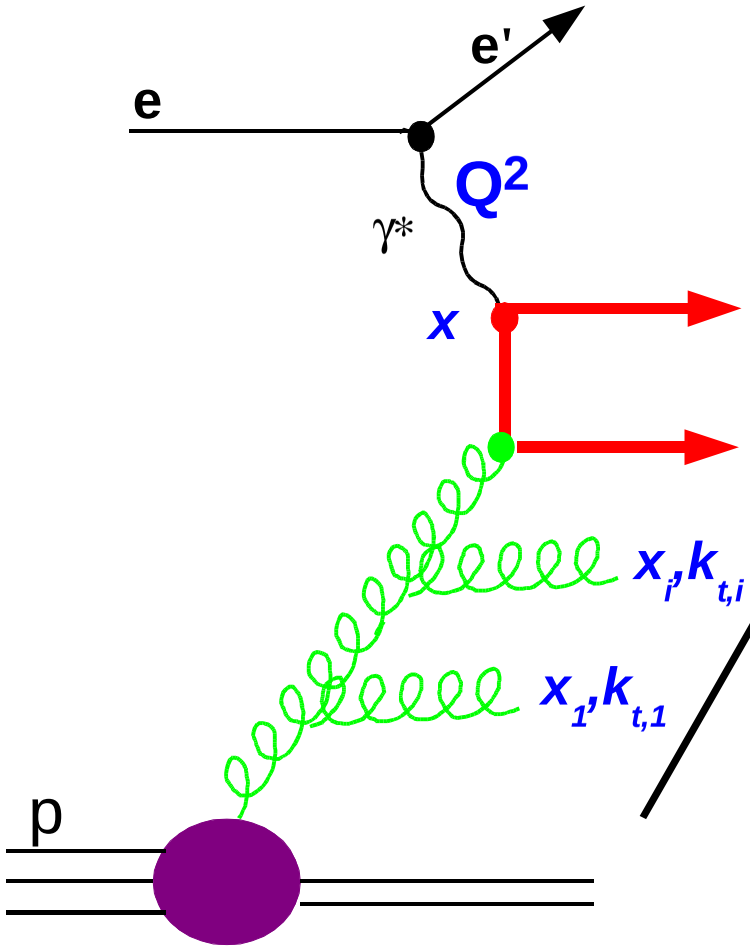
EPS Aachen 17.7.03 -23.7.03

Study of low-x Dynamics using the Hadronic Final State in DIS

Roman Pöschl
DESY Hamburg
for

DIS and Parton Dynamics



Parton Evolution

DGLAP:

$$k_{t,1}^2 \ll \ldots \ll k_{t,i}^2 \ll \ldots \ll Q^2$$

$$x_1 < \ldots < x_i < \ldots < x$$

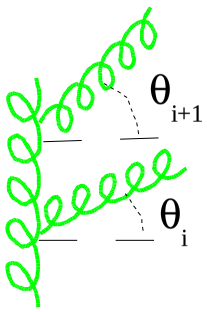
BFKL:

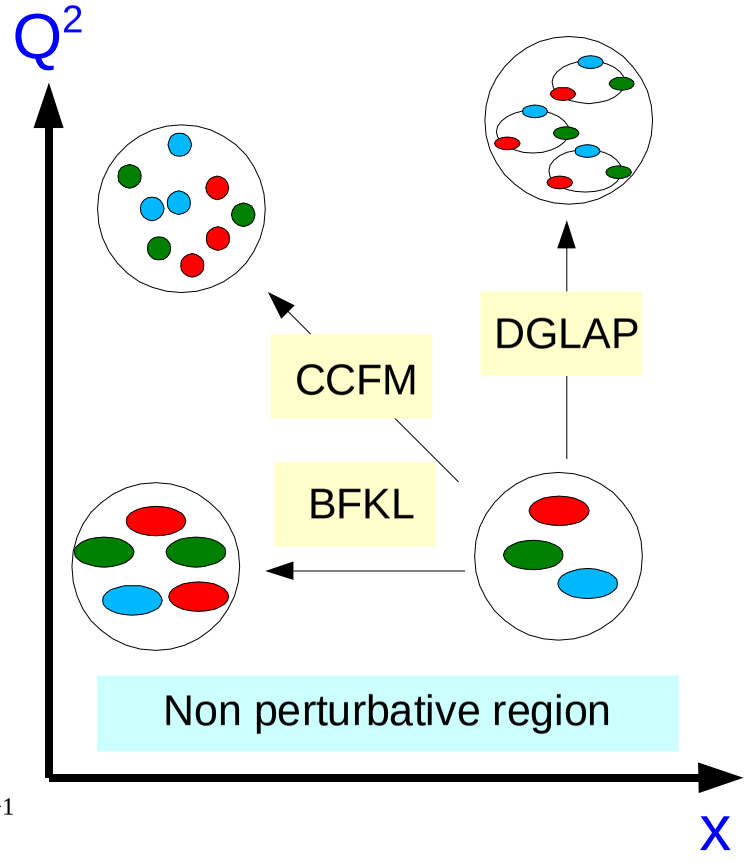
No k_t ordering !

$$x_1 \ll \ldots \ll x_i < \ldots < x$$

CCFM:

