Strangeness production in Deep-Inelastic ep Scattering at HERA

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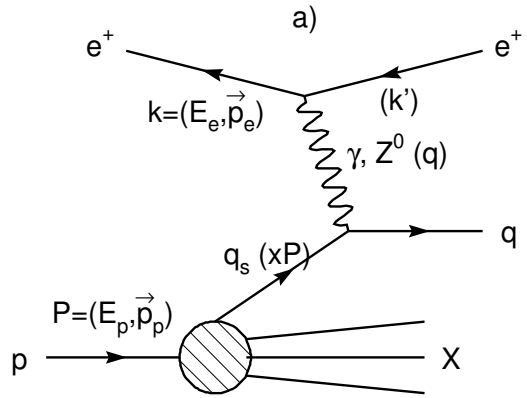
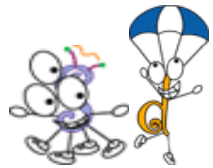
On behalf of H1 Collaboration

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

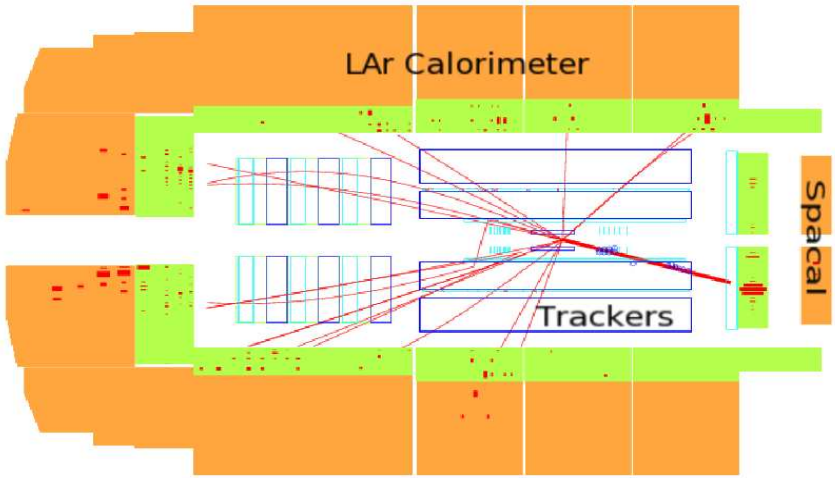
HERA collider and H1 detector



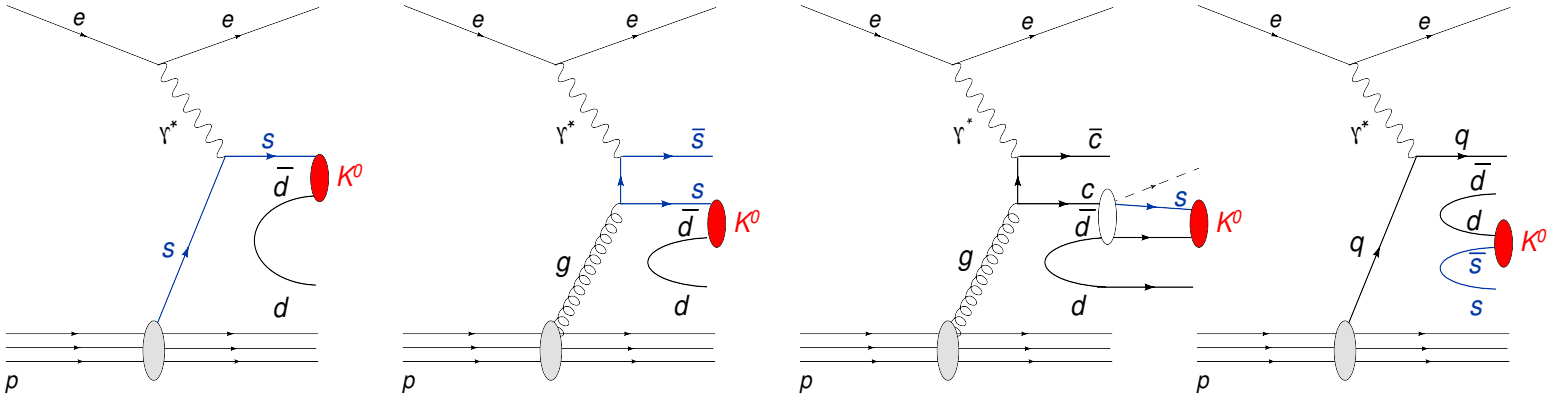


$$Q^2 = -q^2 = -(k - k')^2,$$
$$y = \frac{qP}{kP},\ x_{Bj} = \frac{Q^2}{2qP}$$

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



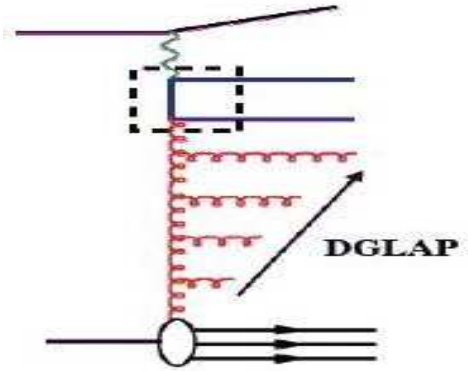
Strange production mechanism



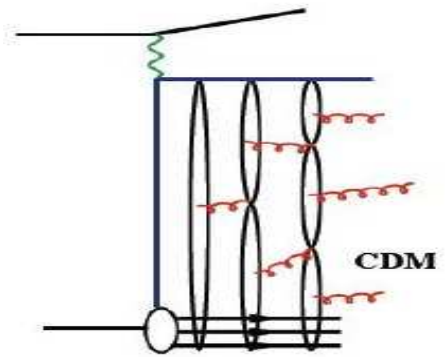
QPM hard process | Boson gluon fusion | heavy quark decays | hadronisation

- $s\bar{d}$ for K^0_s , $s\bar{u}$ 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.

