

Strangeness production in Deep-Inelastic ep Scattering at HERA

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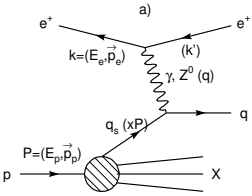
CINVESTAV Mérida
On behalf of H1 Collaboration



- Introduction
- Measurement of K_S^0 and Λ
- Measurement of $K^{*\pm}$
- Summary



HERA collider and H1 detector

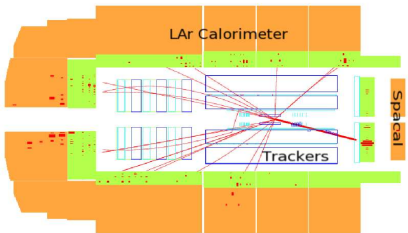


$$Q^2 = -q^2 = -(k - k')^2,$$

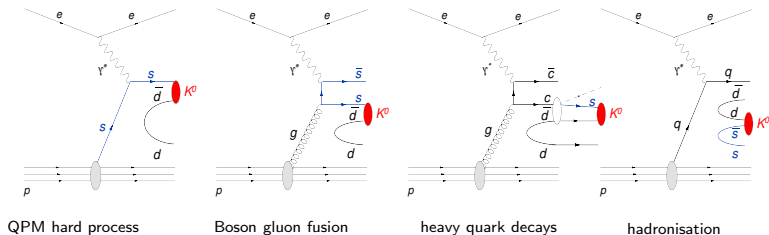
$$y = \frac{qP}{kP}, \quad x_{Bj} = \frac{Q^2}{2qP}$$



$$\sqrt{s} = 319 \text{ GeV}$$

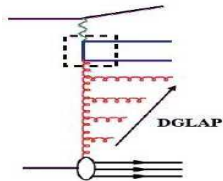


Strange production mechanism

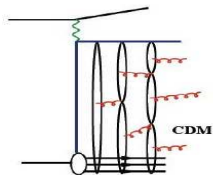


- ◇ $s\bar{d}$ for K_S^0 , $s\bar{u}$ for $K^{*\pm}$ and uds for Λ .
- ◇ Production dominated by hadronisation process.
- ◇ Test models based on fragmentation and hadronisation.
- ◇ Optimisation of models parameters.

Models and parameters



Matrix Elements +
Parton Showers (RAPGAP-MEPS)
DGLAP: Strong ordering in k_T for gluon emission.

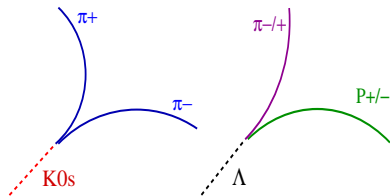


Matrix Elements +
Color dipole model (DJANGO-CDM)
no ordering in k_T for gluons emission,
independent radiation.

Interfaced to Lund string fragmentation

- ♣ strangeness suppression factor $\lambda_s = P(s)/P(q)$
- ♣ diquark suppression factor $\lambda_{qq} = P(qq)/P(q)$
- ♣ strange diquark suppression factor $\lambda_{sq} = (P(sq)/P(qq))/(P(s)P(q))$
- ♣ e^+e^- ALEPH tuning: $\lambda_s = 0.286$, $\lambda_{qq} = 0.108$, $\lambda_{sq} = 0.690$