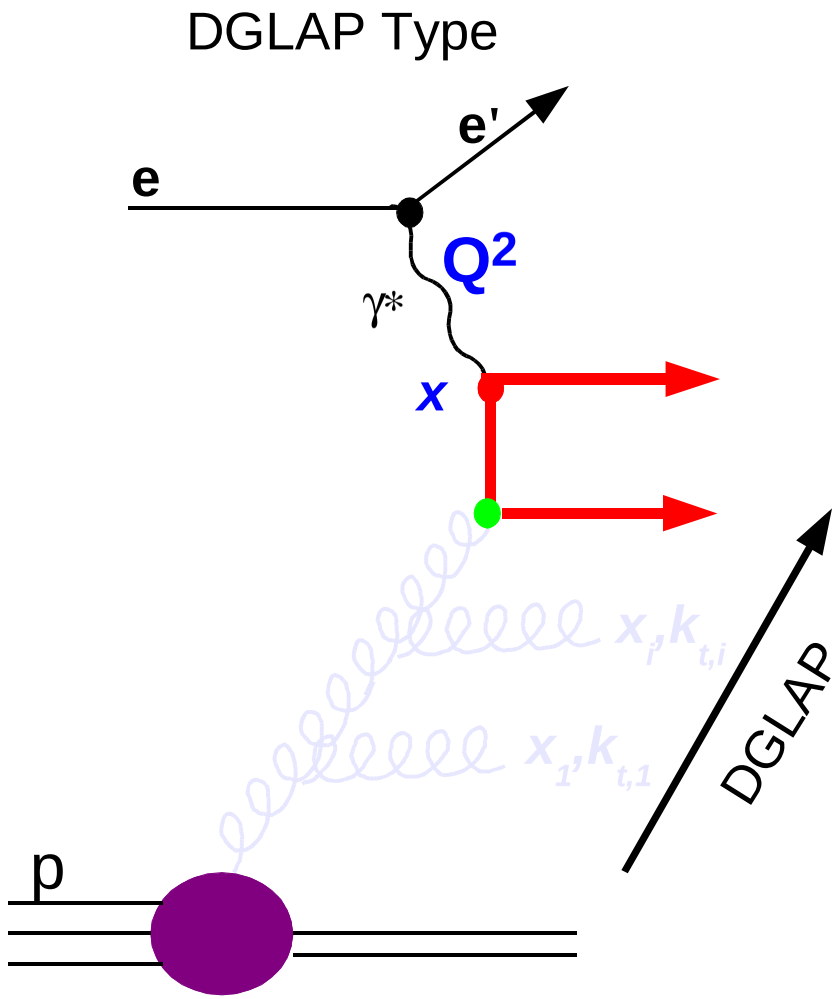
Angular Ordering





Explore the Hadronic Final State to study Parton Dynamics

Monte Carlo Models and QCD Calculations

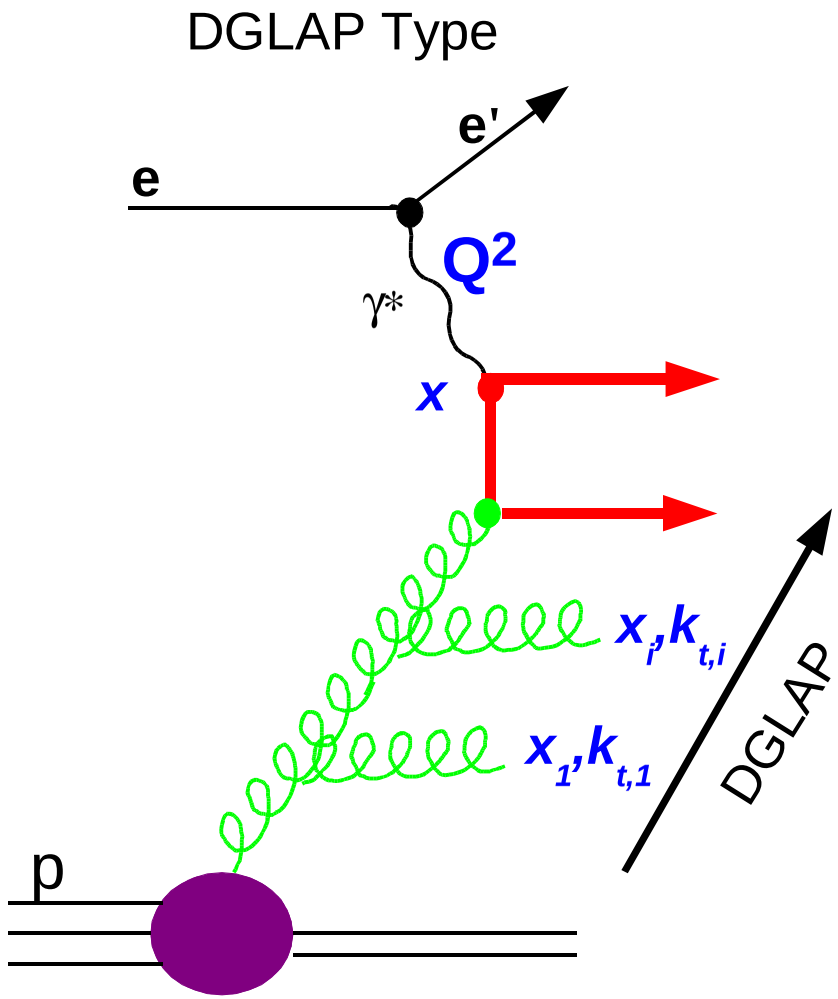


QCD calculations (e.g. DISENT)

ME up to α_s^2

partonic final state only

Monte Carlo Models and QCD Calculations



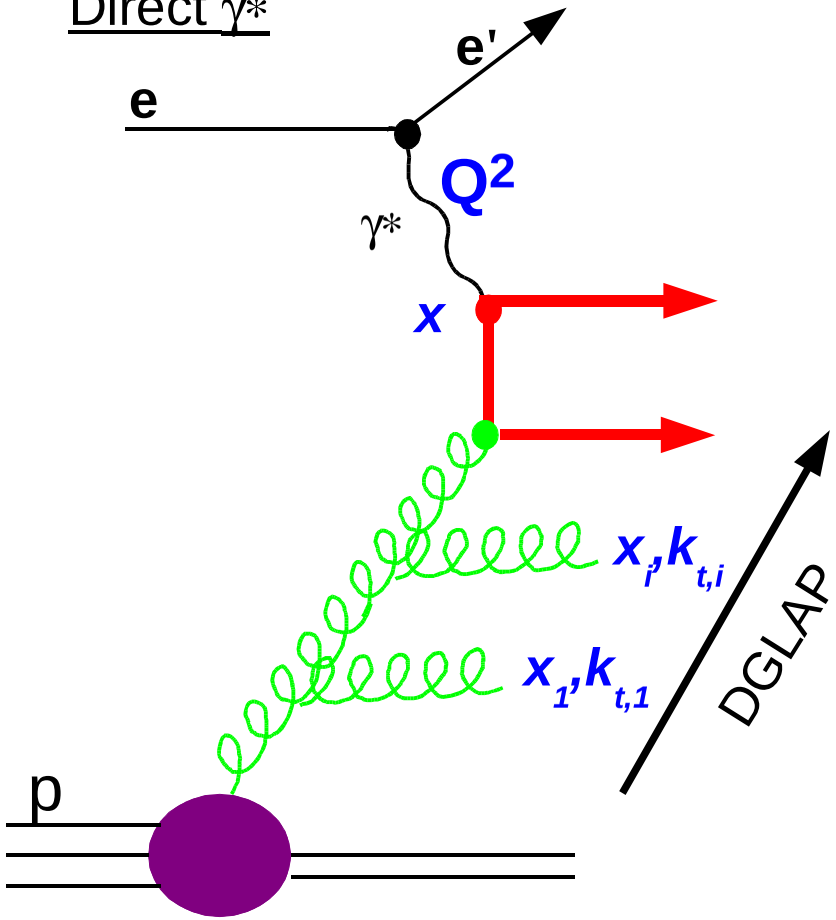
QCD calculations (e.g. DISENT)
ME up to α_s^2
partonic final state only

ME+PS (e.g. RAPGAP)
complete hadronic
final state

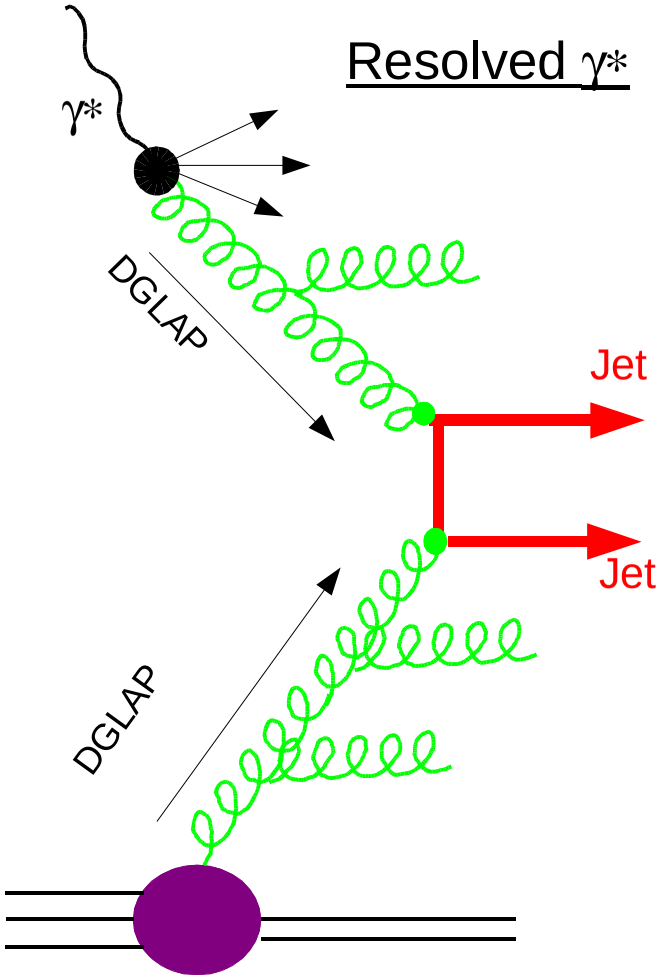
Monte Carlo Models and QCD Calculations

DGLAP Type

Direct γ*



Resolved γ*



QCD calculations (e.g. DISENT)
ME up to α_s^2
partonic final state only

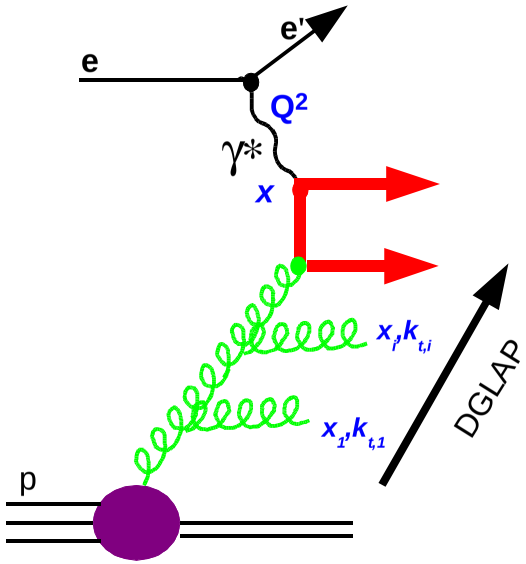
ME+PS (e.g. RAPGAP)
complete hadronic
final state

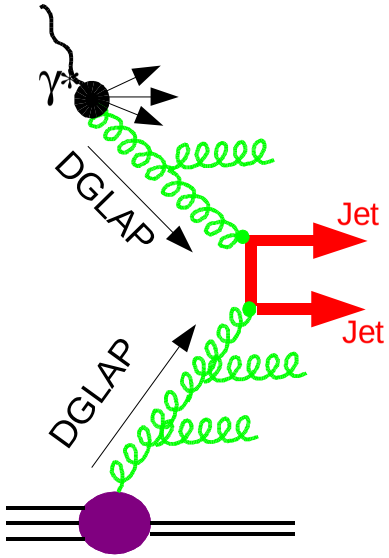
Resolved γ* might
mimic break in k_t -order