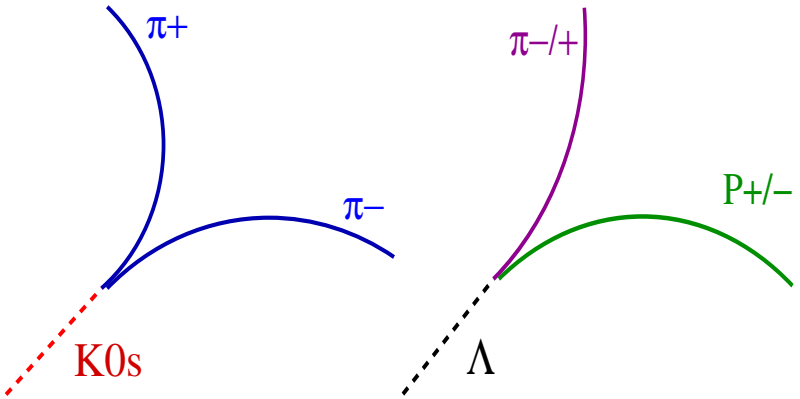


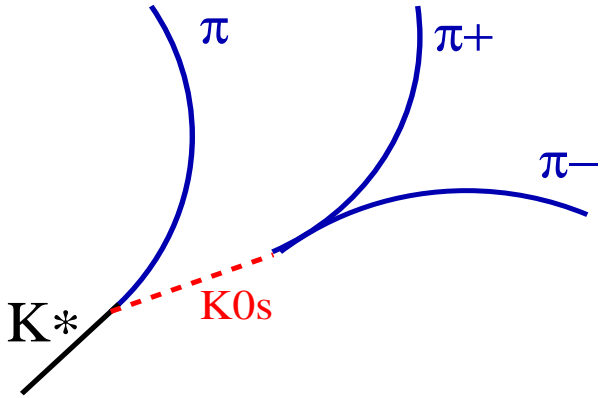
Matrix Elements +
Color dipole model (DJANGO-CDM)
no ordering in k_T for gluons emission, independent radiation.

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





$K_s^0 \rightarrow \pi^+\pi^-$ $\quad$ $\Lambda \rightarrow \pi^{\pm}P\pm$

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

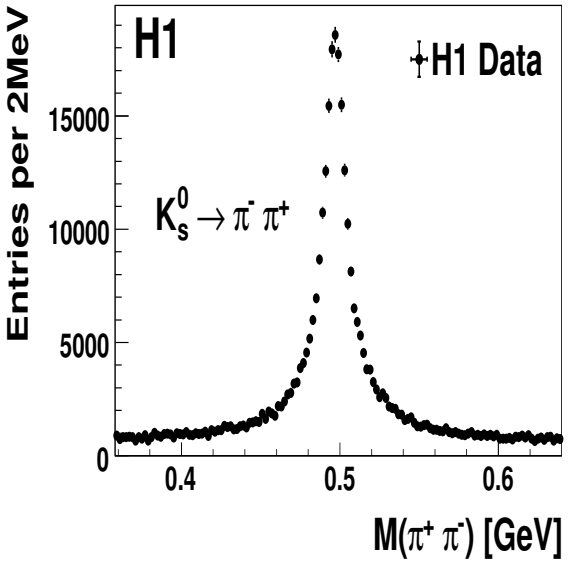
$$2 < Q^2 < 100 GeV^2$$
$$0.5 < p_t < 3.5 GeV$$
$$-1.3 < \eta < 1.3$$
$$\mathcal{L} = 50\ pb^{-1}$$

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

BR: $\sim 23.06\,\%$

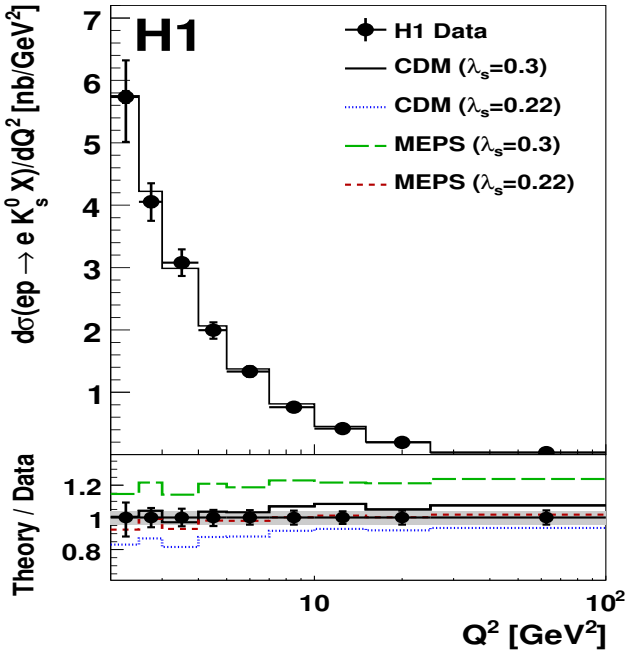
$$5 < Q^2 < 100 GeV^2$$
$$p_t > 1.0 GeV$$
$$-1.5 < \eta < 1.5$$
$$\mathcal{L} = 302\ pb^{-1}$$

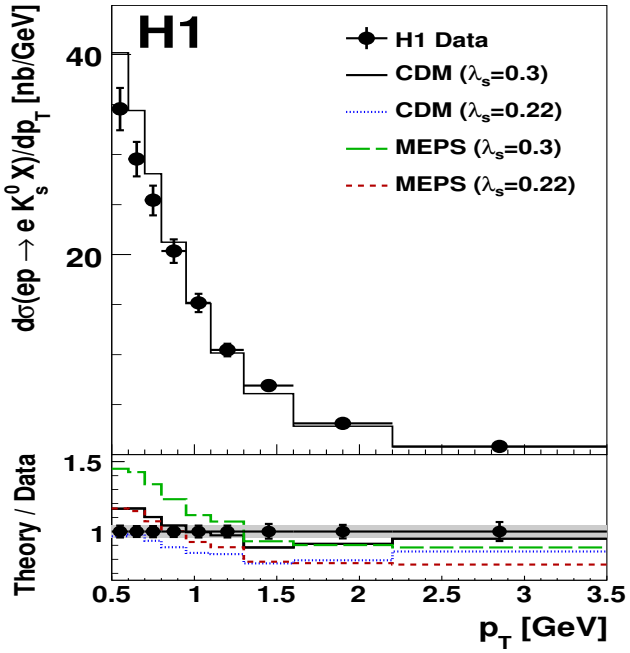
K_s^0 differential cross section in laboratory frame

