hermes news on

$\pi^{\pm}$, $K^{\pm}$ multiplicities and S(x)

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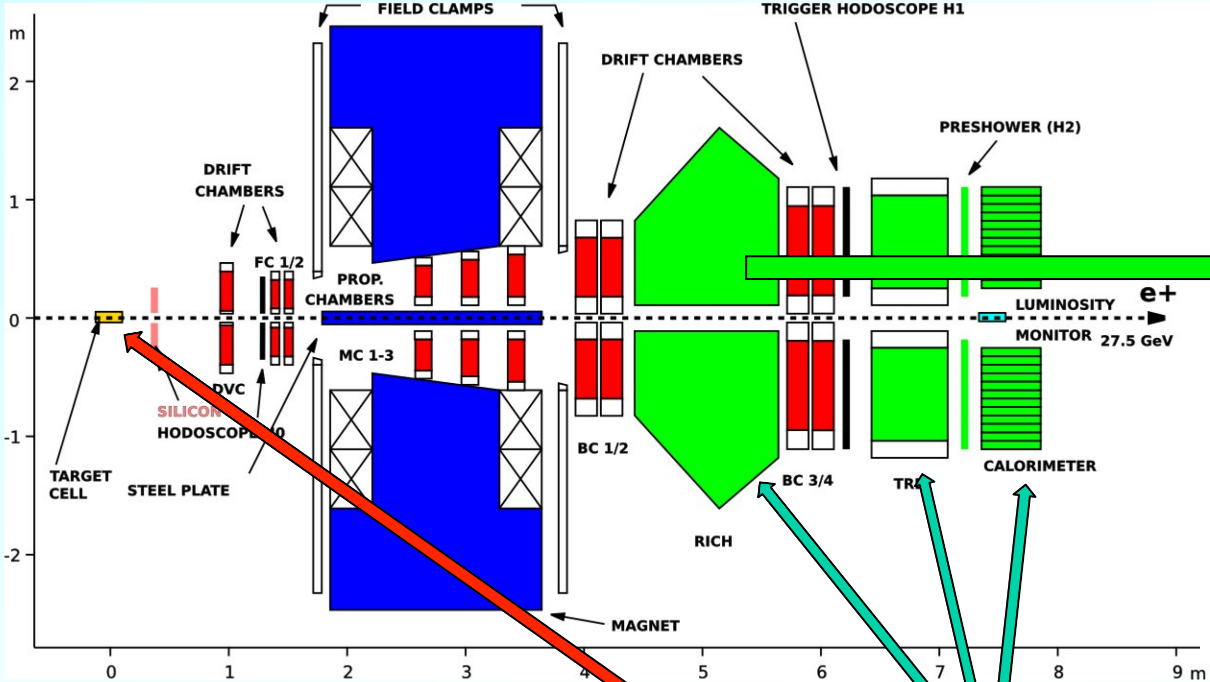
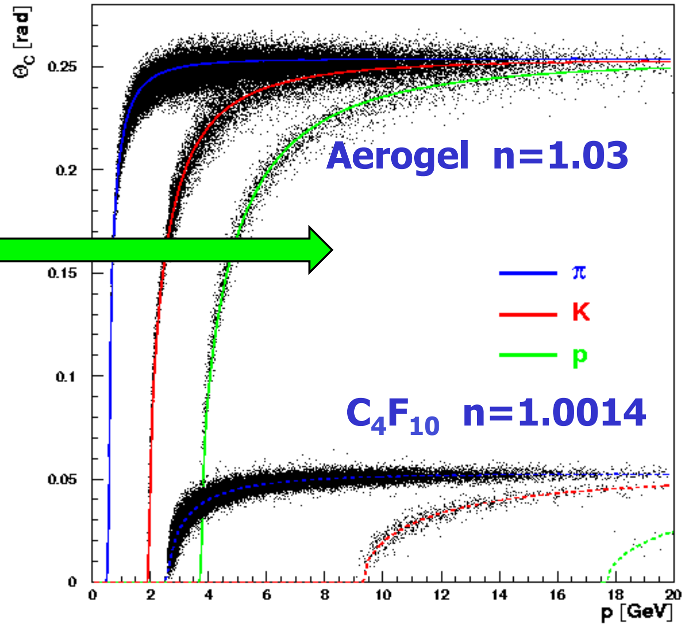
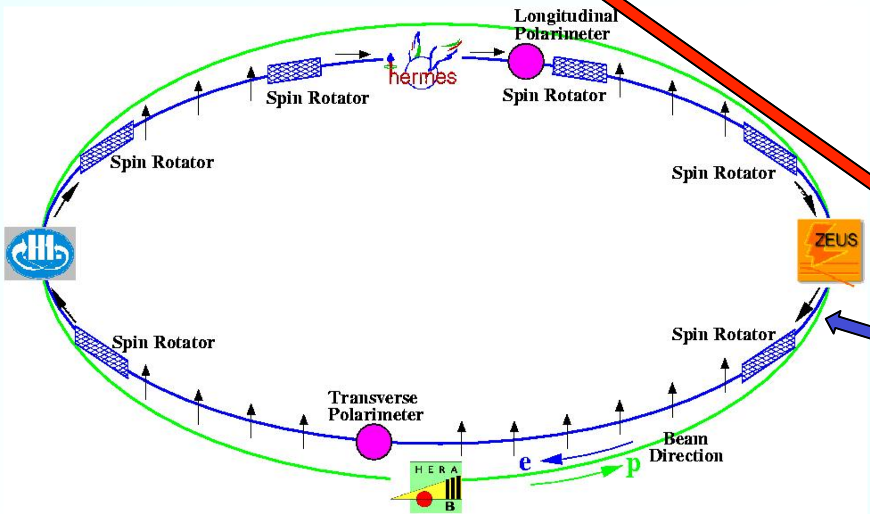
Dual radiator RICH

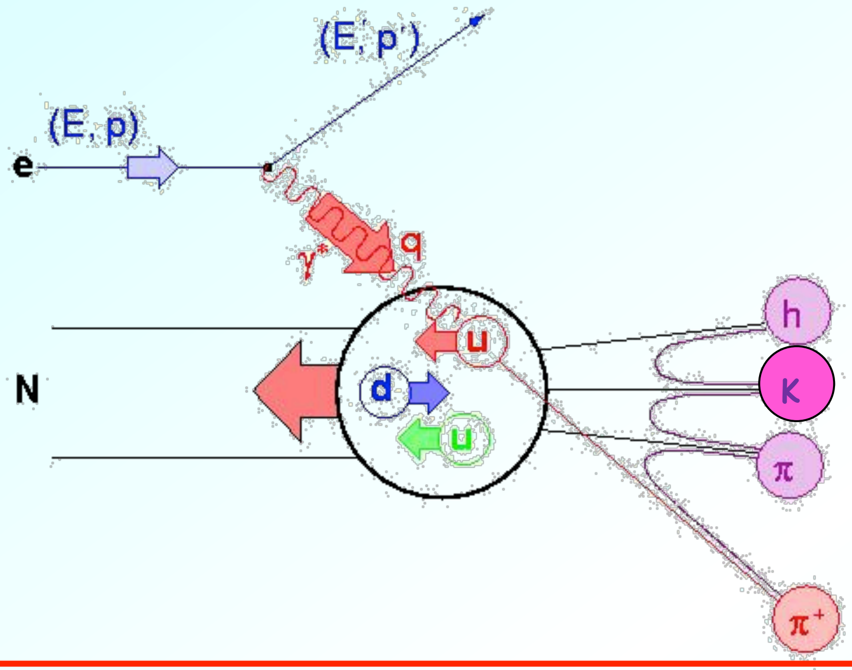


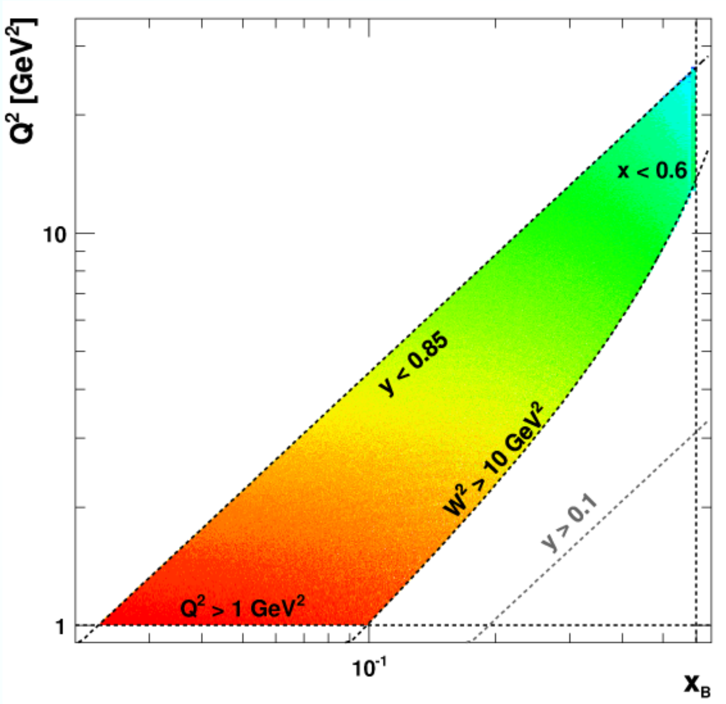




- PID: RICH, TRD, Preshower, Calorimeter
- Internal gas targets
- 27.6 GeV HERA e+/e- beam

Semi-Inclusive Deep-Inelastic Scattering





Factorisation ⇒ $\sigma^{eN\to ehX} = \sum_q DF^{N\to q} \otimes \sigma^{eq\to eq} \otimes FF^{q\to h}$