Monte Carlo Models and QCD Calculations

DGLAP Type

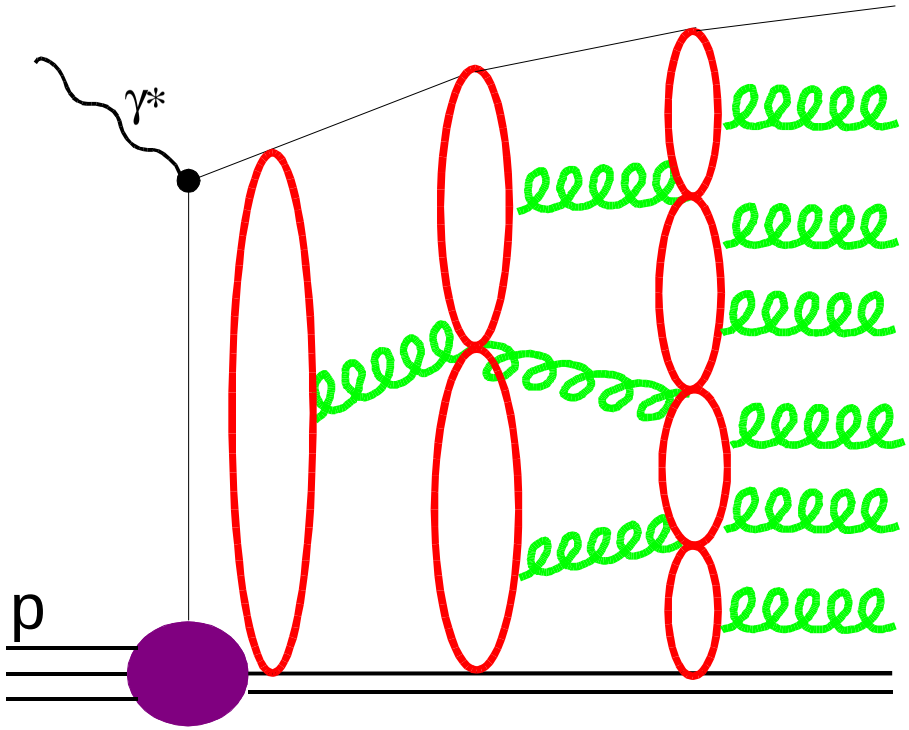
DISENT, RAPGAP





'BFKL'-Type

Colour Dipole Model



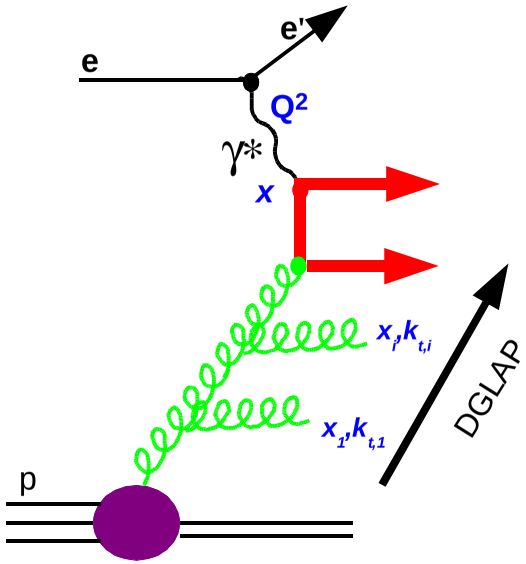
Emission from independent dipoles produces no k_t-ordering (e.g. ARIADNE)

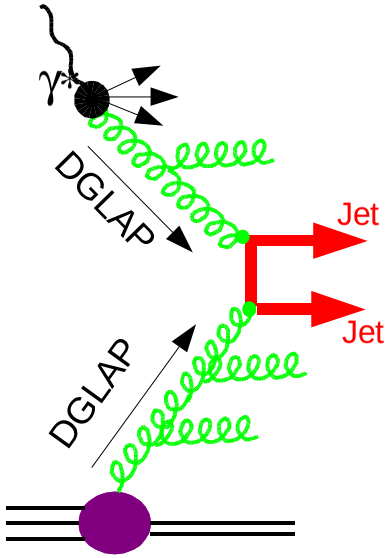
Parton shower from Dipole emission

Monte Carlo Models and QCD Calculations

DGLAP Type

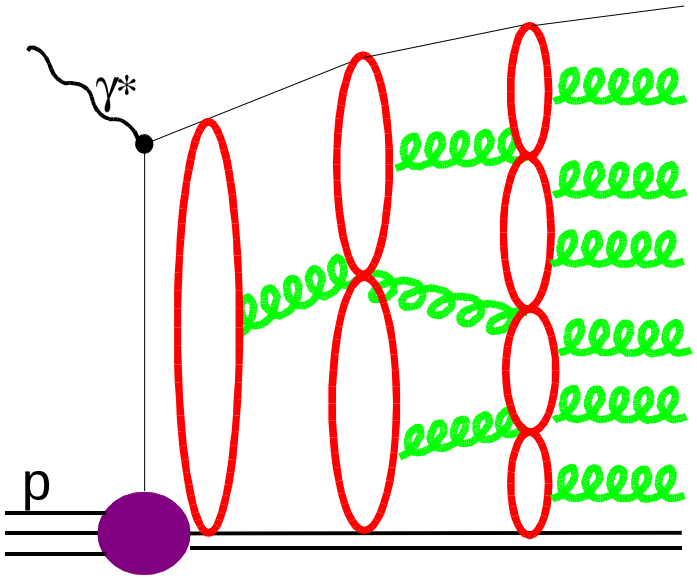
DISENT, RAPGAP





'BFKL'-Type

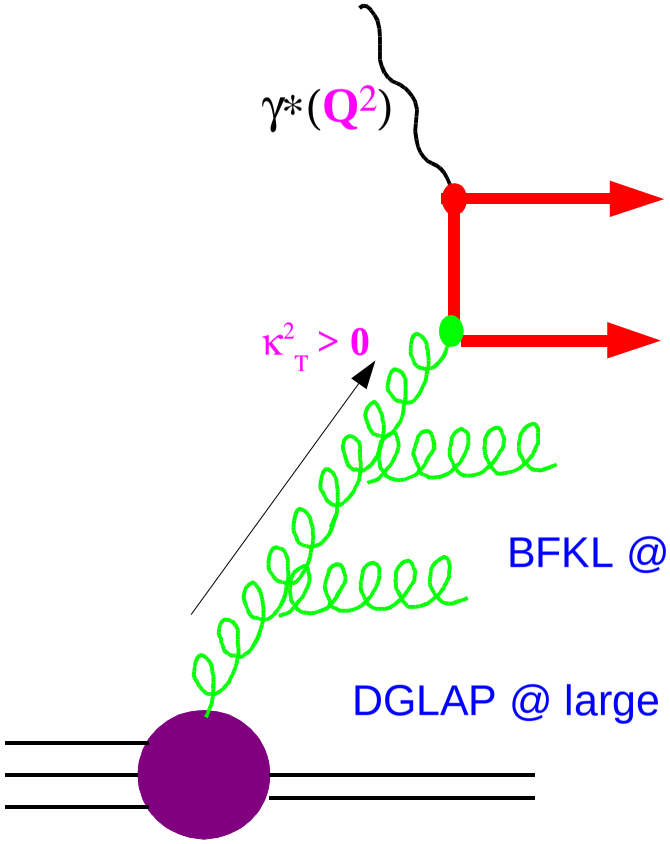
ARIADNE



Colour Dipole Model
Emission from independent dipoles produces
no k_t-ordering

CCFM

CASCADE

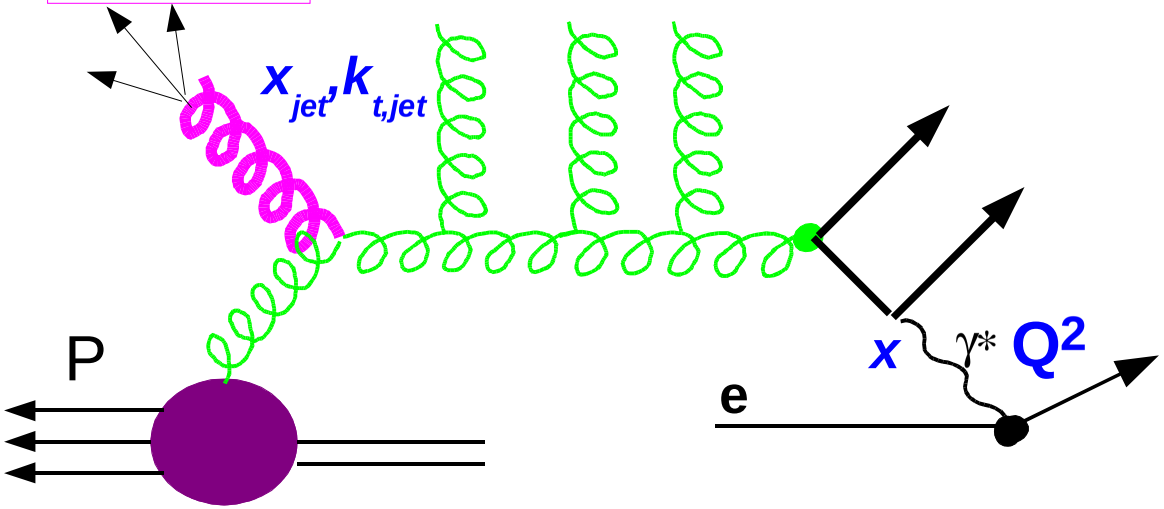


'k_t-factorisation'

