New Measurements of the Hadronic Final State from H1

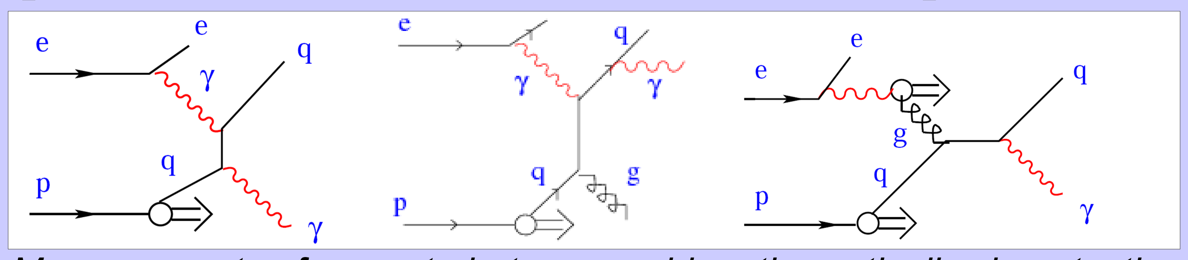
Albert Knutsson on behalf of the H1 Collaboration. Presented at Lepton Photon 2009, 17-22 August, Hamburg.

Prompt Photons in Photoproduction

H1prelim-09-035

Abstract

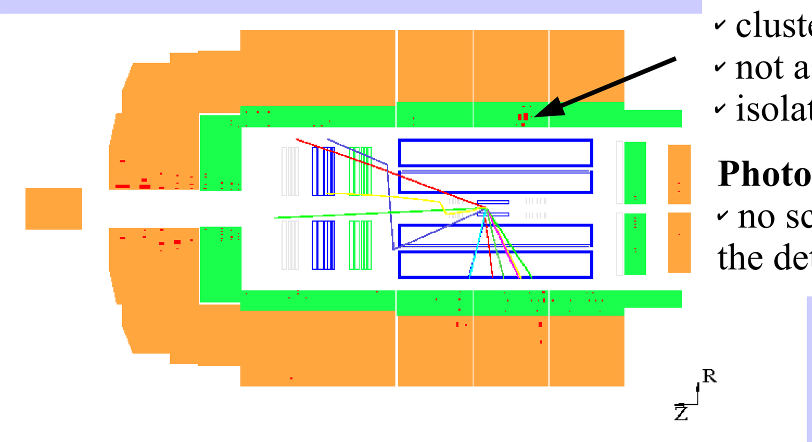
The yield of prompt photons is measured in photoproduction. The analysis is based on data taken by the H1 experiment in the years 2004-2007, with a total integrated luminosity of 340 pb-1. Cross sections are measured for photons with transverse momenta and pseudorapidities in the range 6 < E_T < 15 GeV and 1.0 < η < 2.4, for events with and without an additional jet.

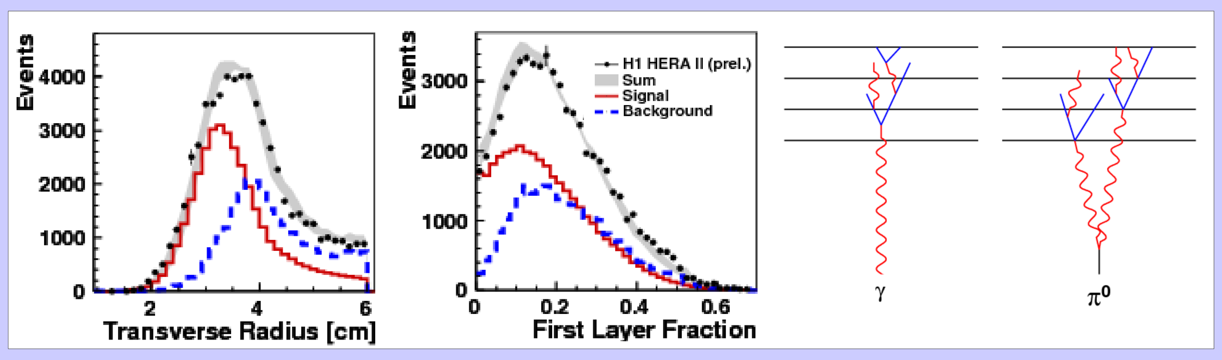


Measurements of prompt photons provide a theoretically clean testing ground for fixed order calculations and for probing the structure of the proton. The diagrams above show examples of different contributions. The last diagram illustrates the contribution from resolved photon events.