DF(x,Q^2): Parton Distribution Function – $q(x,Q^2)$, $\Delta q(x,Q^2)$, $\delta q(x,Q^2)$…

FF(z,Q^2): Fragmentation Function – $D_1(z,Q^2)$, $H_1^\perp(z,Q^2)$, …

Multiplicities

Publication: A. Airapetian et al., Phys. Rev. D87 (2013) 074029

Thesis: S. J. Joosten, Dissertation, University of Illinois at
Urbana-Champain, 2013, DESY-THESIS 2013-044

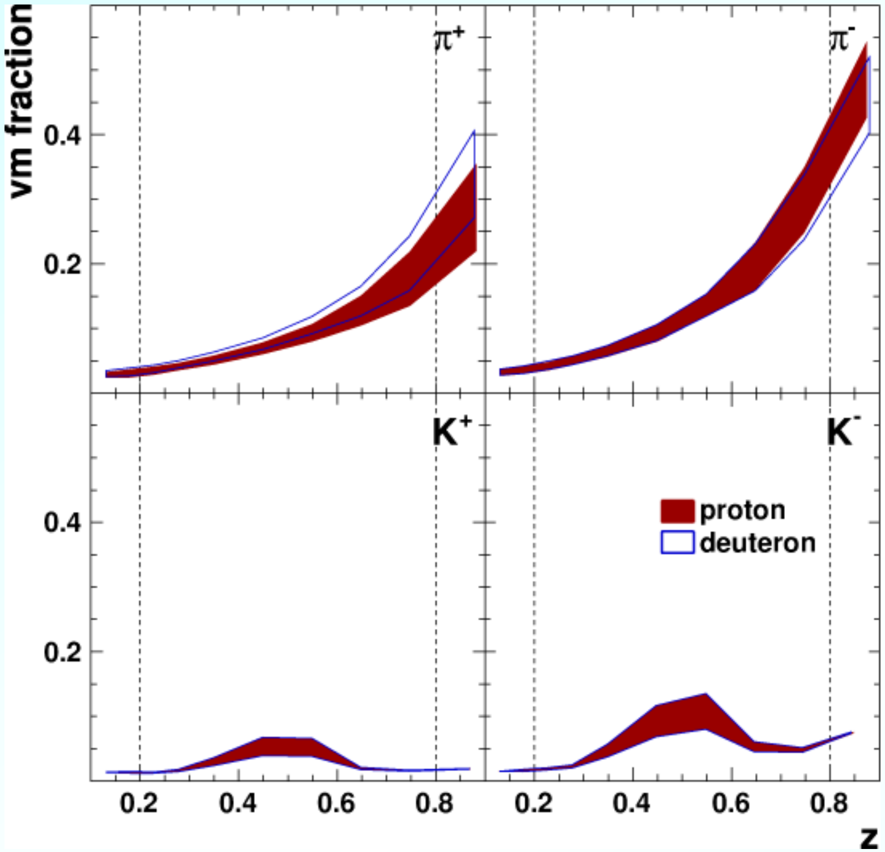
Website: www-hermes.desy.de/multiplicities

Final HERMES multiplicities for $\pi^{\pm}$, $K^{\pm}$

$$M^h(x,Q^2,z,P_{h\perp}) = \frac{N^h}{N^{DIS}} \overset{L.O.}{\sim} \frac{\sum_q e_q^2\, q(x,Q^2,k_T)\, D_q^h(z,Q^2,p_T)}{\sum_q e_q^2\, q(x,Q^2,k_T)}$$

- 3D analysis (in x, z, $P_{h\perp}$ and Q^2, z, $P_{h\perp}$)
- RICH unfolding
- Corrections for
  Trigger inefficiencies, charge-symmetric background
  contamination by exclusive vector mesons (optional)
- Multidimensional smearing-unfolding for
  radiative effects, limited acceptance, decay in flight,
  secondary hadronic interactions, detector smearing
- Final results corrected to 4π Born

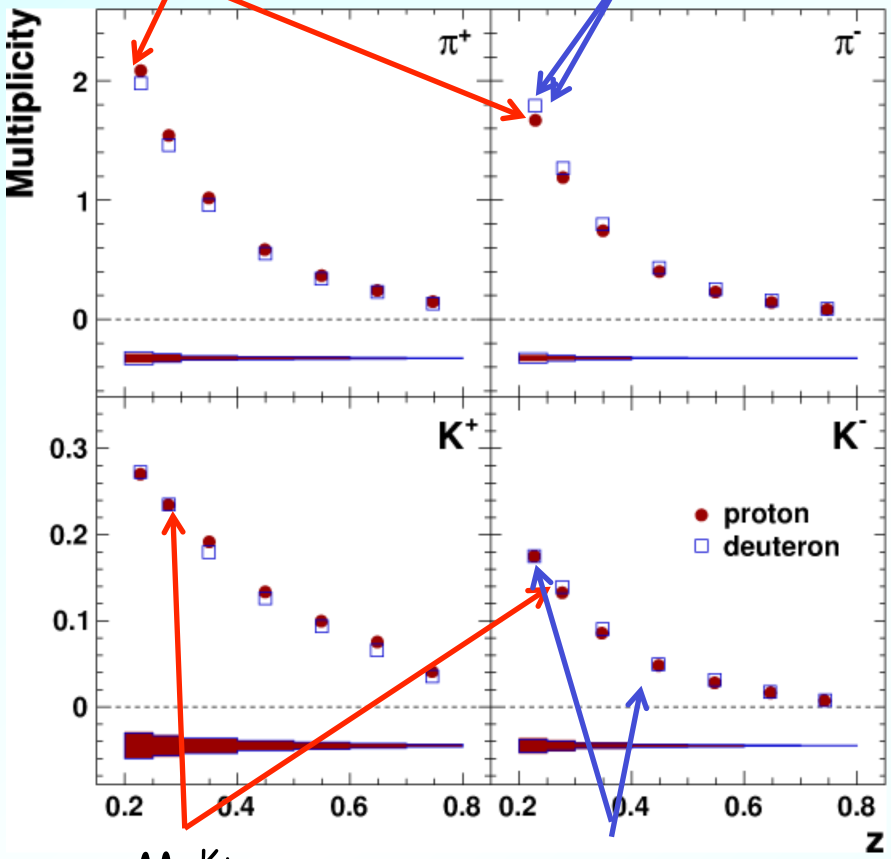
Exclusive Vector-Meson Contamination



- SIDIS π and K sample contaminated by decays of diffractive ρ and ϕ
- Corrections obtained from tuned PYTHIA MC
- Results available both with and without this correction
- This presentation:with correction

Multiplicities projected vs z

$\frac{M_p^{\pi+}}{M_p^{\pi-}} = 1.2\text{-}2.6 \qquad \frac{M_D^{\pi-}}{M_p^{\pi-}} > 1$



$\frac{M_p^{K+}}{M_p^{K-}} = 1.5\text{-}5.7, \qquad \frac{M_D^{K-}}{M_p^{K-}} \approx 1$

Multiplicities reflect

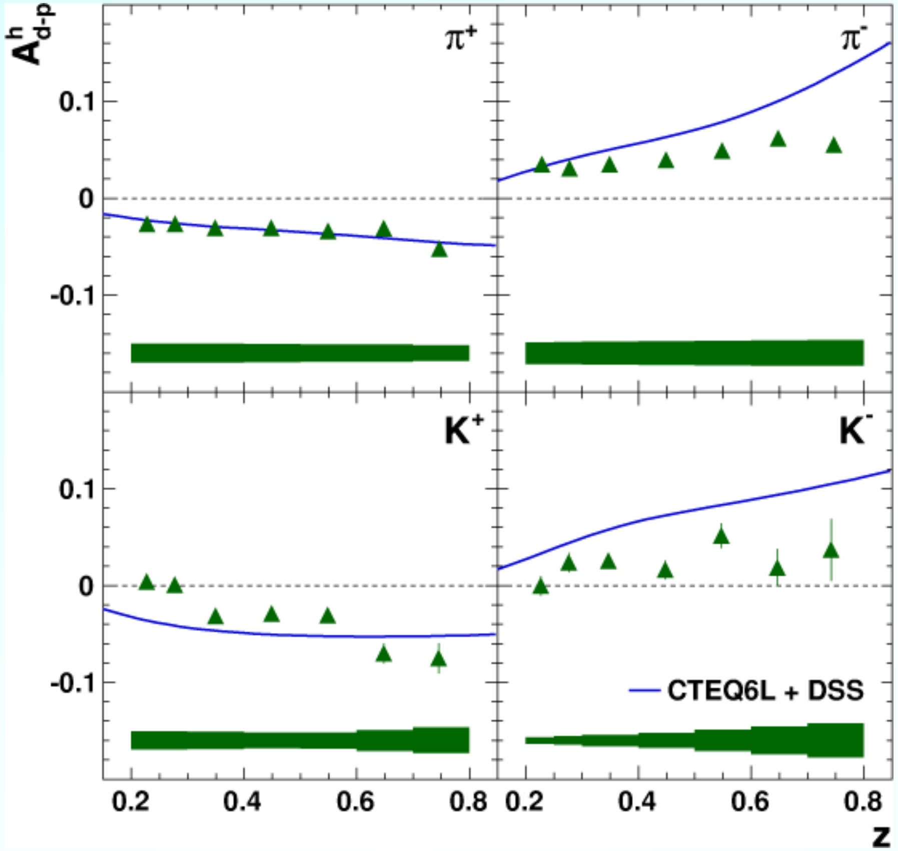
- valence-quark content of p, n
  p= (u,u,d), n = (d,d,u)

