Strange particle production at HERA

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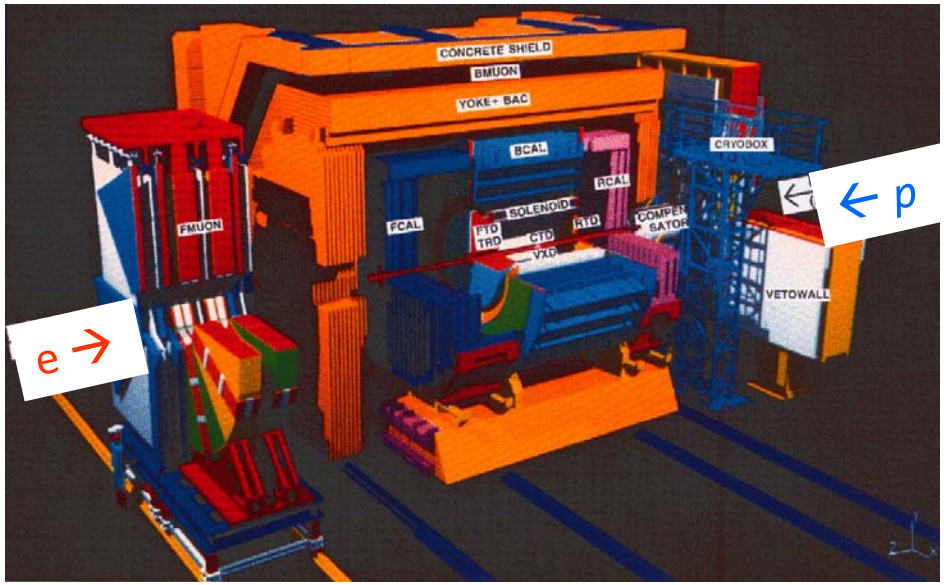
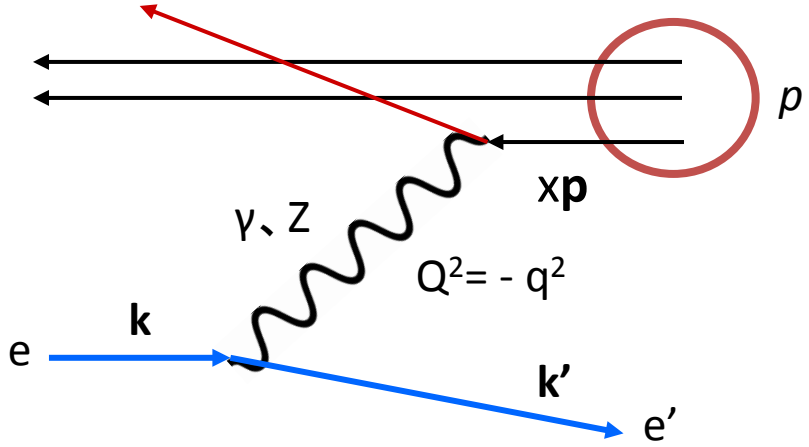
on behalf of ZEUS collaboration

e*p* collision at HERA





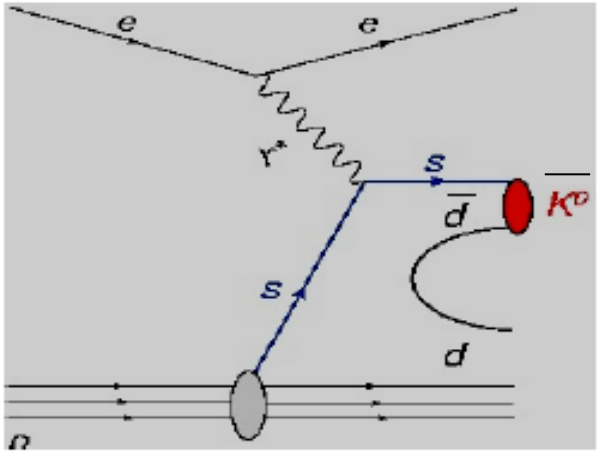
- HERA at Humburg
- HERA-II Run (2003-2007)
  - Ep = 920GeV
  - Ee = 27.5GeV
  - √s = 318 GeV
  - total luminosity ~ 0.4 fb^{-1}