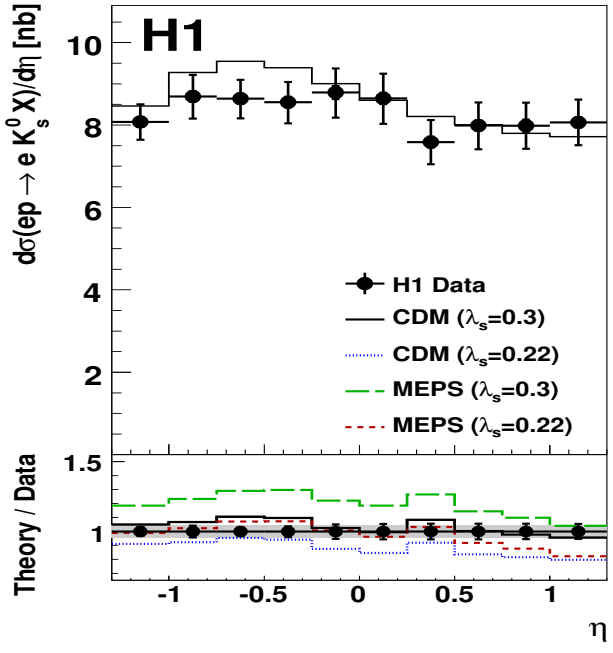


$$\sigma = 21.18 \pm 0.09(\text{stat.})^{+1.19}_{-1.23}(\text{syst.}) \quad \text{nb}$$

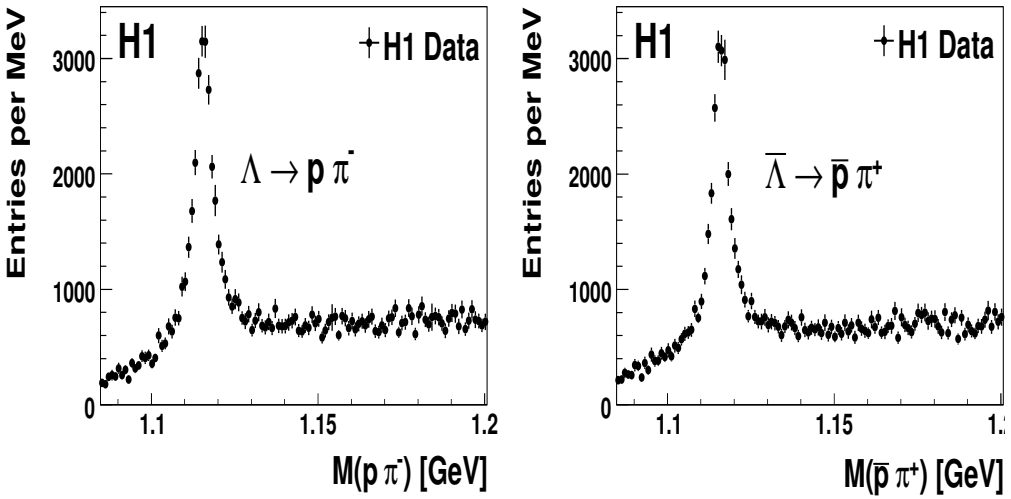
- ~ 213000 K_s^0 .
- CDM $\lambda_s = 0.3$ for Q^2, η and p_t but also MEPS $\lambda_s = 0.22$ for Q^2.
- Shape of η and low p_t show difficulties.





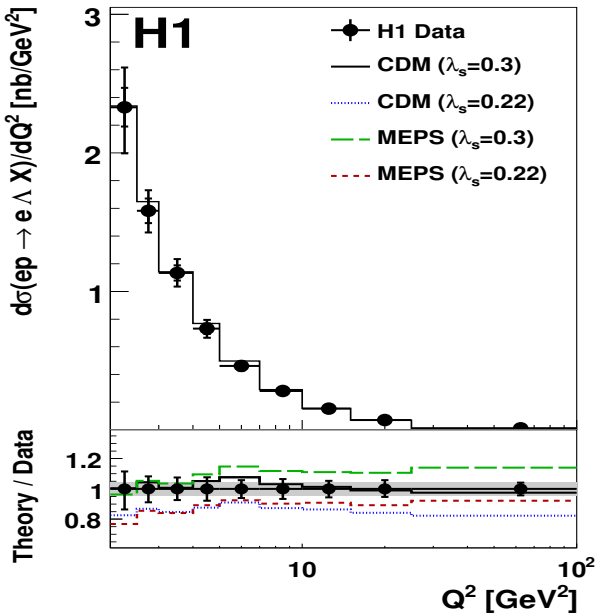


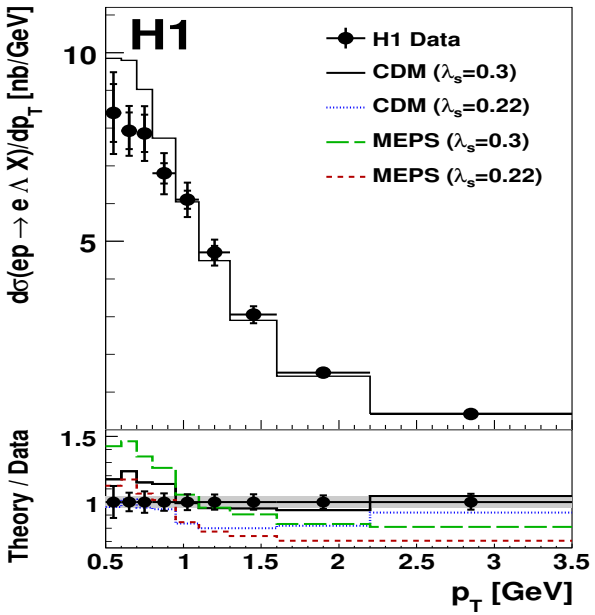
Λ differential cross section in laboratory frame

