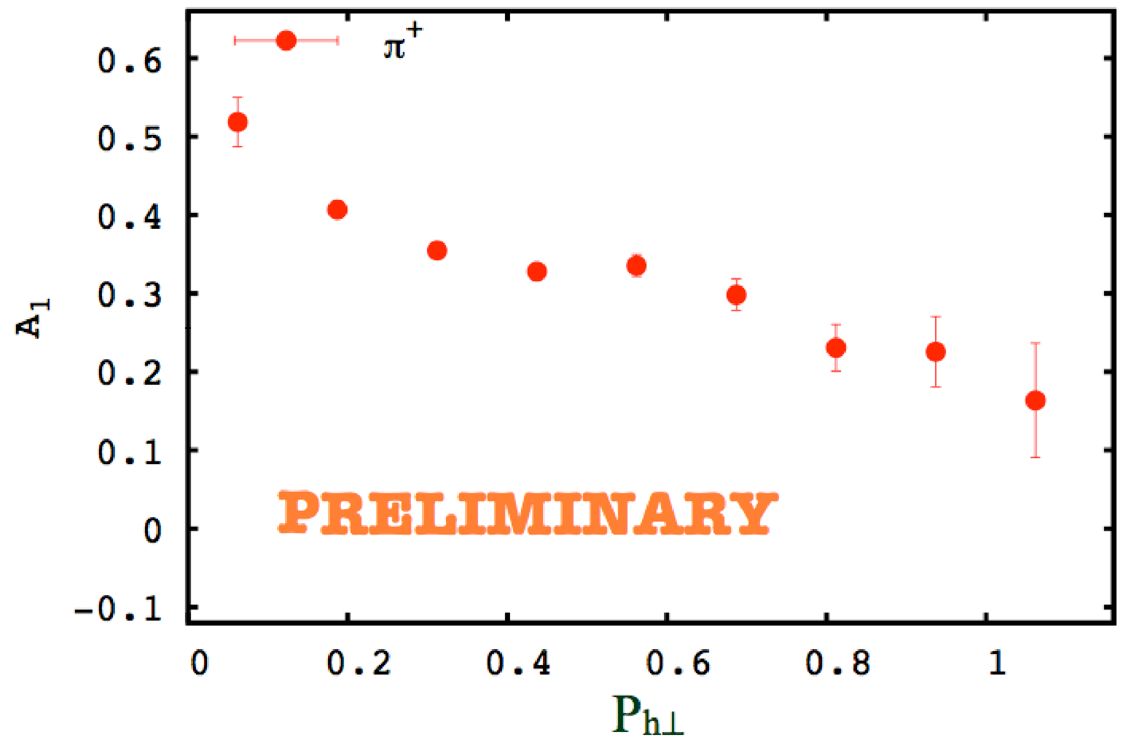
between kaons and pions

F. Giordano's talk

Strange TMDs: longitudinally polarized

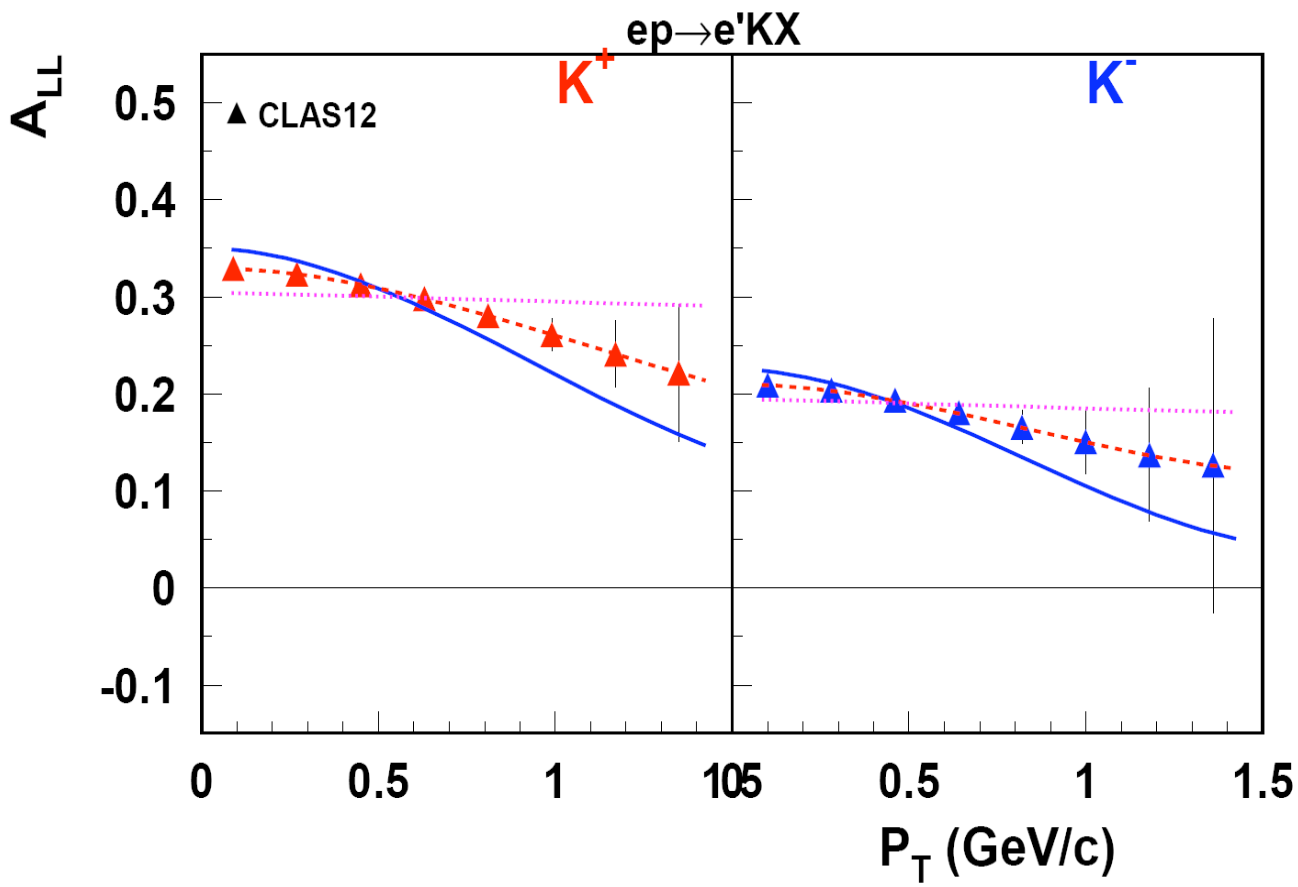
Hints of correlations
between transverse momentum and spin





