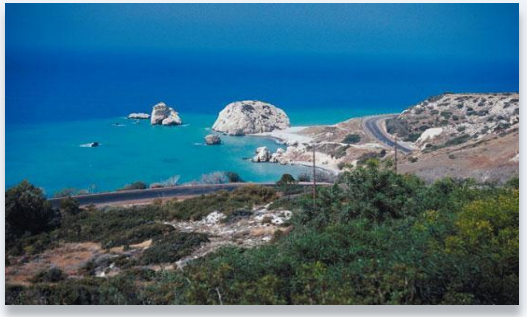
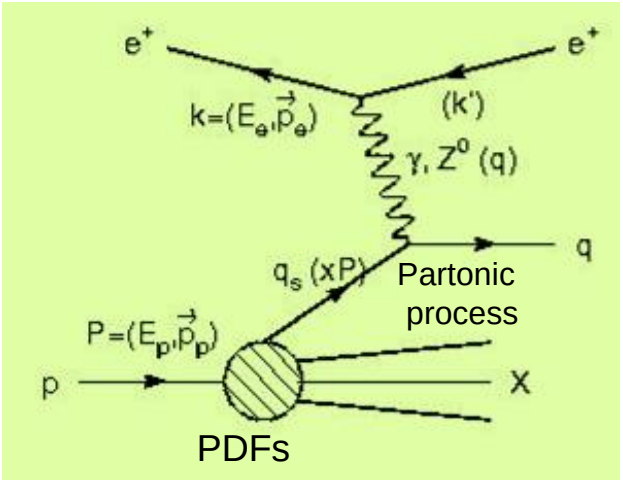


Scaled momentum distributions for K^0_S and $\Lambda / \bar{\Lambda}$ in DIS at HERA

Leszek Zawiejski
Institute of Nuclear Physics PAN, Cracow
on behalf of ZEUS Collaboration

Motivation

DIS NC process



$q = k - k'$, $Q^2 = -q^2 > 0$, , $Q^2 > 1\ GeV^2$

Hadronisation – non pQCD process → Hadronic final state: reconstruction of K^0_S, Λ, $\bar{\Lambda}$

Particles production - two approaches in description:

Monte Carlo:
PDF, leading log parton shower and Lund string model

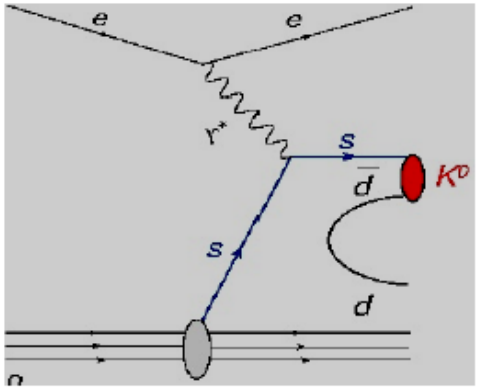
or

NLO QCD:
PDF, matrix elements of the partonic processes and fragmentation functions

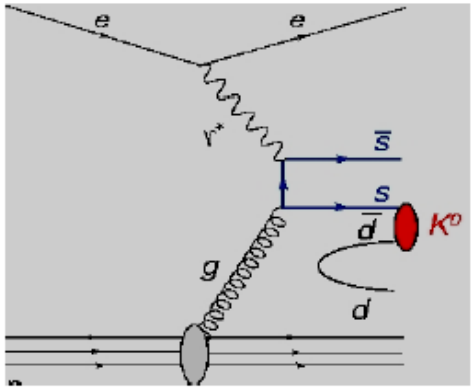
- Comparison of the K^0_S, Λ / $\bar{\Lambda}$ production in DIS with MC and NLO QCD calculations
- Test pQCD, factorization and quark universality fragmentation
- Analysis can yield results which can give additional constrains in description a quark, anti-quark and gluon fragmentation into the strange hadrons