The Lower End -Forward π^0 + Forward Jets -

Forward Jet, π^0

$\sigma(\pi^0) = \sigma(\text{Jet}) \times \text{Fragmentation}$



Mueller-Navelet Jets

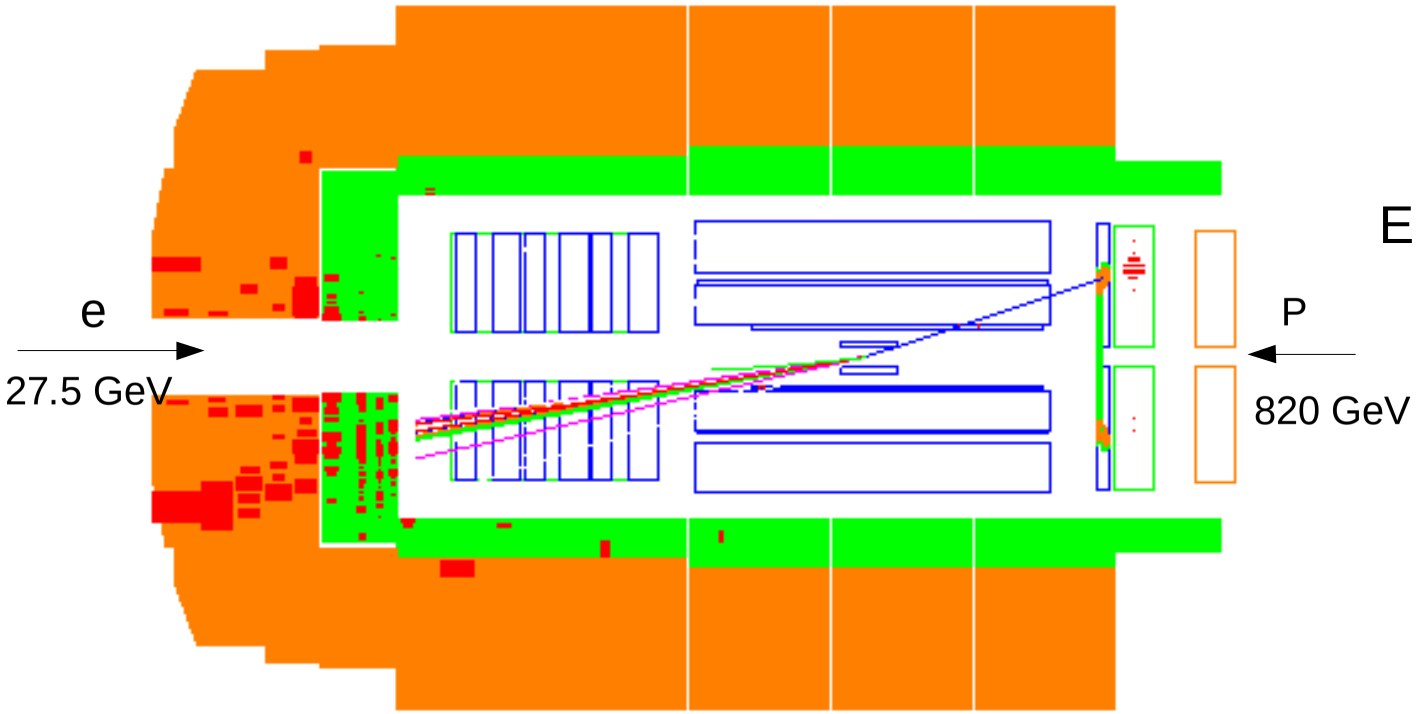
Measure Jets/Particles in Forward direction

Suppress DGLAP evolution in Q^2

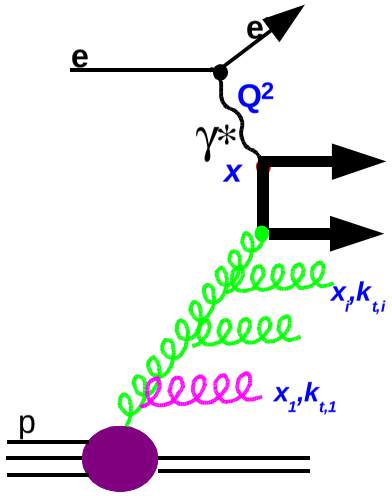
$k^2_{T,jet/\pi^0} \approx Q^2$

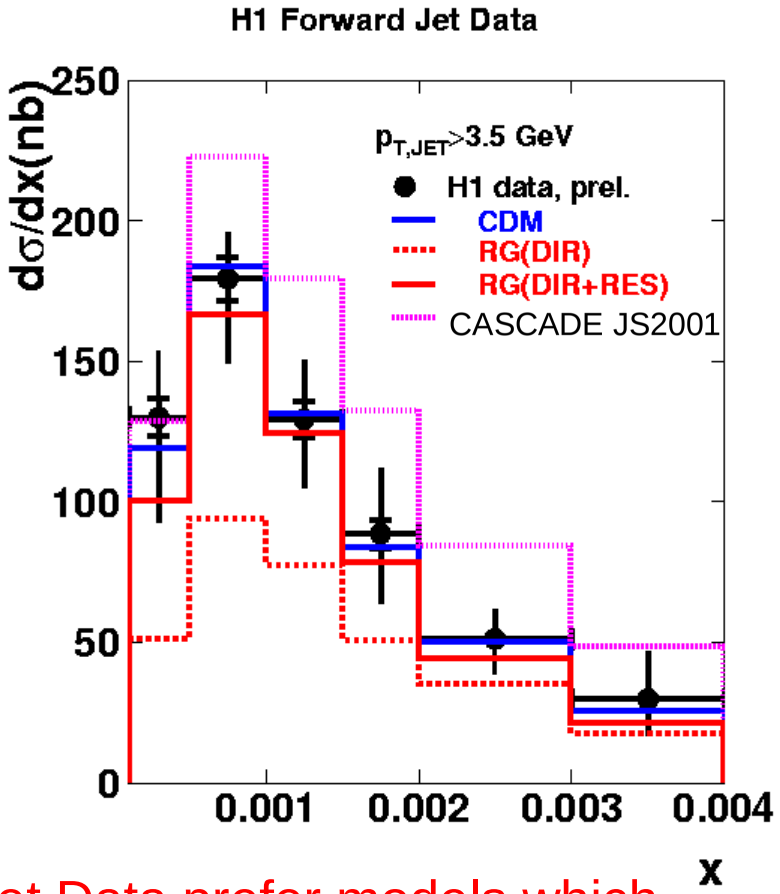
Enhance BFKL evolution in x

$x_{T,jet/\pi^0} = E_{T,jet/\pi^0} / E_p >> x$



Forward Jet Cross Sections

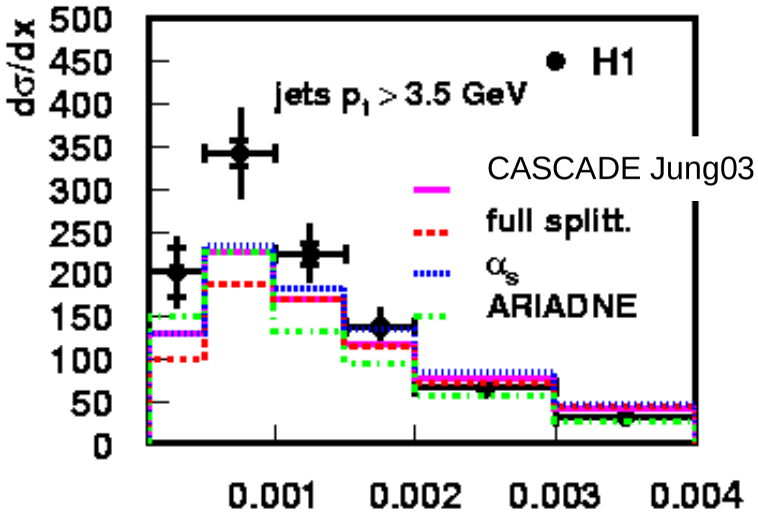




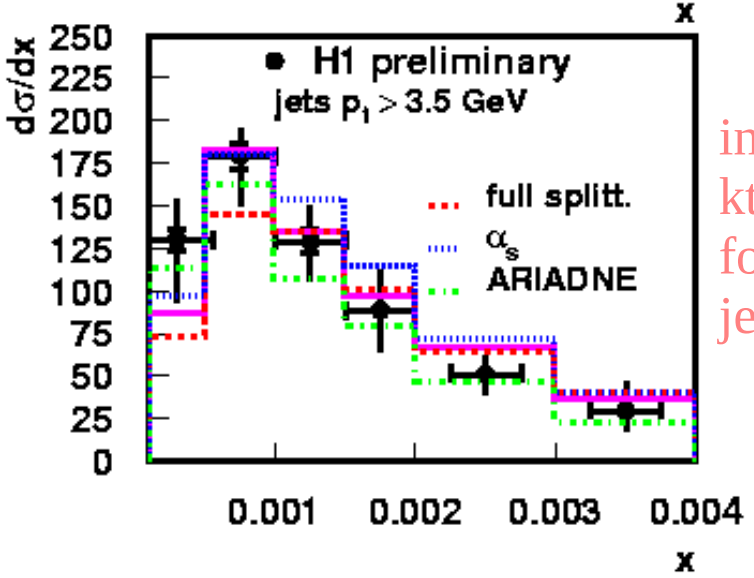
Forward Jet Data prefer models which do not impose k_t-ordering

ARIADNE ok
RAPGAP direct + resolved ok
RAPGAP direct only

CASCADE too high (designed for low-x physics)