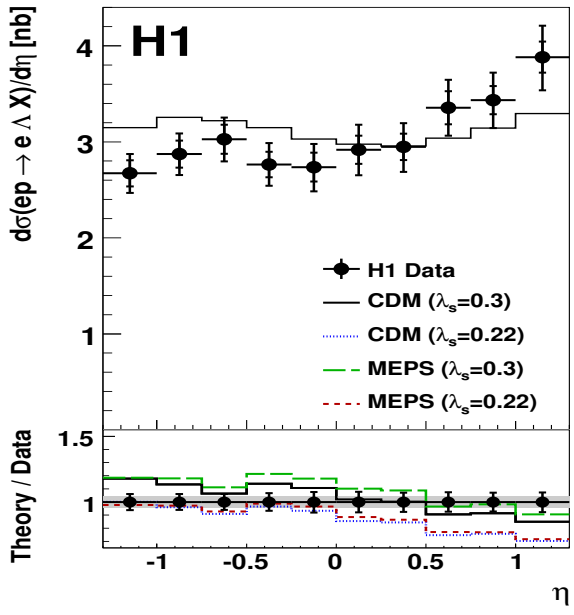


$$\sigma = 7.88 \pm 0.10(\text{stat.})^{+0.45}_{-0.47}(\text{syst.})\ \text{nb}$$

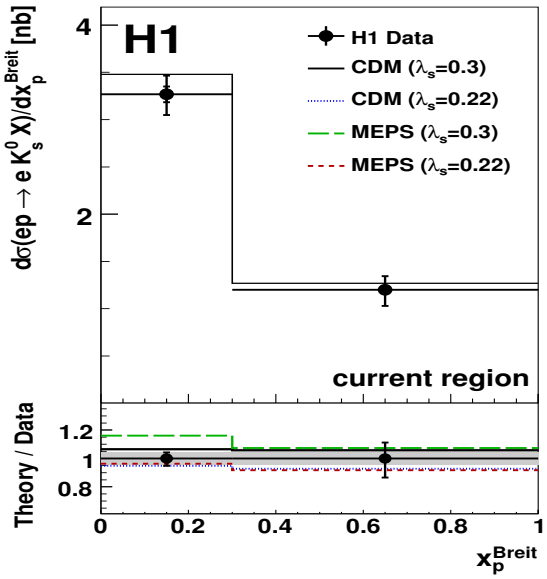
- $\sim 22000\Lambda$ and $\sim 20000\bar{\Lambda}$.
- CDM with $\lambda_s = 0.3$.
- Shape of η and low p_t fail.
- Expected sensitivity to $\lambda_{qq}, \lambda_{sq}$.