H1 strangeness measurement



$$K_S^0 \rightarrow \pi^+ \pi^- \quad \Lambda \rightarrow \pi^\pm P^\pm$$

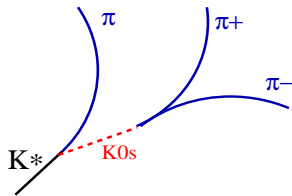
BR : $\sim 69.2\%$ BR : $\sim 63.9\%$

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

$$0.5 < p_t < 3.5 \text{ GeV}$$

$$-1.3 < \eta < 1.3$$

$$\mathcal{L} = 50 \text{ pb}^{-1}$$



$$K^{*\pm} \rightarrow K_S^0 \pi^\pm \rightarrow (\pi^+ \pi^-) \pi^\pm$$

BR: $\sim 23.06\%$

$$5 < Q^2 < 100 \text{ GeV}^2$$

$$p_t > 1.0 \text{ GeV}$$

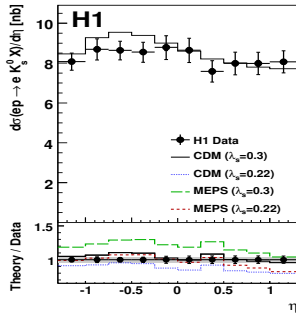
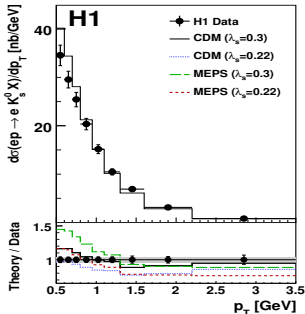
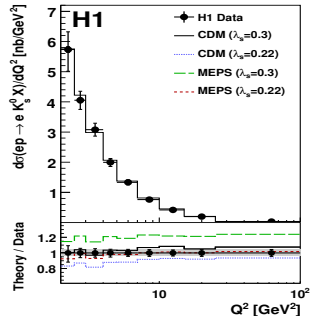
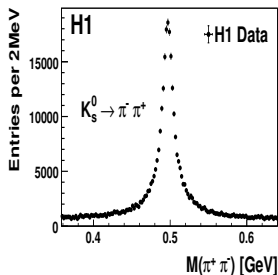
$$-1.5 < \eta < 1.5$$

$$\mathcal{L} = 302 \text{ pb}^{-1}$$

K_S^0 differential cross section in laboratory frame

$$\sigma = 21.18 \pm 0.09(\text{stat.})_{-1.23}^{+1.19}(\text{syst.}) \text{ nb}$$

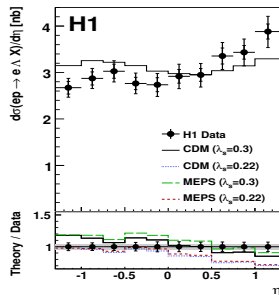
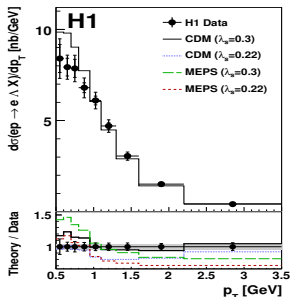
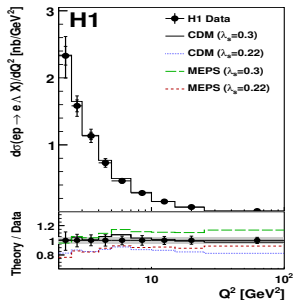
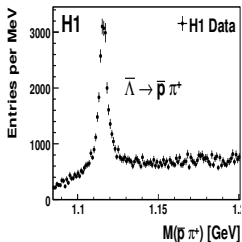
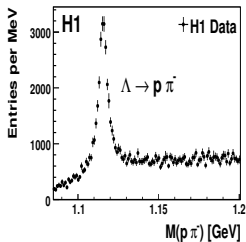
- $\sim 213000 K_S^0$.
- CDM $\lambda_s = 0.3$ for Q^2 , η and p_T but also MEPS $\lambda_s = 0.22$ for Q^2 .
- Shape of η and low p_T show difficulties.



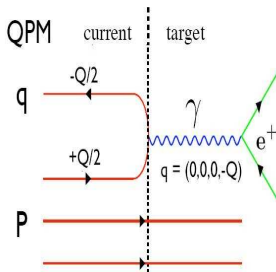
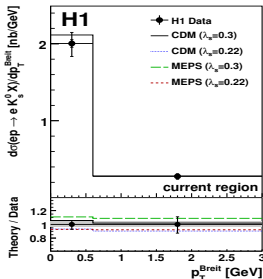
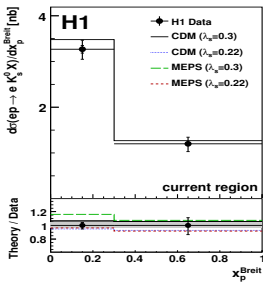
Λ differential cross section in laboratory frame

$$\sigma = 7.88 \pm 0.10(\text{stat.})^{+0.45}_{-0.47}(\text{syst.}) \text{ nb}$$

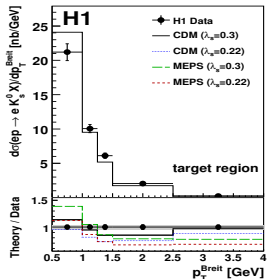
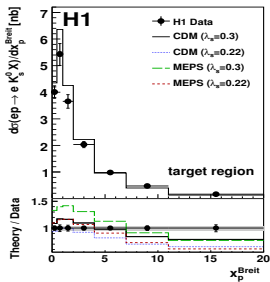
- ▷ $\sim 22000\Lambda$ and $\sim 20000\bar{\Lambda}$.
- ▷ CDM with $\lambda_s = 0.3$.
- ▷ Shape of η and low p_t fail.
- ▷ Expected sensitivity to $\lambda_{qq}, \lambda_{sq}$.