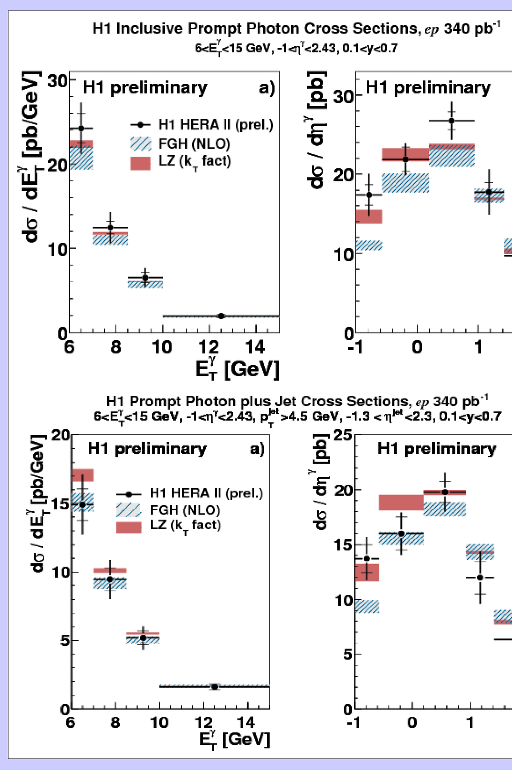
Photon candidate:
- cluster in em calorimeter
- not associated to track
- isolated

Photoproduction:
- no scattered electron in the detector





Several cluster shape variables were used to discriminate between signal and background in a multivariate analysis. Typical backgrounds are due to π^0, η and ω decays, leading to multi-photon final states.



The prompt photon cross sections – without (top) and with (bottom) an additional jet – are compared to fixed order QCD calculations: FGH and LZ, based on collinear and k_T factorization respectively. Both describe the E_T spectrum of the photons. The very backward region is only described by the k_T factorization approach.

Charged Particles and the Hadronic Final State Charge Asymmetry

Phys.Lett.B654:148-159,2007 (DESY-07-065) and DESY-09-084

Abstract

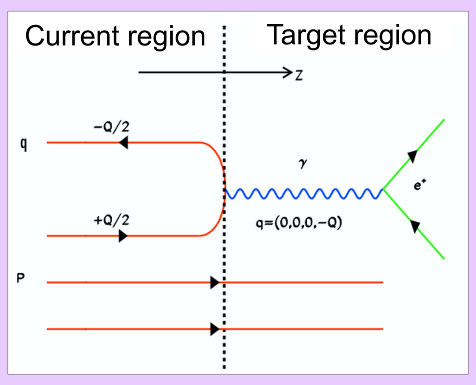
The average multiplicity and the normalised distribution of the scaled momentum, x_p, of charged final state particles are measured in deep inelastic *ep* scattering at high Q^2 (100 < Q^2 < 20 000 GeV^2) in the Breit frame of reference. In addition, a first measurement at HERA of the hadronic final state charge asymmetry is presented.