K. Griffioen's talk

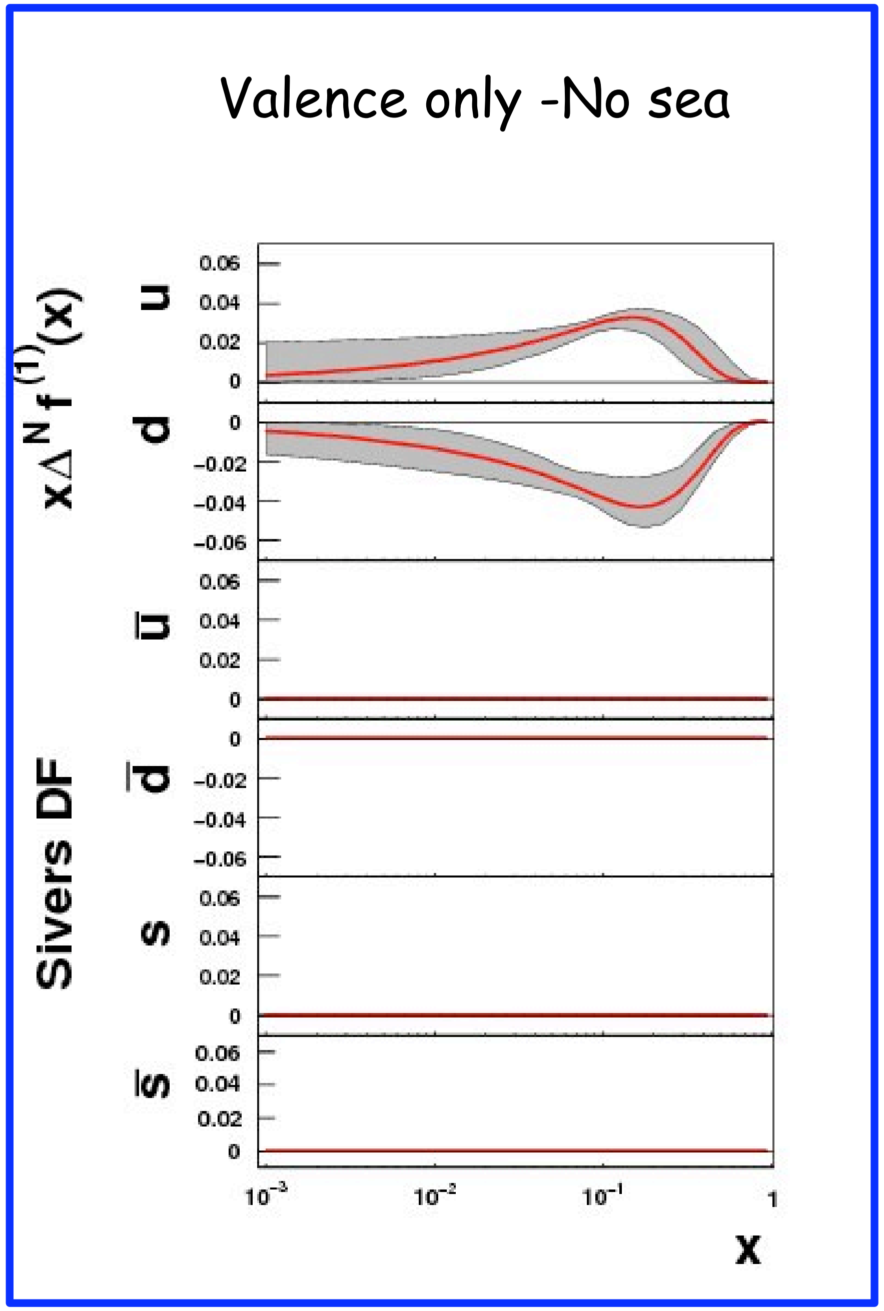
What is going to happen with the kaons?