- DIS kinematical variable
  - $Q^2 = -q^2$: square of 4-momentum transfer
  - x: fraction of p momentum carried by quark
  - y: inelasticity parameter
- DIS event selection in this analysis
  - $Q^2 > 10\ GeV^2$
  - $E_e > 10$ GeV
  - $35 < E - P_Z < 65$ GeV
  - $|Z_{vertex}| < 50$ cm

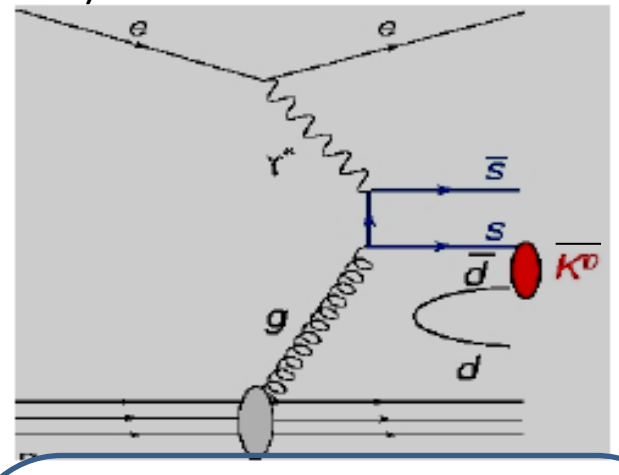
Strange production mechanisms of HERA

The main processes of strange quark production.

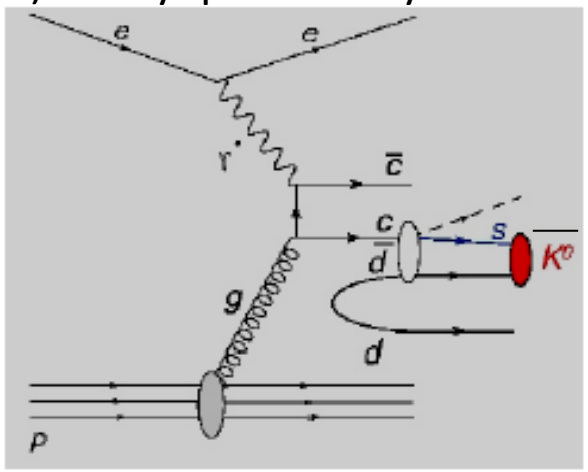
a) QPM, sea quark scattering



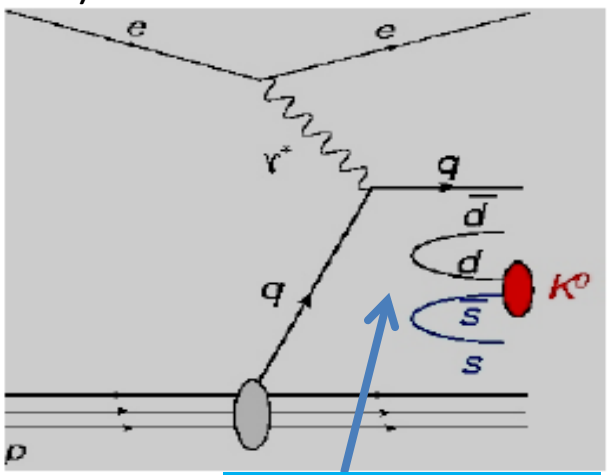
b)Boson-Gluon Fusion



c) Heavy quark decay



d) Hadronaization



Fragmentation

Motivation

Strange hadron productions in e*p* collisions are not yet well understood.

- Is quark fragmentation function (FF) universal?
- Do Next Leading Order (NLO) QCD calculations describe the HERA data?