Main mechanisms of strange quark production

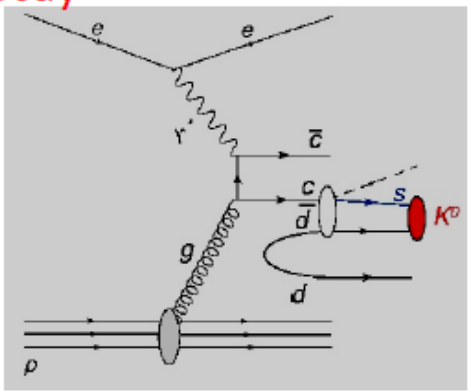
QPM, hard scattering of sea quark



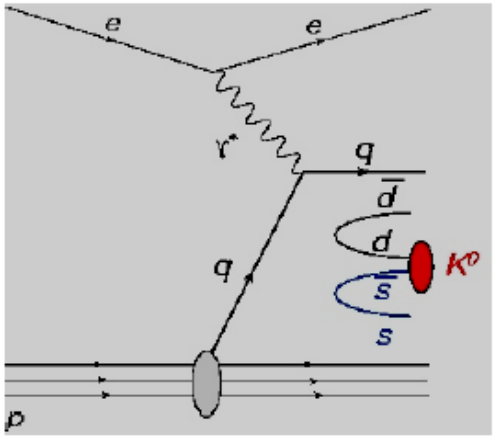
Boson-gluon fusion



Heavy quark decay



Hadronisation



Predictions

Single-inclusive hadron production - exploiting the factorization theorem:

$$\sigma(ep \to e + H + X) = \sum_{j,j' = q,\bar{q},g} f_{j/p}(x, Q) \otimes \hat{\sigma}_{jj'}(x, Q, z) \otimes F_{H/j'}(z, Q)$$

Decomposed into convolutions of three ingredients

proton pdf — non-perturbative

partonic cross section — perturbative QCD: matrix elements up to NLO accuracy

Hadronisation Fragmentation Function (FF) — non-perturbative

NLO QCD:

AKK + CYCLOPS : Albino, Kniehl, Kramer
PDF : CTEQ6M
FF : fit to e^+e^- data

DSS : De Florian, Sassot , Stratmann
PDF: MRST
FF: fit to e^+e^- + pp + ep data

or

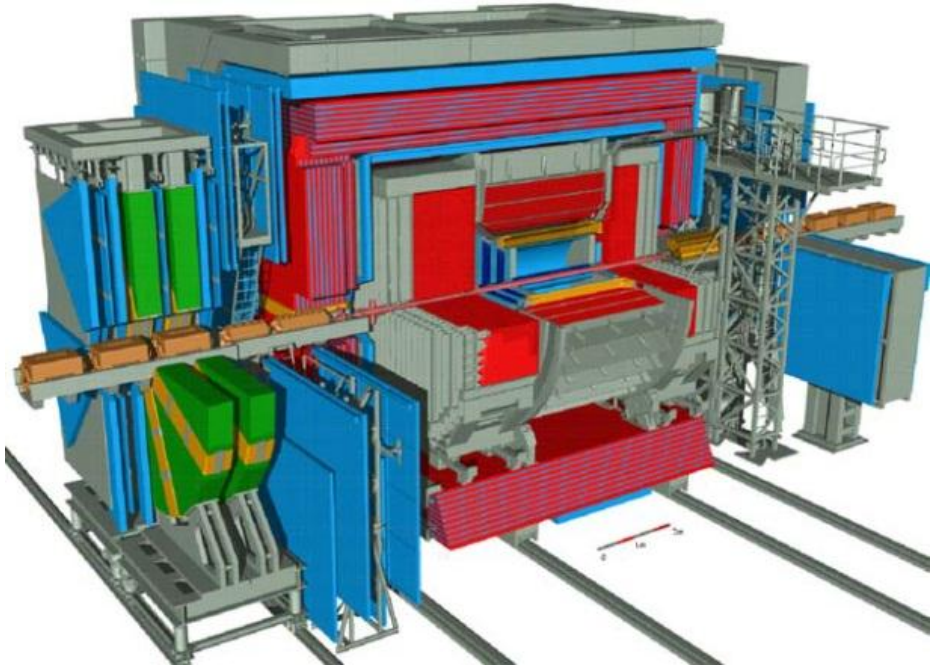
Monte Carlo:

ARIADNE - CDM color dipole mode or LEPTO – MEPS model
PDF: CTEQ5D
JETSET: Lund string model

Experiment

ZEUS at HERA: 1992 – 2007
Studies of $e^{\pm}p$ collisions
Data collected ~ 0.5 fb^{-1}

