

Strangeness at Low Q^2

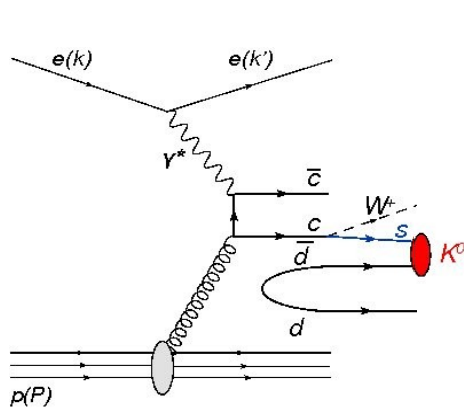
Marc Del Degan, ETH IPP, Zürich

Anna Falkiewicz, IFJ PAN, Kraków

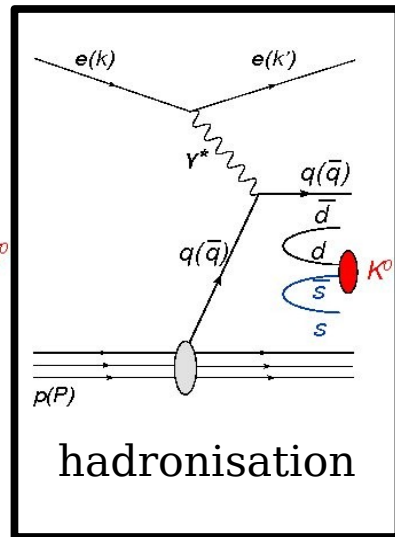
on behalf of H1 collaboration

1. Motivation for strange particle production studies.
2. Identification of K_s^0 , Λ^0 .
3. Results.
 - Differential cross sections in laboratory and Breit frame.
 - Strange to charged particle ratio.
 - Baryon to meson ratio.
 - Baryon-antibaryon asymmetry.
4. Summary.

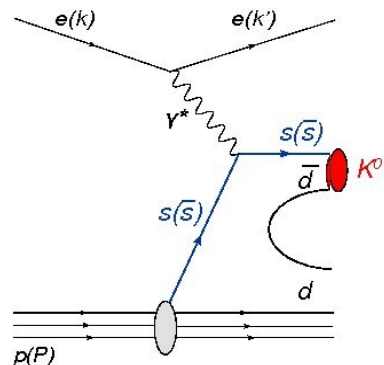
Motivation – Why Strangeness?



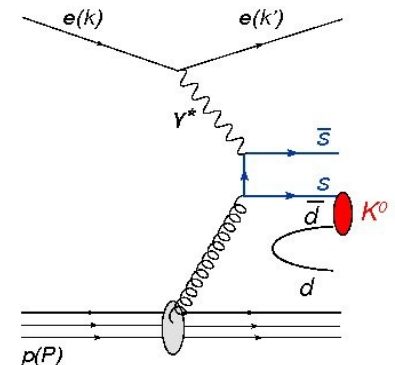
decays of heavy quarks



hadronisation



hard scattering of sea quark



boson-gluon fusion

Dominated by hadronisation
non perturbative process

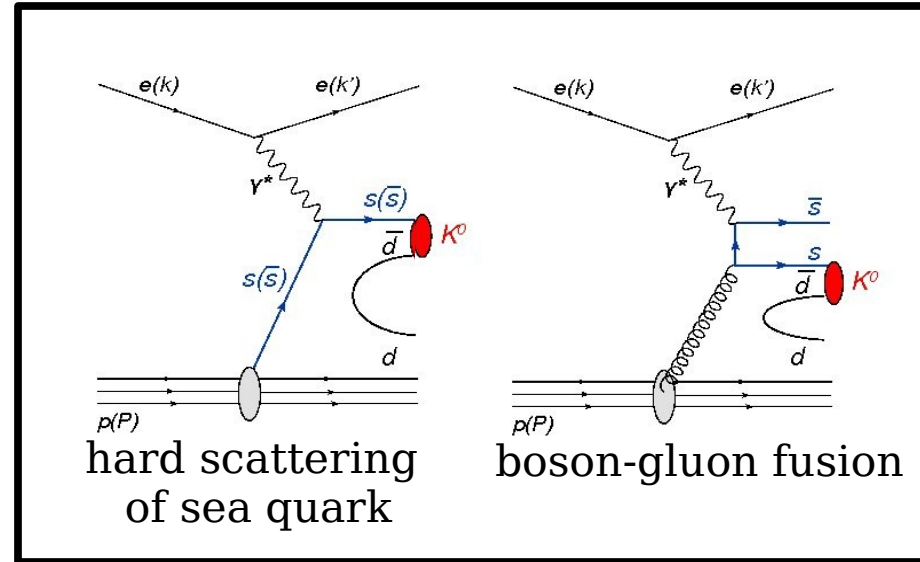
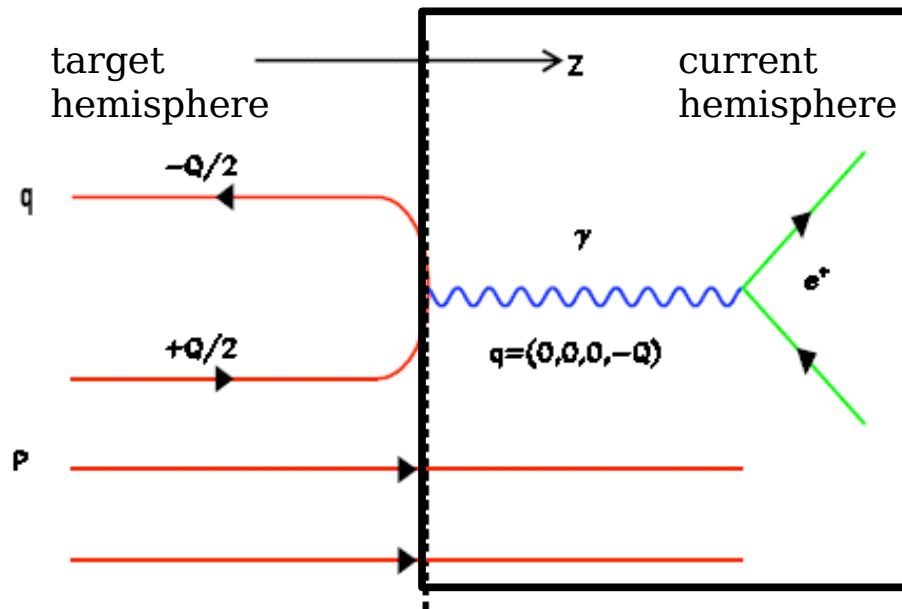
LUND string fragmentation model

strangeness suppression:
 $\lambda_s = P(s)/P(u)$

e^+e^- (LEP) $\lambda_s = 0.3$

hadronisation and parametrs
which determine LUND string
fragmentation universal?

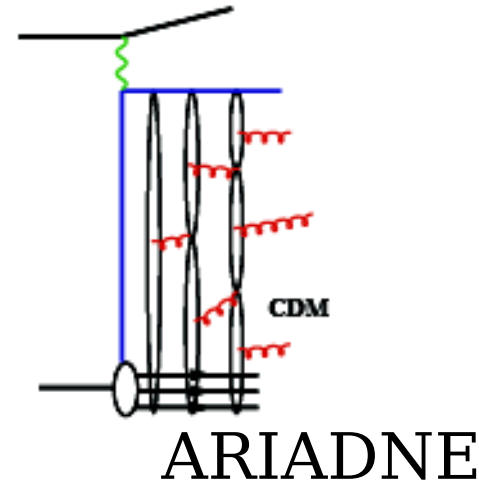
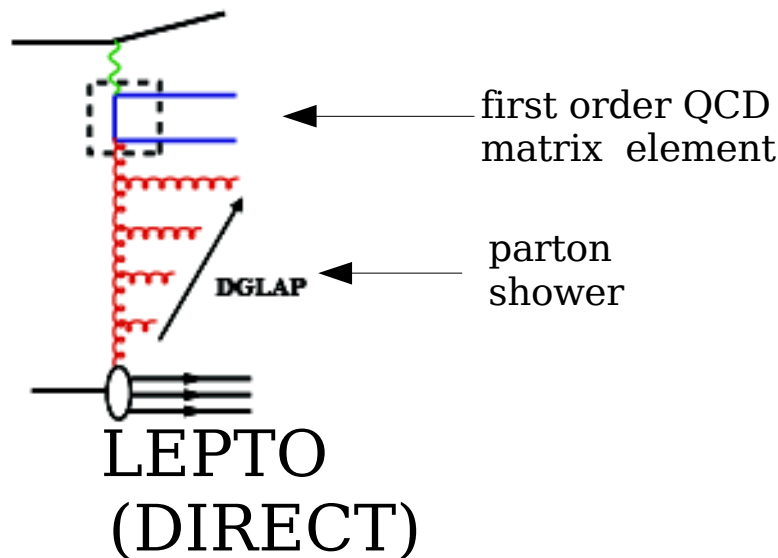
Breit Frame



in QPM ep **current region of Breit frame (struck quark) is analogic to LO $e^+e^- \rightarrow qq$**