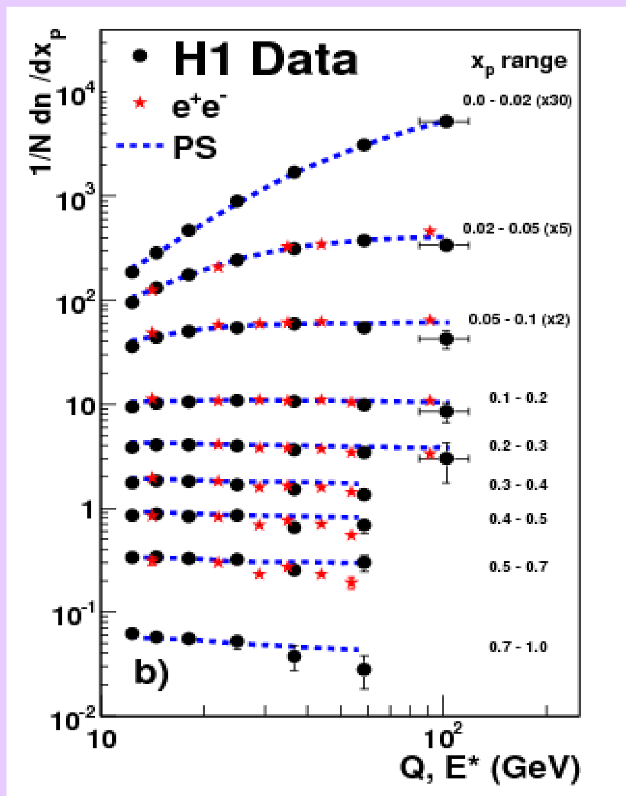
P_h = Momentum of charged particle in the current region of Breit frame

$x_p = \frac{2P_h}{Q}$ = Scaled momentum variable

$D(x_p) = \frac{1}{N_{events}}\frac{dn}{dx_p}$ = Event normalised momentum distribution

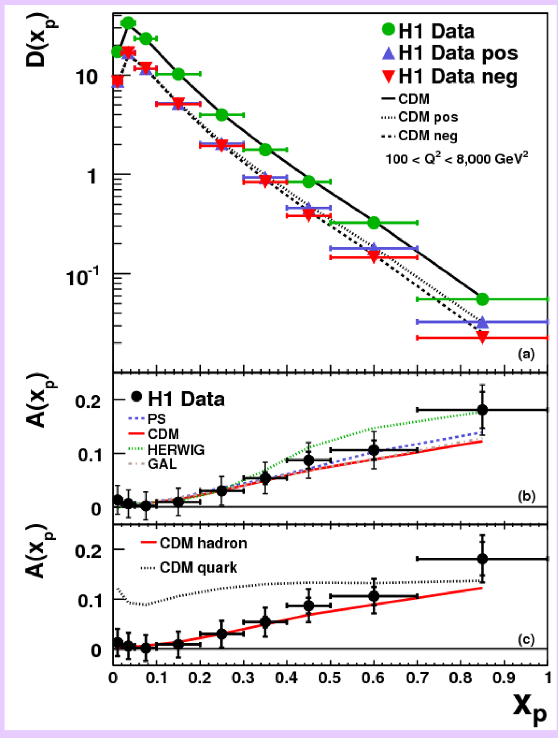
Measurement performed in the current region of the Breit frame in ep collision: Possibility to compare measurement to particle production in e⁺e⁻ collisions.





Normalised momentum distributions as a function of Q for different regions in x_p. The ep data agree with e⁺e⁻ data and are well described by MC with parton showers (PS).

The positive (pos) and negative (neg) momentum distributions as a function of x_p and their sum are also well described by MC. The color dipole model (CDM) is shown here (top figure).



The behaviour of the ***charge asymmetry***

$$A = \frac{pos - neg}{pos + neg}$$

can be undestood as follow:

- ***Large*** x_p ***:*** *Few produced particles. The particles in the hadronic final state retain the information from the hard interactions. A large charge asymmetry from valence quarks is seen.*
- ***Low*** x_p ***:*** *The fragmentation process plays an important role and the asymmetry is smaller. This is also seen in the lower figure where the MC prediction with hadronisation turned off (CDM-quark) maintains the charge asymmetry at low* x_p *in contrast to the data.*

The Underlying Event in Photoproduction

H1prelim-08-036

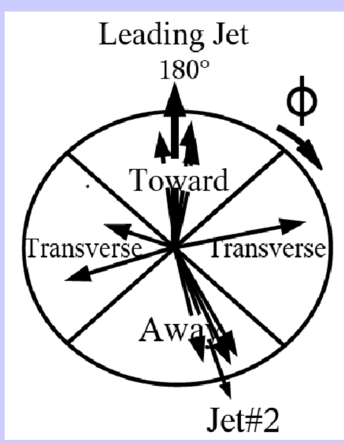
Abstract

Photoproduction data are analysed by requiring dijets with transverse momenta E_T > 5 GeV. The average multiplicity of charged particles is measured in different azimuthal regions, in bins of ET and x_γ with respect to the leading jet. At low x_γ, where the photon has a large hadronic-like substructure, the collision becomes similar to the one at hadron colliders and multiple interactions are expected to be relevant.