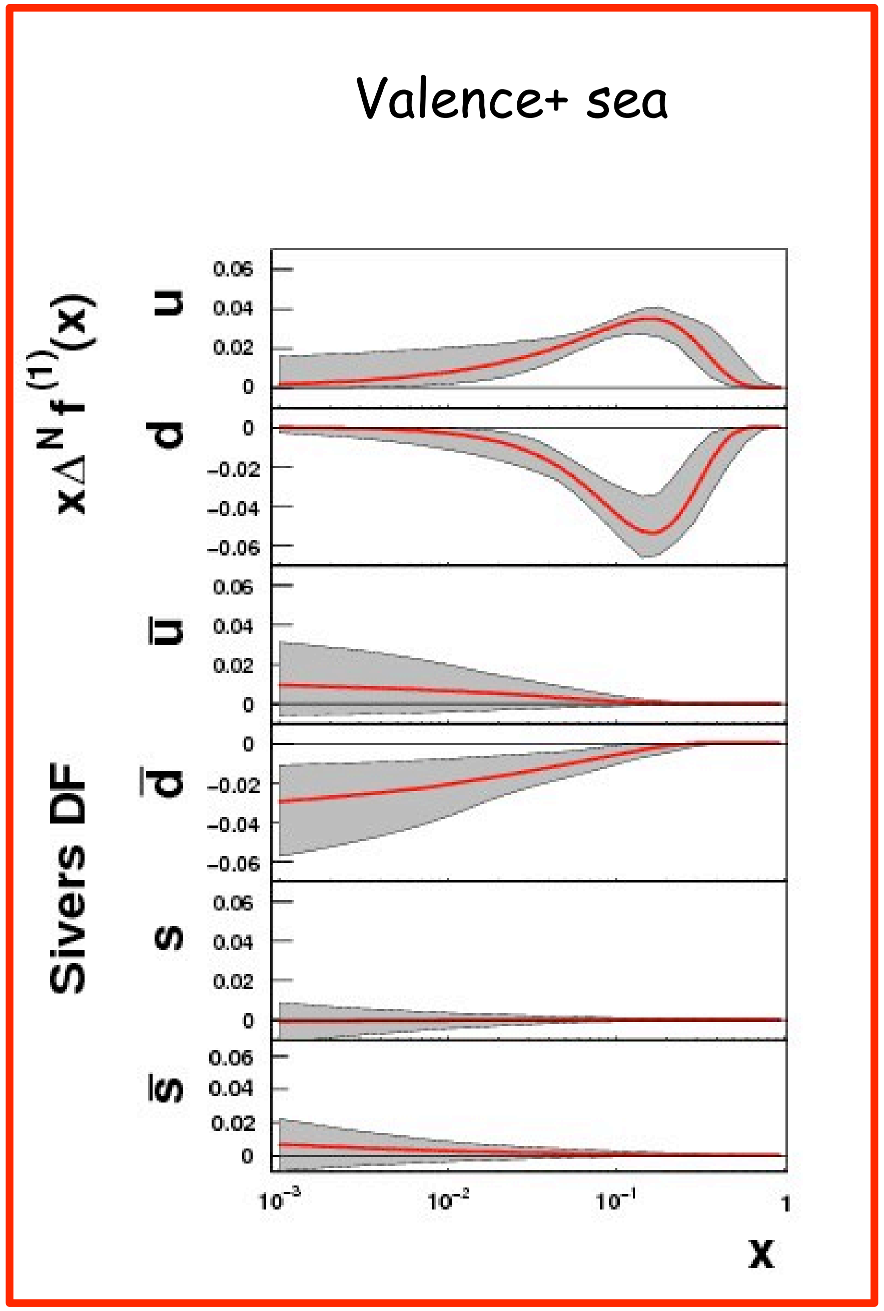
K. Hafidi's talk

Strange TMDs: transversely polarized

Already interesting constraints on Sivers function for sea quarks



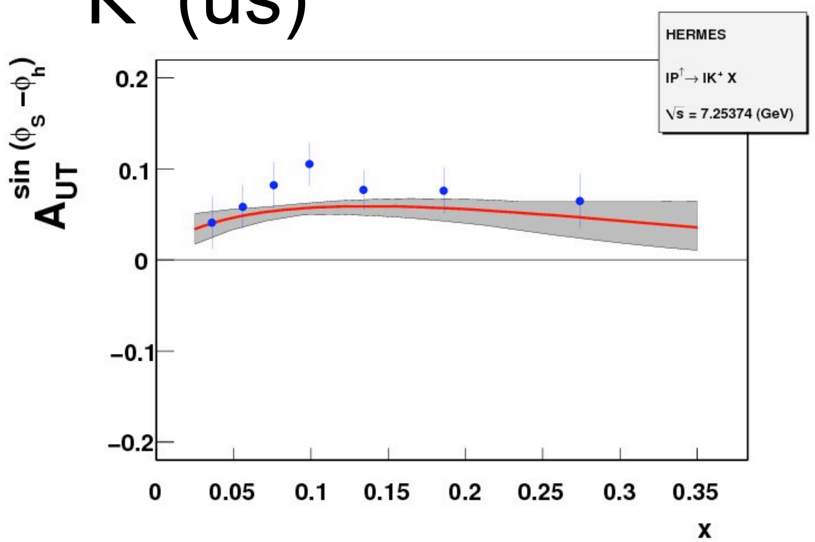
χ^2 /dof=1.07



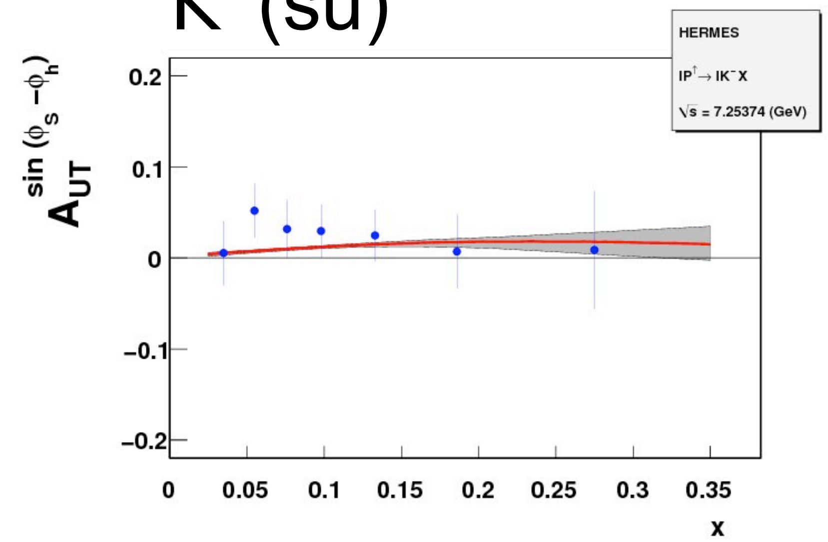
χ^2 /dof=.91

Valence only -No sea

K$^+$ ($u\bar{s}$)

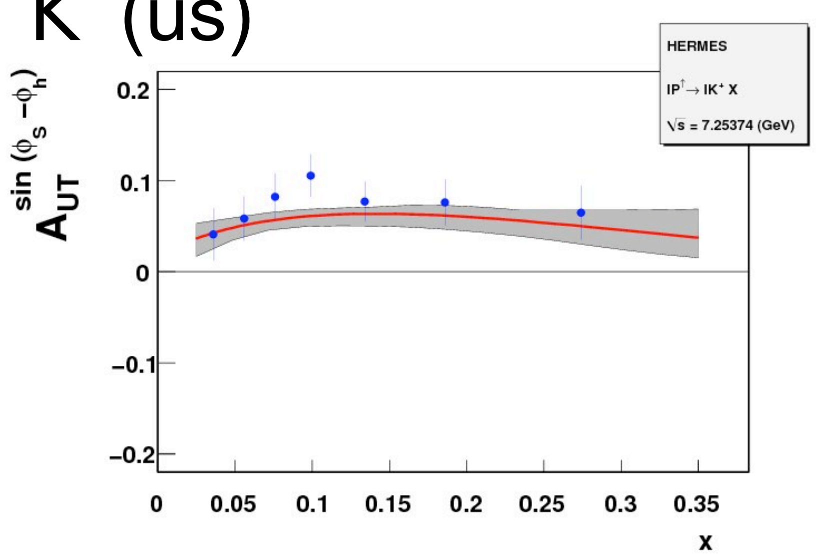


K$^-$ ($s\bar{u}$)

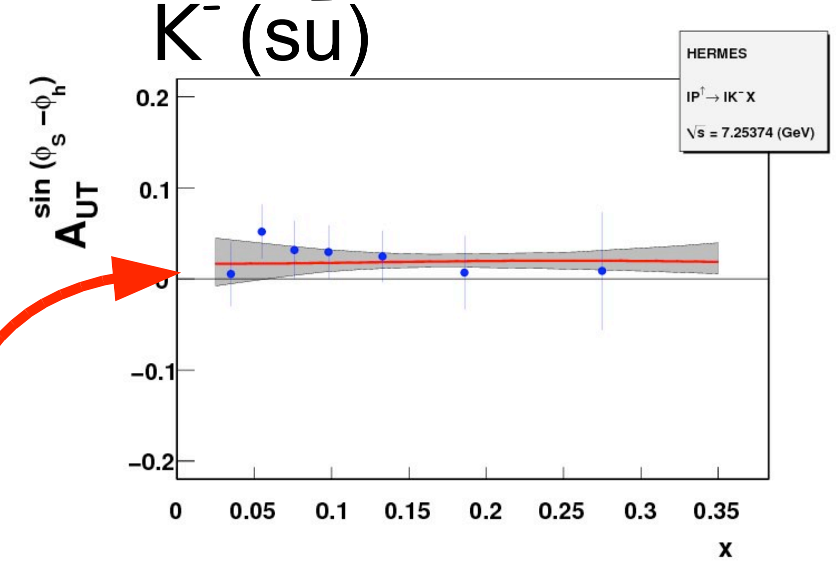


Valence+ sea

K$^+$ ($u\bar{s}$)



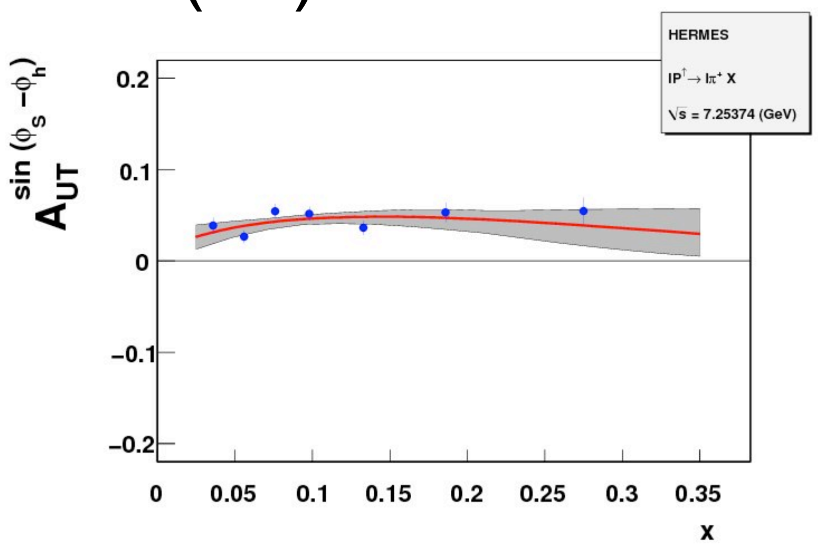
K$^-$ ($s\bar{u}$)



