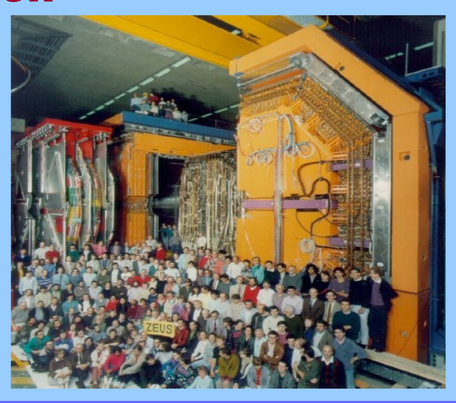
Scaled momentum distribution for K^0_S and Λ particles in DIS at HERA

ZEUS Collaboration

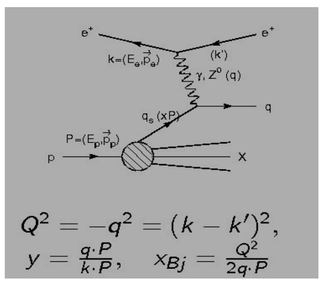
HERA / Hamburg , 1992 -2007
$e^{\pm}$ proton collisions
at $\sqrt{s}$ = 318 GeV (300 GeV)



ca 400 people
from 18 countries

The jet fragmentation and hadronisation process through which coloured partons become confined in colour-neutral hadrons cannot be described within the framework of perturbative QCD (pQCD). Extensive studies of the fragmentation properties of the hadronic final state have been performed in and deep inelastic scattering (DIS) at HERA to better understand the hadronisation process. By comparing data with the next to leading order (NLO) calculations using various fragmentation functionss (FFs) tuned to the e+e- and pp data, the universality of the quark fragmentation is tested.

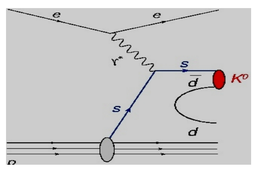
DIS process and strange hadron production



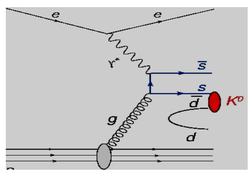
This analysis:

- ZEUS DIS events collected in (2005-2007), corresponding to 330 pb^{-1} of integrated luminosity
- current fragmentation region of the Breit frame

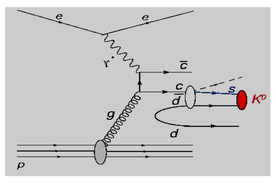
The main processes of strange quark production



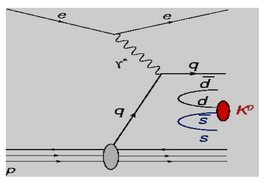
QPM hard process



Boson-Gluon fusion



Heavy quark decay

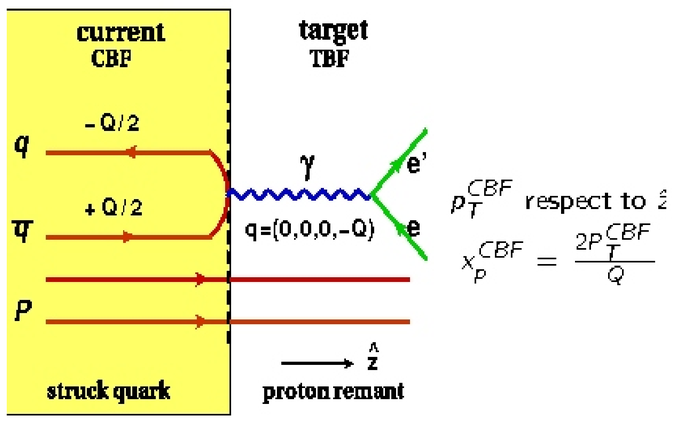


Hadronisation

Studies of K^0_S and Λ production:

- Test of hadronisation models
- Fragmentation properties from scaled momentum distributions
- Test NLO QCD calculations and universality of factorisation theorem

Breit frame



The scaled momentum xp is defined as:
$xp = 2\, p^{Breit} / Q$, where
p^{Breit} is the hadron momentum in the Breit frame and
Q is the momentum transfer.
It separates the struck quark (current hemisphere) and the proton remnant (target hemisphere). The currrent region is analogous to a single hemisphere in e+e- annihilations.

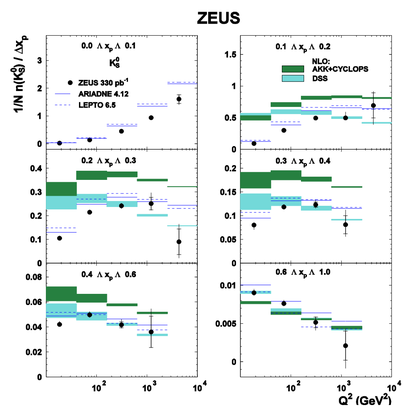
Results

Goal: a comparison of K^0_S and $\Lambda / \bar{\Lambda}$ production in the current fragmentation region of DIS with NL0 QCD calculations plus fragmentation functions (FFs).
FFs: fits to e^+e^-, lp and pp data.
A scaling violations in Q^2 are expected.