→ We need HERA-II measurements

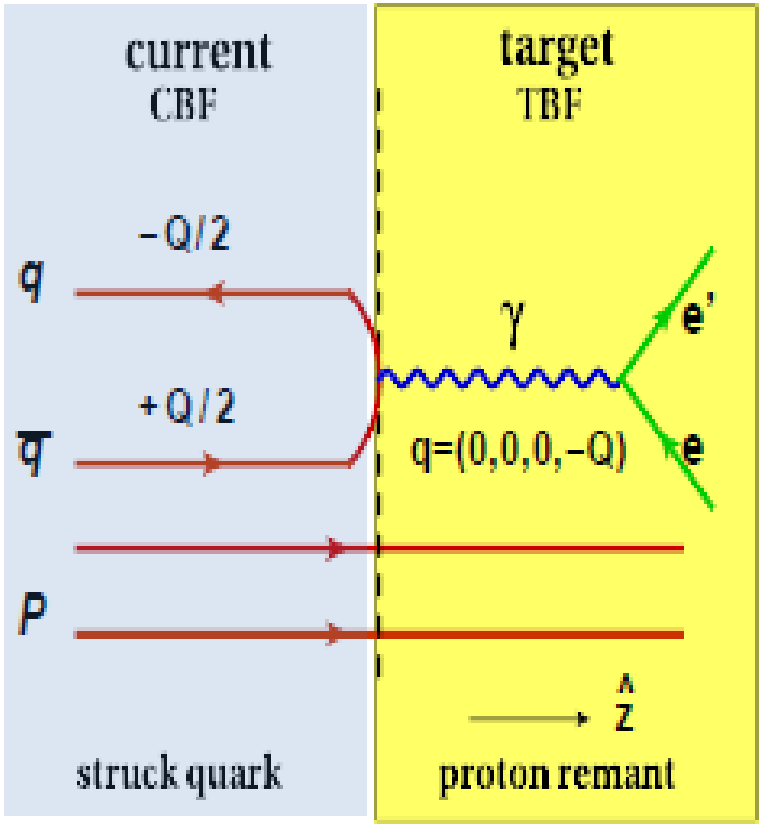
Results shown in this talk

- Scaled momentum distribution for K^0s and Λ (ZEUS)

  $10 < Q^2 < 40000\ \text{GeV}^2$ HERA II;

  Preliminary results , ZEUS-prel-10-013
- The measurements were performed in the current fragmentation region of the Breit frame.

Breit frame



- In the Breit frame, struck quark (current region) and proton remnant (target region) are separated.

  -Current region is analogous to single hemisphere e+e- annihilation.

- Fragmentation studies are based on scaled momentum(xp) distribution:

$$x^p = 2p^{Breit}/Q$$

Outline

- Comparison of K^0s and Λ production with NLO QCD calculations + fragmentation functions (FF).

$$\frac{d\sigma}{dx_p} = f(x,Q^2) \otimes \sigma(Q^2) \otimes D(z,Q^2)$$

$f(x,Q^2)$: parton density function
$\sigma(Q^2)$: cross section of hard-scattering process
$D(z,Q^2)$: FF

Two different FFs are compared with the data.

AKK05+CYCLOPS (for K^0s and Λ)

S. Albino, B.A. Kniekl, G. Kramer, Nucl. Phys. B 725 (2005) 181
S. Albino, B.A. Kniehl, G. Kramer, Nucl. Phys. B 734 (2006) 50
FFs were obtained from fits to e+e- data.
hadrons mass effect was included in small x_p and Q^2.

DSS (for K^0s)

D. de Florian, R. Sassot, M. Stratmann Phys. Rev. D75 (2007) 114010.
FFs were obtained from fits to lp and pp data.
no hadrons mass corrections.

Measurement

Luminosity
- $290pb^{-1}$ (2005 and 2006-7 data)

Kinematical Range
- $10 < Q^2 < 40000GeV^2$
- $0.001 < x < 0.75$

K^0s and Λ are selected by tracking.