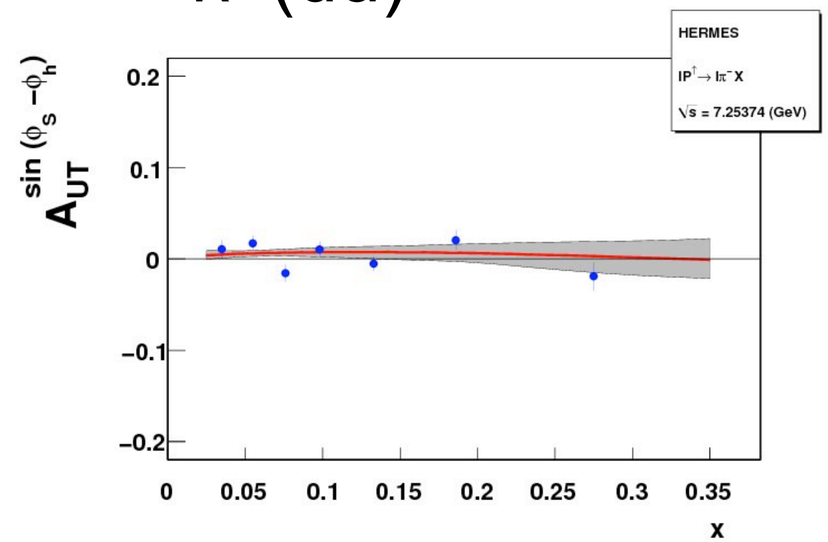
$\Delta^N f_{\bar{u}/p^{\uparrow}} > 0$

Valence only -No sea

$\pi^+ (u\bar{d})$

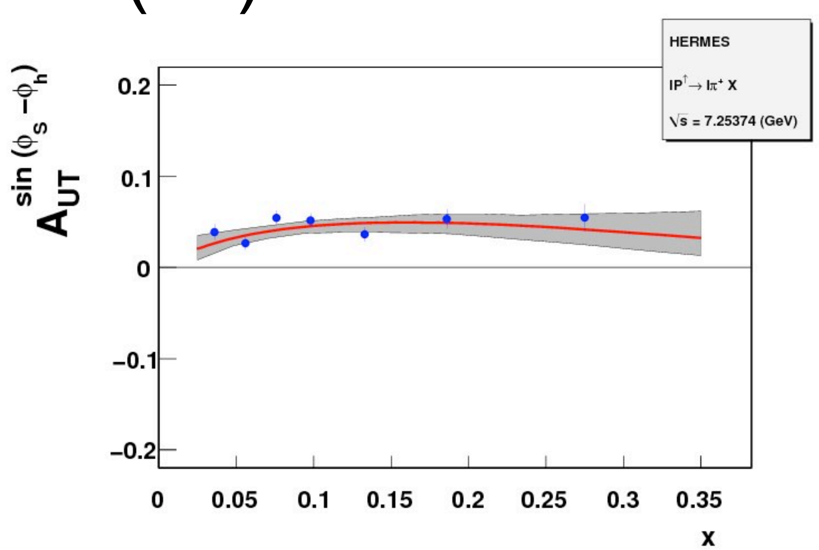


$\pi^- (d\bar{u})$

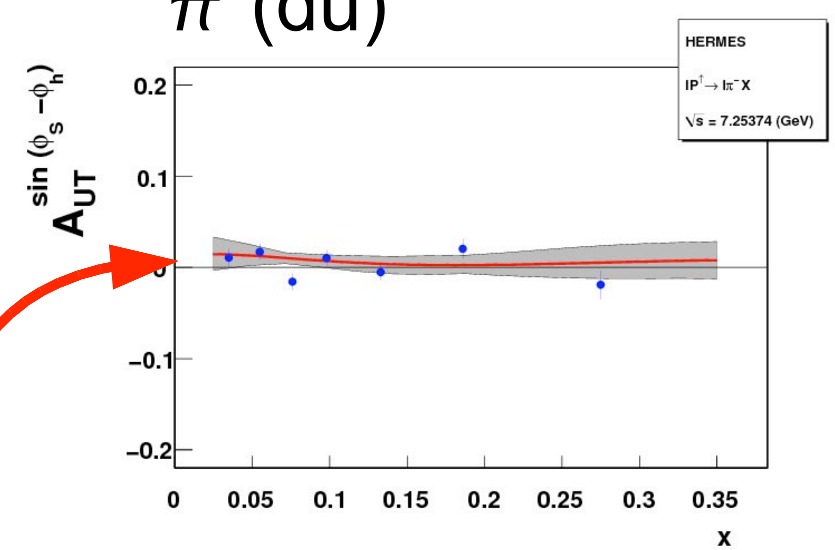


Valence+ sea

$\pi^+ (u\bar{d})$

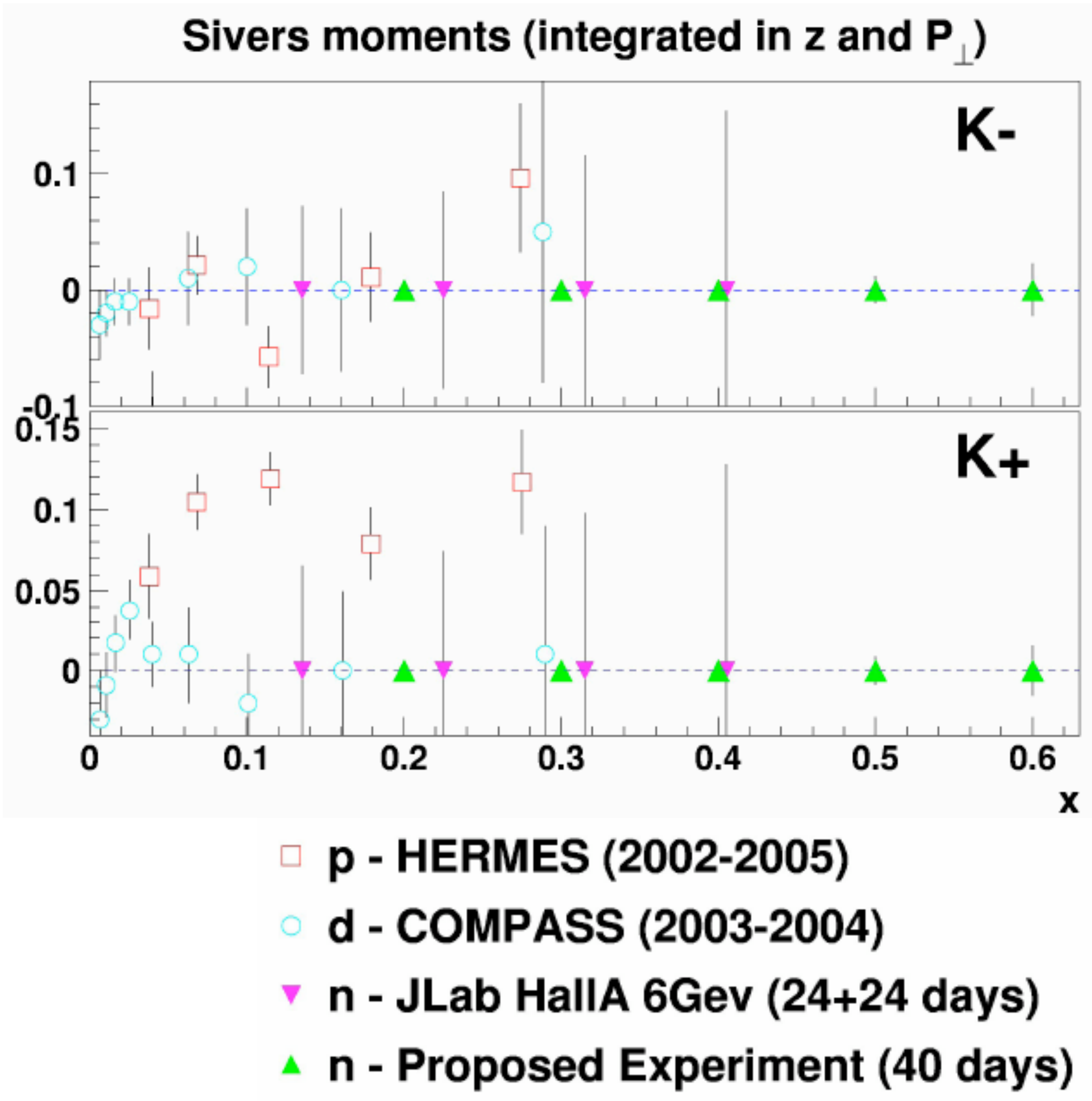


$\pi^- (d\bar{u})$



$$\Delta^N f_{\bar{u}/p^\uparrow} > 0$$

More will come from JLab...