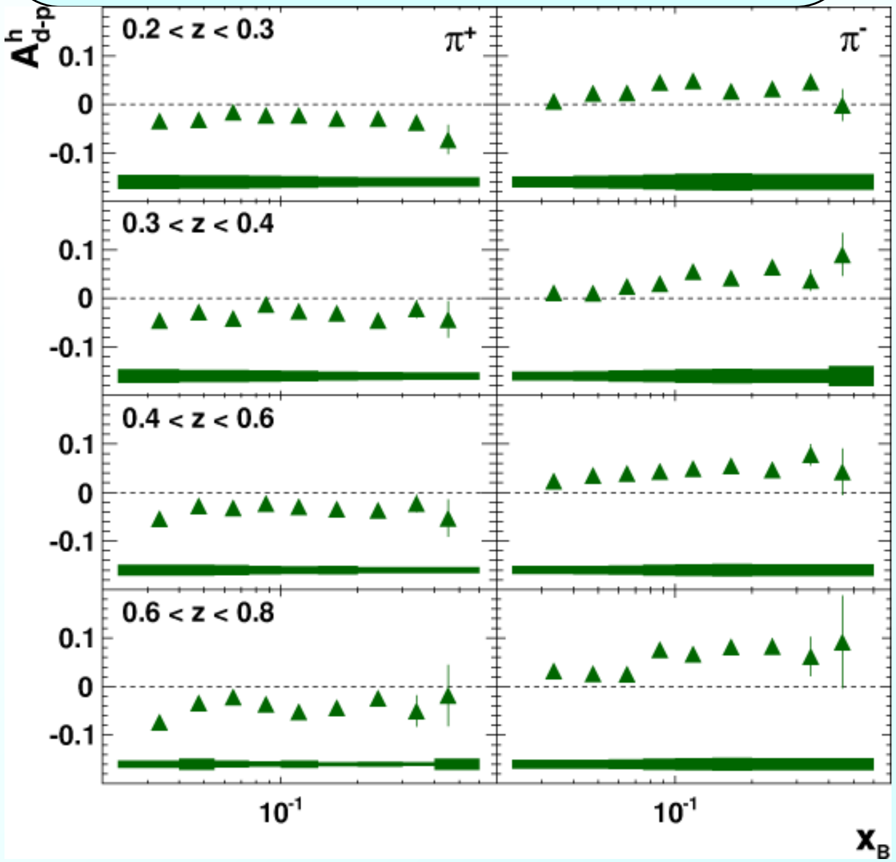
- favoured ↔ unfavoured FF
  $u \rightarrow \pi^+ (\bar{d}u) \leftrightarrow u \rightarrow \pi^- (d\bar{u})$
  $u \rightarrow K^+ (\bar{s}u) \leftrightarrow u \rightarrow K^- (s\bar{u})$

  ⇓ sea object

Proton-Deuteron multiplicity asymmetries

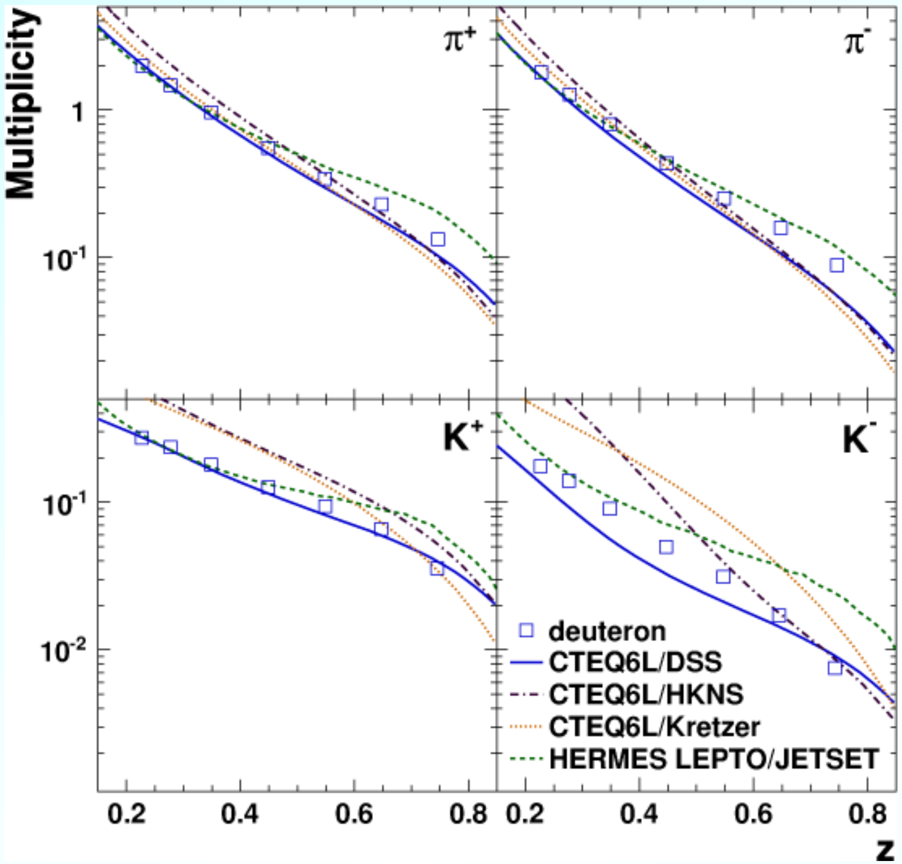
$$A_{d-p}^{h} = \frac{M_{deuteron}^{h} - M_{proton}^{h}}{M_{deuteron}^{h} + M_{proton}^{h}}$$





Almost no dependence on x

1D Comparison with LO predictions

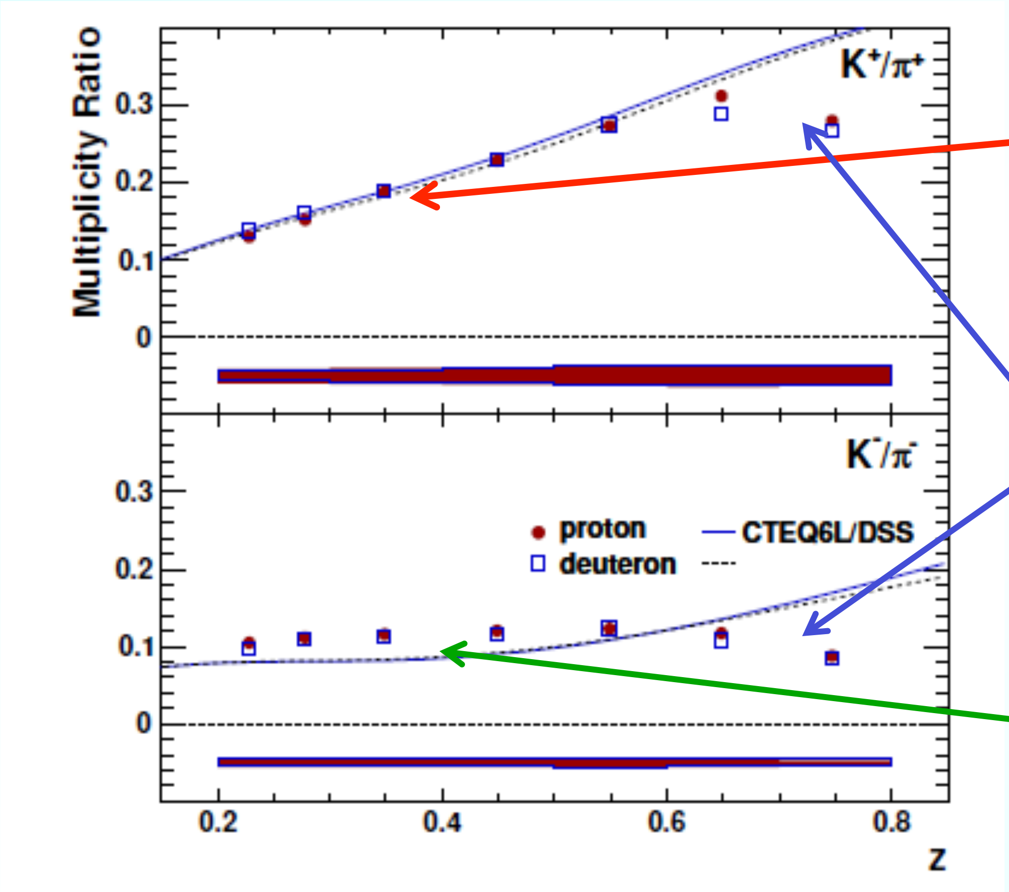


CTEQ6L PDFs, JHEP 02 (2006) 032
Kretzer FFs, PRD 62 (2000 054001
HKS FFs, PRD 75 (2007) 094009
DSS FFs, PRG 75 (2007) 114010

- Fair agreement with DSS FF (used prel. HERMES multiplicities) and data for positive hadrons
- Substantial differences between all FFs and data for negative hadrons
- Plenty of room for improvements especially in disfavored sector