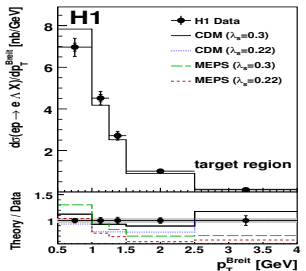
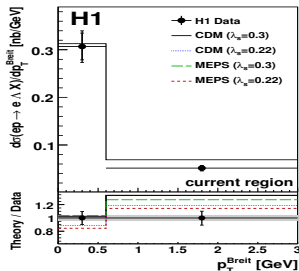
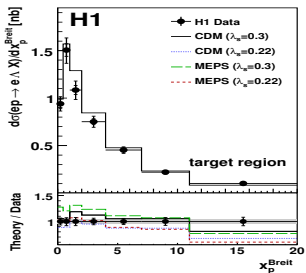
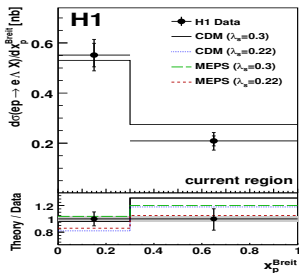
K_S^0 differential cross section in Breit frame



- Struck quark in current region.
- Proton remnant in target region.
- CDM with $\lambda = 0.3$.



A differential cross section in Breit frame

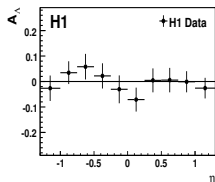
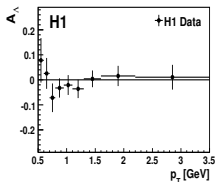
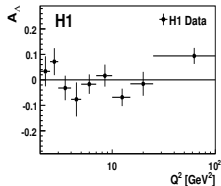


Not clear which model and λ_s makes better prediction.

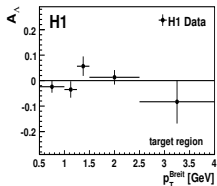
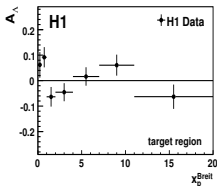
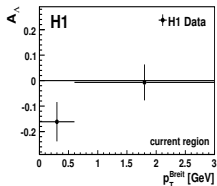
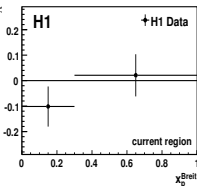
Asymmetries

- ♡ $A_\Lambda = \frac{\sigma_\Lambda - \sigma_{\bar{\Lambda}}}{\sigma_\Lambda + \sigma_{\bar{\Lambda}}}$
- ♡ A_Λ consistent with zero
- ♡ No evidence of baryon number transfer from the proton beam to Λ final states in the measurement.

Laboratory frame:

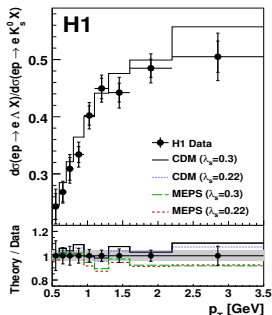
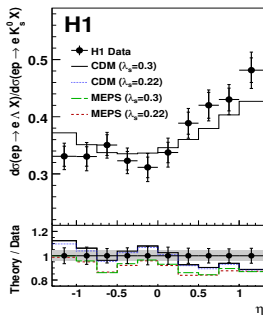
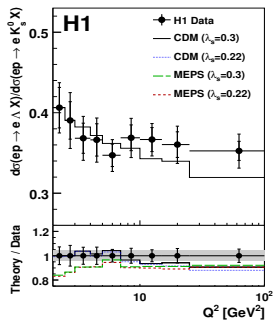


Breit frame:



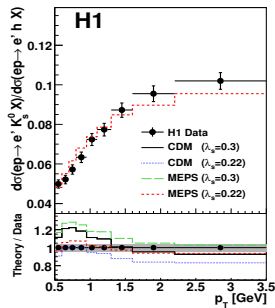
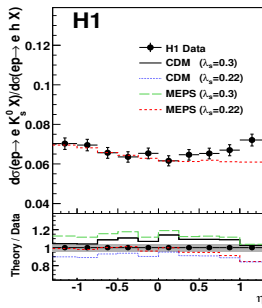
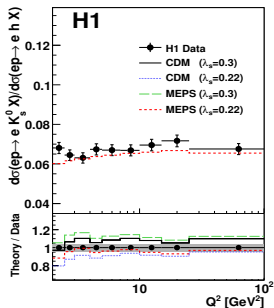
Baryons to mesons ratio in laboratory frame

- ⊗ $ep \rightarrow e\Lambda X / ep \rightarrow eK_s^0 X$.
- ⊗ CDM agrees with data.
- ⊗ Models shows differences in high Q^2 and η shape.
- ⊗ No sensitivity to λ_s but yes to λ_{qq} and λ_{sq} as expected.