ZEUS Collaboration:
about 450 people
from eighteen countries



After 2007 shut down

Many very interesting results are still published

Experiment / Data

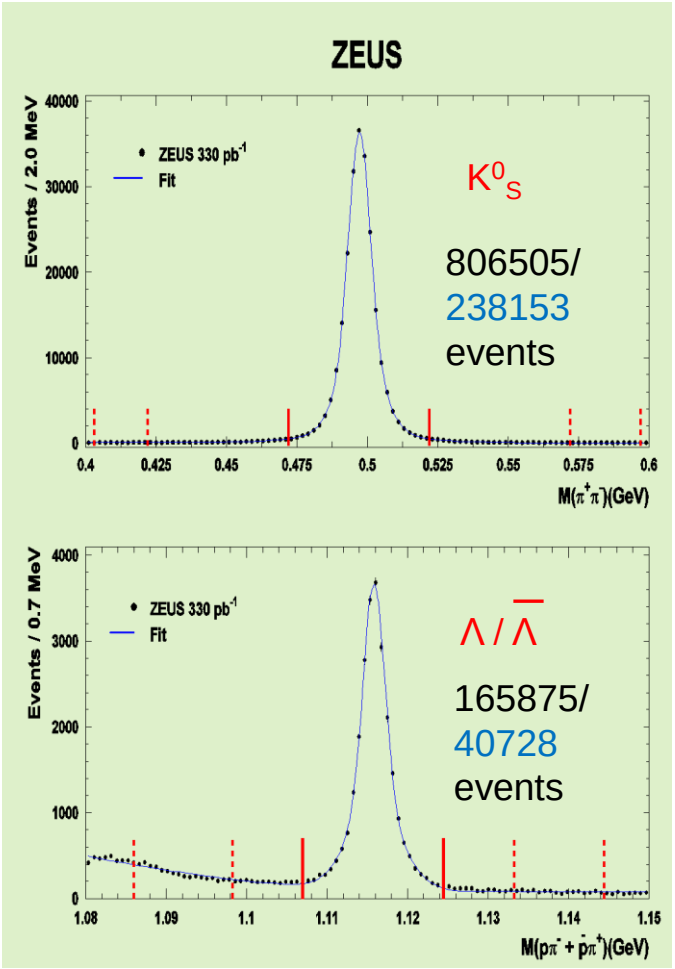
$e^{\pm}$ (27.5 GeV) p(820 GeV) collisions, $\sqrt{s} \sim 318$ GeV
standard NC DIS events selection : 330 pb^{-1}
$10 < Q^2 < 40000$ GeV^2 , $0.001 < x < 0.75$

K^0_S , Λ, $\bar{\Lambda}$ candidates:
two oppositely charged tracks
associated with a secondary vertex.
with cuts on:
dca, effective mass distributions, collinearity angles, distances between candidates decay vertex and primary vertex, P_t variable (Armenteros-Podolanski).