Scaled momentum distribution is defined as:

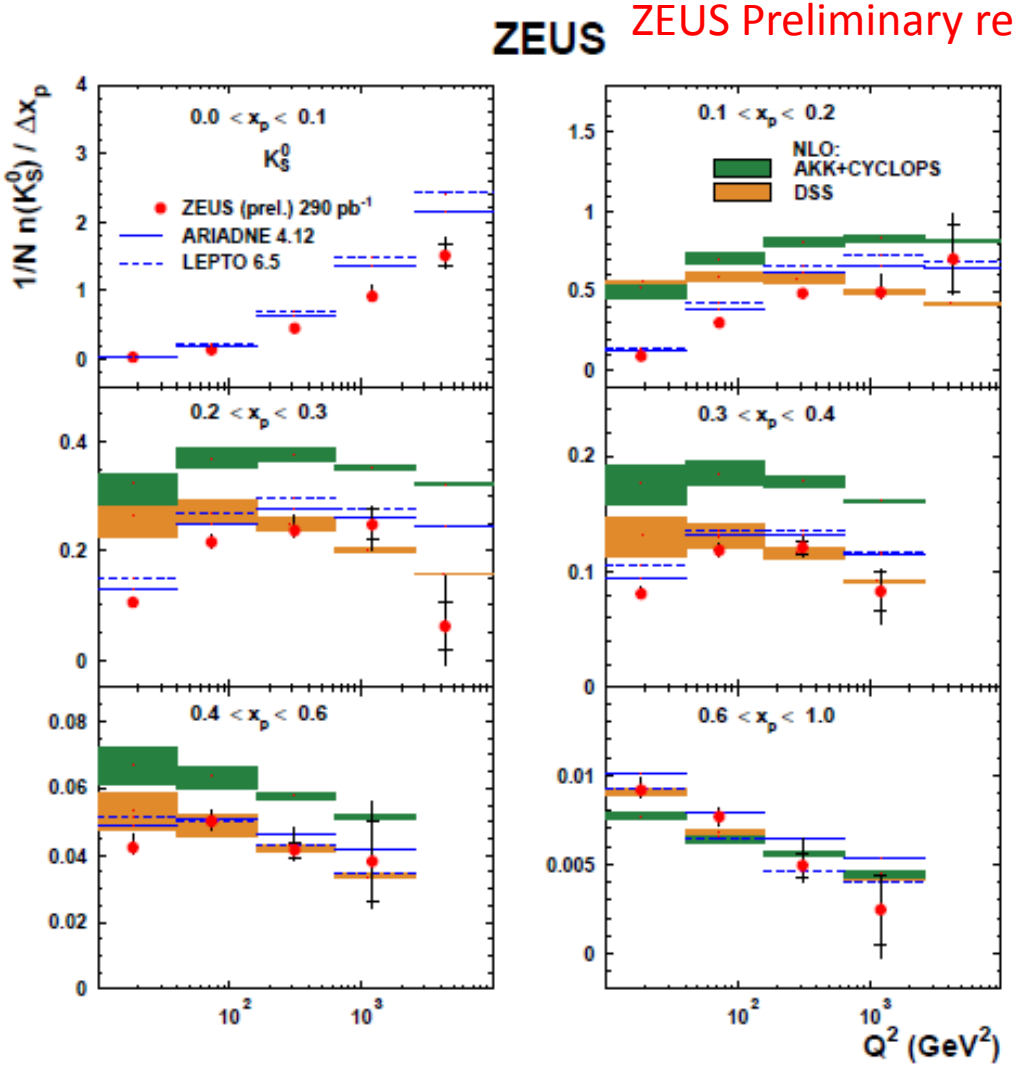
$$\frac{1}{N}\left(\frac{n_h}{\Delta x_p}\right) \qquad h = K_s^0, \Lambda \qquad \Rightarrow D(z,Q^2)$$