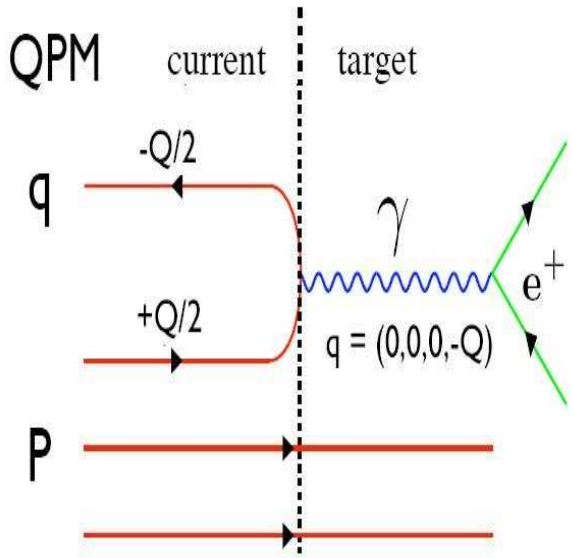


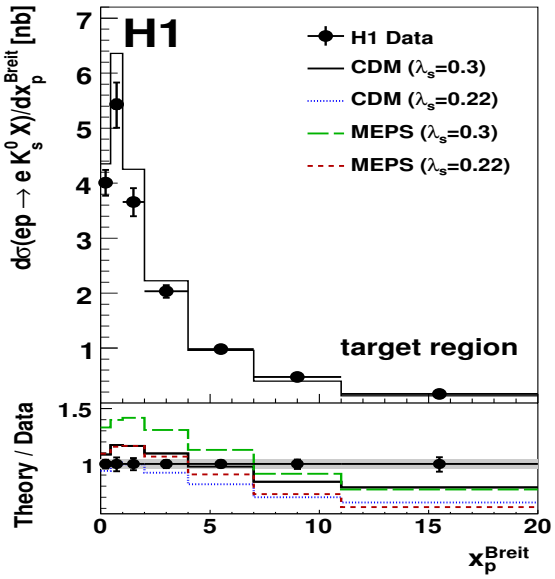


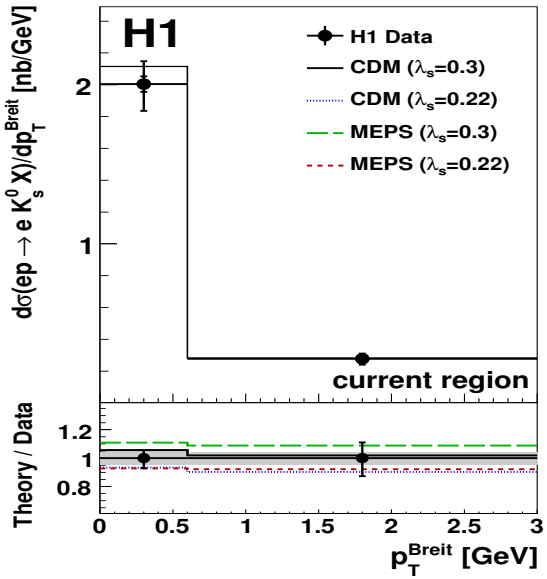


K_s^0 differential cross section in breit frame

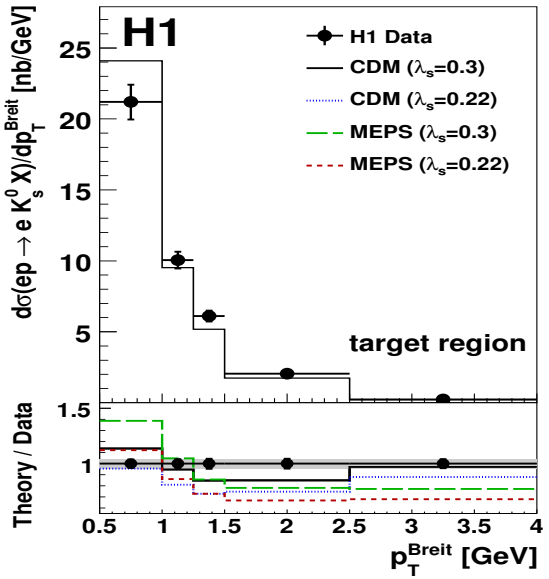




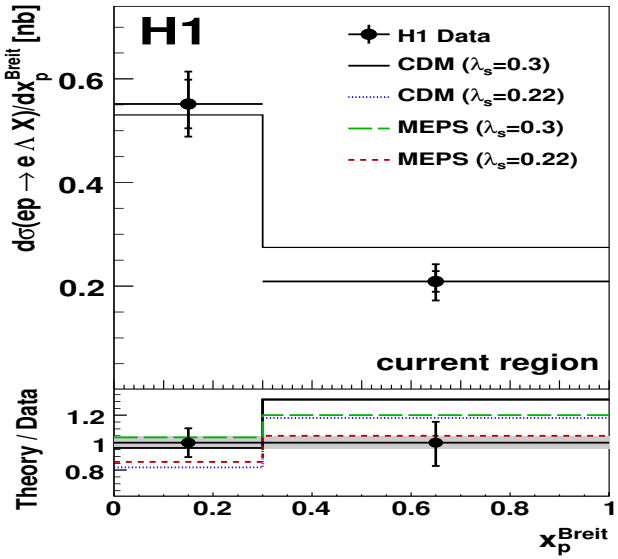


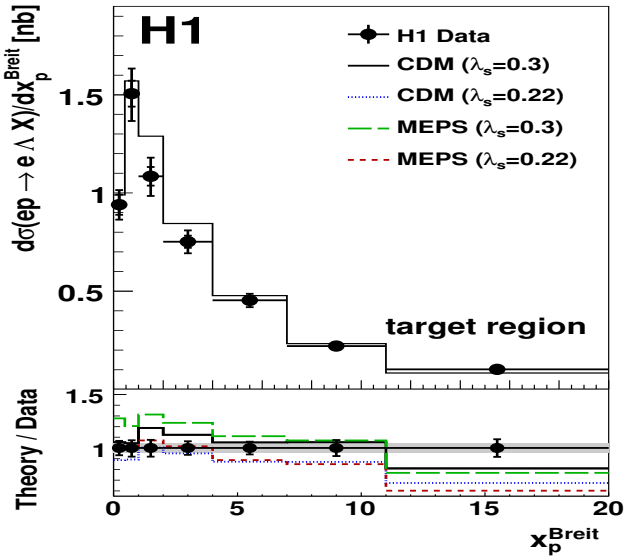


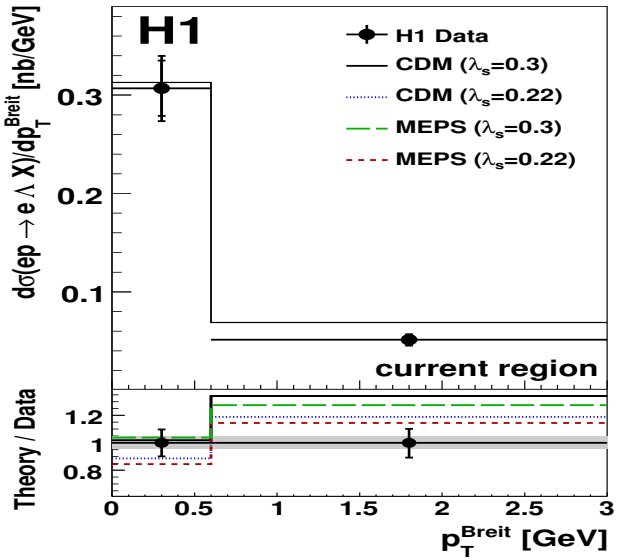
- Struck quark in current region.
- Proton remant in target region.
- CDM with $\lambda = 0.3$.

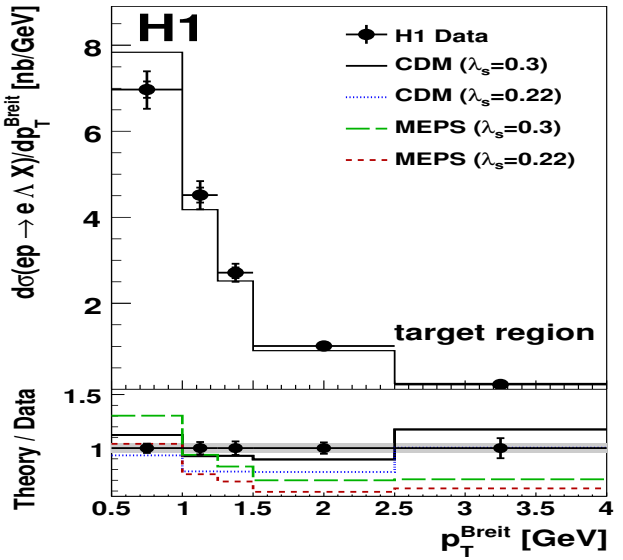


Λ differential cross section in breit frame







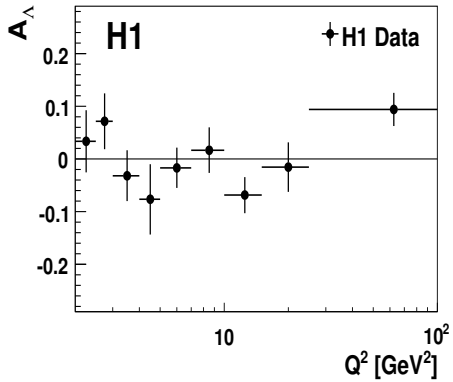


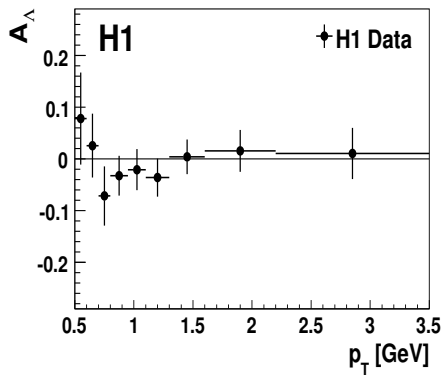
Not clear which model and λ_s makes better prediction.