Cone Algo. For jets

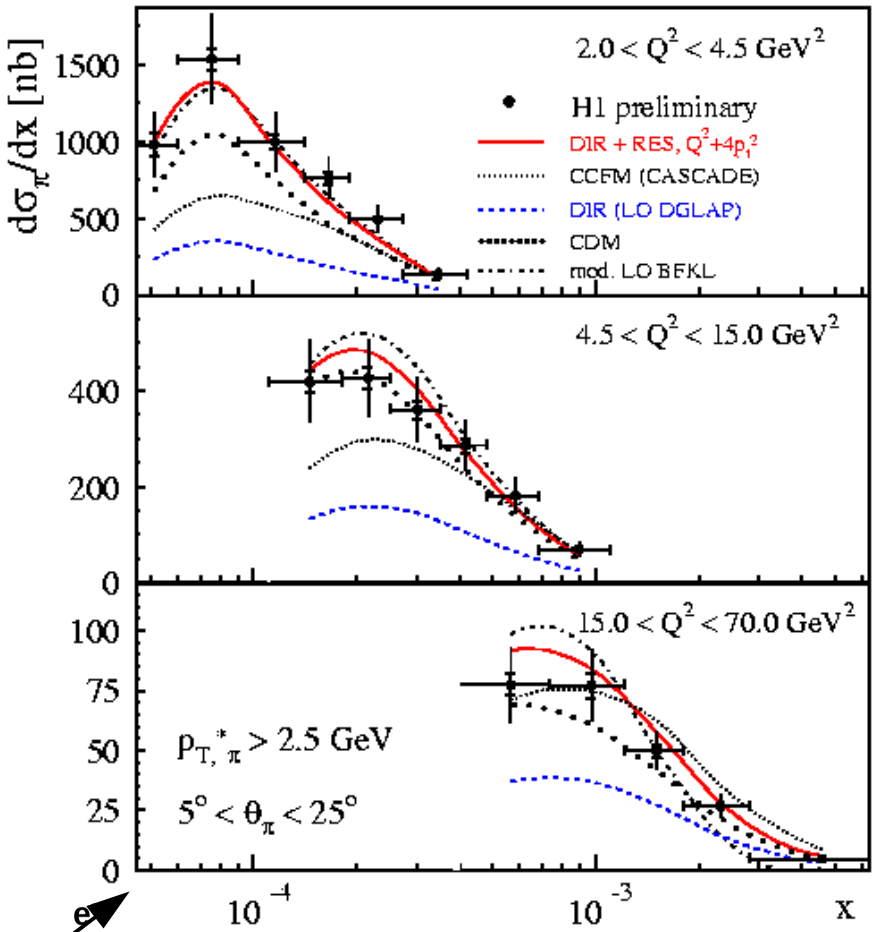


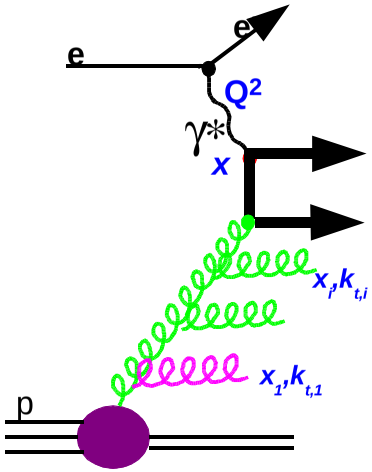
inclusive kt-Algo. for jets

CASCADE prediction sensitive to input pdf

Different conclusions for different ways of jet-finding

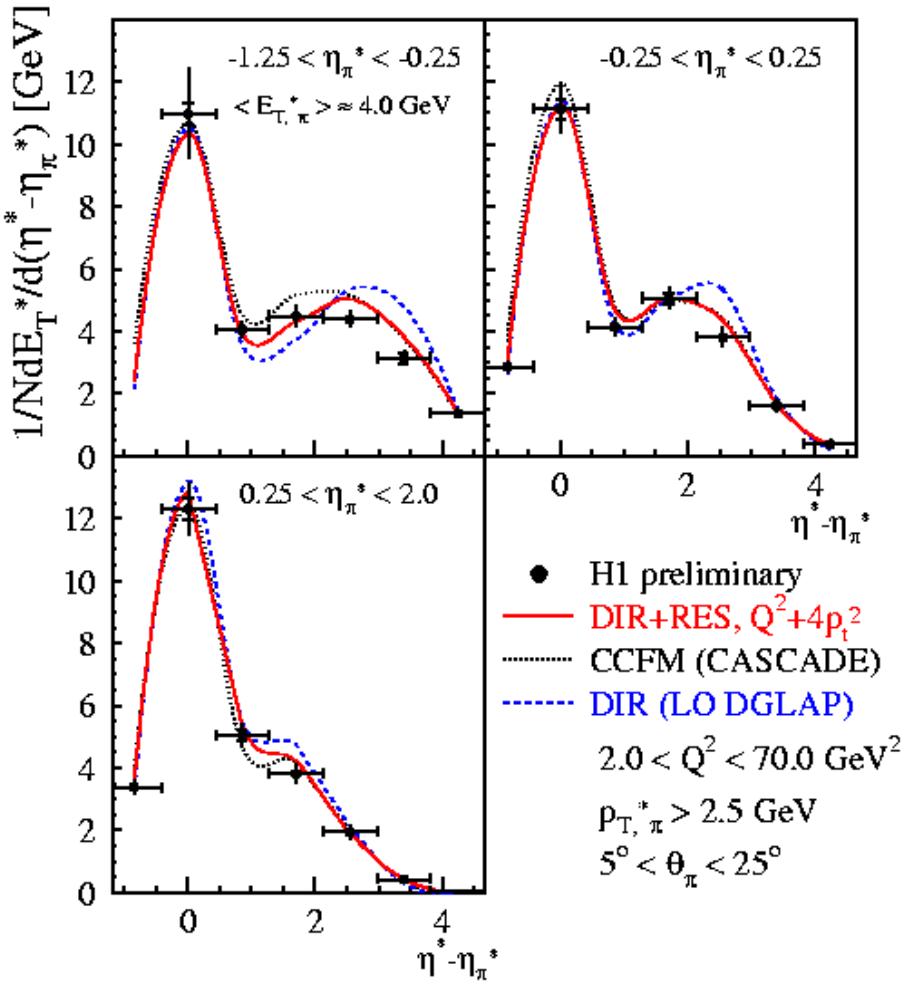
Forward π^0 Cross Sections





Forward π^0 Data prefer models which do not impose k_t-ordering

Transverse Energy Flow around π^0

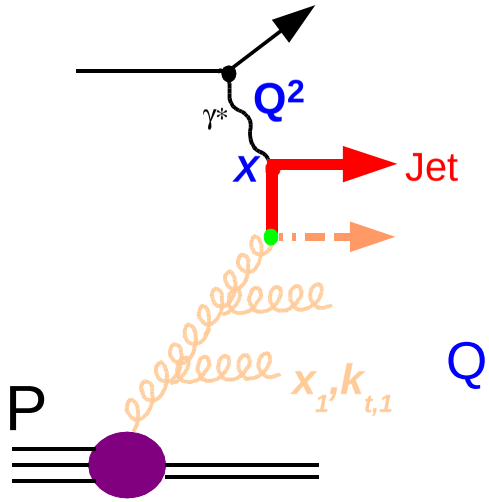


Transverse energy compensation in vicinity of π^0

Data prefer non k_t-ordered ladder

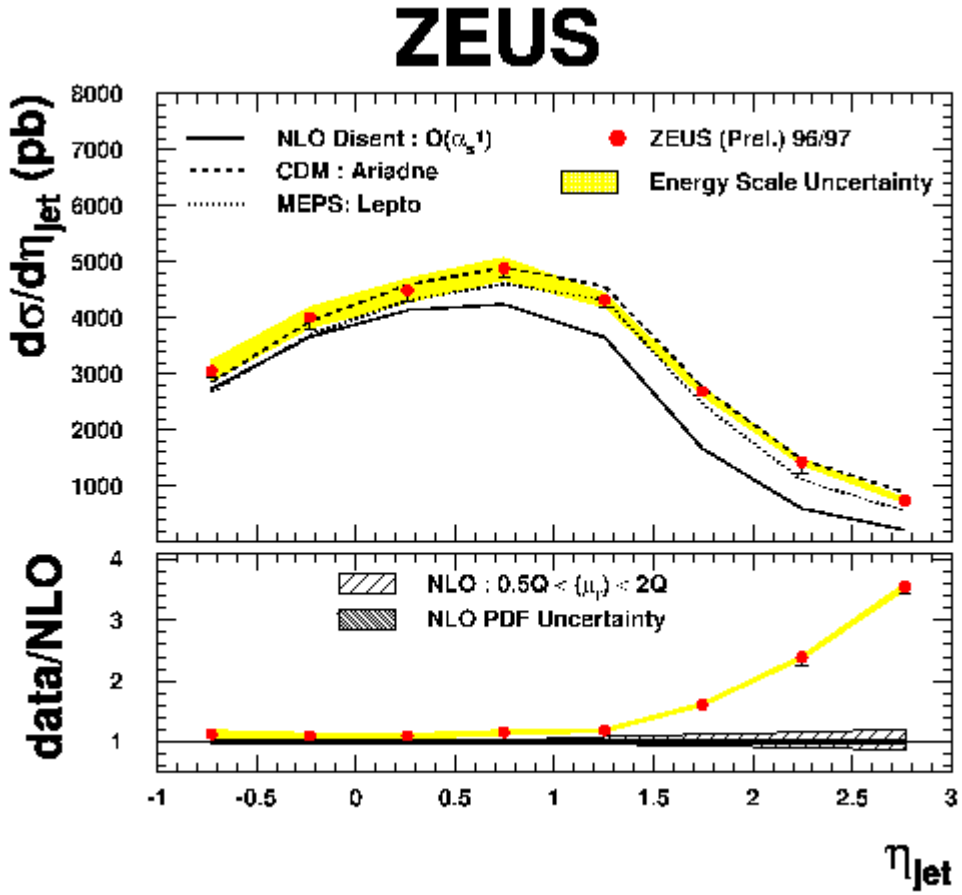
DGLAP approach produces peak further away