N: total number of the hadron

n: number of the hadron in Δx_p

Δx_p: x_p bin

Scaled momentum distributions: K^0s

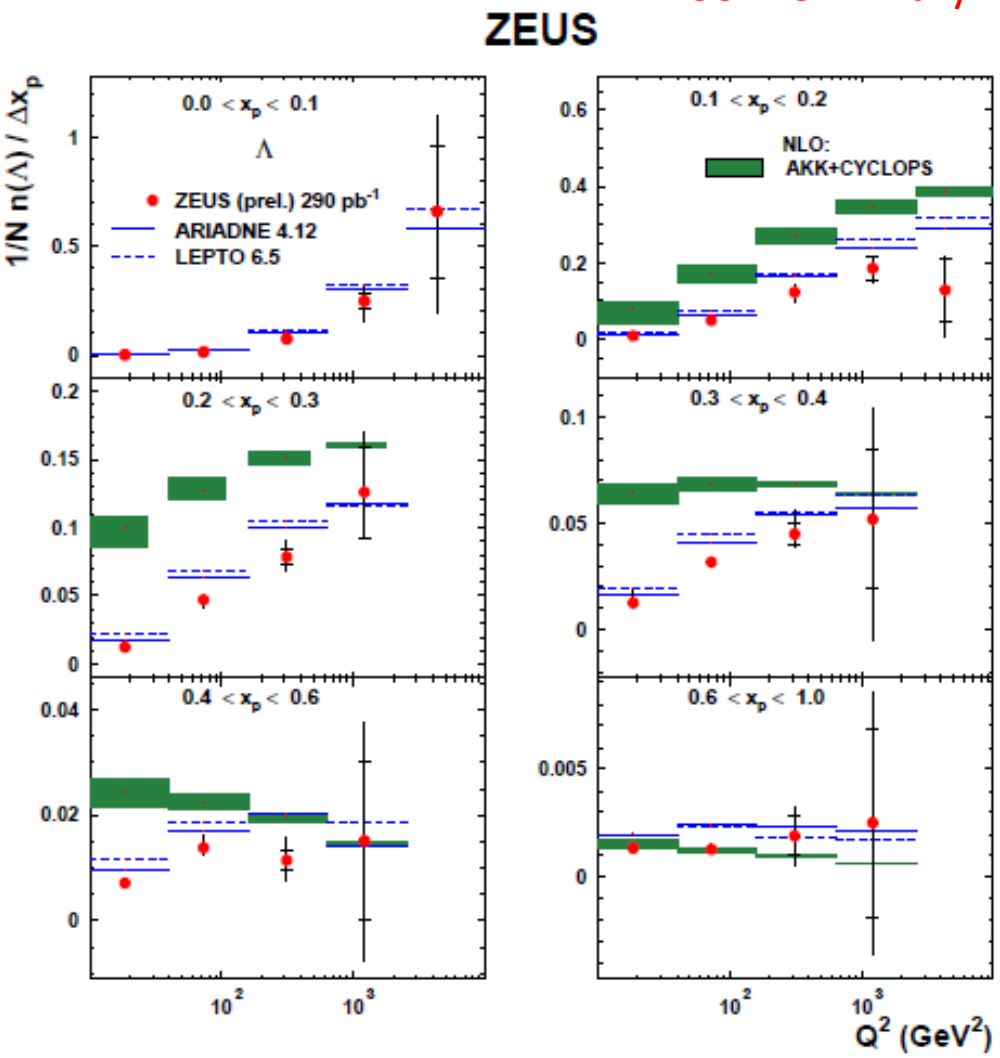


Current region of Breit frame

- Scaling violations are observed.
- MC (ARIADNE, LEPTO) can describe the data in full space.
- None of calculations can describe the measured x_p dependence
  - DSS gives a good description of the data for $x_p > 0.3$ and $20 < Q^2 < 40000 GeV^2$.
  - AKK+CYCLOPS is much higher at lower x_p. But shape is better. <=include mass effect.