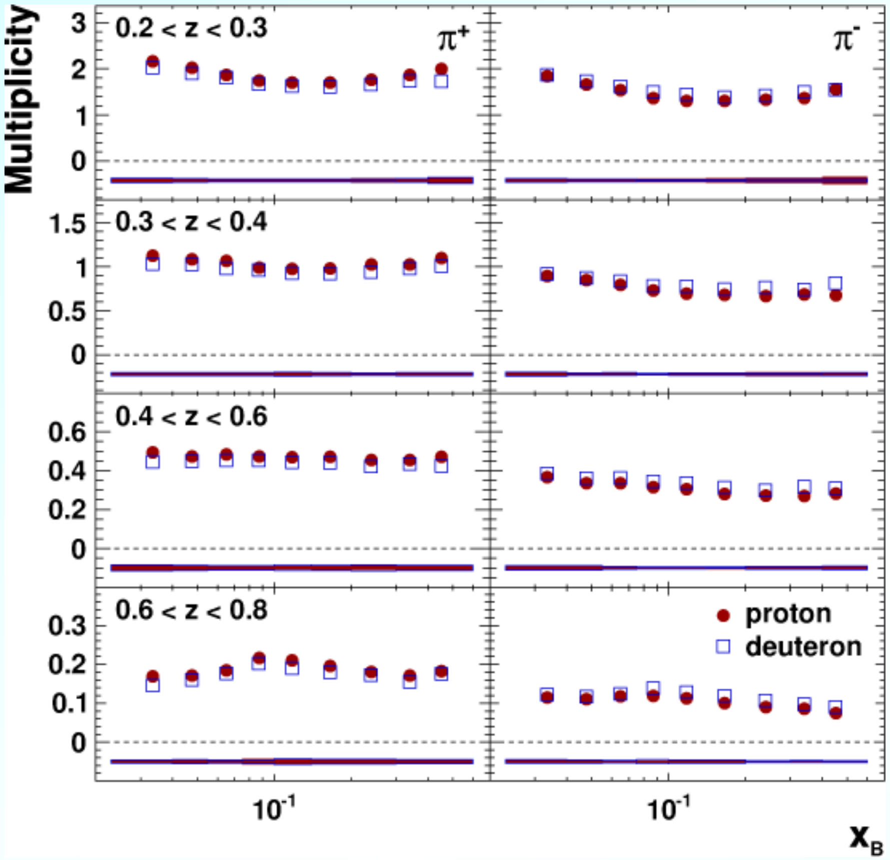
→ E. Aschenauer

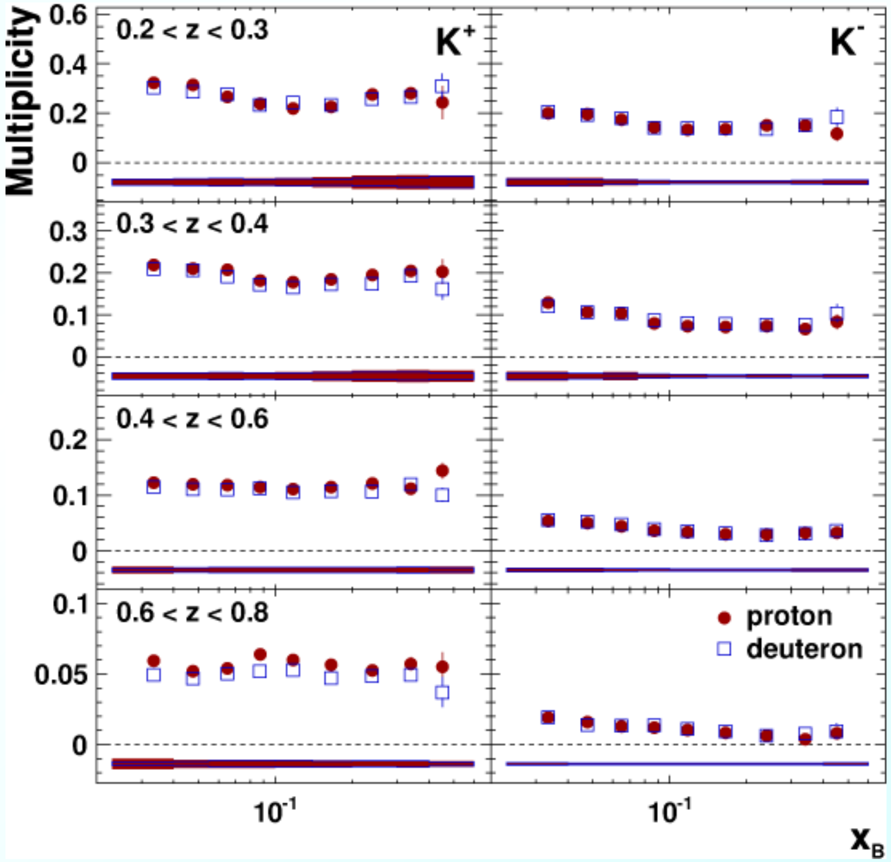
K/π vs z; Strangeness Suppression



- Good agreement with LO parametrisations for K^+/π^+ and $z < 0.6$
- Creation of $s\bar{s}$ less probable than $d\bar{d}$, $u\bar{u}$ at high z
- Worse description of K^-/π^-