E. Cisbani's talk

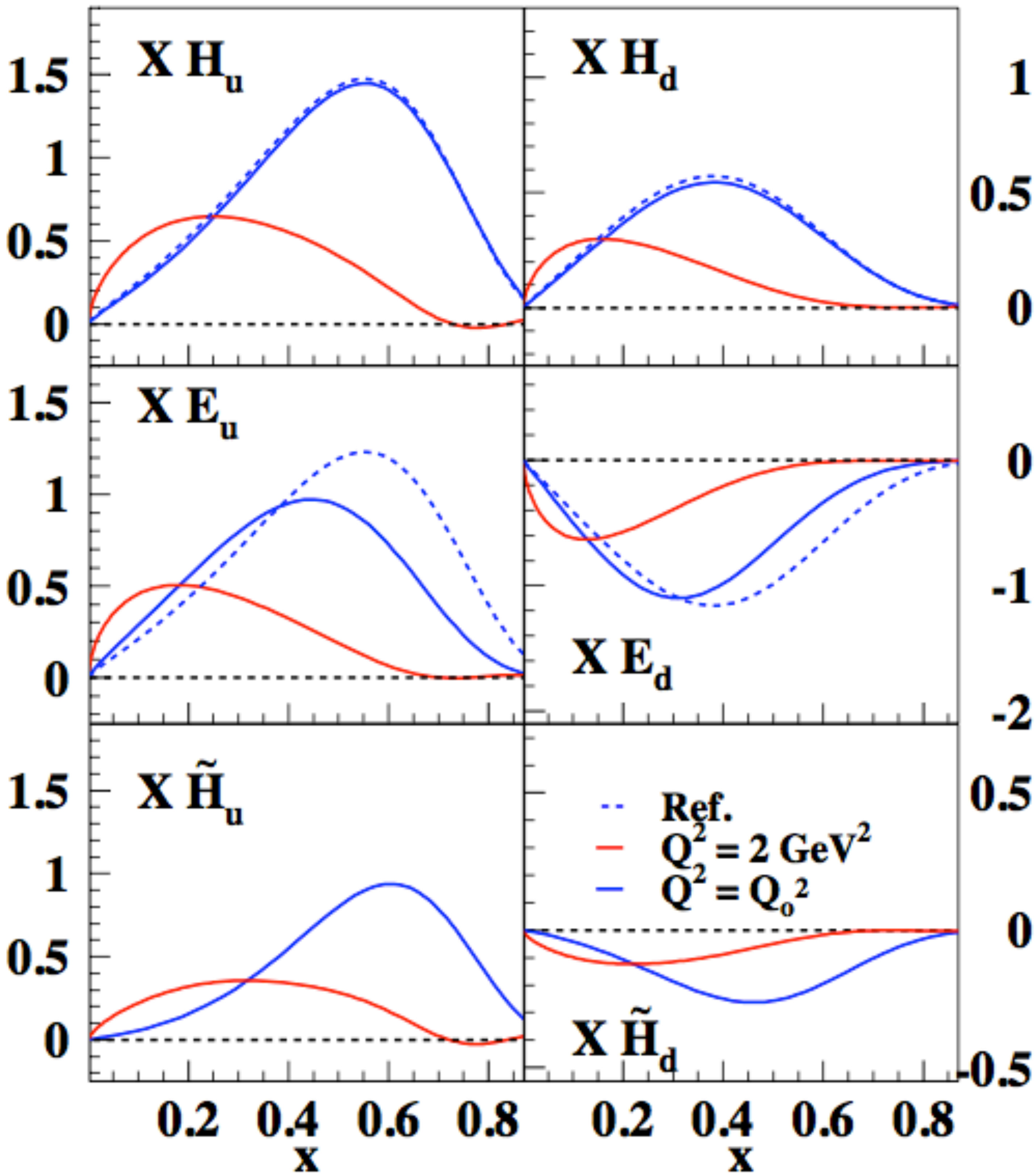
Strange GPDs

What do we know about GPDs?

GPD	probed by	constraints	status
H	ρ^0, ϕ cross sections	PDFs	known
$\widetilde{H}$	$A_{LL}(\rho^0)$	polarized PDFs	probably small
E	$A_{UT}(\rho^0, \phi)$	sum rule for 2^{nd} moments	probably small
others	-	-	unknown
H	ρ^0, ϕ cross sections	PDFs, Dirac ff	known
$\widetilde{H}$	π^+ data	pol. PDFs, axial ff	known
E	$A_{UT}(\rho^0, \phi)$	Pauli ff	known
$\widetilde{E}^{n.p.}$	π^+ data	-	uncertain
H_T	π^+ data	transversity PDFs [1]	known
others	-	-	unknown

Status of small-skewness GPDs as extracted from meson electroproduction data. The upper part is for gluons and sea quarks, the lower part for valence quarks. Except of H for gluons and sea quarks all GPDs are probed for scales of about $4\,\mathrm{GeV}^2$ ([1] Anselmino (09))