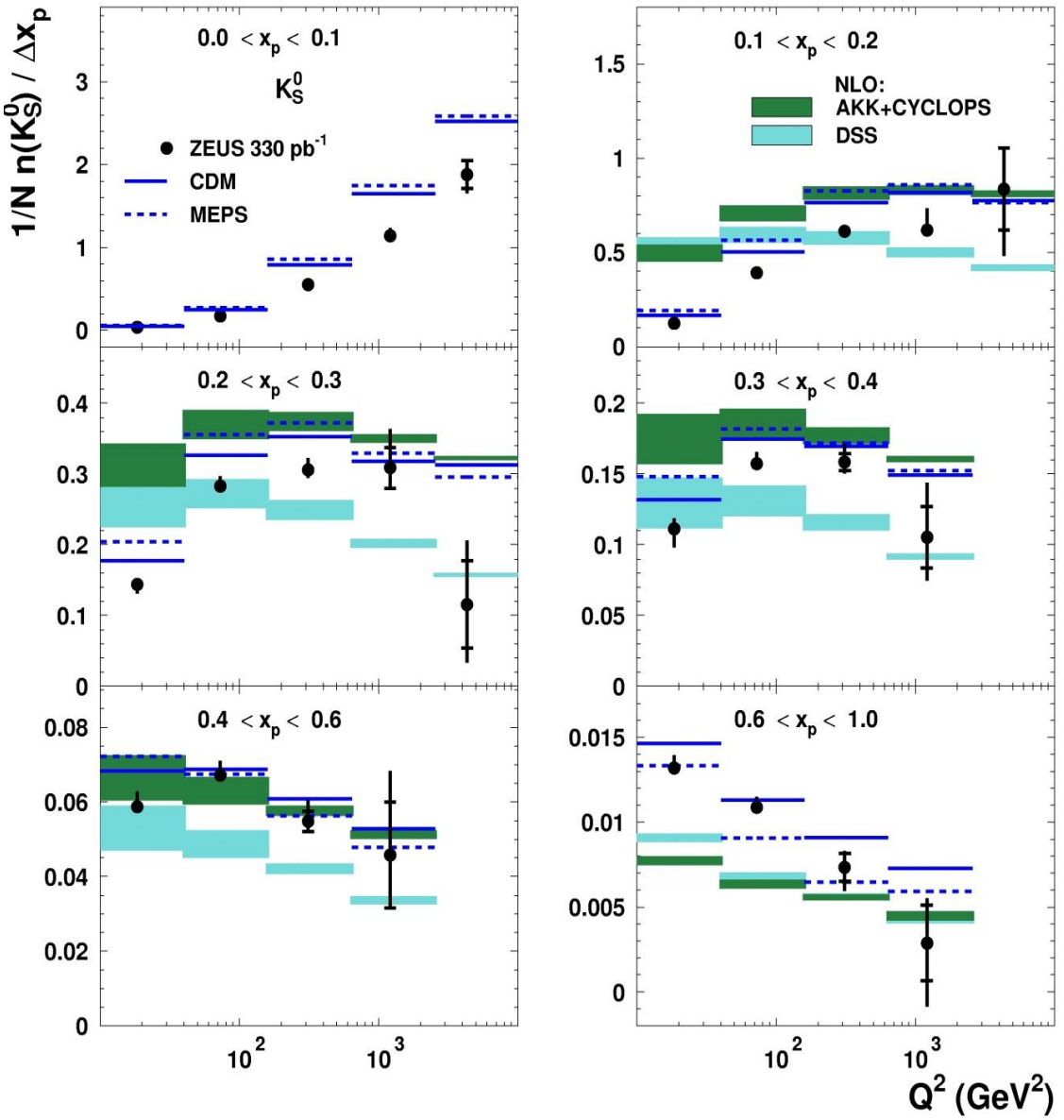
(JHEP 03 (2012) 020)

Analysis: current region of the Breit frame (BF)
(BF: exchanged virtual boson is purely space-like with 3-momentum q = (0,0,-Q))

Distributions presented in $x_p = 2P^{Breit} / \sqrt{Q2}$ $\rightarrow$
an estimator for z : the fraction of parton momentum carried by hadron after fragmentation