Products of hadronisation of strange quarks produced in QPM are contained in current region of Breit frame
This is also valid to some extent for HO (BGF, QCDC)

QCD Models based on DGLAP and CDM



Matrix Element Parton Shower (MEPS)

DGLAP resums $\ln Q^2$ at low x , strong ordering of k_T of emitted partons

Color Dipole Model (CDM)

radiate independently
 k_T non-ordered partons

Both are interfaced to JETSET for hadronisation

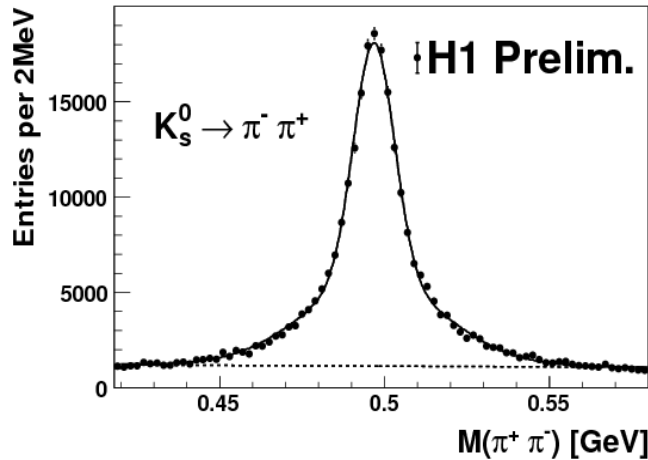
K_s^0 and Λ signals in DIS

$$K_s^0 \rightarrow \pi^+ \pi^- \quad c\tau=2.68\text{cm}$$

$$\Lambda \rightarrow p \pi \text{ and c.c. } c\tau=7.89\text{cm}$$

reconstruct neutral secondary vertices

- 2 oppositely charged tracks from vertex radially displaced from interaction vertex
- using cuts on decay length, dca

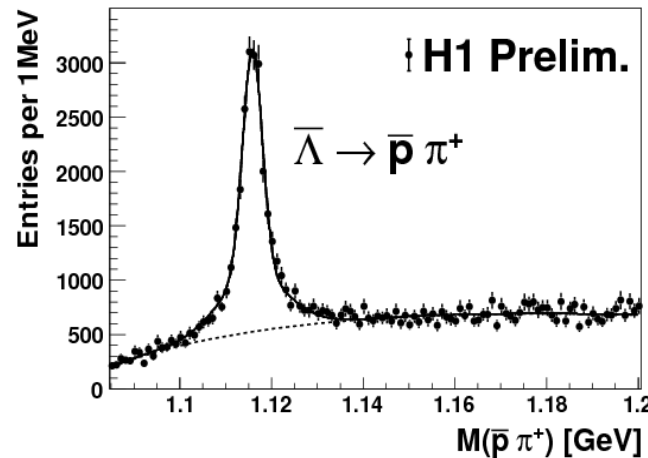
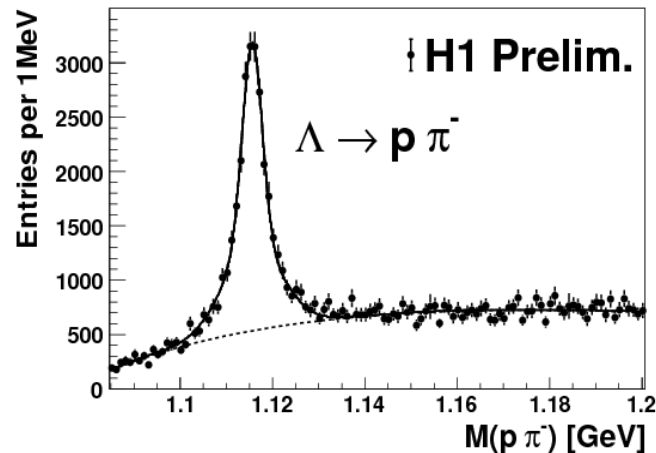


$$\text{mass}(K_s^0)=496.9 \pm 0.1 \text{ MeV}$$

$$\text{mean width}(K_s^0)=13.08 \pm 0.4 \text{ MeV}$$

$$\text{mass}(\Lambda)=1115.8 \pm 0.1 \text{ MeV}$$

$$\text{mean width}(\Lambda)=4.3 \pm 0.3 \text{ MeV}$$



visible range

- $0.5 < p_T < 3.5 \text{ GeV}$
- $|\eta| < 1.3$

Inclusive K_s^0 and Λ cross sections results

H1 e^+ data 1999/2000 $L=49.9 \text{ pb}^{-1}$

- $2 < Q^2 < 100 \text{ GeV}^2$

- $0.1 < y < 0.6$

visible range

- $0.5 < p_T < 3.5 \text{ GeV}$

- $|\eta| < 1.3$

measurement	CDM (ALEPH-tuned JETSET, CTEQ6L)
$\sigma_{\text{vis}}(ep \rightarrow e' K_s^0 X) = 21.18 \pm 0.09(\text{stat.})^{+1.19}_{-1.23}(\text{syst.}) \text{ nb}$	$\sigma_{\text{vis}}(ep \rightarrow e' K_s^0 X) = 21.77 \text{ nb}$
$\sigma_{\text{vis}}(ep \rightarrow e' [\Lambda, \bar{\Lambda}] X) = 7.88 \pm 0.10(\text{stat.})^{+0.45}_{-0.47}(\text{syst.}) \text{ pb}$	$\sigma_{\text{vis}}(ep \rightarrow e' [\Lambda \bar{\Lambda}] X) = 7.94 \text{ pb}$