Mesons to charged particles ratio

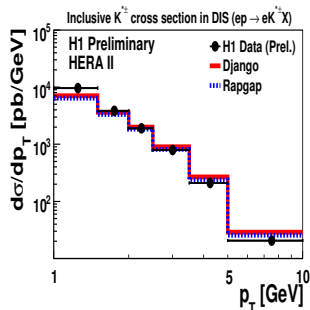
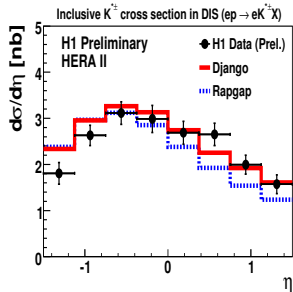
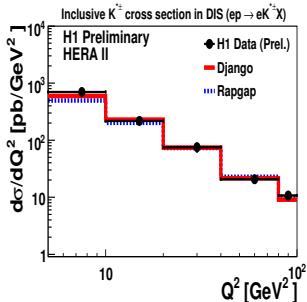
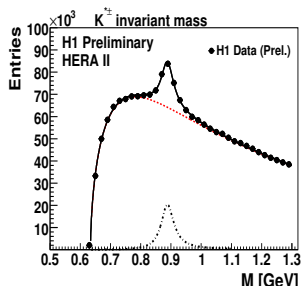
- † $ep \rightarrow eK_s^0 X / ep \rightarrow eh^\pm X$.
- † Increase with p_t .
- † MEPS with $\lambda = 0.22$ agrees better to data.
- † Discrepancies at high η and low p_t .



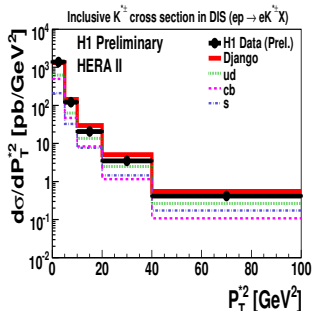
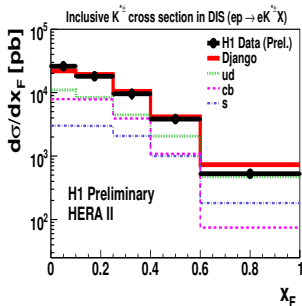
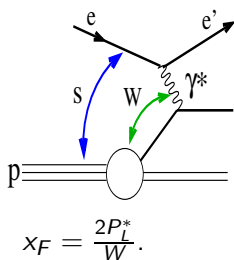
$K^{*\pm}$ differential cross section in lab frame

$$\sigma = 7.36 \pm 0.09(\text{stat.}) \pm 0.9(\text{syst.}) \text{ nb}$$

- ★ $\sim 80000 K^{*\pm}$
- ★ Django-CDM and Rapgap-MEPS with $\lambda_s = 0.286$.
- ★ Django gives better description.
- ★ MC's have problems to describe η shape as for K_S^0 and Λ .



Flavour contribution for $K^{*\pm}$ production



$K^{*\pm}$ coming from:

- △ **ud** mainly from fragmentation, see the small dependence on x_F .
- △ **cb** mostly from heavy hadrons (created by BGF) decays, seen at small x_F .
- △ **s** also directly from hard subprocess, see the rises in x_F .

20% of $K^{*\pm}$ comes from **s** prominent at high P_T^{*2} and x_F .

The sensitivity of x_F can be used for flavour composition studies.

Summary

- K_s^0 , Λ and $K^{*\pm}$ measurements by H1 collaboration.
- Data is described by CDM with $\lambda_s = 0.3$ and MEPS with $\lambda_s = 0.22$ models in general features but there is not one single model with a determined strangeness factor value matching all data.
- No $\Lambda - \bar{\Lambda}$ asymmetry observed \rightarrow no indication of baryon number transfer to strange final states.
- $K^{*\pm}$ in agreement to CDM with $\lambda_s = 0.286$.