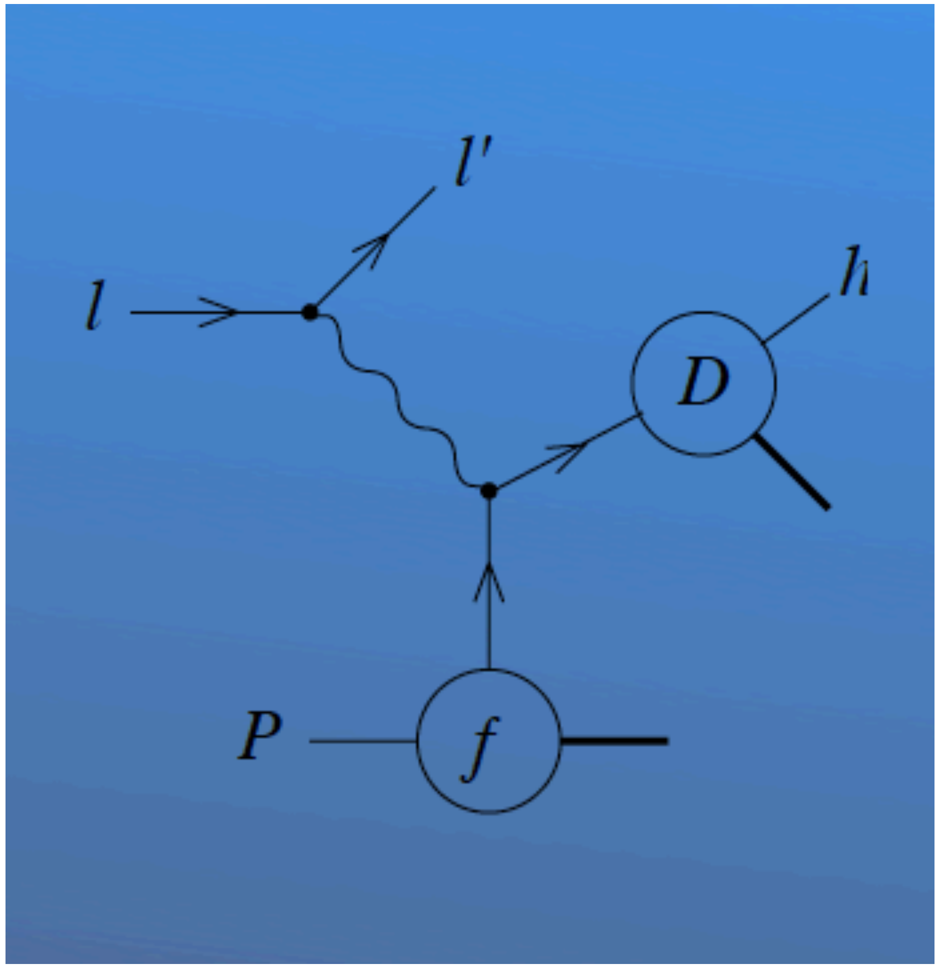
P. Kroll's talk

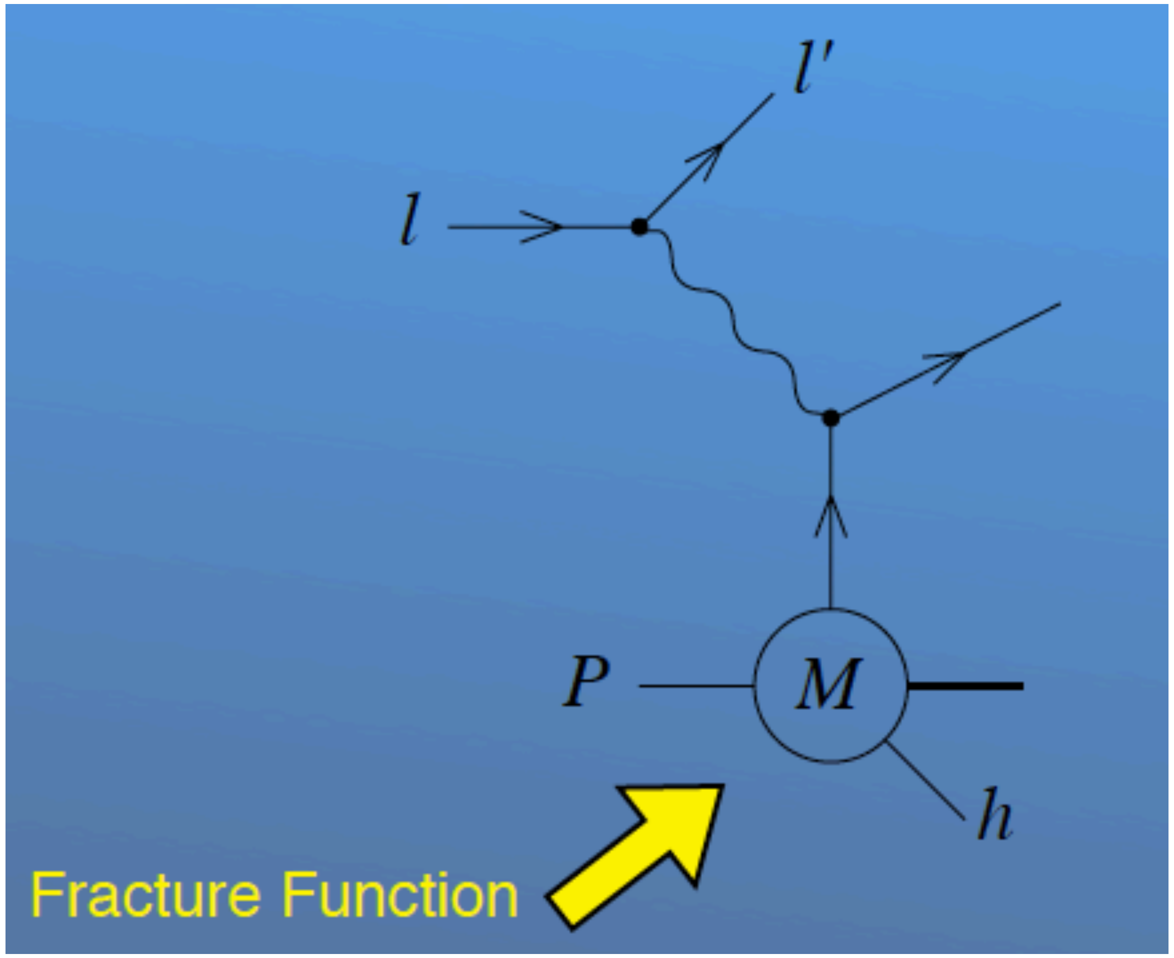


New GPDs
"physically motivated"
Parametrization
G.Goldstein, O. Gonzalez Hernandez, S.L.