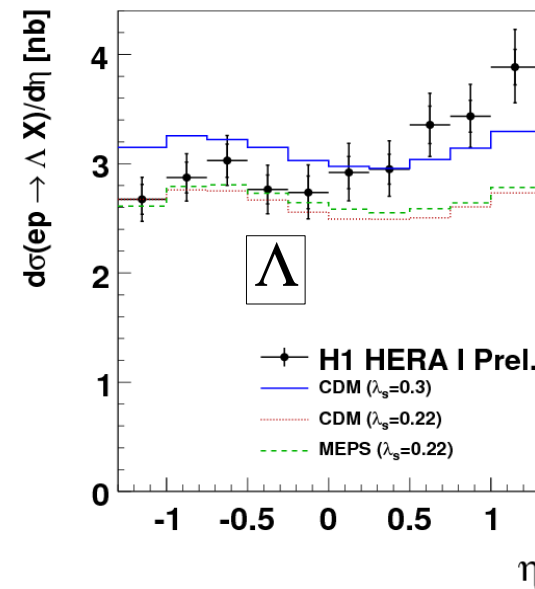
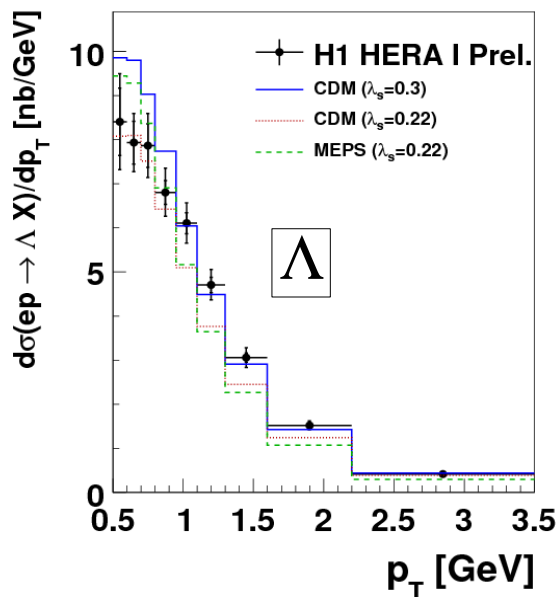
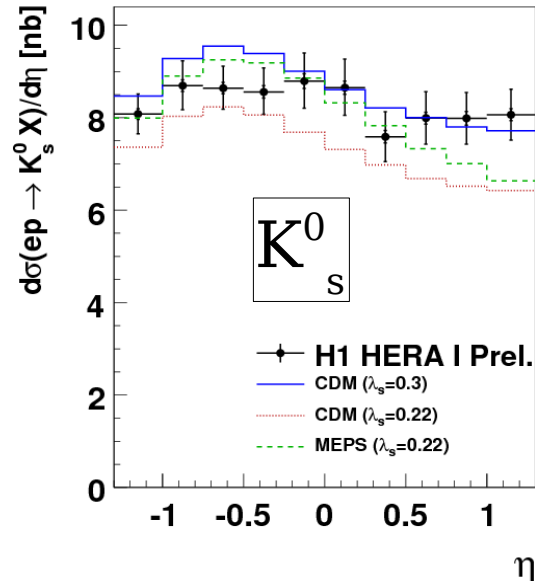
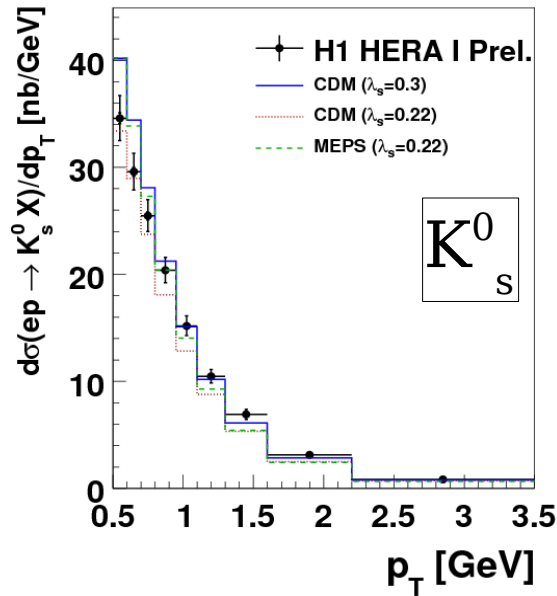
$$\sigma_{\text{vis}}(ep \rightarrow e' [\Lambda] X) = 3.96 \pm 0.06(\text{stat.}) \text{ pb}$$

$$\sigma_{\text{vis}}(ep \rightarrow e' [\bar{\Lambda}] X) = 3.94 \pm 0.07(\text{stat.}) \text{ pb}$$

- CDM ALEPH-tuned predictions is in good agreement with the measurement of the total cross section for neutral strange particle production

Differential K_s^0 and Λ cross sections in Lab. Frame

Comparison with MEPS and CDM



p_T, η spectrum of K_s^0

- CDM $\lambda_s = 0.3$ close to the data, at low p_T region smaller $\lambda_s = 0.22$ preferred

- MEPS $\lambda_s = 0.2$ close to the data

p_T, η spectrum of Λ

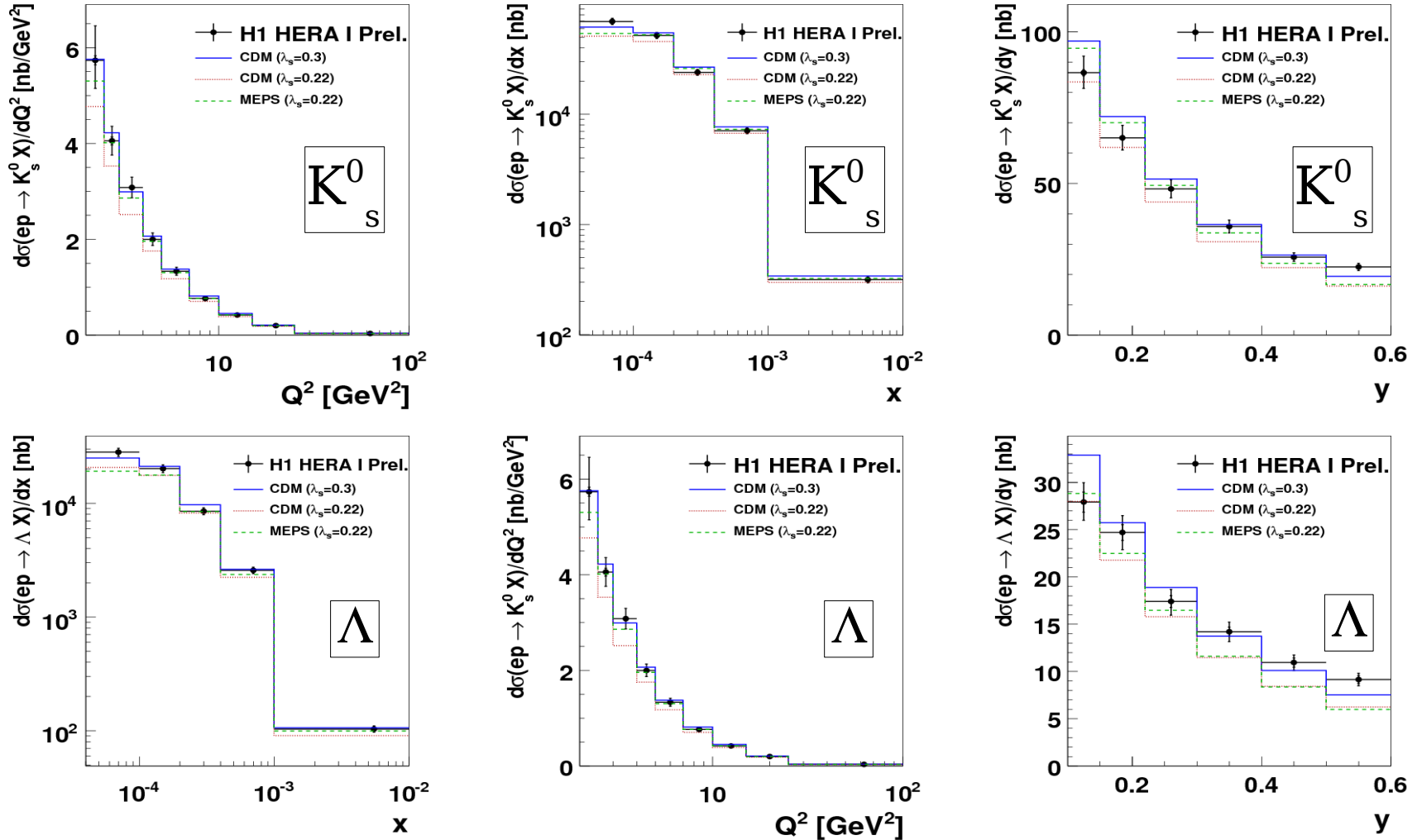
- CDM $\lambda_s = 0.3$

preferred

- MEPS $\lambda_s = 0.3$

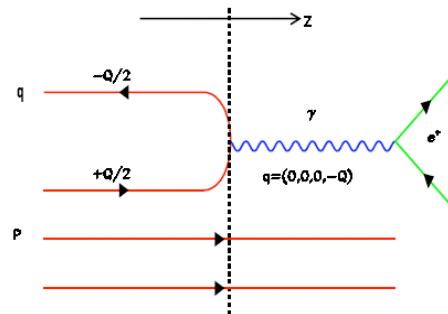
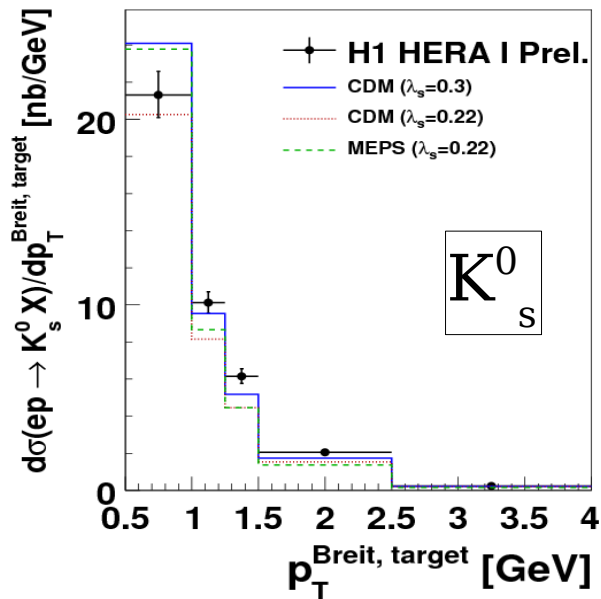
(baryon production depends not only on λ_s but also on diquark creation parameters)