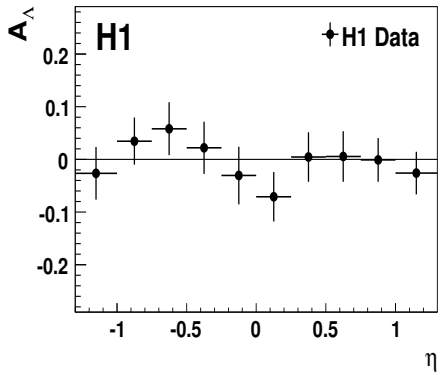
Asymmetries

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

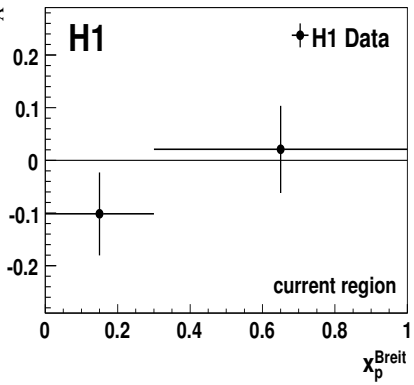
Laboratory frame:

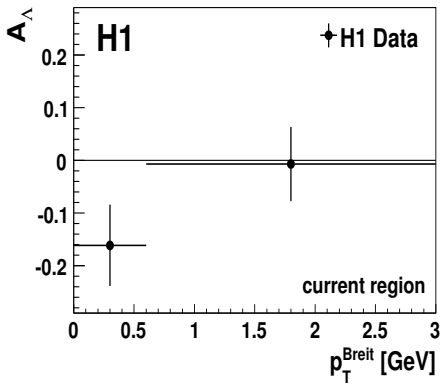


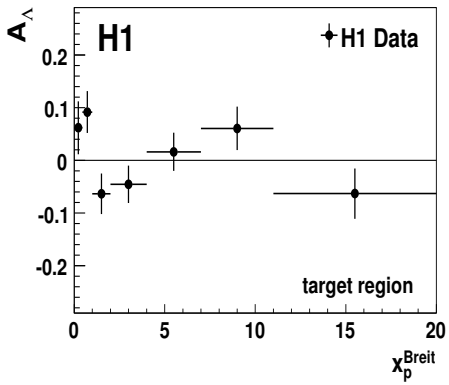


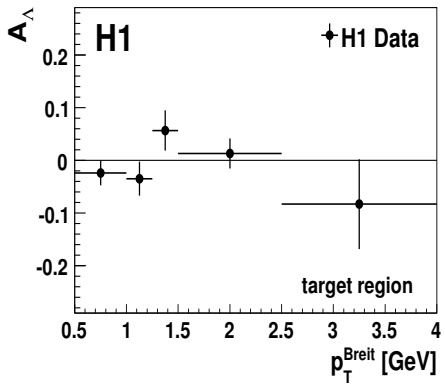


Breit frame:



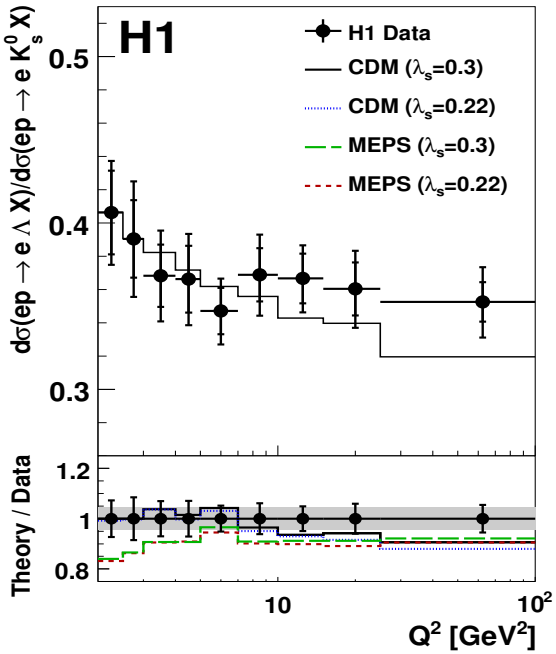


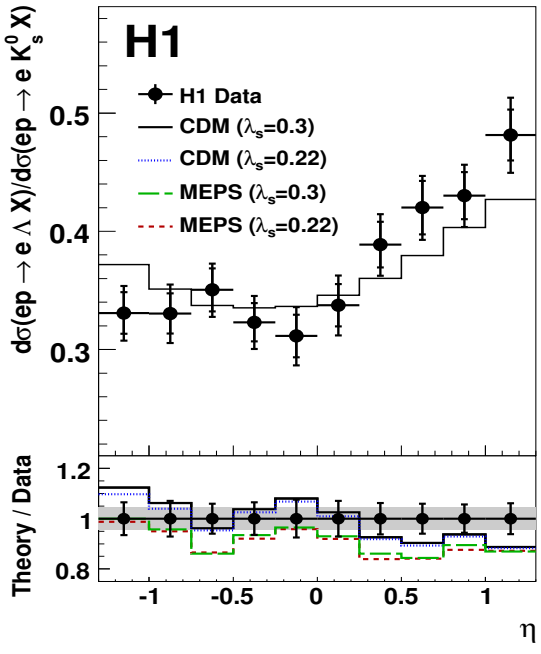


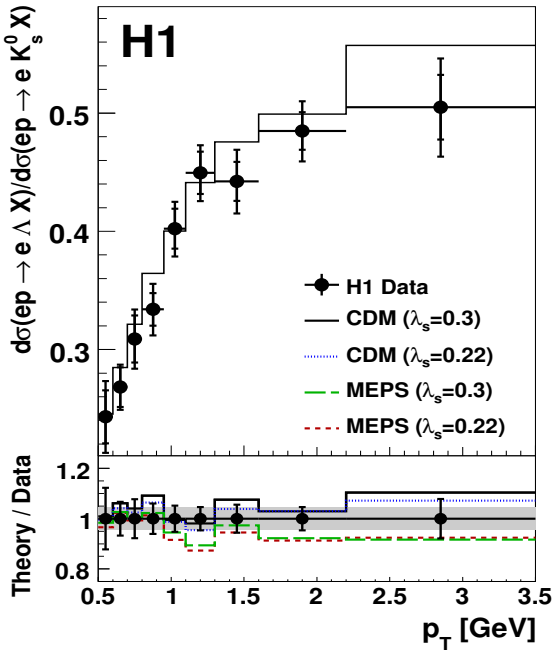


Baryons to mesons ratio in laboratory frame

- $ep \to e\Lambda X / ep \to eK_s^0 X$.
- 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.