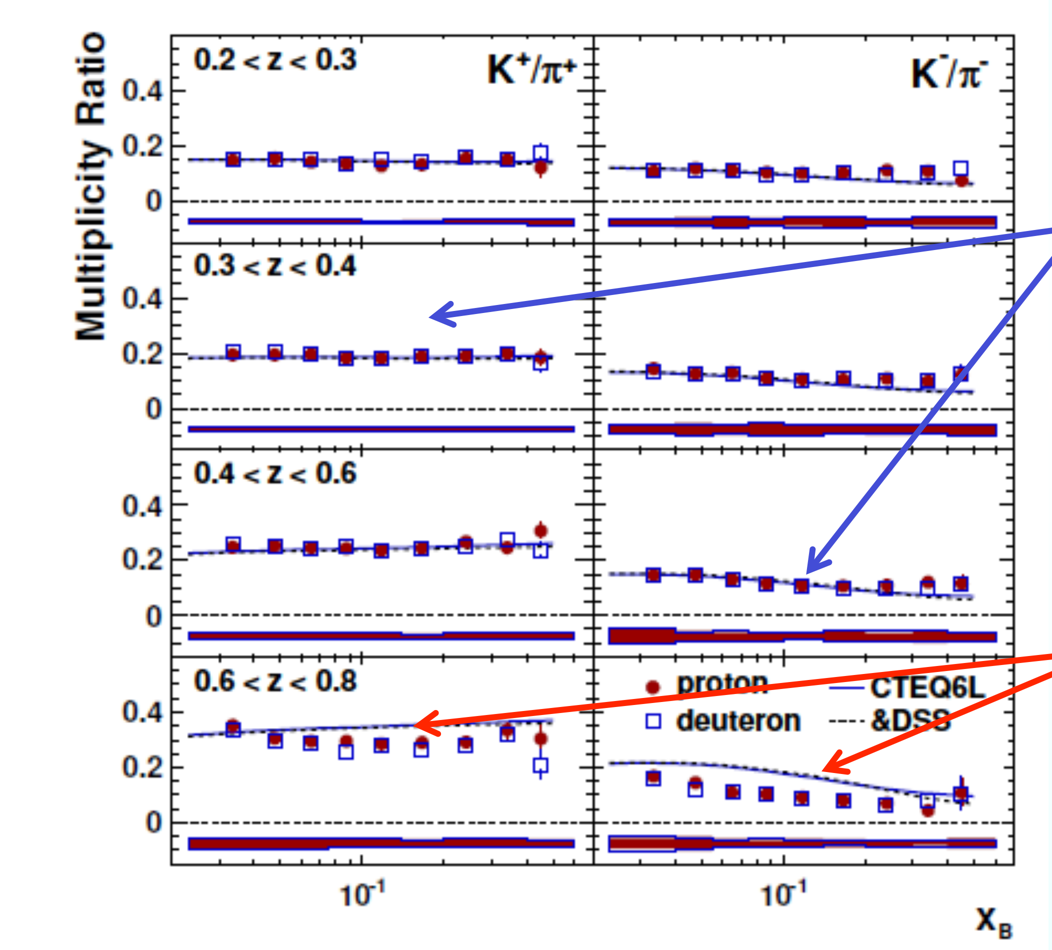
Multiplicities vs x in slices of z





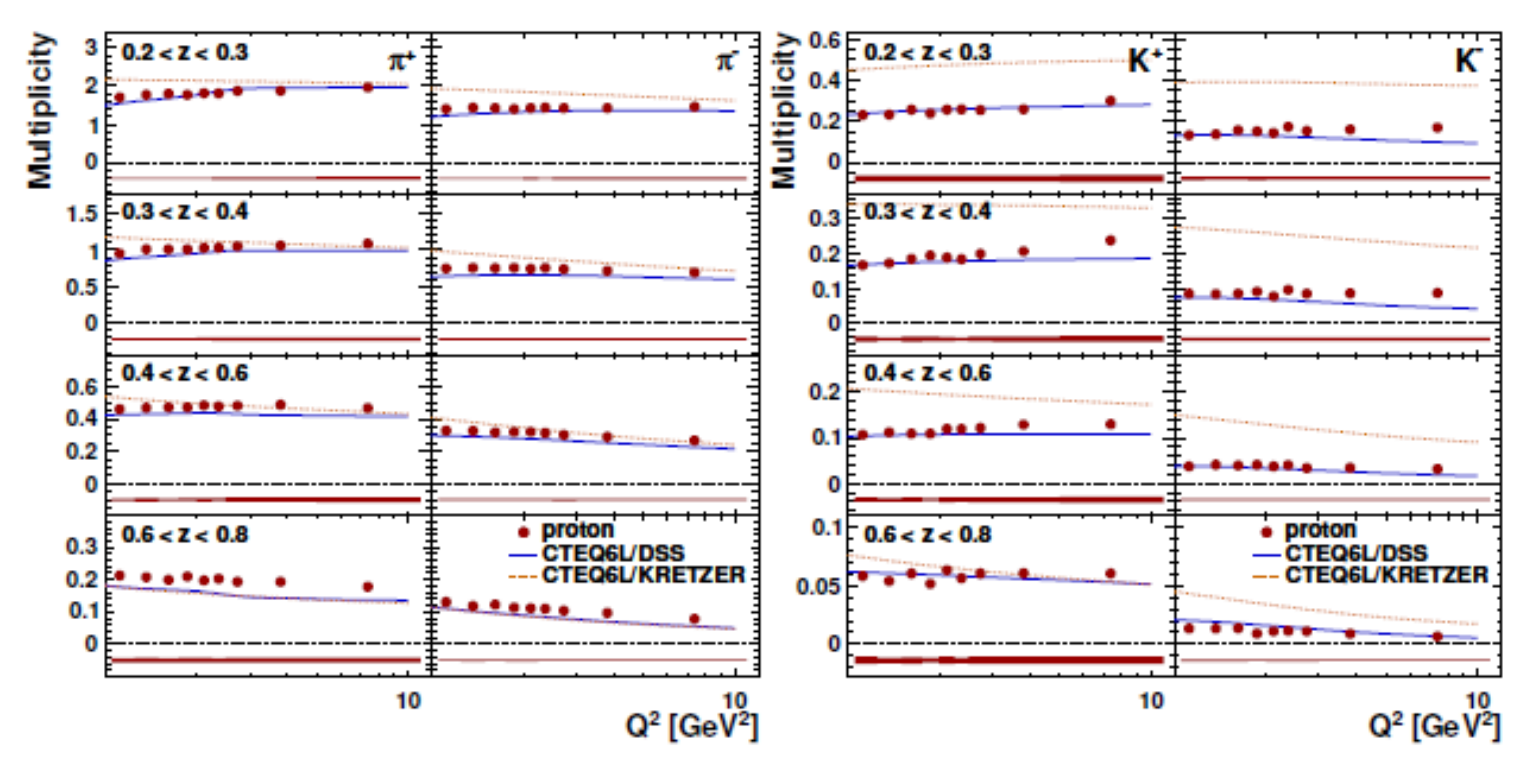
Some (small) dependence on x

K/π vs x in slices of z



- Good agreement with LO parametrisations for z < 0.6
- At high z LO parametrisations overshoot data for all x

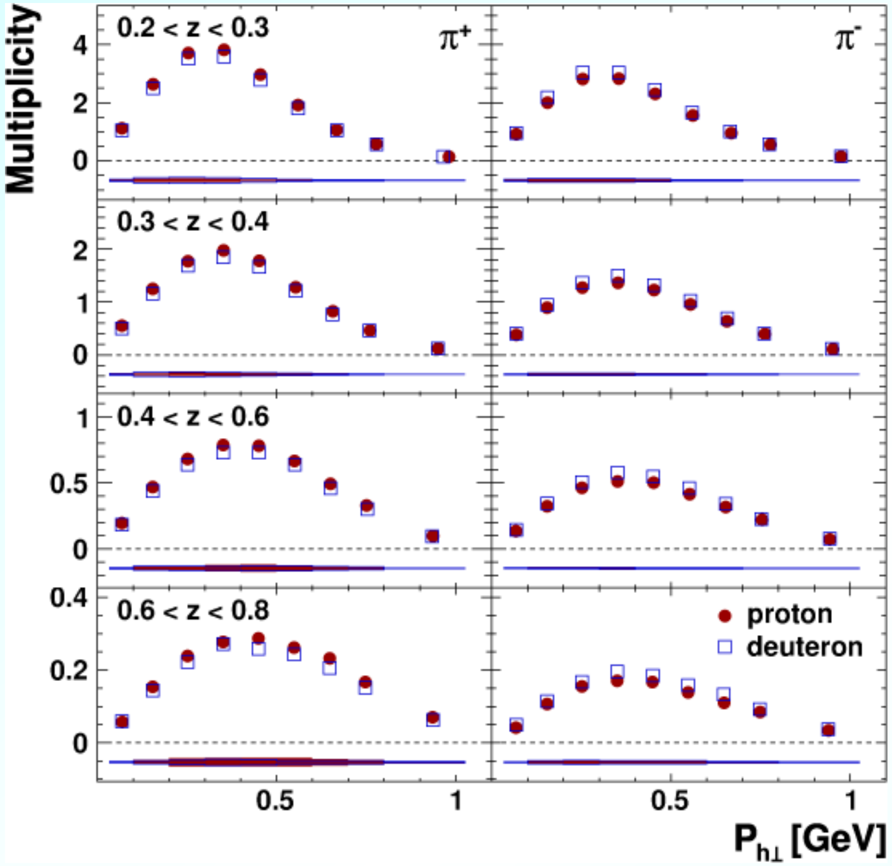
Multiplicities vs Q^2 in slices of z



Small Q^2 dependence

Rather good agreement with CTEQ6L + DSS

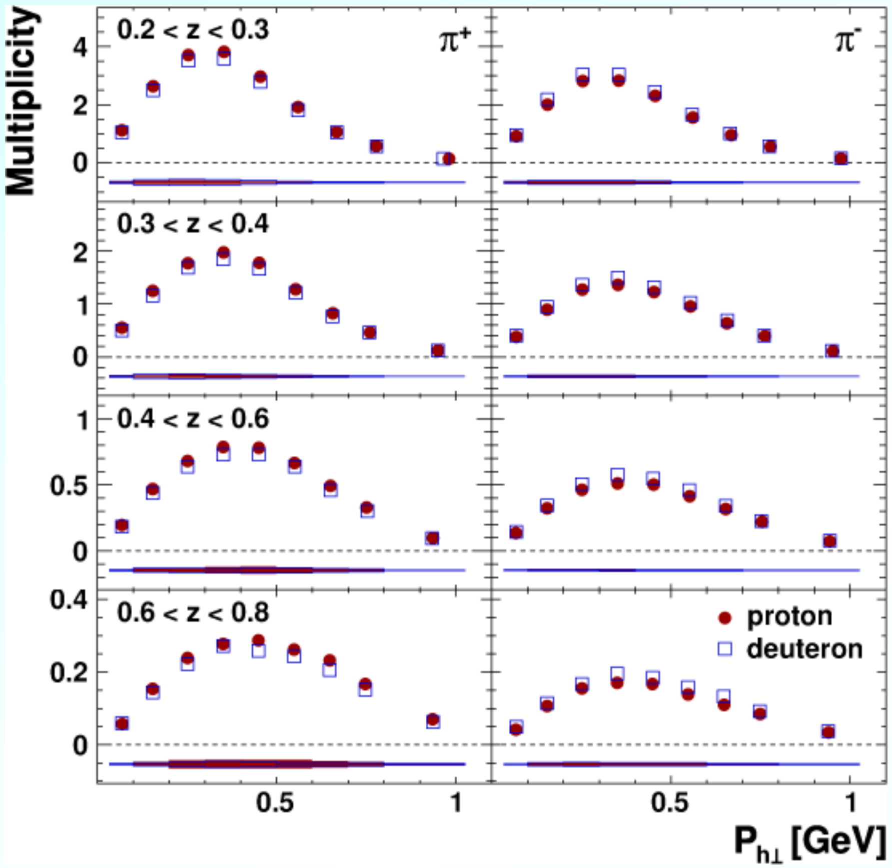
Multiplicities vs $P_{h\perp}$ in slices of z

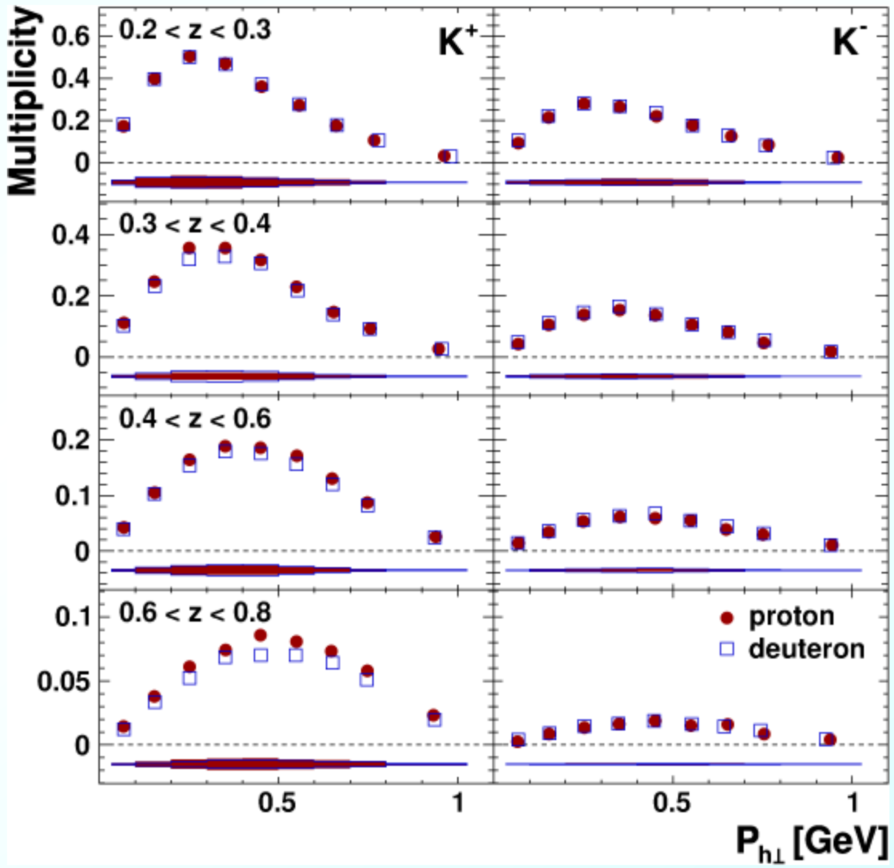


- Access to quark intrinsic transverse momentum k_T and fragmentation p_T
- Gaussian ansatz:

$$\langle P_{h\perp}{}^2 \rangle = z^2 \langle k_T{}^2 \rangle + \langle p_T{}^2 \rangle$$