Differential K_s^0 and Λ cross sections in Lab. Frame



- K_s^0 : CDM $\lambda_s=0.3$ and MEPS $\lambda_s=0.2$ provides good description
- Λ : CDM and MEPS $\lambda_s=0.3$ describe the data reasonably well

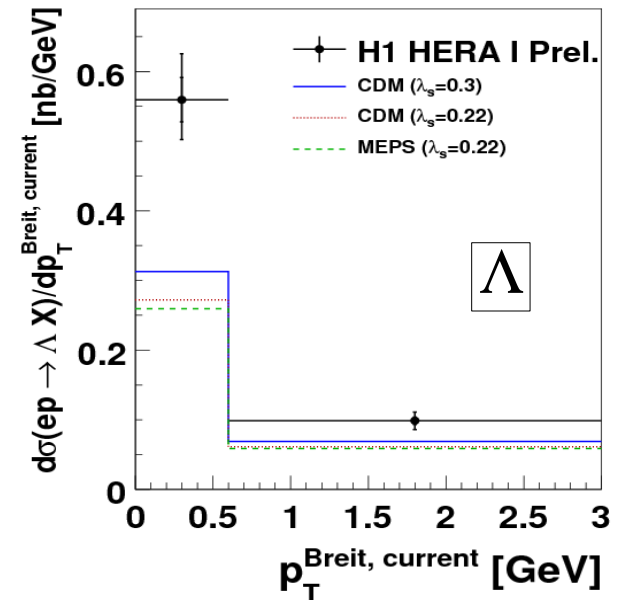
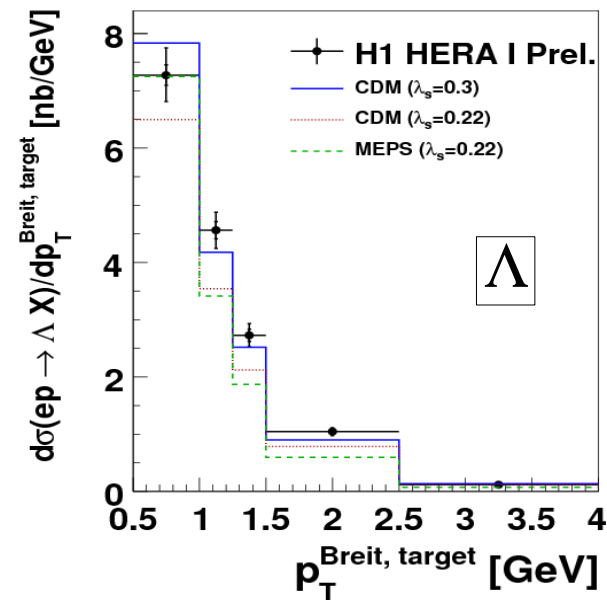
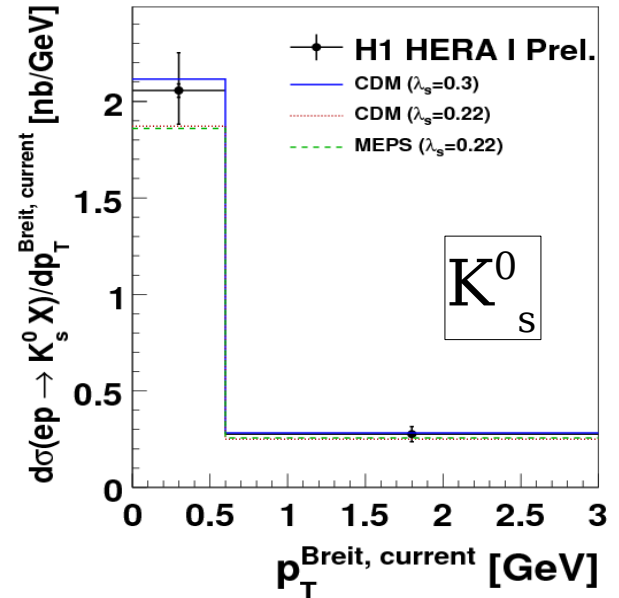
Differential K^0_s and Λ cross sections in Breit Frame



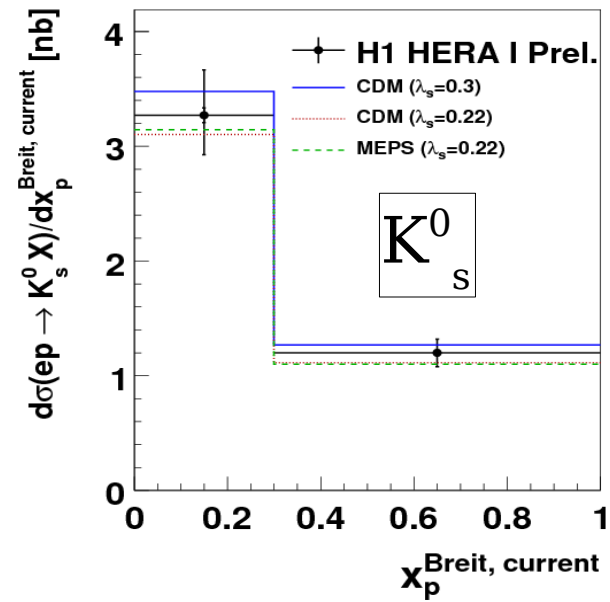
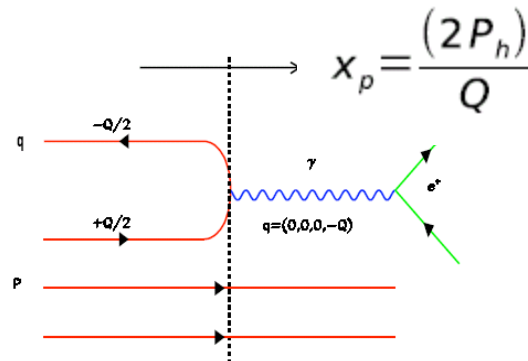
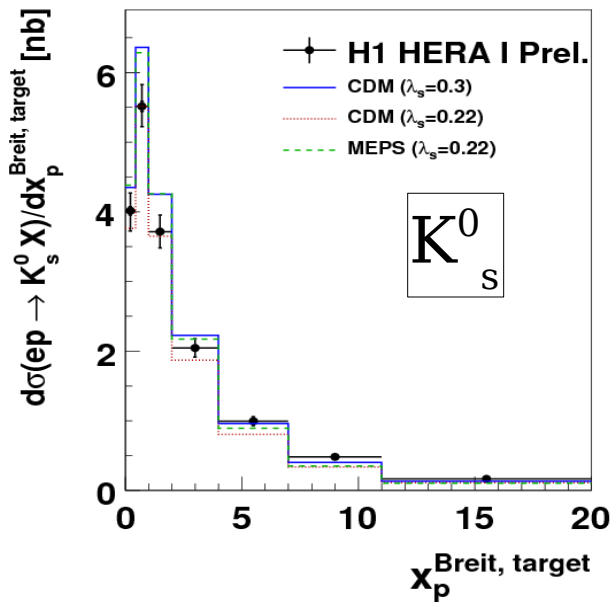
•**Target:**
cross sections in
target hemisphere
favor $\lambda_s=0.3$