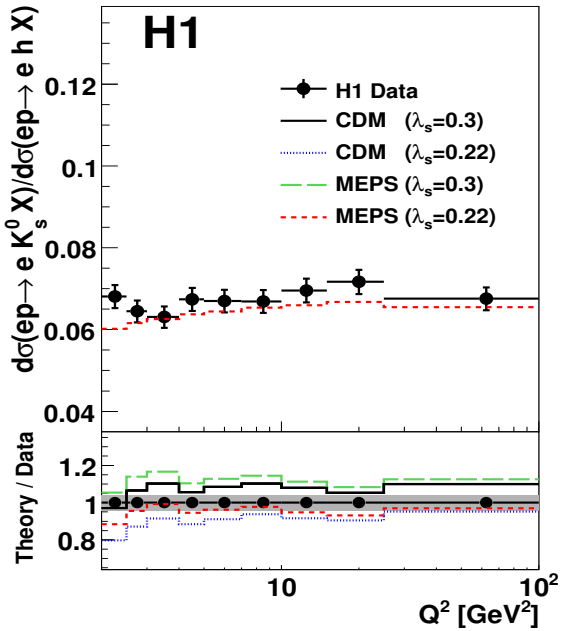


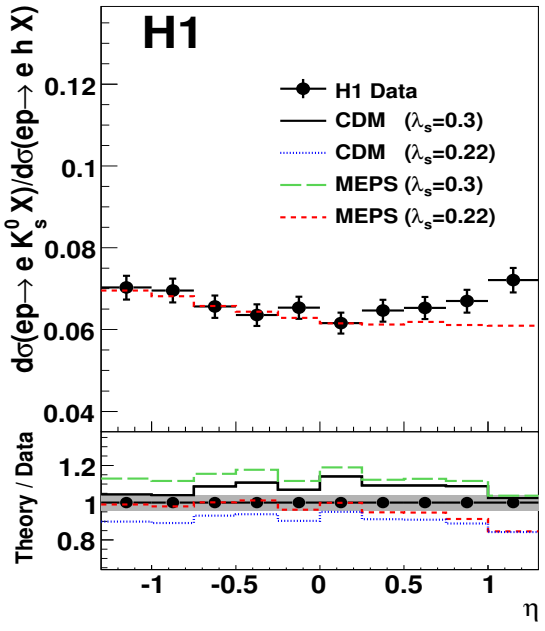


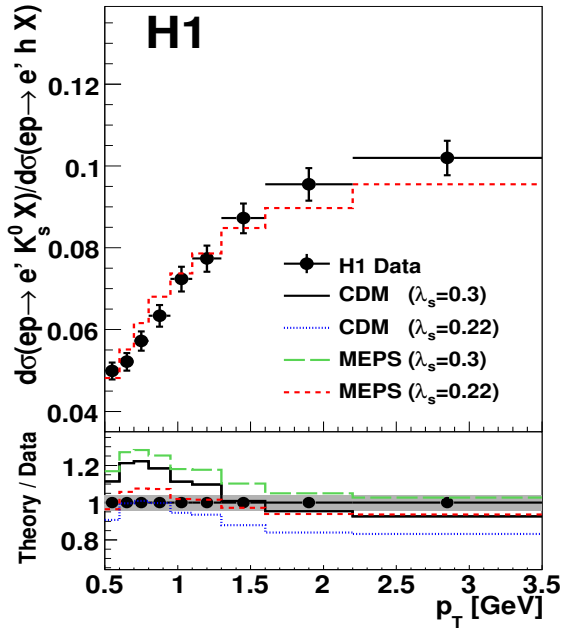


Mesons to charged particles ratio

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



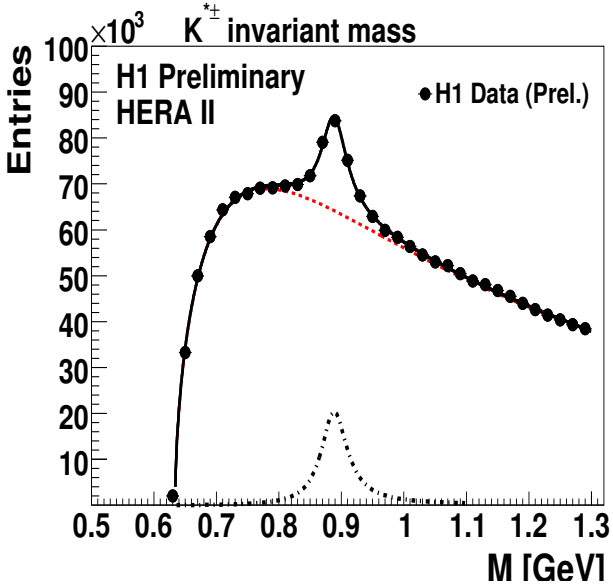


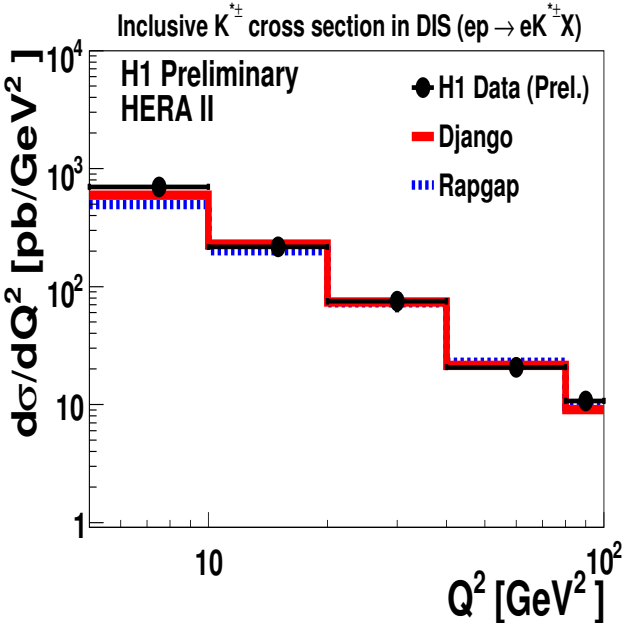


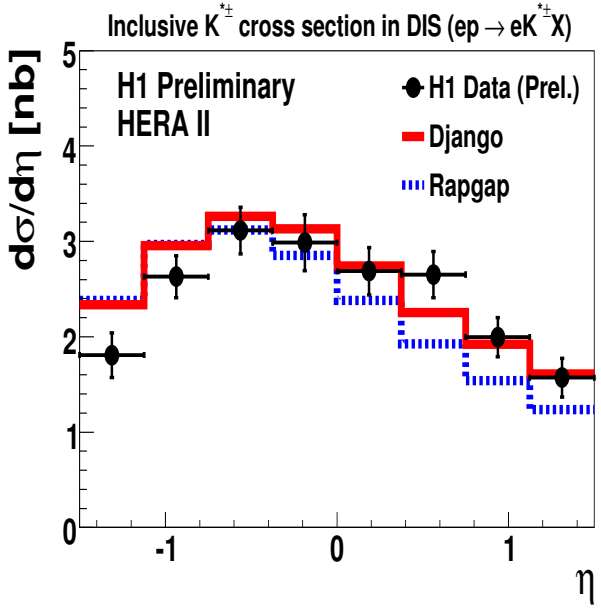
$K^{*\pm}$ differential cross section in lab frame

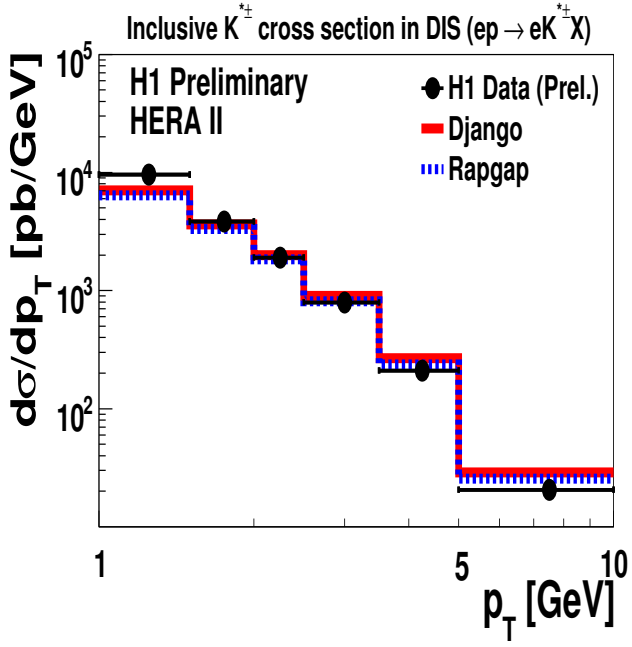