x_γ – Energy fraction of the photon carried by the parton taking part in the interaction.

x_γ = 1: Direct photon interaction

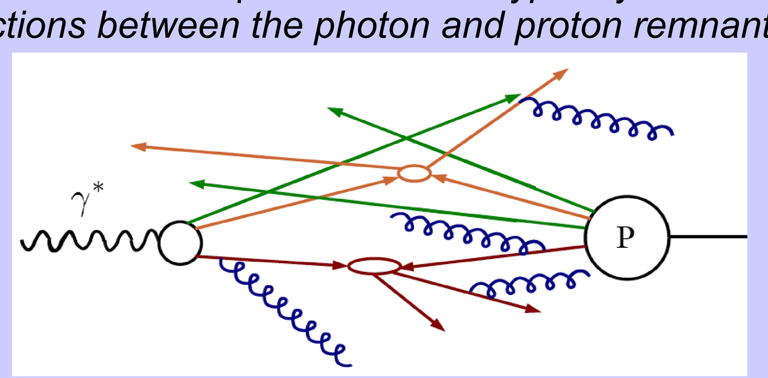
x_γ < 1: Photon has substructure

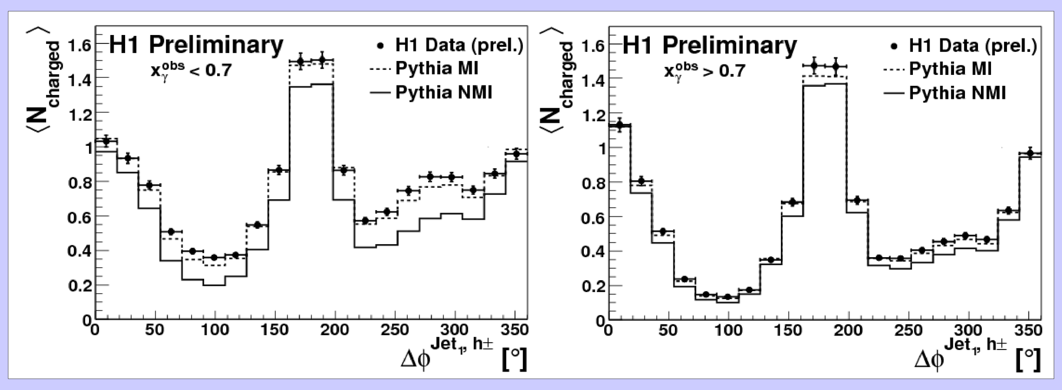


The average charged particle multiplicity is measured in different azimuthal regions with respect to the leading jet.