•**Current K^0_s :**
good description
of the data by both
models

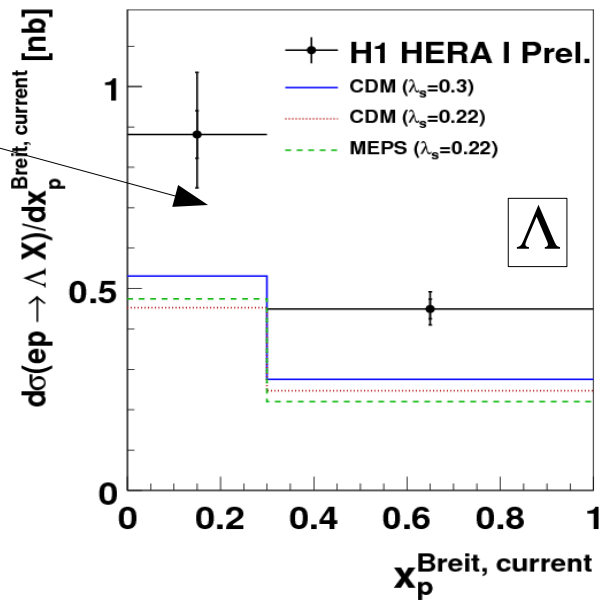
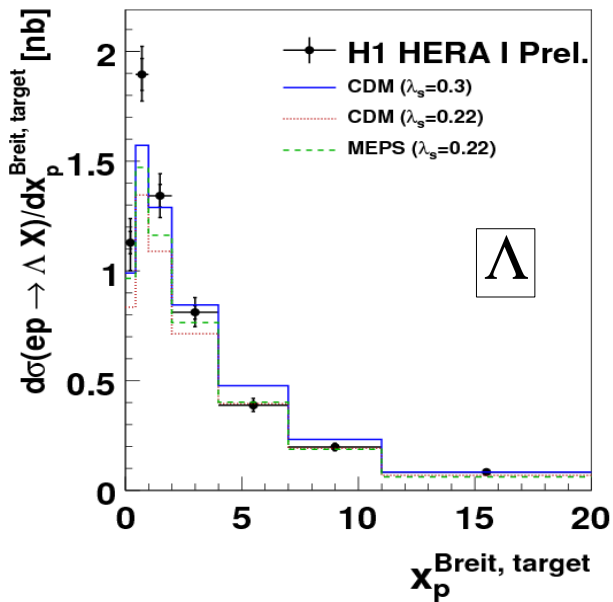
•**Current Λ :**
both models below
the data (factor 2)



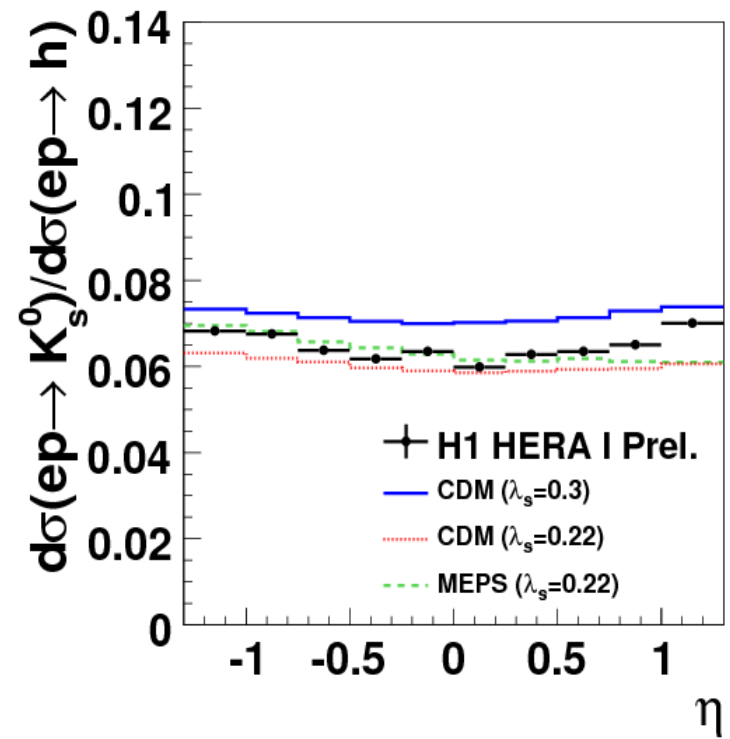
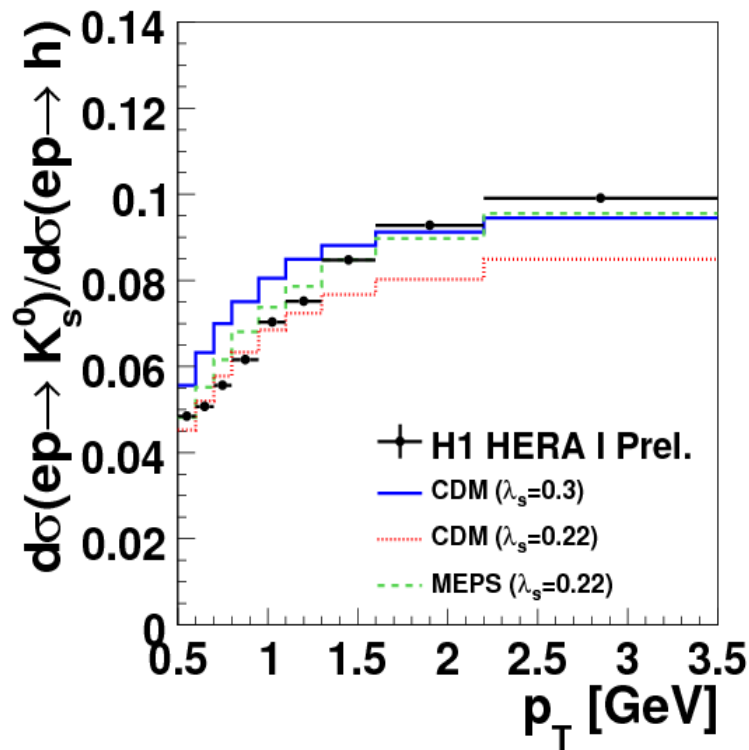
Differential K_S^0 and Λ cross sections in Breit Frame



• Models fail to describe Λ production in current hemisphere

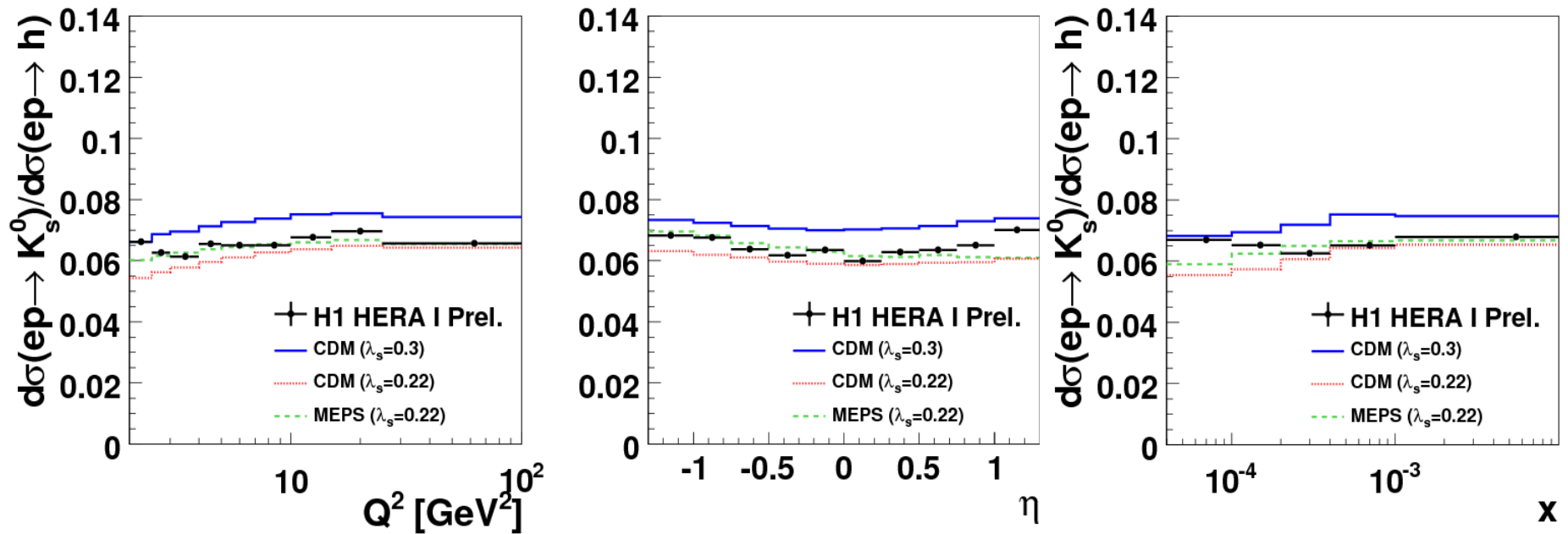


K_s^0 Meson to Charged Hadrons Ratio (Lab. Frame)