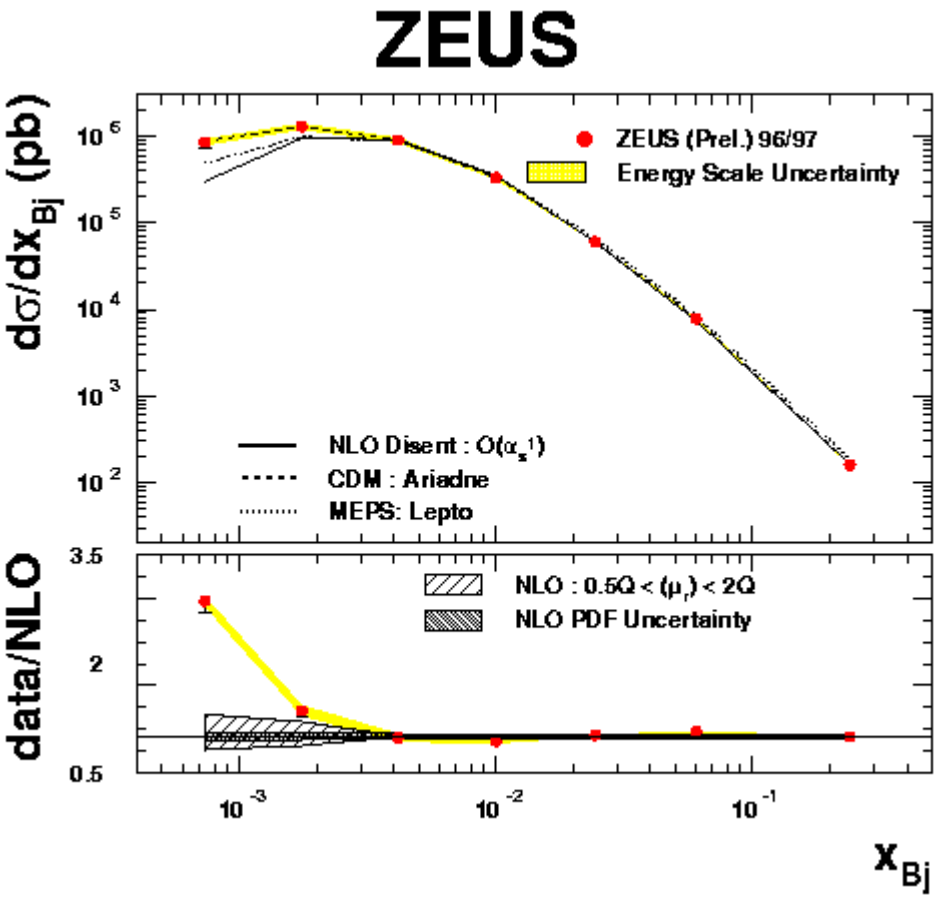
Single Inclusive Jet Cross Sections -I-



Count Jets with
$E_{T,Jet} > 6$ GeV in the Lab

Quark Parton Model event
dominate sample

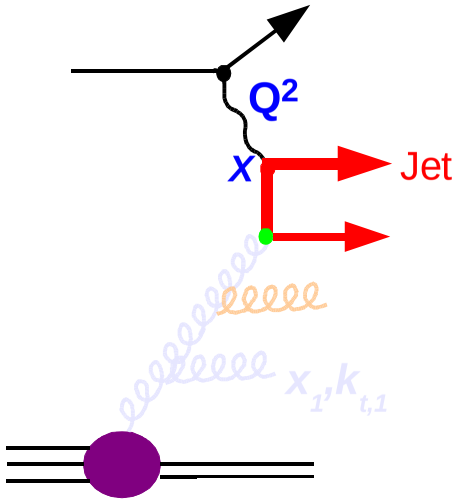




Discrepancy between Data and NLO calc.
in fwd region ↔ low x
Model with full partonic final state lead
to better description

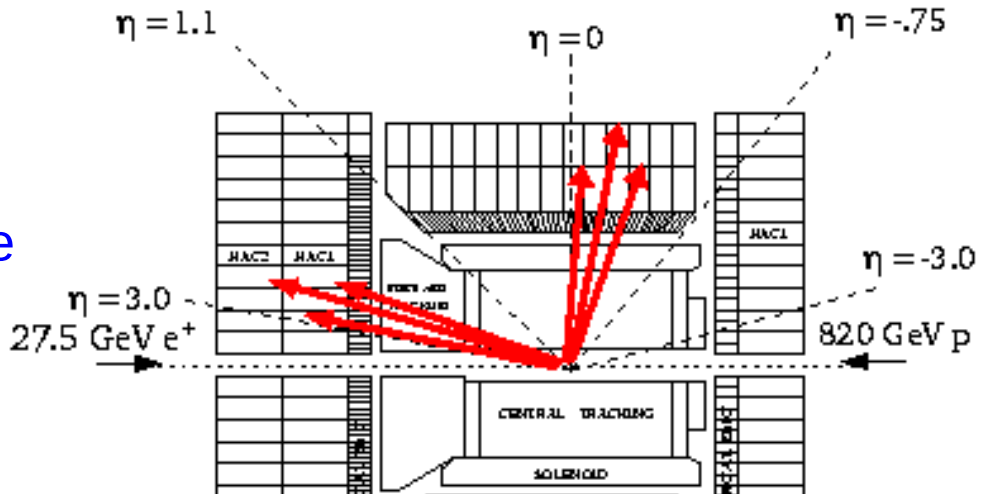
Analytic calculation with ≤ 2 partons
in final state not sufficient

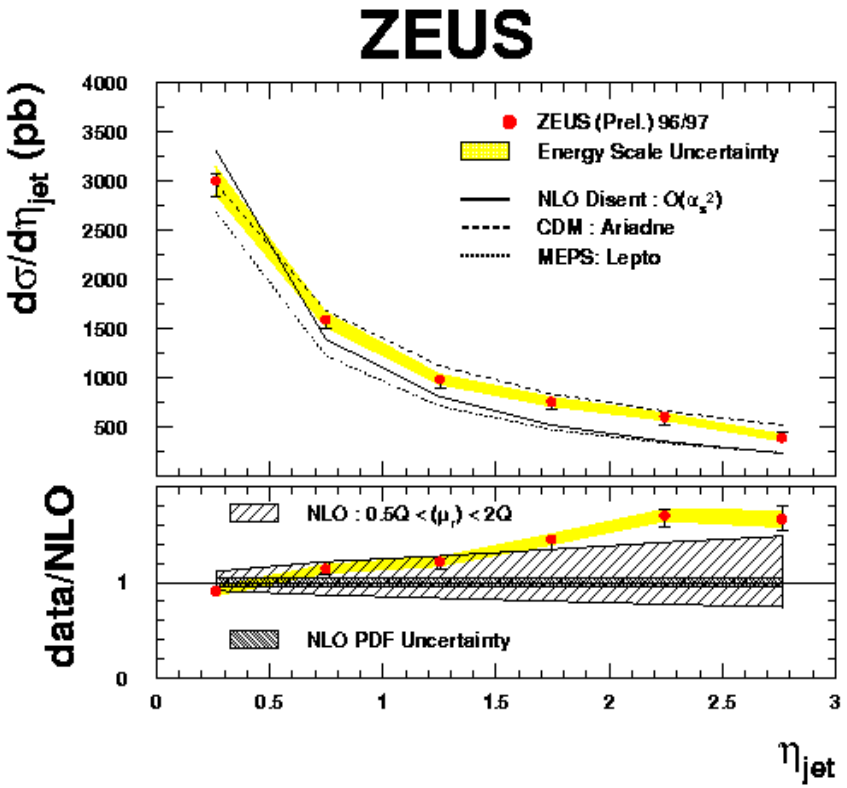
Single Inclusive Jet Cross Sections -II-