Multiplicities vs $P_{h\perp}$ in slices of z

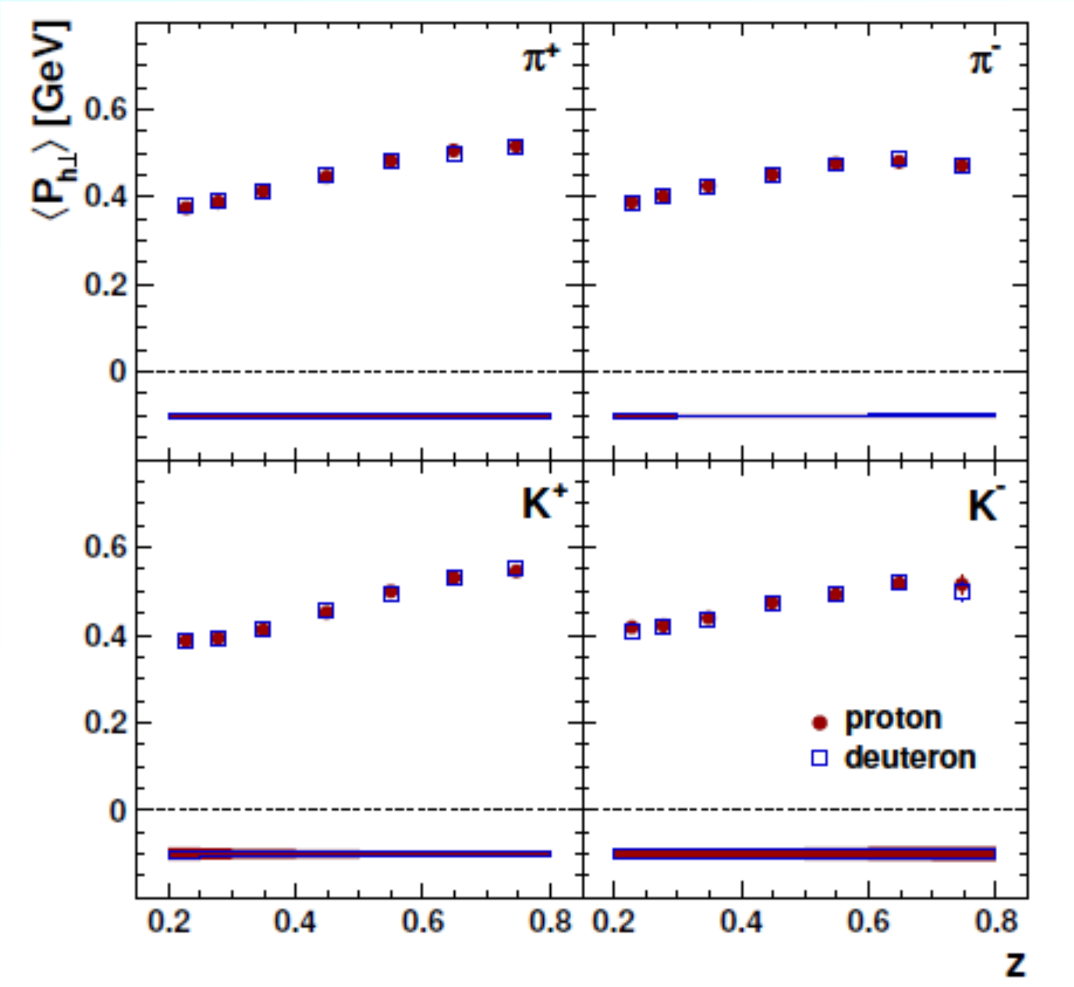




- Average and width function of kinematics and hadron type
- Hint of broader distribution for K^-,

$P_{h\perp}$ vs z

Thesis S. Joosten, no official HERMES plot



- Rising function of z

$$\langle P_{h\perp}^2 \rangle = z^2 \langle k_T^2 \rangle + \langle p_T^2 \rangle \; ?$$

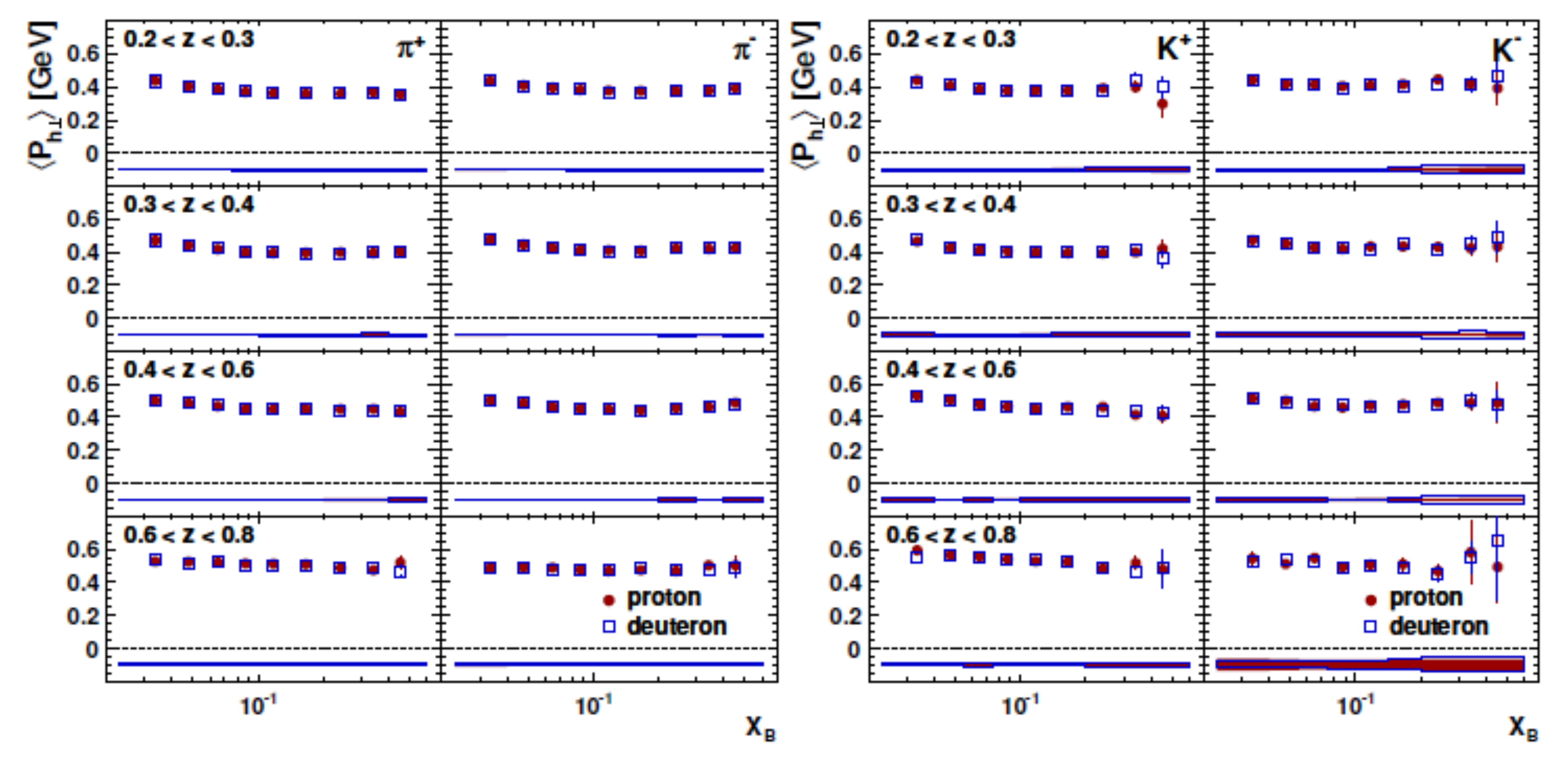
($\langle P_{h\perp}^2 \rangle$ vs z^2 would be better)