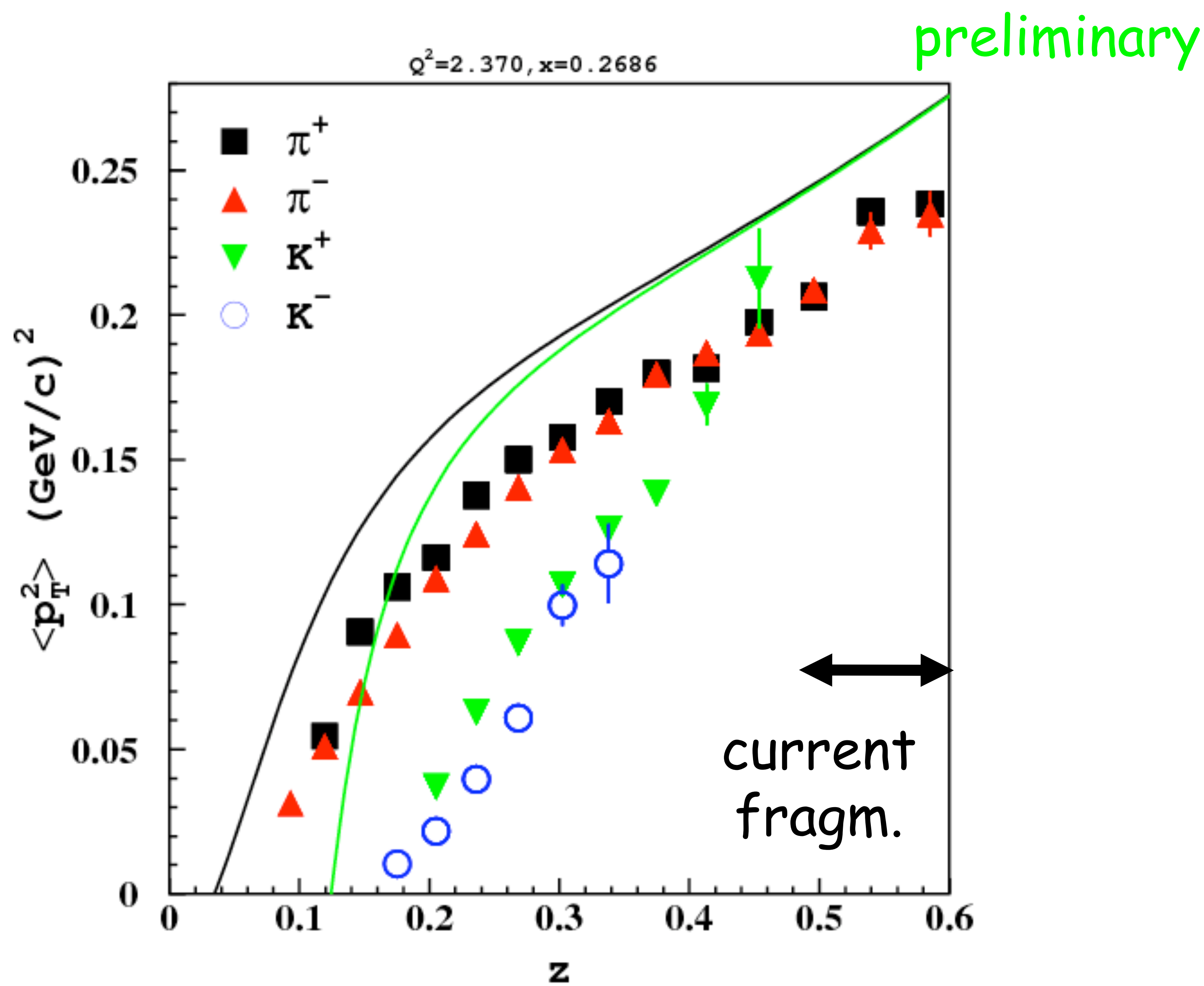
S. Liuti's talk

Strange fracture functions

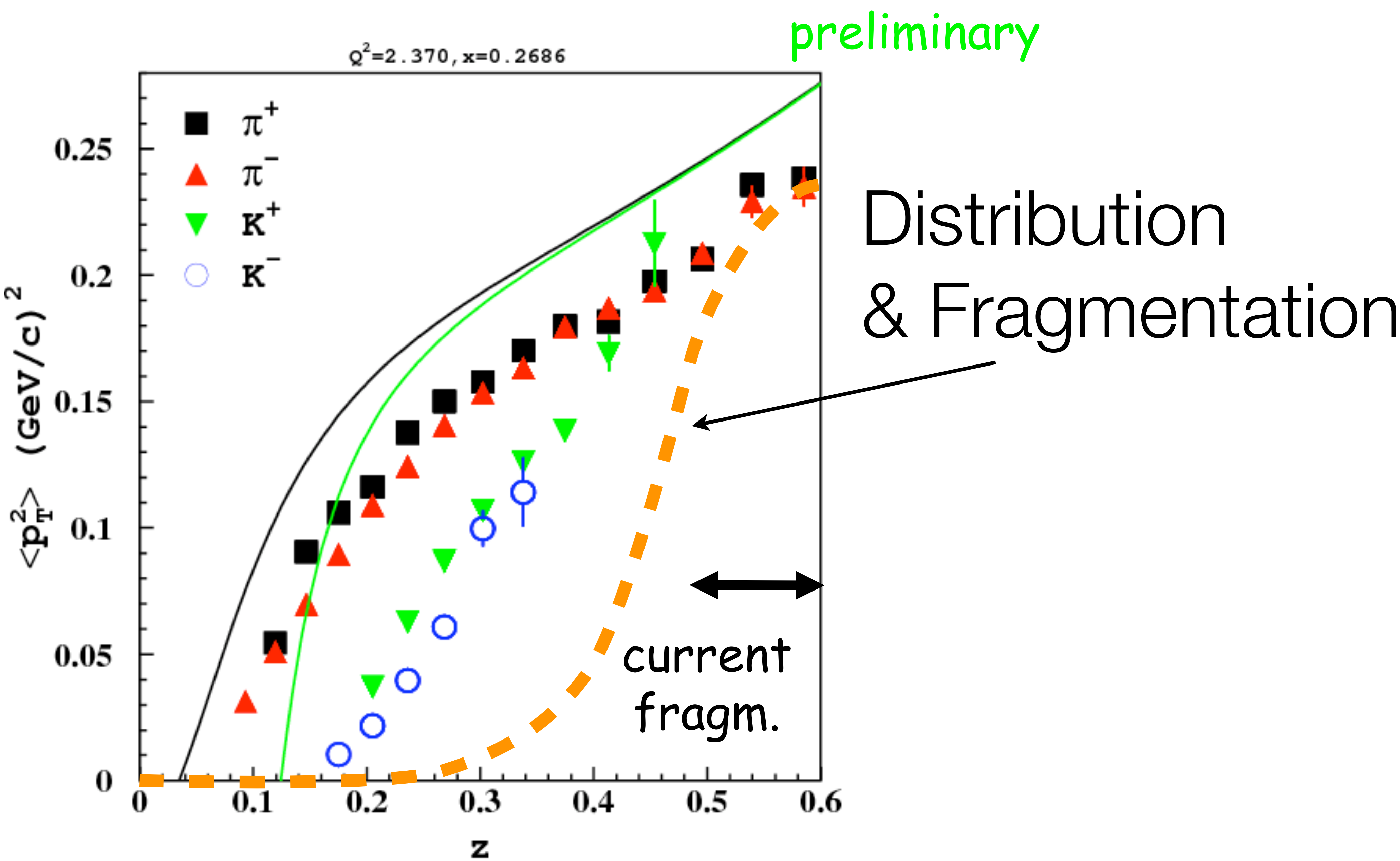




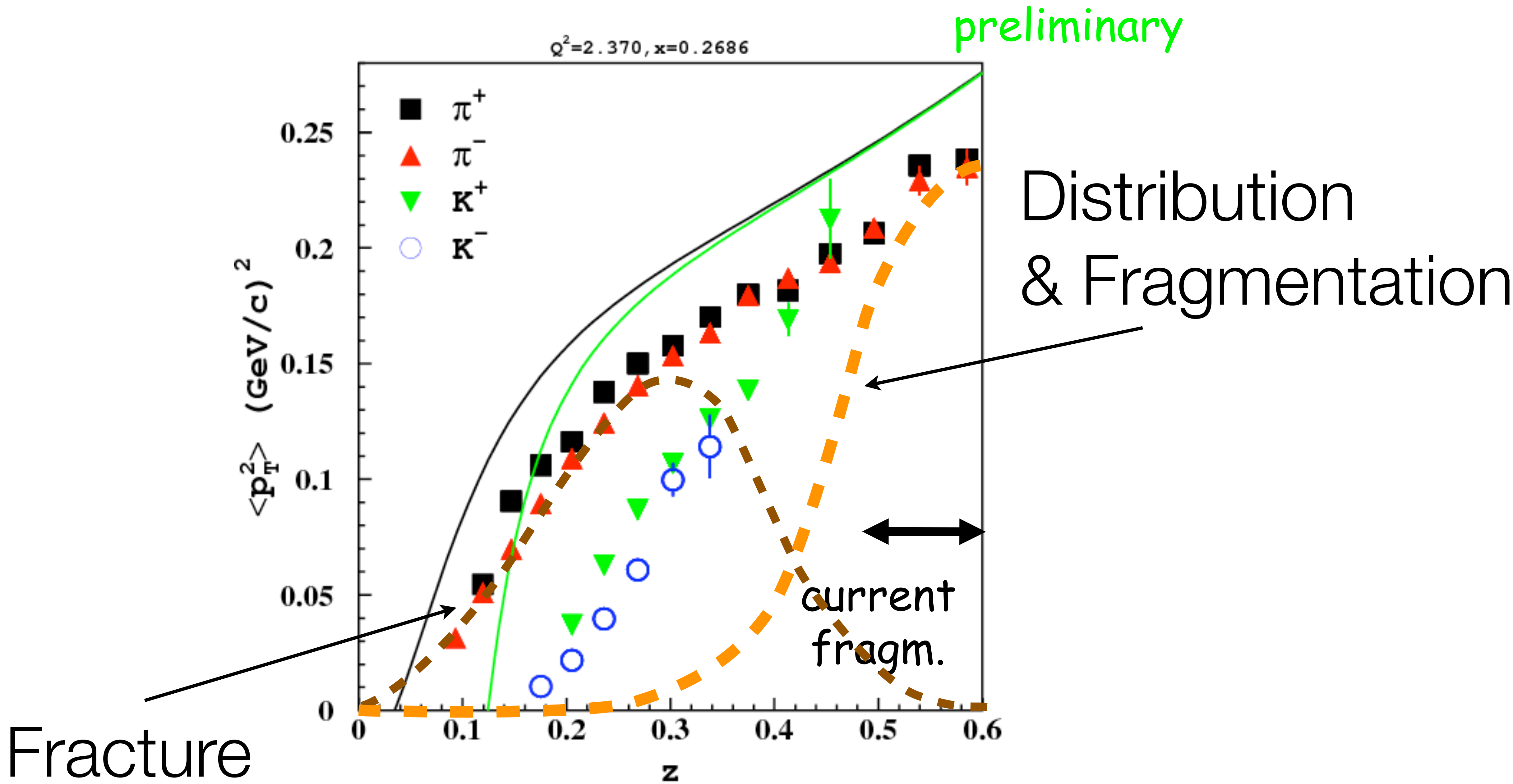
L. Trentadue's and O. Teryaev's talks



M. Osipenko's talk

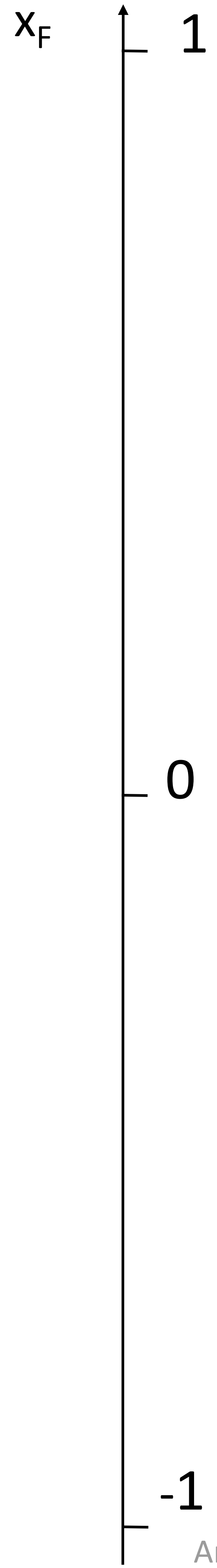


M. Osipenko's talk



M. Osipenko's talk

Current fragmentation