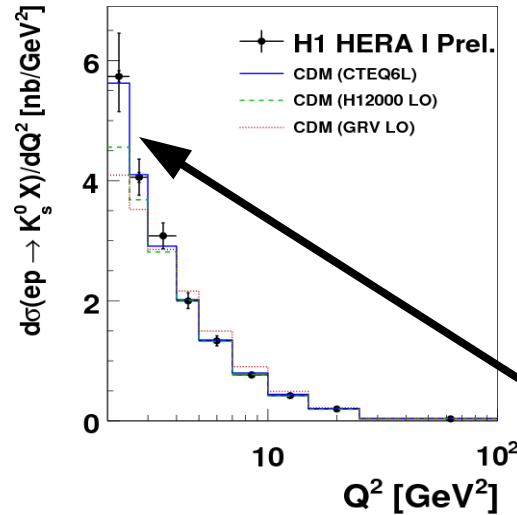
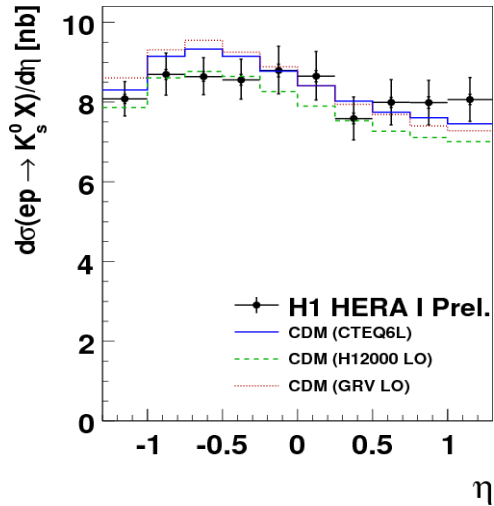
- MEPS is consistent with constant $\lambda_s=0.22$ over almost full range p_T and η
- CDM requires $\lambda_s=0.22$ at lower p_T region and $\lambda_s=0.3$ at higher p_T region (consistently with indications from cross section measurement)

K_s^0 Meson to charged hadrons ratio (Lab. Frame)



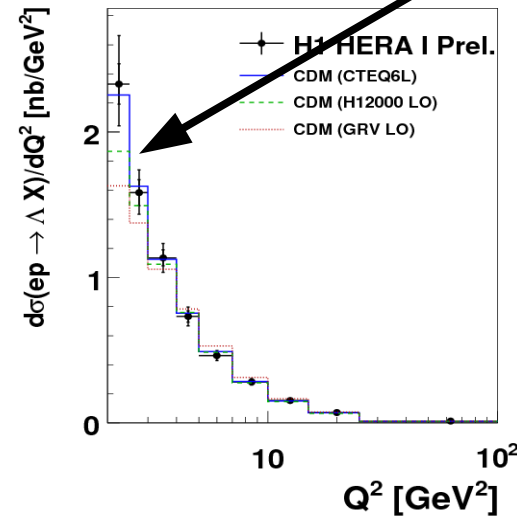
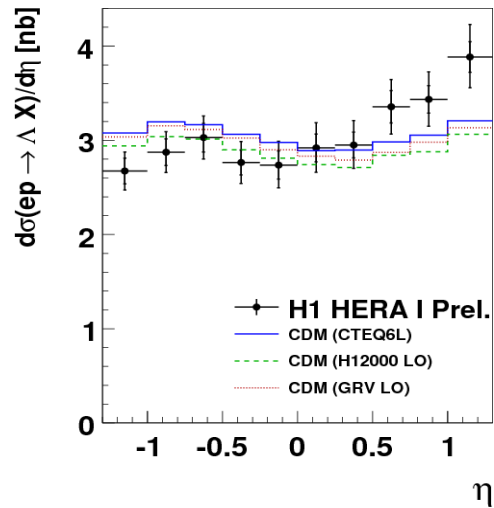
- Ratios are constant as a function of kinematical variables
- MEPS: prediction with $\lambda_s=0.22$ describes the data reasonably well
- CDM: data not consistent with constant λ_s and fall between $\lambda_s=0.2$ and $\lambda_s=0.3$ curves

Sensitivity to proton PDF

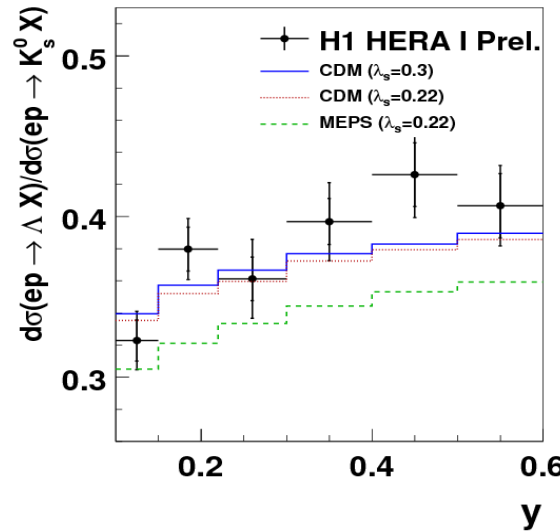
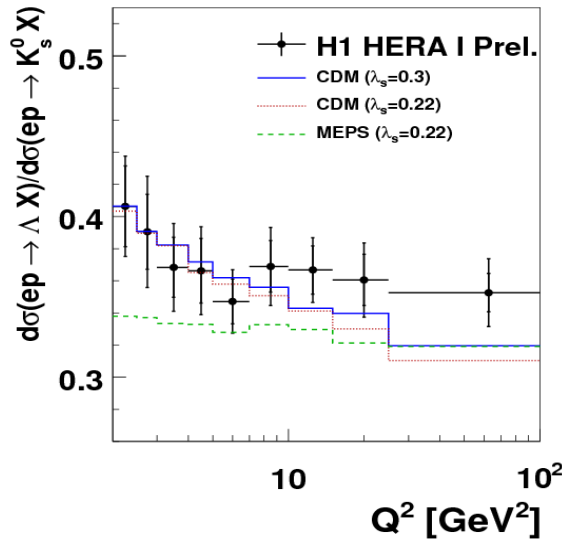
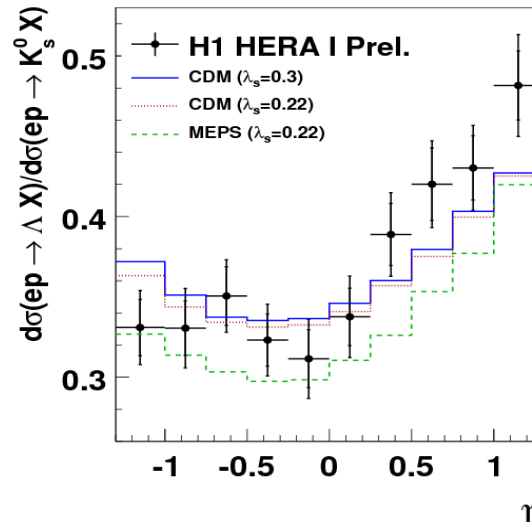
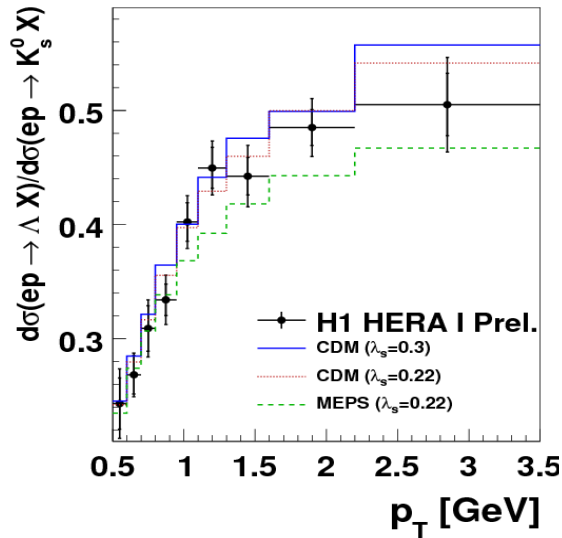