Determination of $\langle p_T^2 \rangle$, $\langle k_T^2 \rangle$

→ J. O. Gonzalez Hernandez

M. Radici

$\langle P_{h\perp} \rangle$ vs x in slices of z



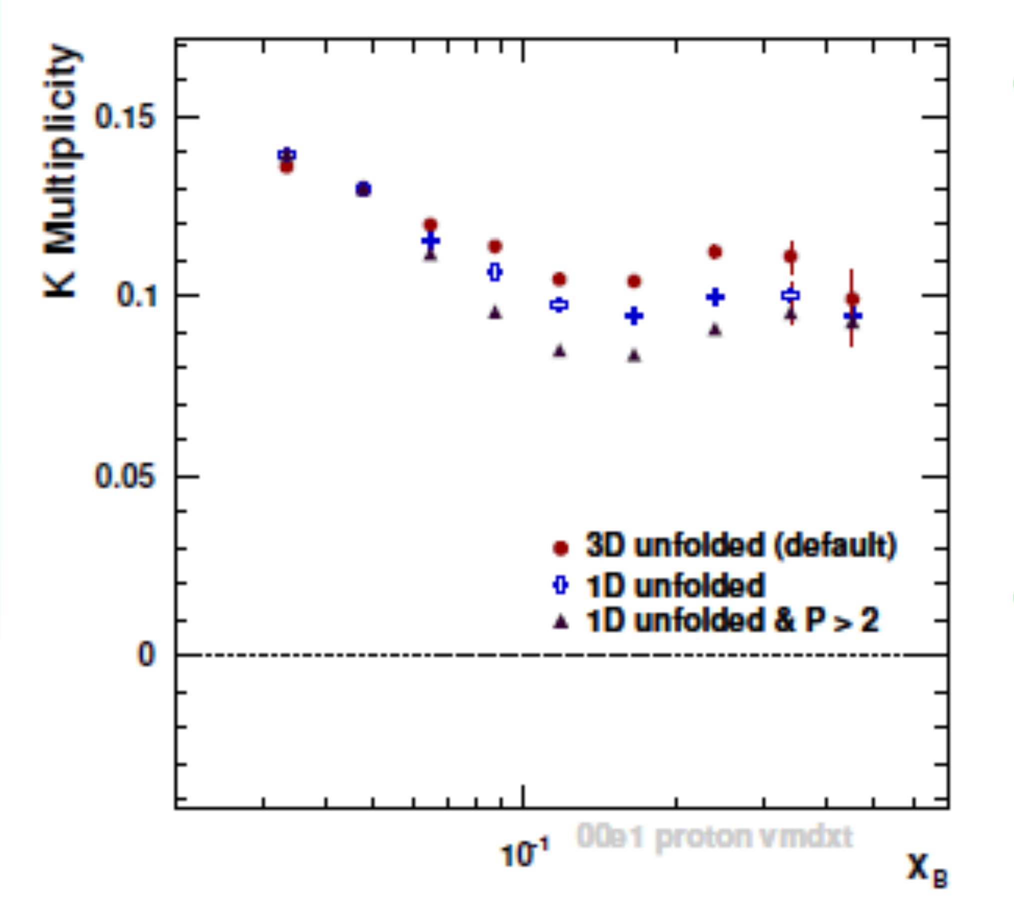
- Slightly falling function of x

Reevaluation
of the strange-quark distribution

Publication 1: A. Airapetian et al., Phys. Lett. B666 (2008) 446

Publication 2: soon

Impact of multidimensional approach



- Published results were based on 1D-unfolded multiplicities with the requirement $p_h > 2$ GeV
- Final 3D-unfolded multiplicities are rather different

Reevaluation of S(x)

Input:

- L.O. Multiplicities for K+ and K- with deuteron target

$$d^2N_D^{DIS}/dxdQ^2 = K(x,Q^2)[5Q(x) + 2S(x)]$$

where $Q(x) = u(x)+\bar{u}(x)+d(x)+\bar{d}(x)$ and $S(x) = s(x) + \bar{s}(x)$

$$d^2N_D^{K\pm}/dxdQ^2 = K(x,Q^2)[Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz]$$

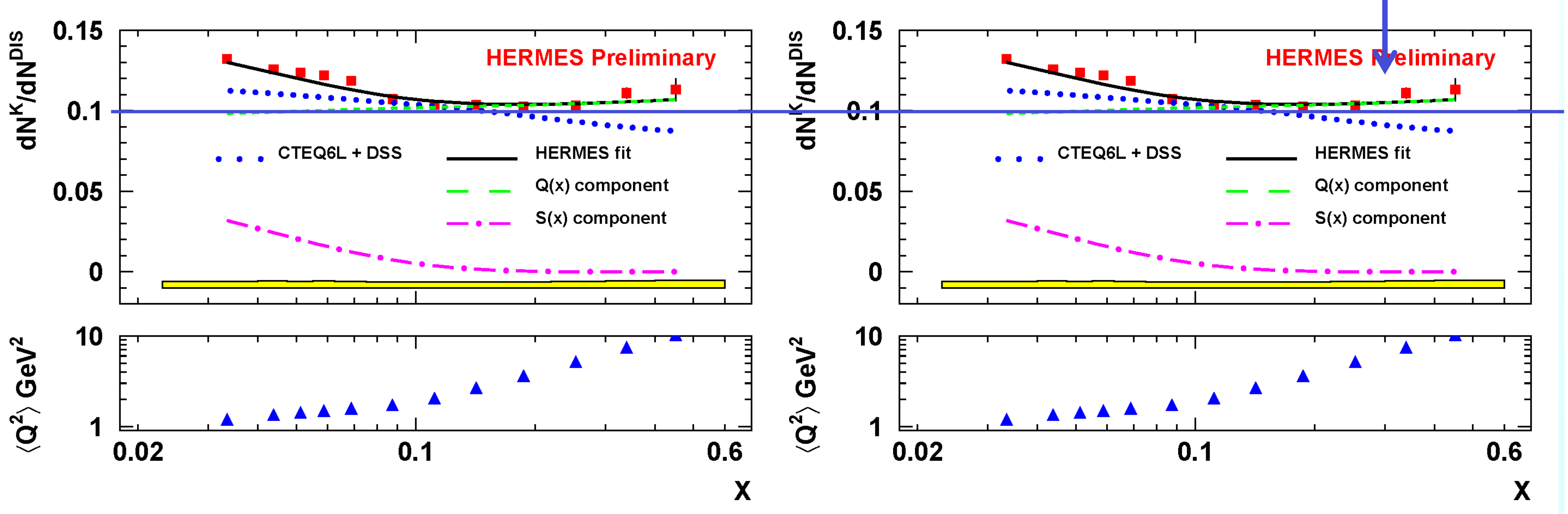
where $D_Q^K(z) = 4D_u^K(z)+D_d^K(z)$ and $D_S^K(z) = 2D_s^K(z)$

$$\frac{dN^{K\pm}}{dN^{DIS}} = \frac{Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz}{5Q(x) + 2S(x)}$$

Reevaluation of S(x)

$$\frac{dN^{K\pm}}{dN^{DIS}} = \frac{Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz}{5Q(x) + 2S(x)} \xrightarrow{x > 0.35} \frac{\int D_Q^K(z)dz}{5}$$

A. Airapetian et al., P. L. B666(2008)446

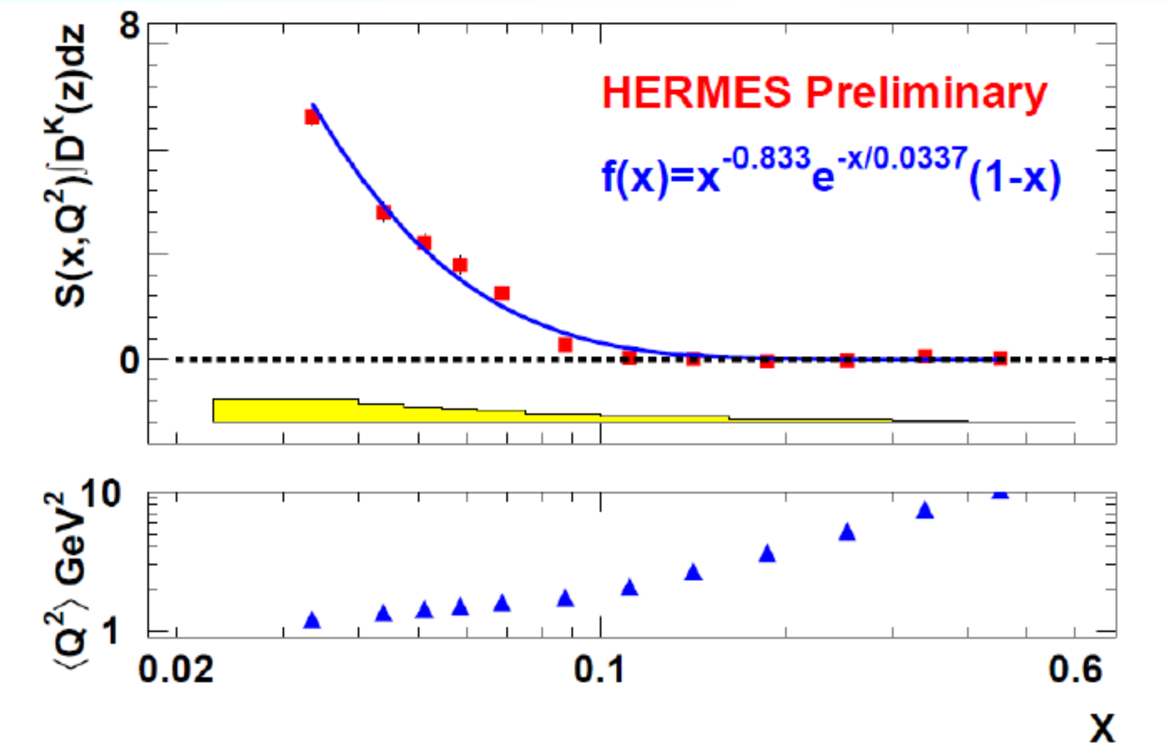


- $S(x)$ from CTEQ6L with $\int D_Q^K(z)dz$ & $\int D_S^K(z)dz$ as free parameters (dotted) does not fit the data

Reevaluation of S(x)

$$\frac{dN^{K\pm}}{dN^{DIS}} = \frac{Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz}{5Q(x) + 2S(x)} \xrightarrow{x>0.35} \frac{\int D_Q^K(z)dz}{5}$$