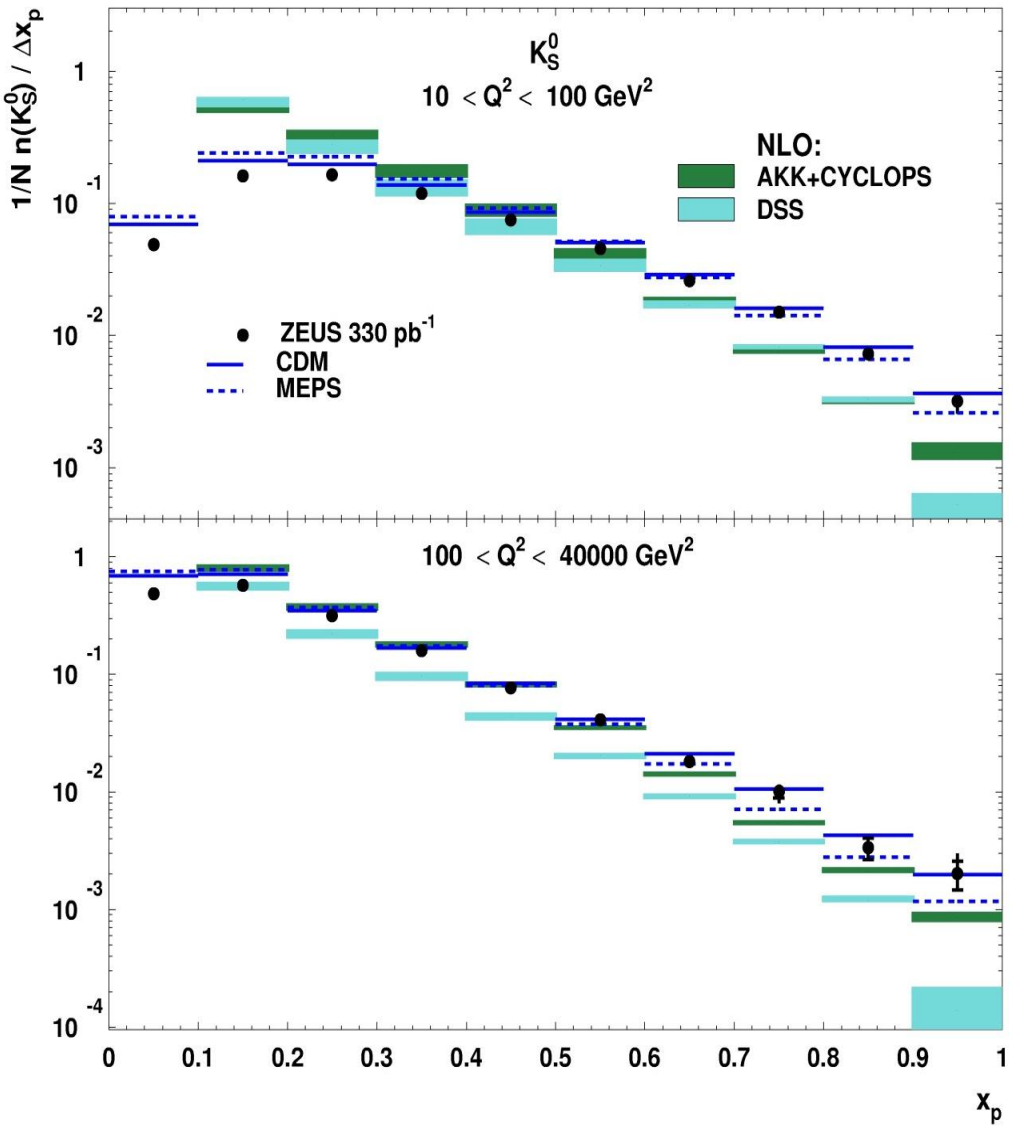


Scaled Momentum Distribution: K^0_S (1)



- Scaling violation is observed:
  with increasing Q more soft gluons are radiated → more particles with low x_p are produced
- Calculations with the Fragmentation Functions based