Scaled momentum distributions: Λ

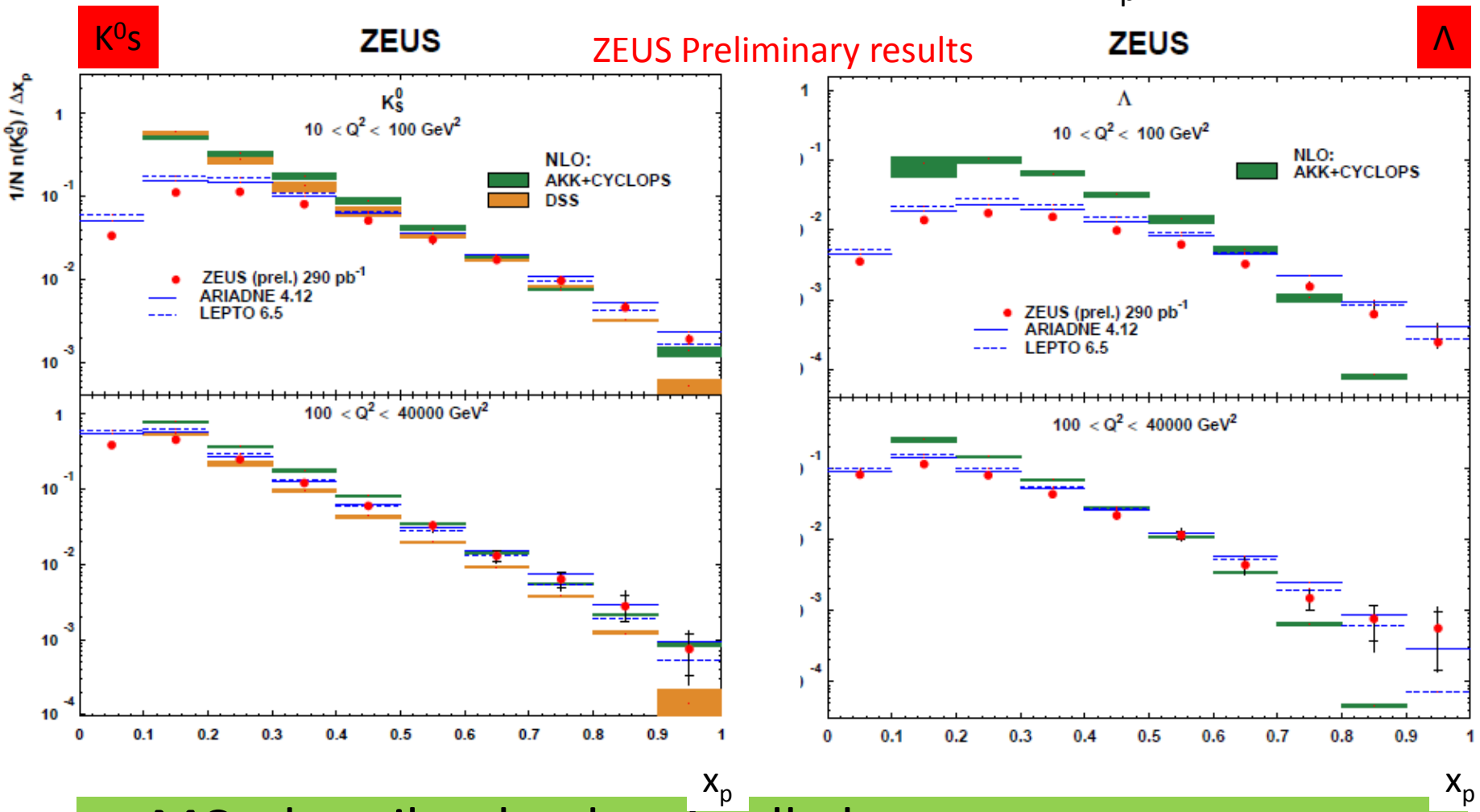
ZEUS Preliminary results



Current region of Breit frame

- Scaling violations are observed.
- MC (ARIADNE, LEPTO) describe the data in most parts of phase space.
- AKK+CYCLOPS does not describe the data $x_p < 0.6$.
  - $0.3 < x_p < 0.6$: different shape

Scaled momentum distributions(K^0s, Λ) in low and high Q^2 as function of x_p



- MCs describe the data in all phase space.
- Description of NLO QCD calculations(AKK+CYCLOPS, DSS) become better at high Q^2 and high x_p.

Summary

- Scaled momentum distributions (K^0s, Λ) clearly show the scaling violation.
- MC(LO) calculations (LEPTO and ARIADNE) describe well agreement in all phase space.
- NLO QCD calculations with 2 different theoretical approaches (AKK+CYCLOPS and DSS) can describe the data in certain regions of the phase space, but not perfectly.
- We hope that ZEUS results will be useful to constrain the theoretical uncertainties in a description of the strange hadrons.