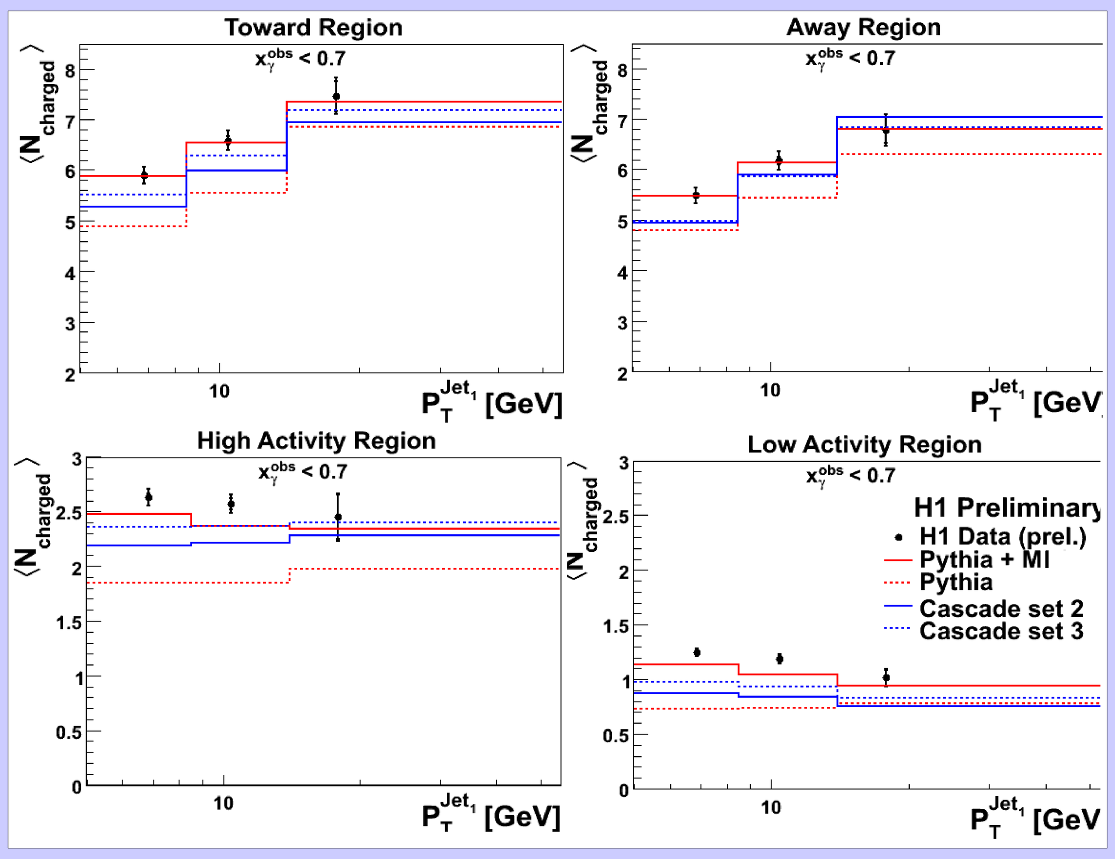
The high and low activity (transverse) regions are defined with respect to the scalar sum of the particle transverse momenta.

Multiple interactions: Several parton-parton interactions within the same event. In ep collisions this typically means additional interactions between the photon and proton remnant.





The azimuthal difference between the leading jet and the charged particles, for high and low x_γ. The contribution from multiple interactions (MI) are largest at low x_γ where the photon has hadronic structure.



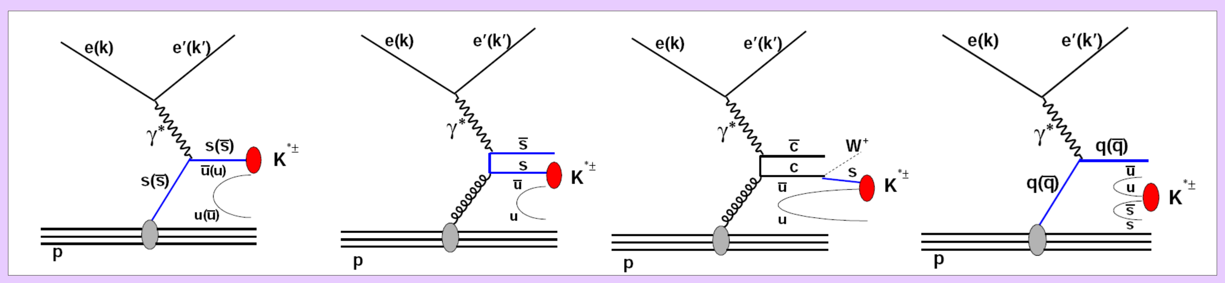
The data are compared to PYTHIA with and without multiple interactions (MI), and CASCADE, a MC without MI, which is based on the k_T factorization approach. It appears that the k_T factorization approach is in competition with the MI predictions.