CTEQ 6L
H1 2000 LO
GRV LO

sensitivity of
strangeness
production to
proton PDF
at small Q^2

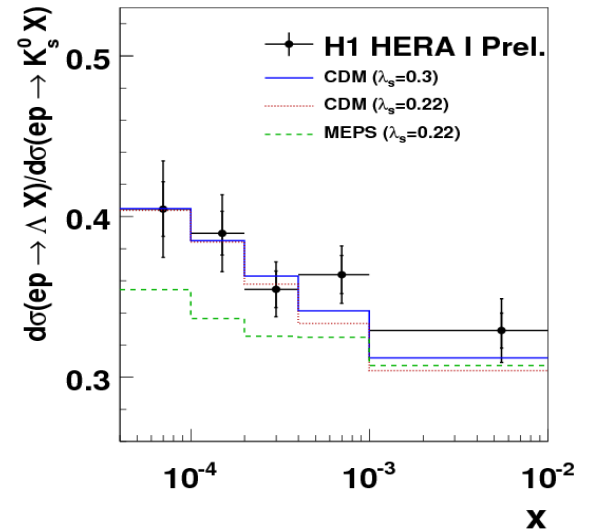


Baryon to meson ratio (Lab. Frame)



Baryon production in LUND string model:

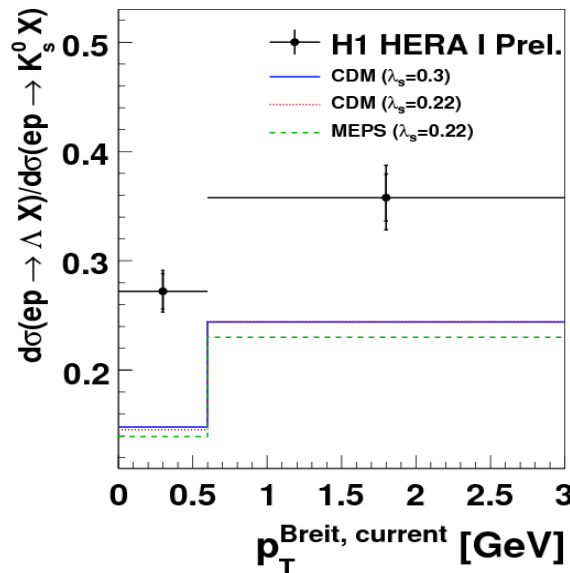
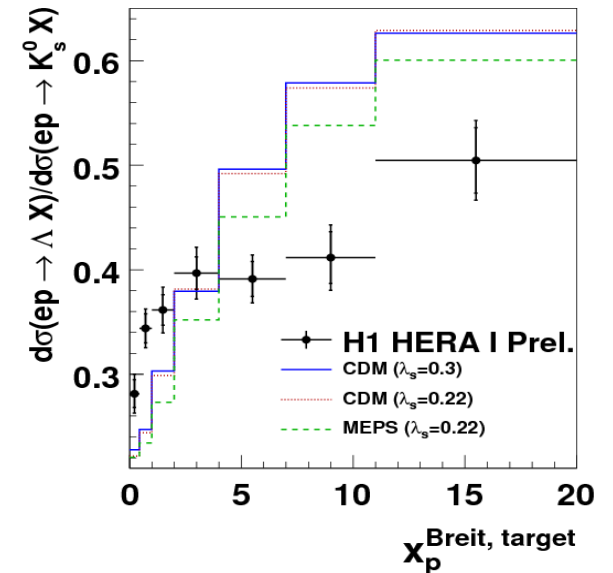
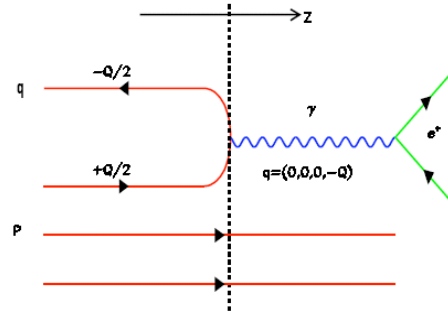
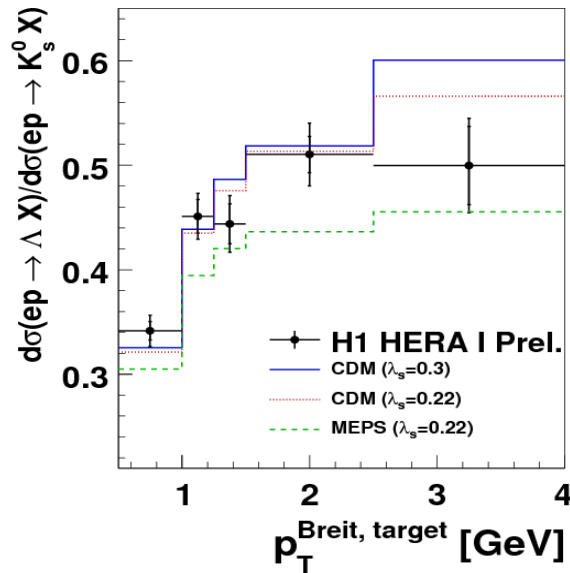
- input for tuning diquark creation parameters
- insensitive to λ_s variation



- Reasonably good description by CDM
- MEPS fails to describe the data

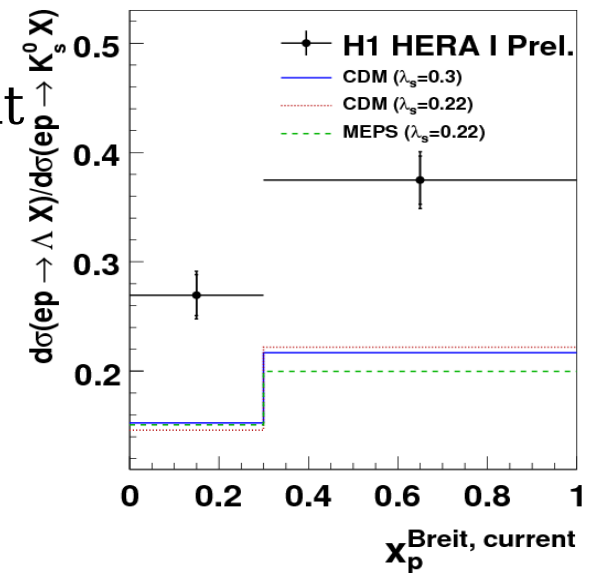
Strangeness at low Q^2 , DIS08

Baryon to meson ratio (Breit Frame)

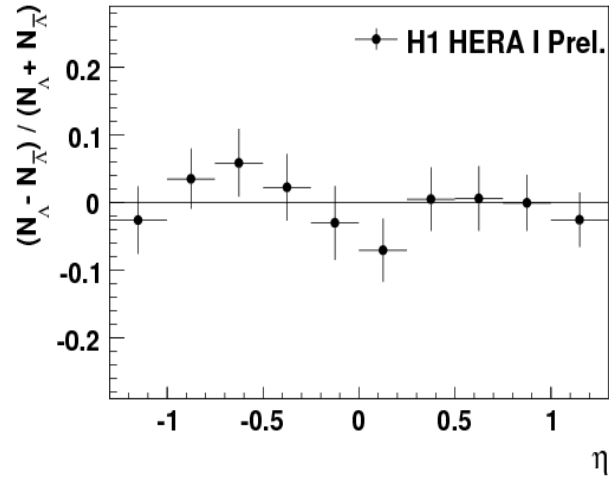
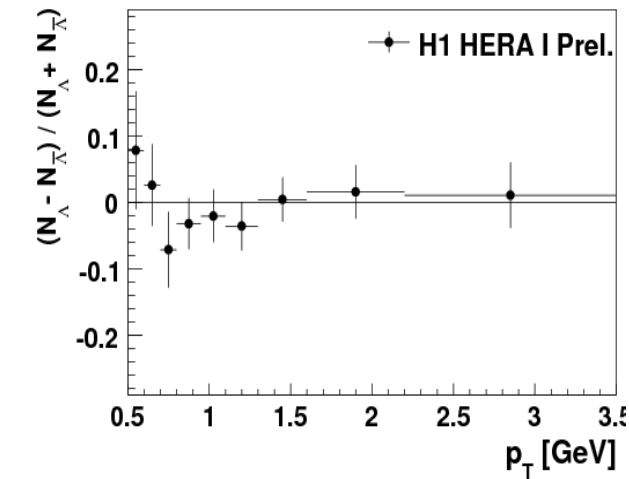