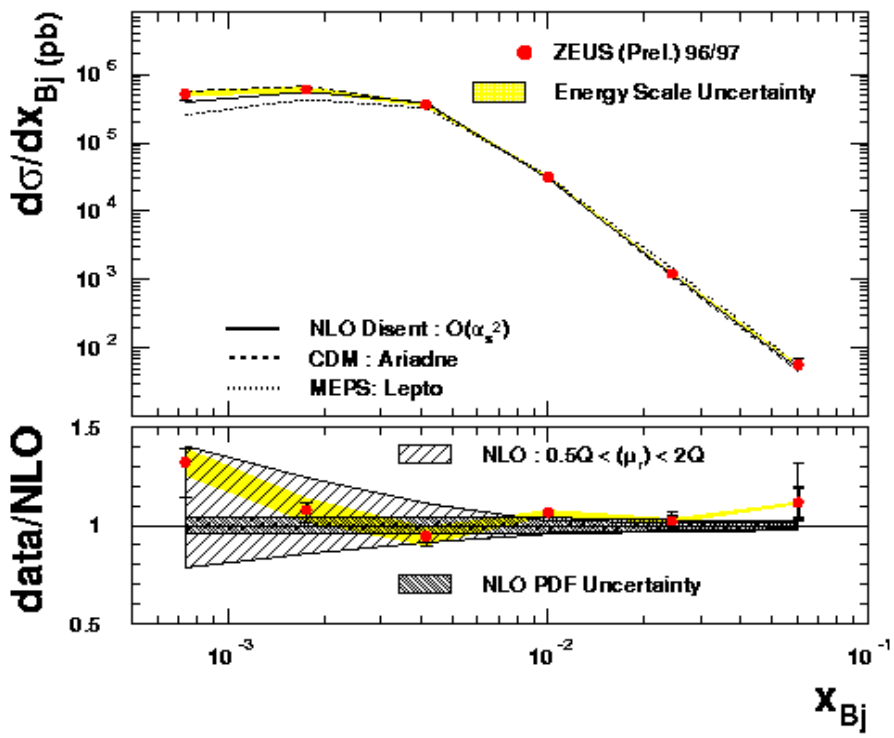


Count Jets with
$E_{T,Jet} > 6$ GeV in the Lab

'Dijet events' enriched sample



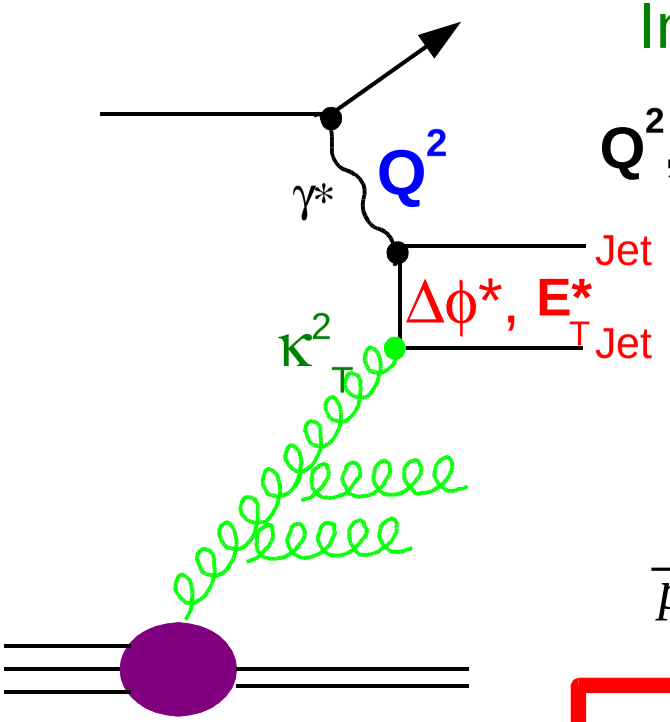




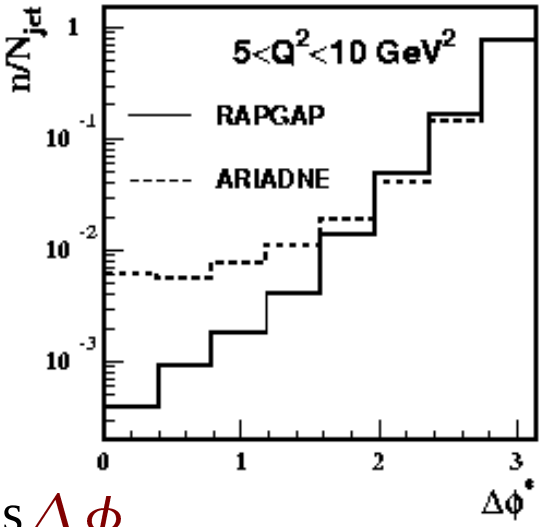
Better agreement between data and NLO
Large theoretical uncertainties prevent strong conclusion

Study of Azimuthal Correlations - $\Delta\phi^*$

Insight into *unintegrated* gluon density



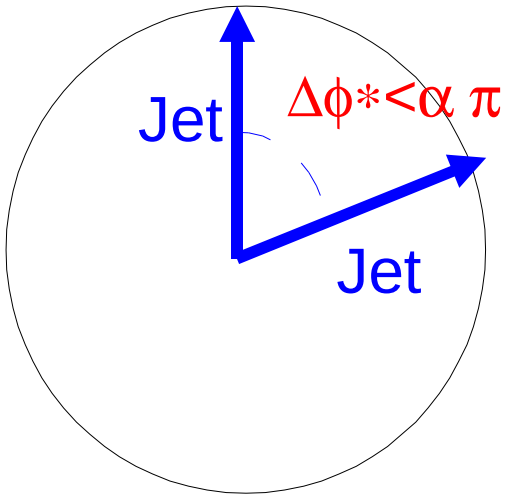
$Q^2, E_T^{*2} >> \kappa_T^2$: $g(x, \kappa_T^2, Q^2) \rightarrow g(x, Q^2)$



$\kappa_T^2 \approx 0$: jets back-to-back in ϕ^*

momentum-conservation: $\Delta\phi^*$ –jet compensates κ_T^2

$$\vec{p}_{t,1} = \vec{\kappa} - \vec{p}_{t,2}, \kappa_T^2 = p_{t,1}^2 + p_{t,2}^2 + 2 p_{t,1} p_{t,2} \cos \Delta\phi$$



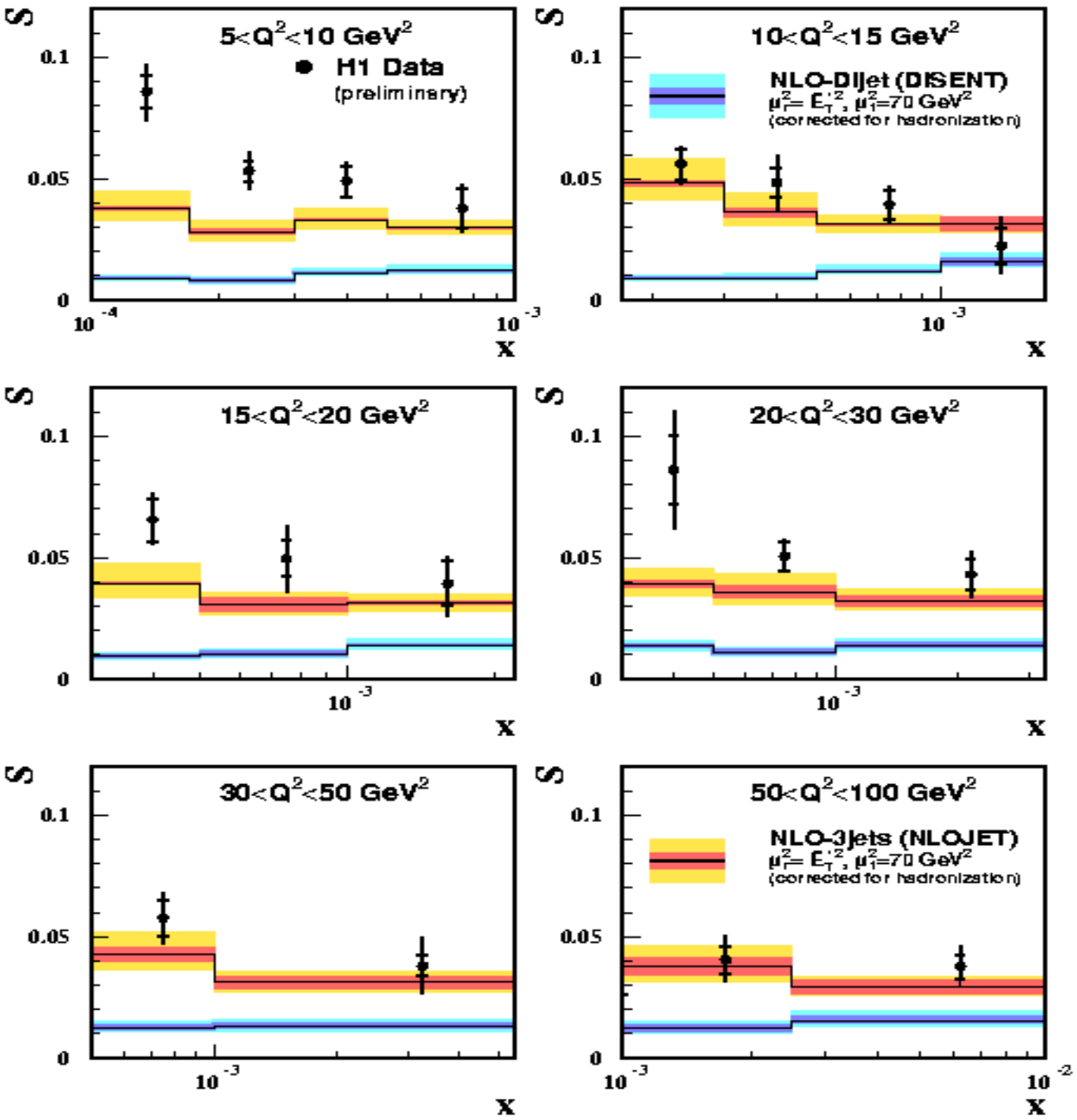
$$S = \frac{\#\ Events\ with\ \Delta\phi^* < 120^o}{All\ Dijet\ Events}$$