Strangeness Production at Low Q2

Eur.Phys.J.C61:185-205,2009 (DESY-08-095)
H1prelim-08-132

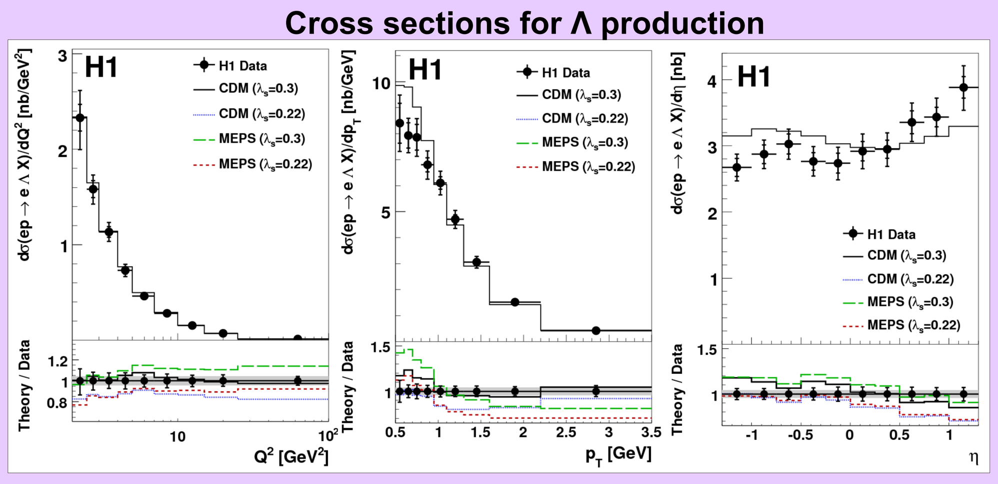
Abstract

The production of strange hadrons is investigated using low Q^2 deep-inelastic scattering events. The K^0_S and Lambda production cross sections are presented differentially as a function of several kinematical variables. In addition, the Lambda – Anti-Lambda asymmetry is measured. The production of $K^{*\pm}$ vector mesons, observed through the decay $K^{*\pm} \to K^0_S \pi^\pm$, is measured for the first time at HERA.

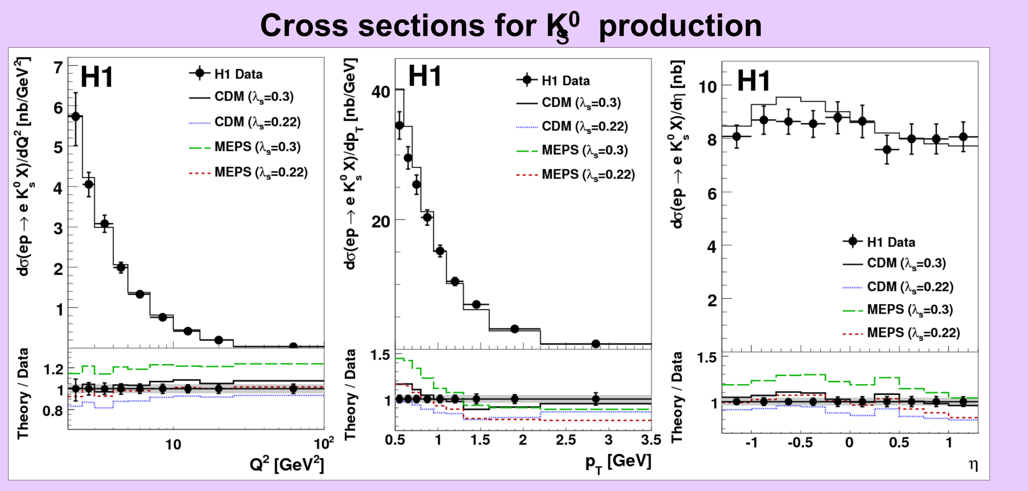


Production mechanisms of strange hadrons: The fragmentation process is dominating the production (see plots below.)