on **e^+e^- (AKK+CYCLOPS)** or on **e^+e^- + pp + ep data (DSS)** cannot describe x_p distributions. DSS do it a little better in mid-range of x_p
- MCs descriptions are reasonable

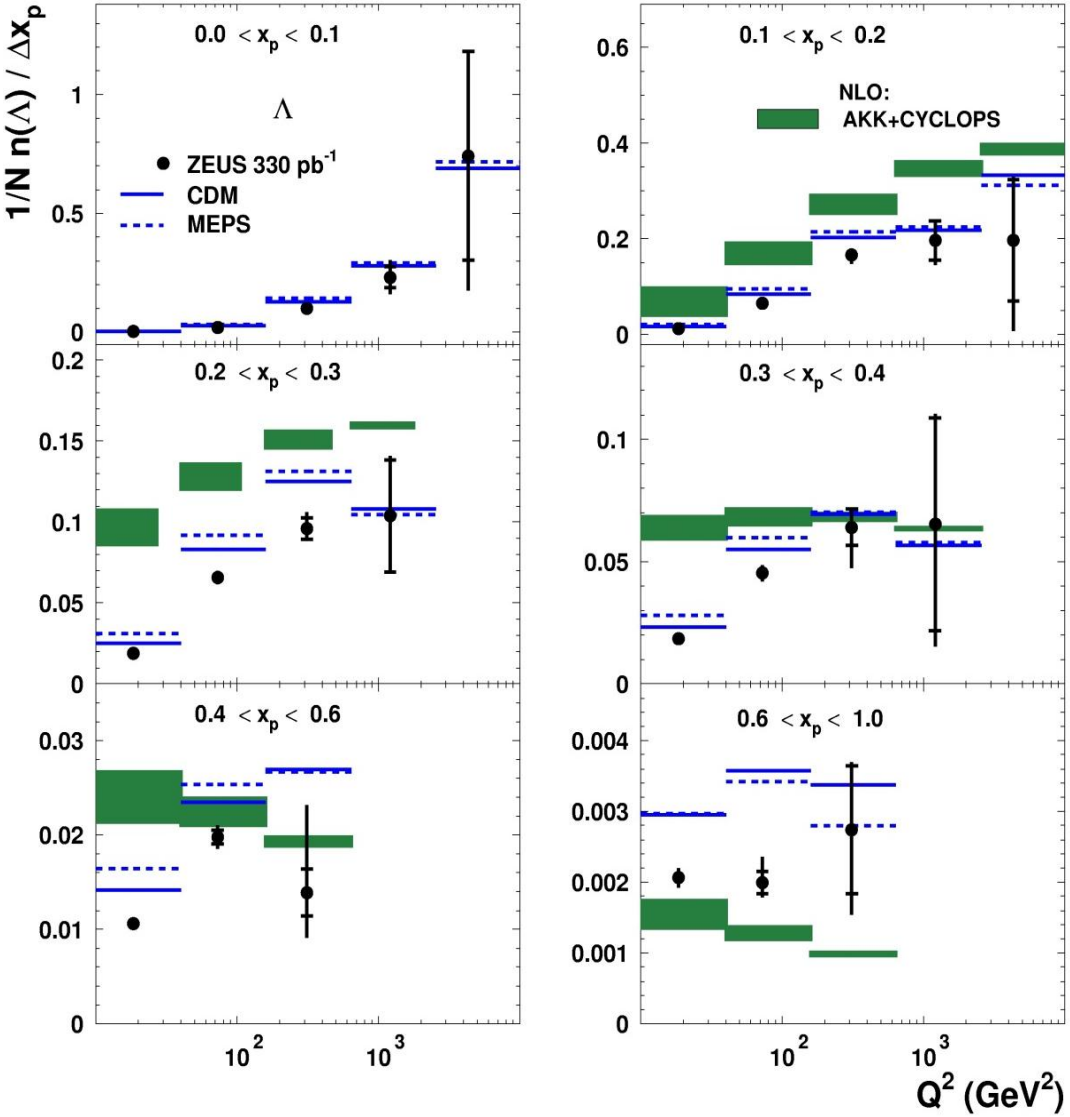
Scaled Momentum Distribution: K^0_s (2)