$\sigma = 7.36 \pm 0.09(\text{stat.}) \pm 0.9(\text{syst.})$ nb

- ~ 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^0_s and Λ.

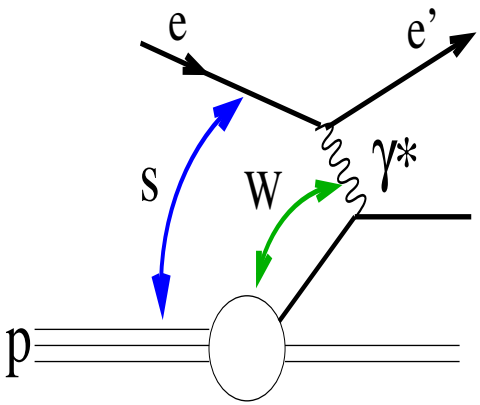




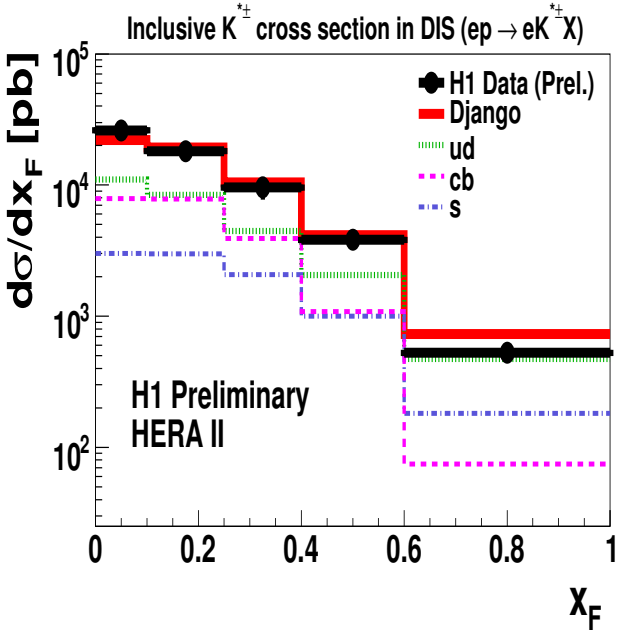


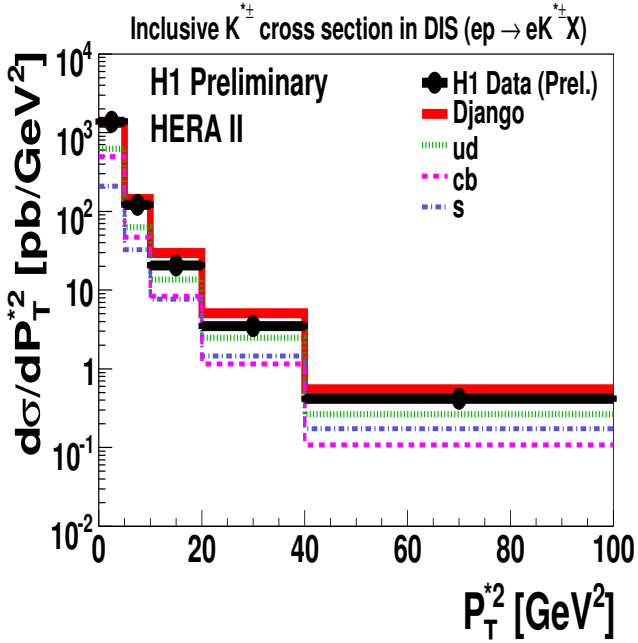


Flavour contribution for $K^{*\pm}$ production



$$x_F = \frac{2P_L^*}{W}.$$





$K^{*\pm}$ 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 tranfer to strange final states.
- $K^{*\pm}$ in agreement to CDM with $\lambda_s = 0.286$.