Cross sections for Λ production

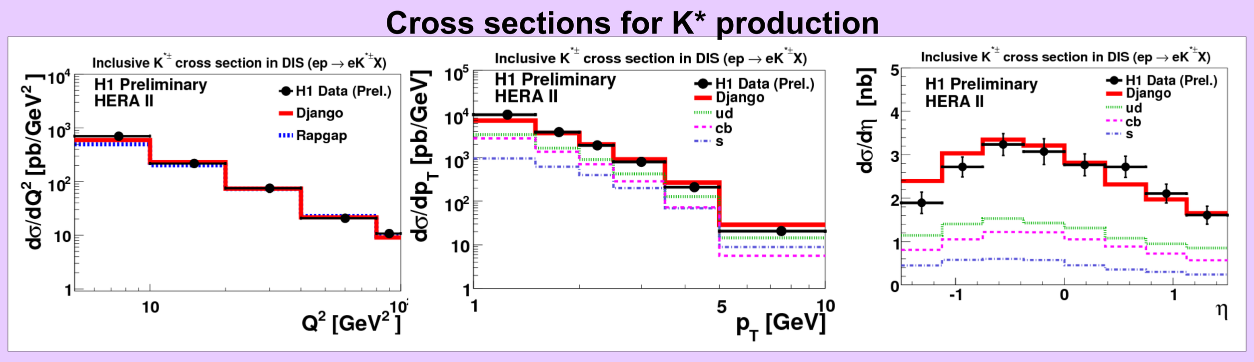


Cross sections for K^0_S production



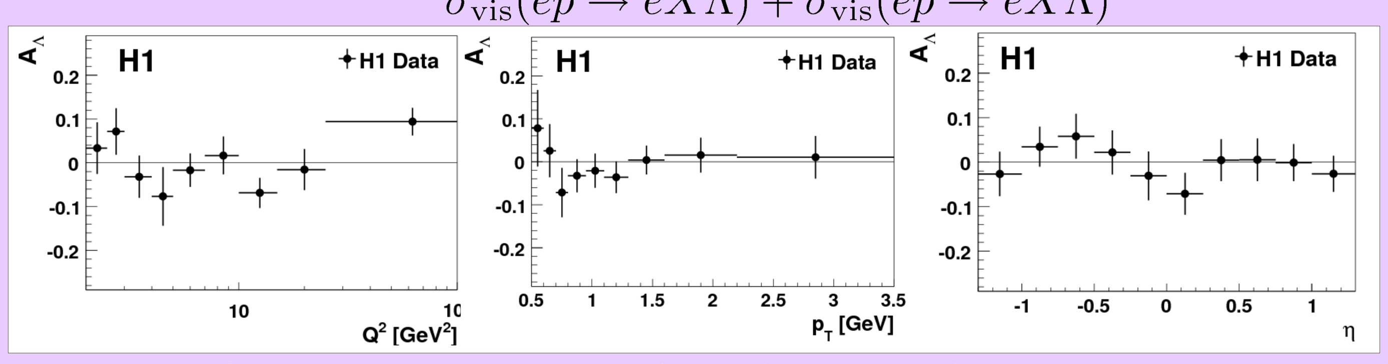
The cross sections for Λ (left) and K^0_S (right) production are compared to predictions from MC with parton showers (MEPS) and to MC with dipole showers from the Color Dipole Model (CDM). The predictions are made for different values of the strangeness suppression factor, λ_s. Although the CDM with λ_s=0.3 describes the data best, no MC and no λ_s describes all data points. Especially the shape of the transverse momentum (P_T) and the pseudo rapidity (η) are not reproduced.

Cross sections for K* production



Cross section for $K^{*\pm}$ production as a function of the transverse momentum of the $K^{*\pm}$. The MC predictions of the P_T and η dependence of the $K^{*\pm}$ are decomposed into the contributions to the $K^{*\pm}$ of the various quark flavors produced in the hard interaction.

$$A_\Lambda = \frac{\sigma_{vis}(ep \to eX\Lambda) - \sigma_{vis}(ep \to eX\bar{\Lambda})}{\sigma_{vis}(ep \to eX\Lambda) + \sigma_{vis}(ep \to eX\bar{\Lambda})}$$



The Lambda/Anti-Lambda asymmetry (as defined above) is consistent with being flat and zero within errors as a function of Q^2, P_T and η. Thus, no baryon number transfer from the proton to the hadronic final state is observed.