Two different regions of Q^2:

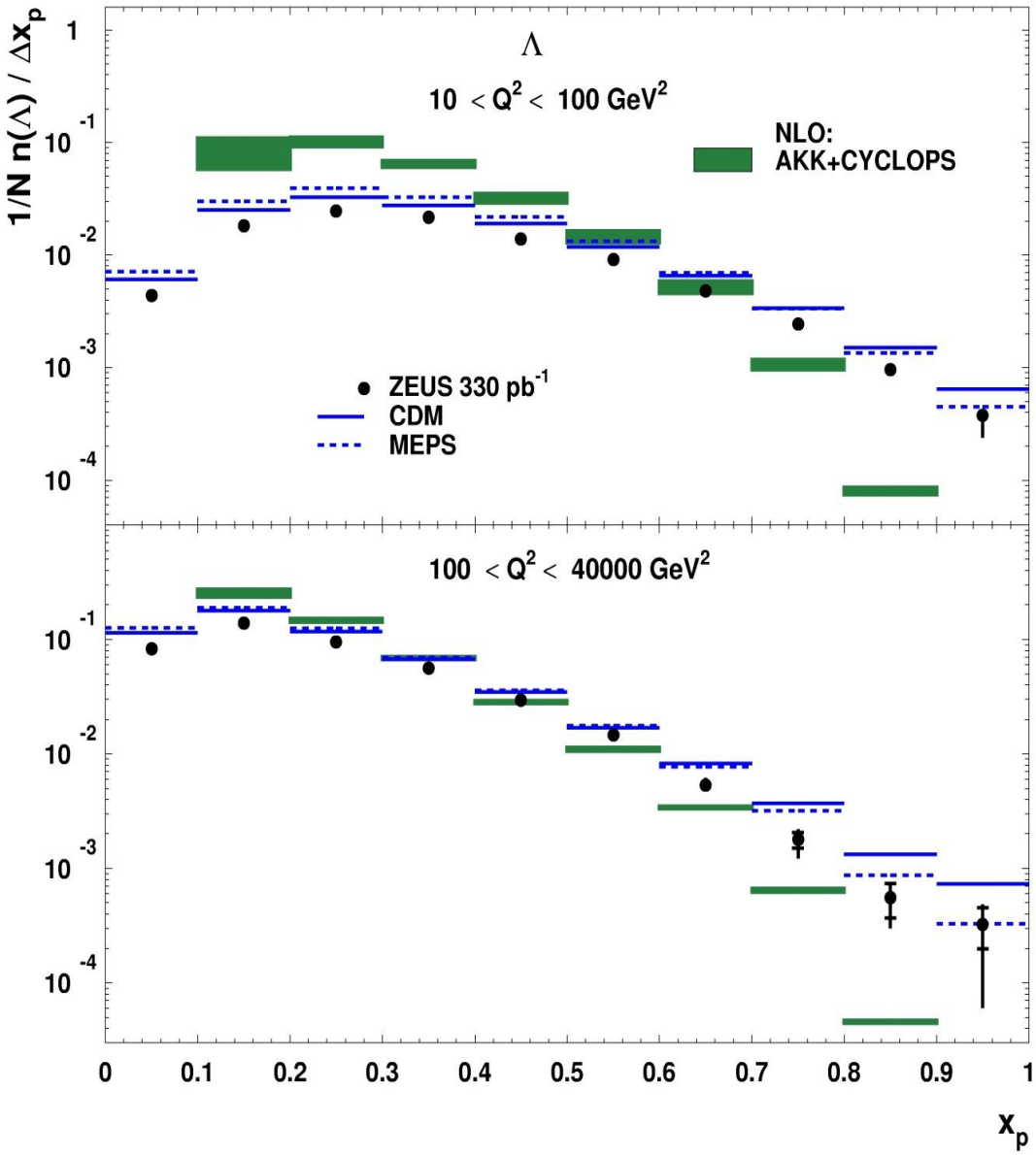
- For small Q^2:
  AKK+CYCLOPS
  and DSS calculations
  predict too steep spectra
  with significant overestimation
  of the data at small x_p
- For high Q2 :
  the similar tendency,
  AKK+CYCLOPS
  gives a little better
  description
- MCs still describe x_p distributions in a reasonable way.