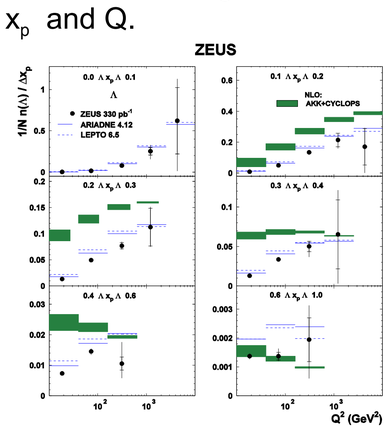
NLO QCD:
$d\sigma/dxp$ = $f(x,Q2) \otimes \sigma(Q2) \otimes D(z,Q2)$ - universality of factorization theorem
f(x,Q2) – parton density in proton
σ(Q2) – hard-scattering process – NLO (full matrix elements)
D(z,Q2) – fragmentation function: probablity for a parton to fragment into a hadron carrying a fraction z of its momentum

Two different predictions were compared to the data:
AKK + CYCLOPS (S. Albino, B. A.Kniehl, G. Kramer) -
→ FFs were obtained from fits to e+e- data,
→ hadrons mass effect was included
DSS (D. de Florian, R. Sassot, M. Stratmann)
→ FFs were obtained from fits to lp and pp data,
→ hadron mass effect was not included

K^0_S and Λ : scaled momentum distributions x_p and QCD predictions

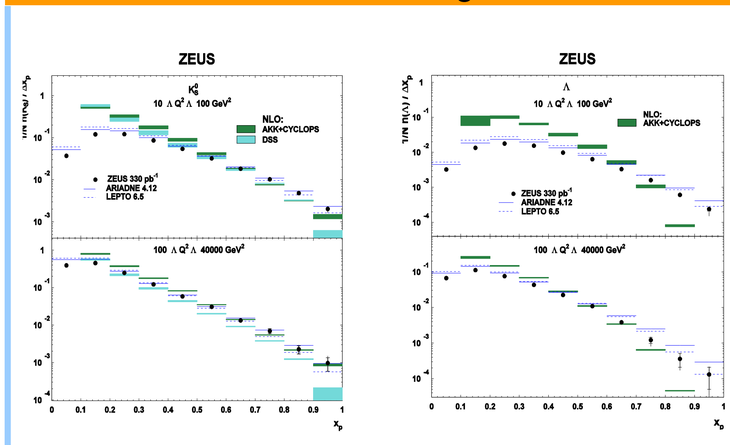


- Scaling violations are observed where with increasing Q value, the phase space for soft gluon increases, leading to a rise of number of soft particles with small x_p
- QCD NLO predictions describe the data only in certain region of the phase space
- LO predictions : ARIADNE (CDM) and LEPTO (MEPS) describe the data in the full phase space
- Inclusion of the hadron mass effect in AKK+CYCLOP prediction improves the agreement with the data for small x_p and Q.



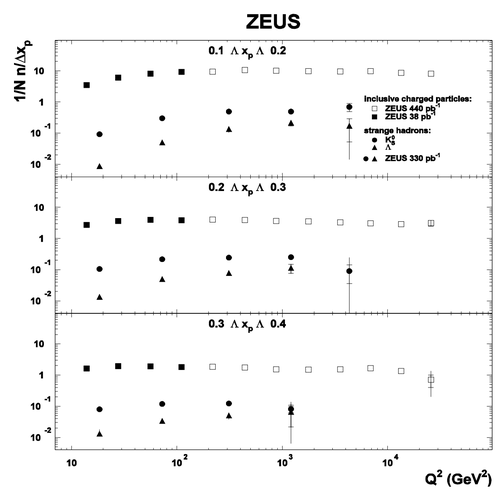
- Scaling violations are observed
- NLO QCD prediction does not descibe the data
- LO predictions : ARIADNE and LEPTO supply much better description of the data in most parts of the phase space.

Scaled momentum distribution for K^0_S and Λ at low and high Q^2



- NLO QCD predictions describe the data in the high Q^2 and high x_p region
- LO MC (ARIADNE, LEPTO) gives a reasonable description of the data in the full phase space

Inclusive charged hadrons and K^0_S and Λ



Comparison of the results of this analysis with measurements of scaled momentum distributions for inclusive charged particles in DIS published recently by ZEUS
ZEUS Coll. JHEP 1006 (2010) 009

Summary and Conclusions

- Scaled momentum distributions show scaling violations
- NLO QCD predictions for different fragmentation functions describe the data only in certain regions of the phase space
- LO Monte Carlo (ARIADNE, LEPTO) predictions supply better agreement with data over full phase space
- High precision measurements of K^0_S and Λ obtained in this analysis have the potential to constrain the fragmentation functins further if they will be included as input in global fits.