Rate of dijet events separated by an azimuthal angle (much) smaller than π

(proposed by A.Szczurek et al. hep-ph/0011281)

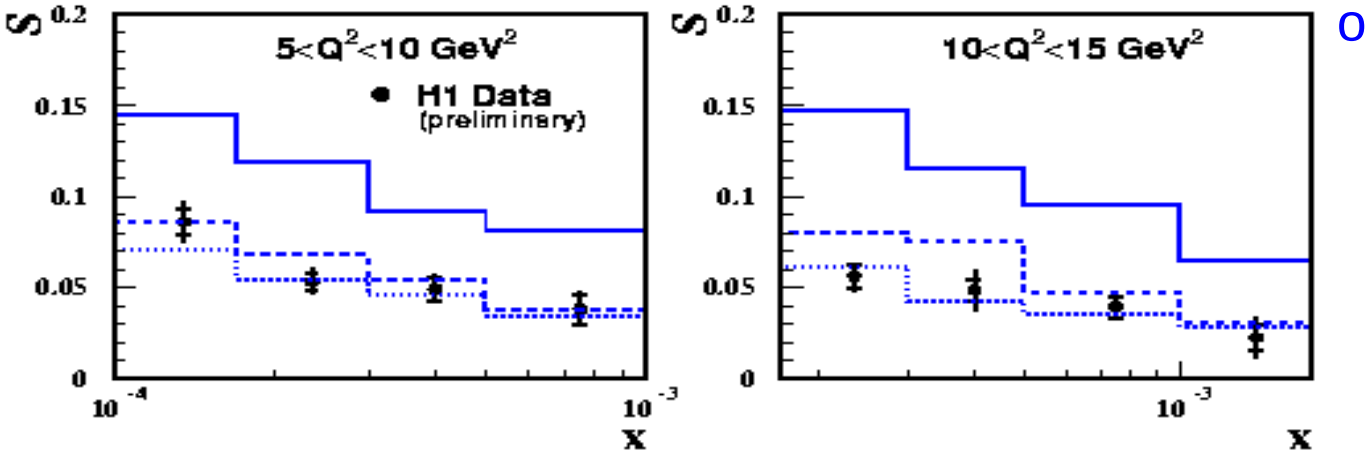
Sensitivity to low-x effects ?!

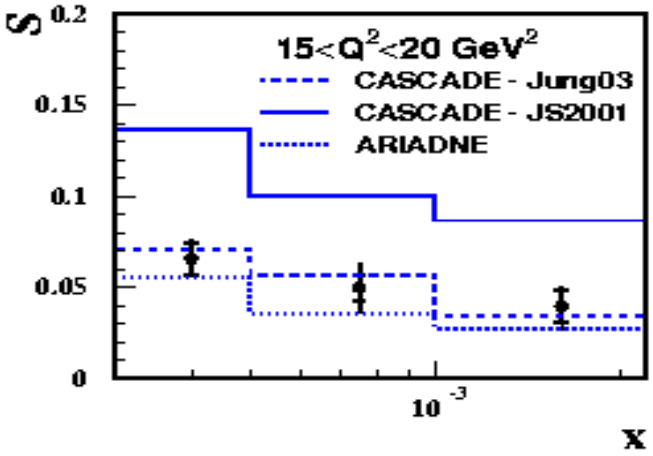
Results for $\Delta\phi^*<120^o$

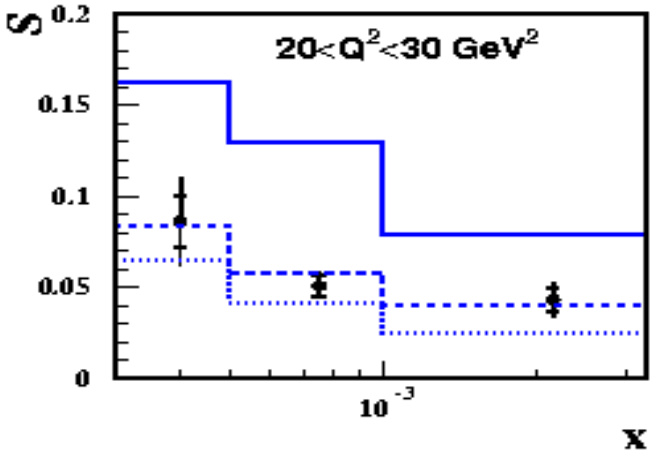


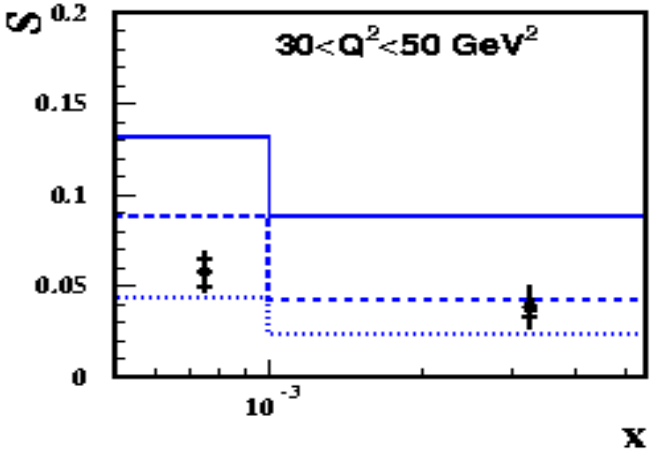
- Data rises towards low x
  - Increasing parton virtuality due to longer parton ladder ?
- NLO-Dijet is significantly away from data
  - Only LO for observable ?
- NLO-3Jet calculations closer to data
  - Still problems towards lowl-x

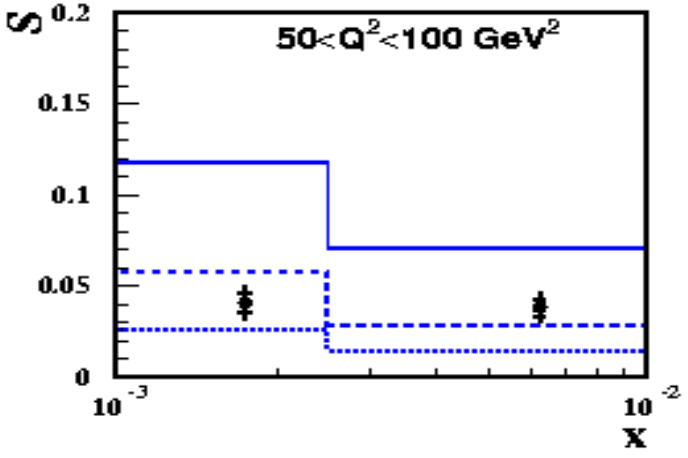
Predictions based on Unintegrated Pdfs

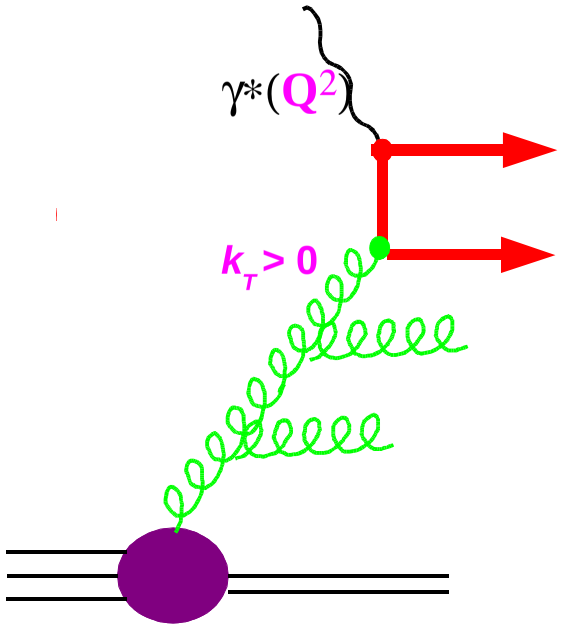












- Unintegrated pdfs provide mechanism to produce Same Side Jets
- Data useful to constrain unintegrated pdf
  S described by CASCADE using recent unintegrated pdfs
- Colour Dipole Model (ARIADNE) describes data, too

Summary and Conclusions

Talk summarized abstracts: A081, A086, A109, A507

- Overview on studies to understand parton dynamics at low-x in DIS presented

- Forward Jet and π^0 production best described by models not imposing DGLAP assumptions (still open questions)

- NLO-QCD calculations have problems to describe single inclusive jet cross sections when jets were measured in the laboratory frame.

- Azimuthal Jet Correlations a powerful tool to study parton dynamics at low-x

  Good agreement with models which incorporate unintegrated gluon pdfs and/or non k_t -ordered parton cascades