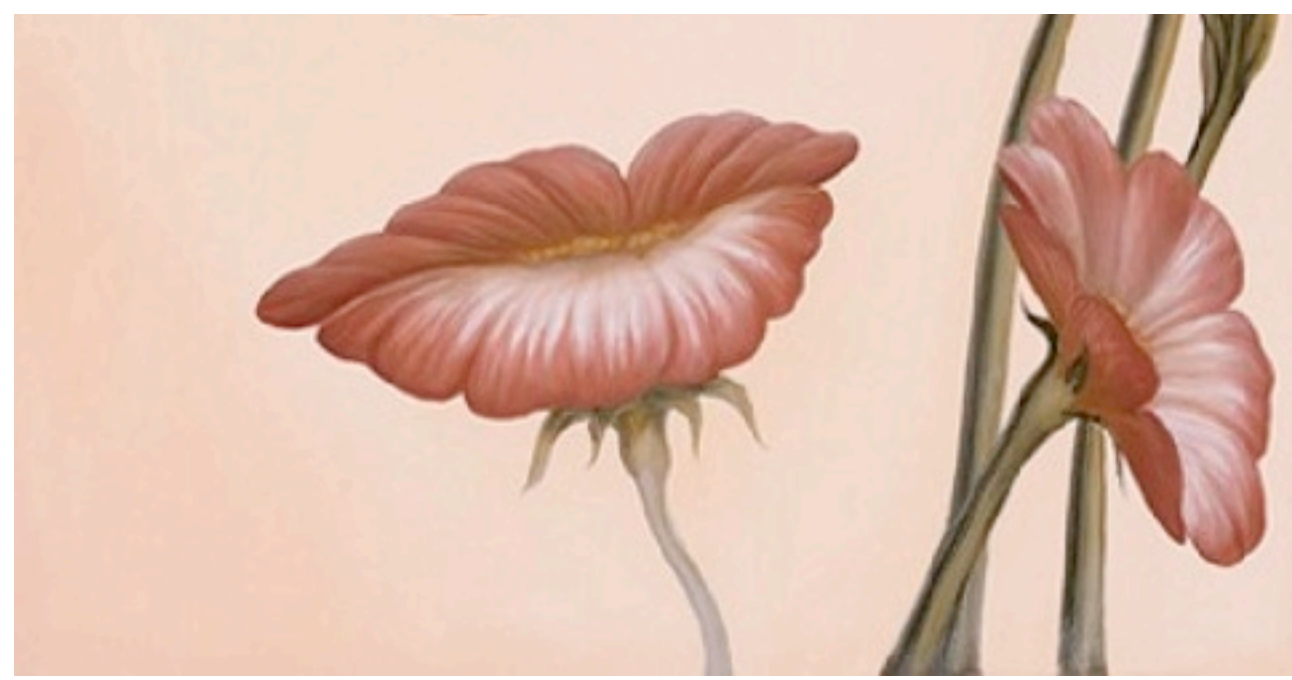
x_F

1

0

Target fragmentation

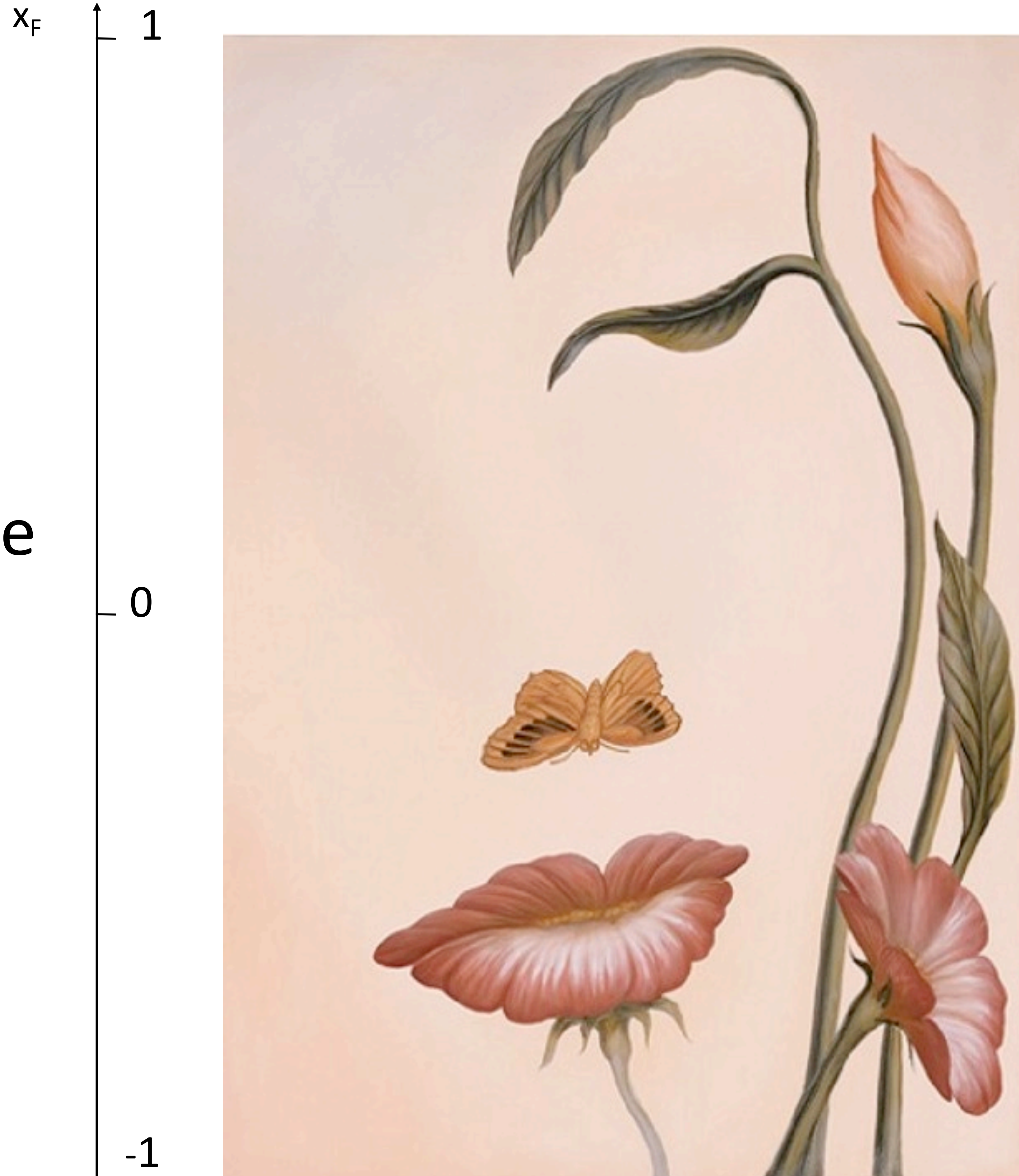
-1



INT Workshop, Seattle,
September 24, 2010

Aram Kotzinian

Full picture can be surprising and beautiful



Aram Kotzinian

Thank you to all participants
(on behalf of all summary speakers)


Thank you to Patrizia