- models do not describe ratios except for p_T spectrum

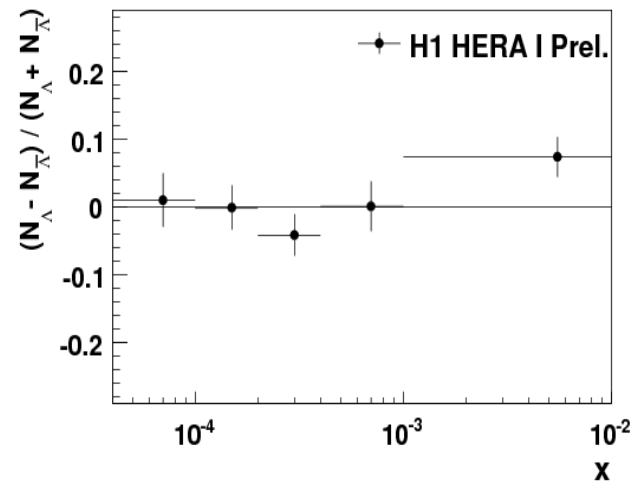
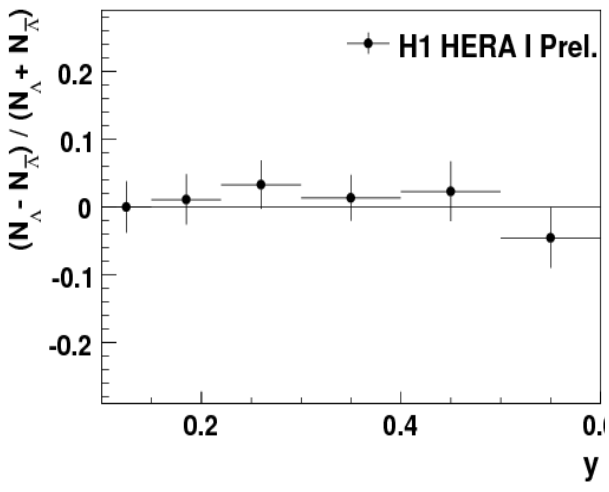
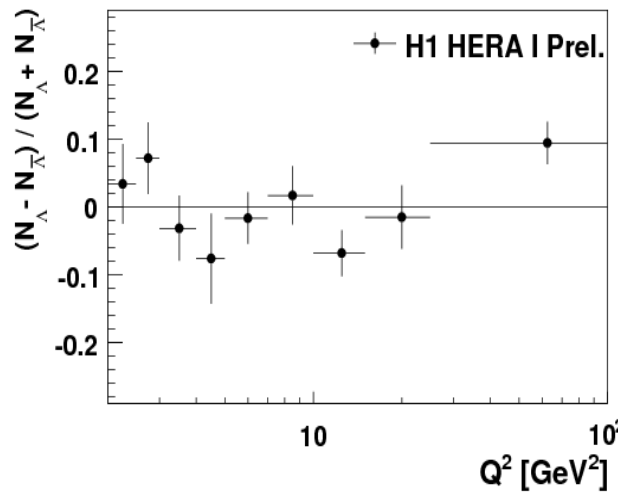
- smaller baryon to meson ratio in current



Baryon-antibaryon Asymmetry (Lab. Frame)

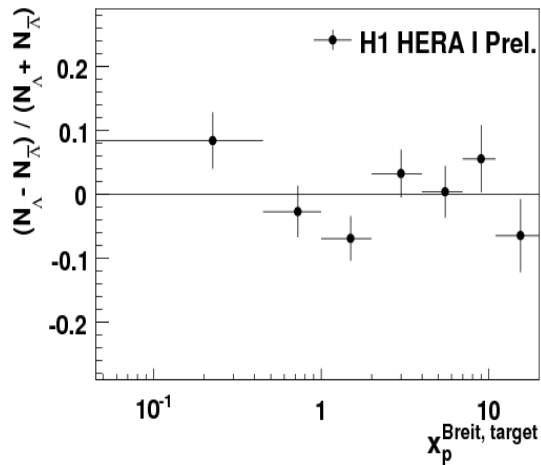
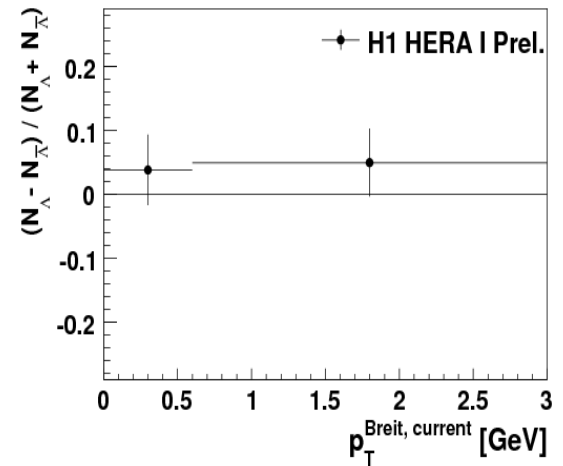
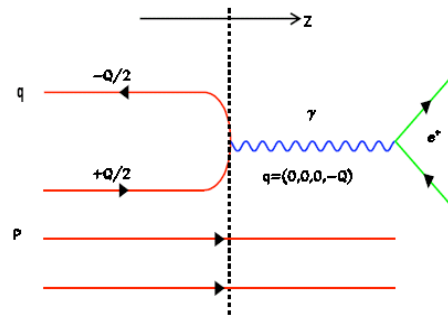
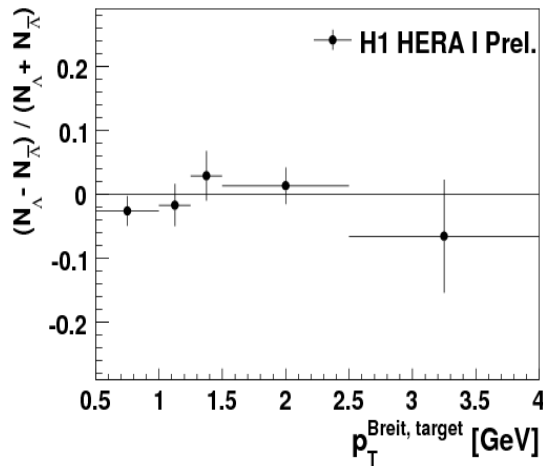


$$\frac{N_{\Lambda} - N_{\bar{\Lambda}}}{N_{\Lambda} + N_{\bar{\Lambda}}}$$

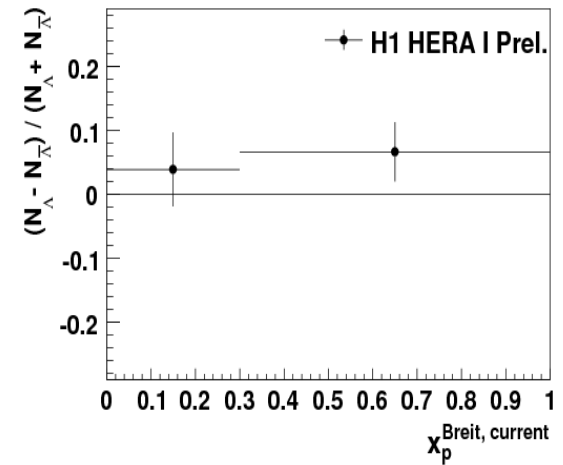


- All distributions compatible with zero within errors

Baryon-antibaryon Asymmetry (Breit Frame)



• All distributions compatible with zero within errors



Summary

- Measurements of K_s^0 and Λ inclusive and differential cross sections have been made.
- Neither MEPS nor CDM with a single λ_s value is able to give a complete description of the K_s^0 and Λ cross sections:
 - CDM $\lambda_s = 0.3$ close to the data but fails to describe all the details.
 - MEPS $\lambda_s = 0.22$ close to K_s^0 data.
 - MEPS $\lambda_s = 0.3$ close to Λ data.
- **K_s^0 cross sections and K_s^0 to charged hadrons reasonably well described by MEPS with $\lambda_s = 0.22$.**
- CDM describes baryon to meson ratio in laboratory frame.
- Models fail to describe baryon to meson ratio in Breit frame.
- No sizable baryon-antibaryon asymmetry is observed.