Scaled Momentum Distribution: Λ / $\bar{\Lambda}$ (1)



- No DSS calculations are available
- Scaling violation is observed
- AKK+CYCLOPS prediction with FF based only on e^+e^- data fail in data description
- Monte Carlo are still reasonable
- Poor statistics for the highest x_p bin

Scaled Momentum Distribution: Λ / $\bar{\Lambda}$ (2)

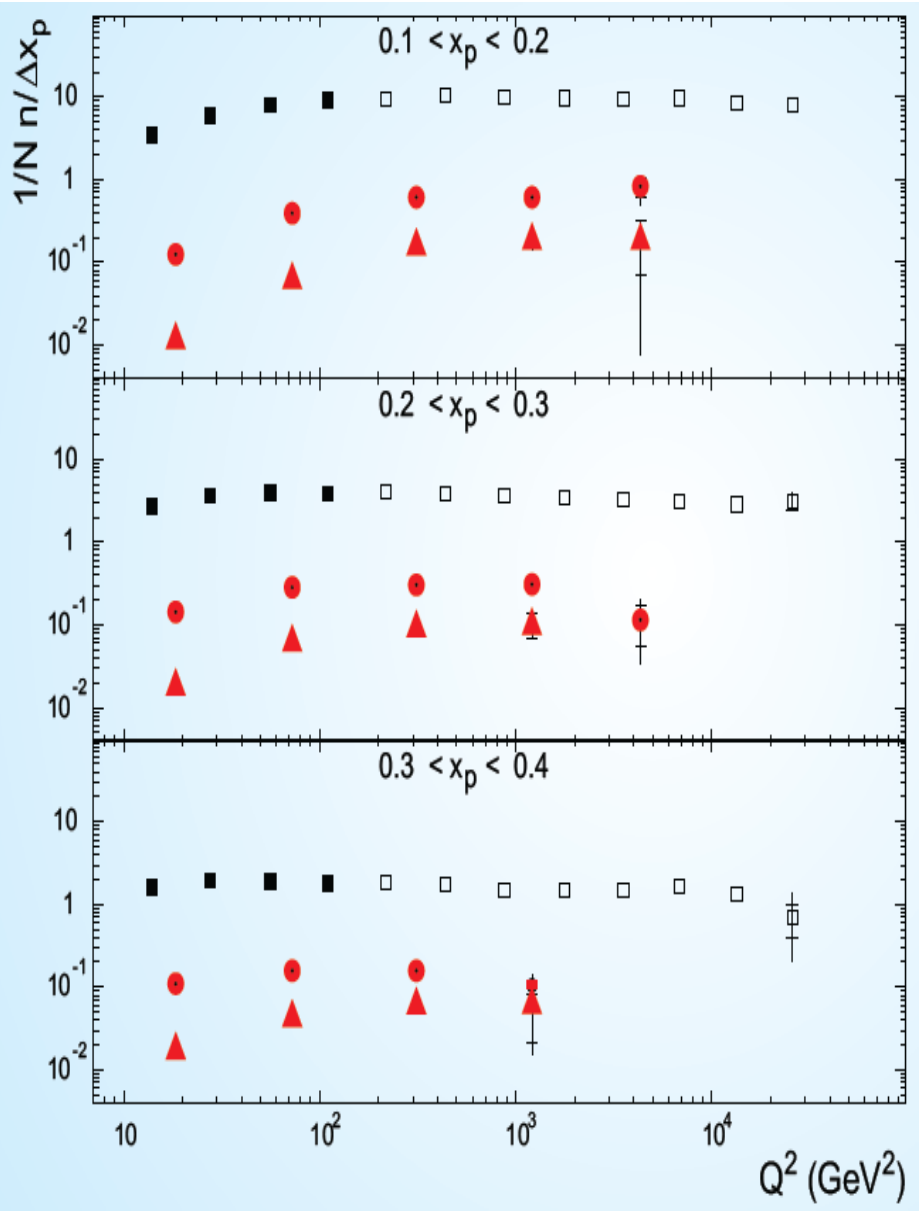


Two different regions of Q^2 :

- AKK+CYCLOPS with FF based on e^+e^- data only predicts too steep spectrum in both Q^2 regions
- Monte Carlo predictions give a much better description of x_p distributions
- Not enough statistics at large x_p

x_p distributions : inclusive charged and neutral strange hadrons

Strange hadrons



Charged hadrons, ZEUS

JHEP 6 (2010) 1 and JHEP 10 (2010) 1

Inclusive charged particles:

- ZEUS 440 pb^{-1}
- ZEUS 38 pb^{-1}

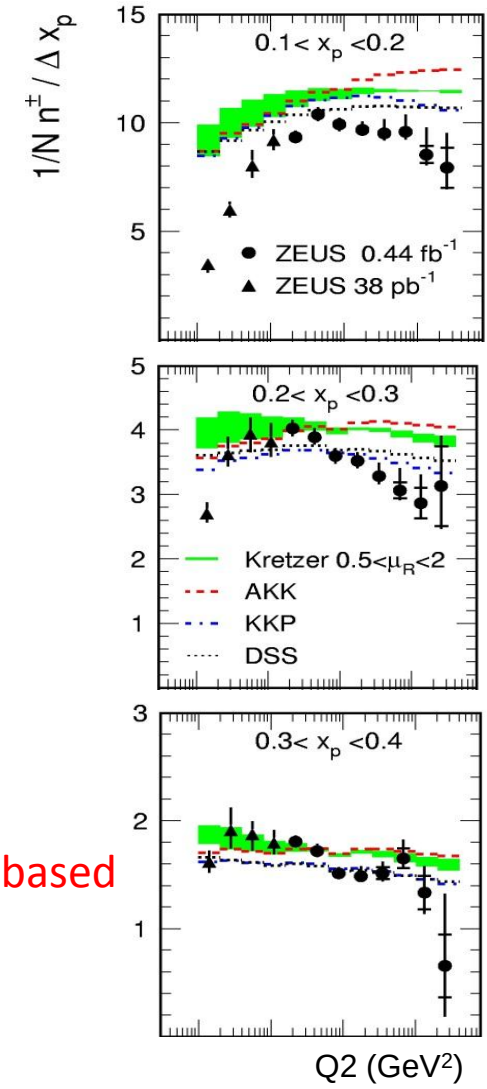
strange hadrons:

- K^0_S ZEUS 330 pb^{-1}
- Λ

Similarity distributions -
- at small Q^2 and x_p
- mass effect is stronger for strange hadrons .

Most of the charged particles are pions

AKK calculations with FF based only on e+e- also failed to describe the x_p distributions of charged hadrons



Summary

- Scaled momentum distributions for K^0_S , Λ / $\overline{\Lambda}$ strange hadrons were measured for the first time in ep DIS

- The comparison of the data with NLO QCD calculations based on different parametrisations of the FFs show that FFs are still not constrained enough to describe the strange hadrons production

- It is hoped that the results will be useful for further improvement of the fragmentation functions for strange hadrons