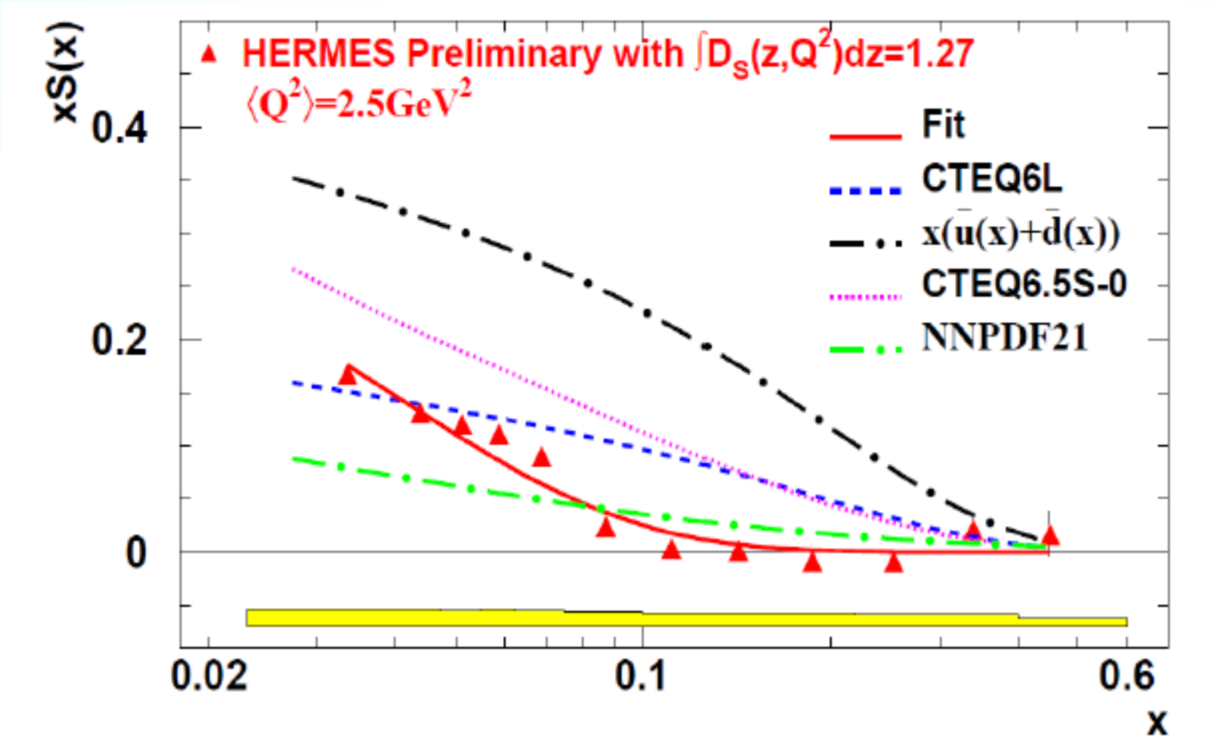
with Q(x) from CETQ6L (Result very similar with NNPDF)



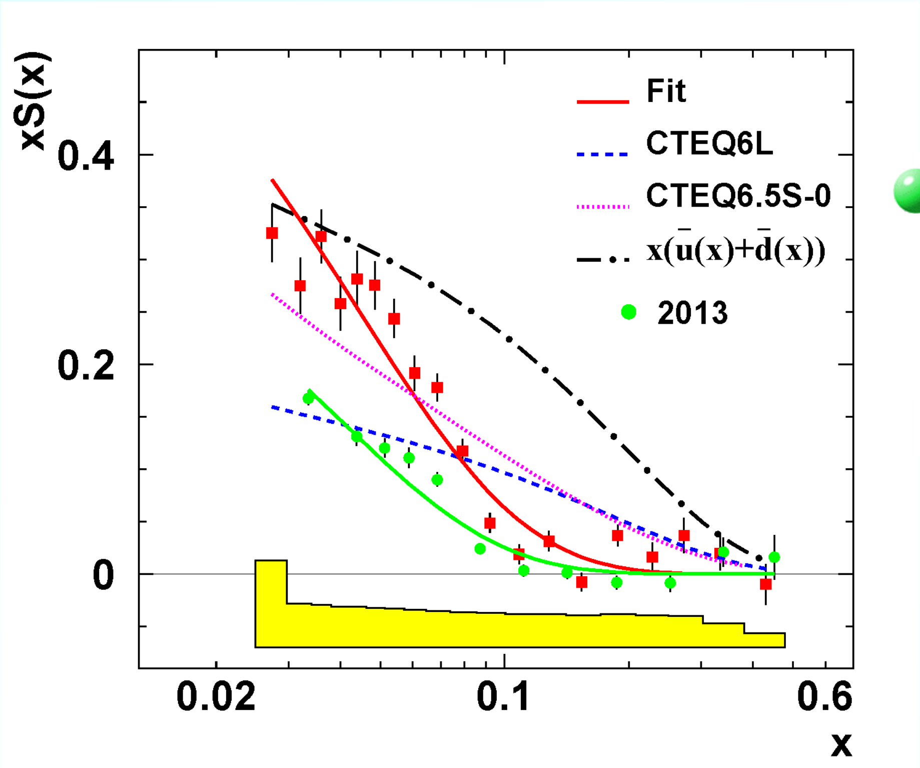
Reevaluation of S(x)

$$\frac{dN^{K\pm}}{dN^{DIS}} = \frac{Q(x)\int D_Q^K(z)dz + S(x)\int D_S^K(z)dz}{5Q(x) + 2S(x)} \xrightarrow{x > 0.35} \frac{\int D_Q^K(z)dz}{5}$$

with $\int D_S^K(z)dz = 1.27$
from DSS



Comparison 2008-2013



- New result for xS(x) smaller in magnitude by factor of ≈ 0.6
- Message doesn't change: S(x) much softer than assumed by current PDFs (mainly based on $\nu N \rightarrow \mu^+\mu^- X$ see e.g., NOMAD, arXiv:13084750)

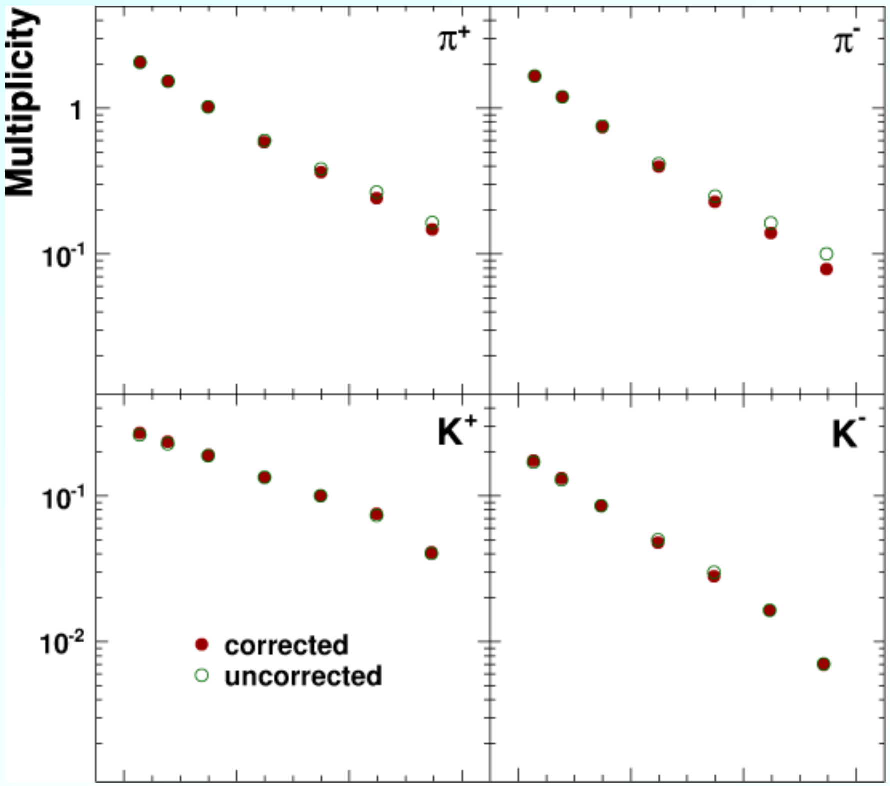
→ J. Peng

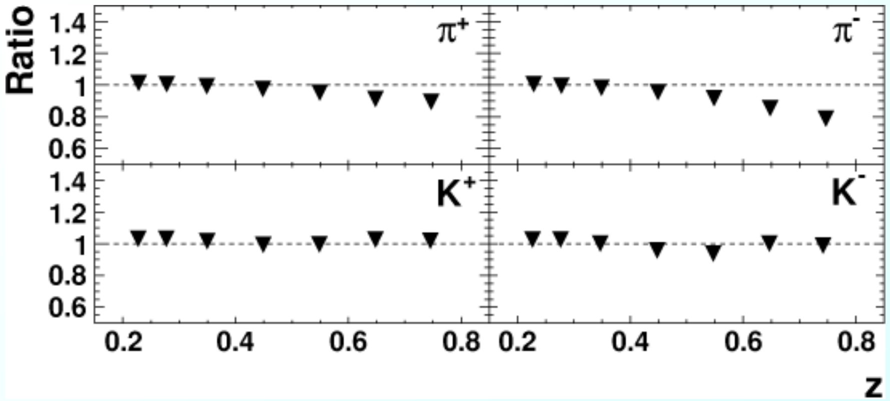
Summary

- High-statistics HERMES data set of charged pion and kaon multiplicities
- Multidimensional analysis in x, z, Q^2, $P_{h\perp}$
- These data are a basis for improved extractions of PDFs and FFs (in NLO)
- Reevaluation of $S(x)$, based on these final multiplicities
  $S(x)$ is softer than assumed by current PDFs.

Backups

Effect of corection for exclusive VM





Comparison with NNPDF parametrisation