BFKL and saturation effects in jet physics at the LHC/Tevatron

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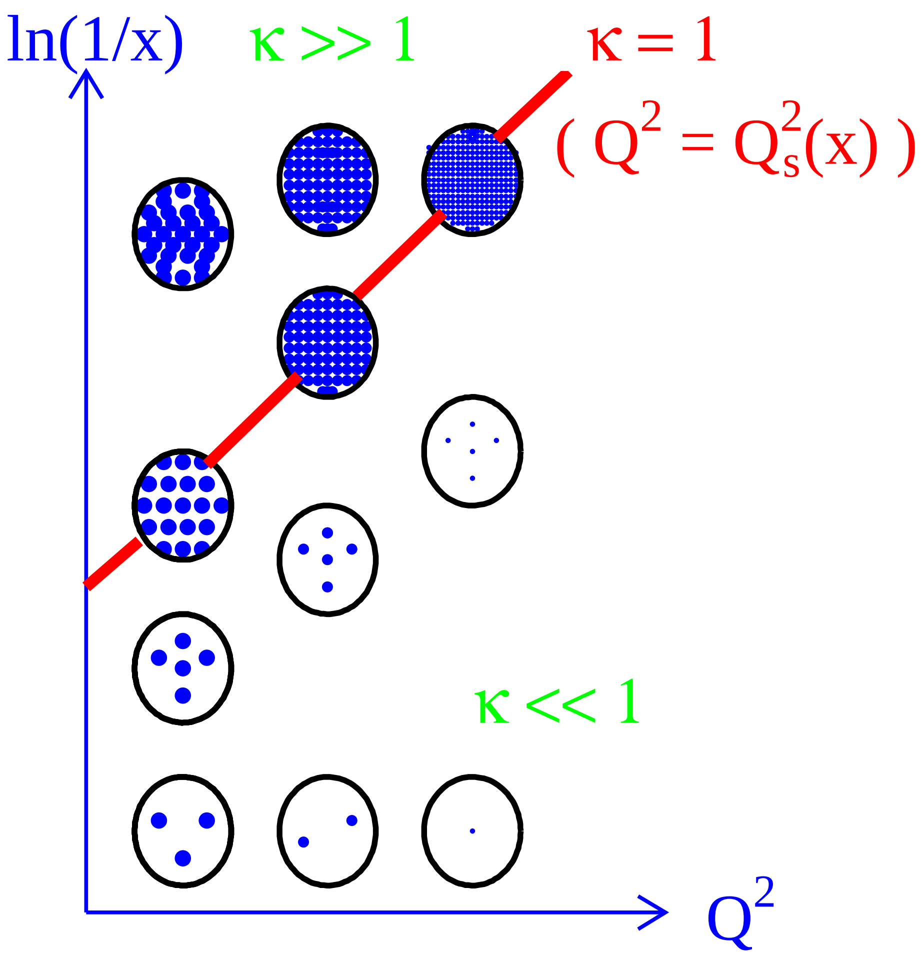
Contents:

- Forward jet production at HERA
- Saturation effects
- Mueller Navelet jets at the Tevatron and LHC

BFKL and DGLAP evolution equations

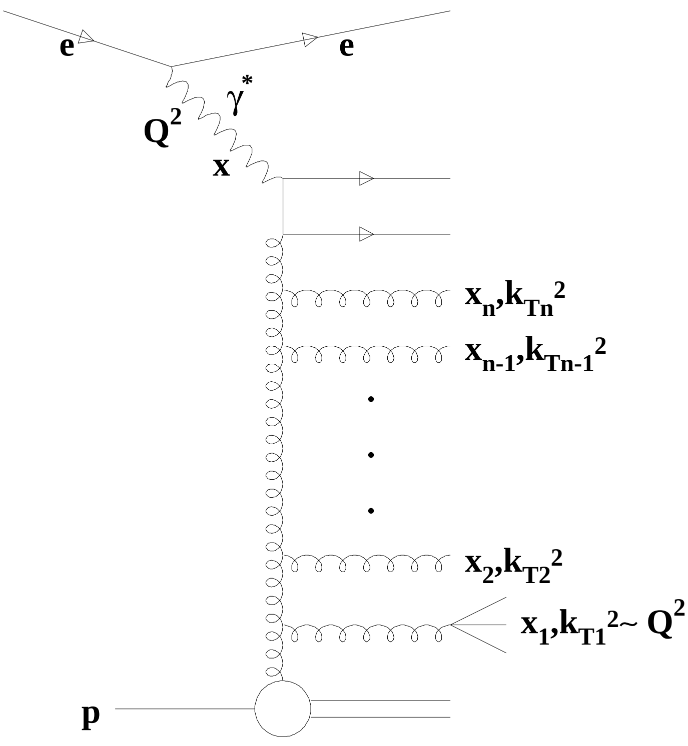
- Dokshitzer Gribov Lipatov Altarelli Parisi (DGLAP) resums all terms in $\alpha_S log Q^2$
- Baltiski Fadin Kuraev Lipatov (BFKL) resums all terms in $\alpha_S log 1/x$
- Saturation effects: low x, low Q^2



BFKL: look for forward jets at HERA

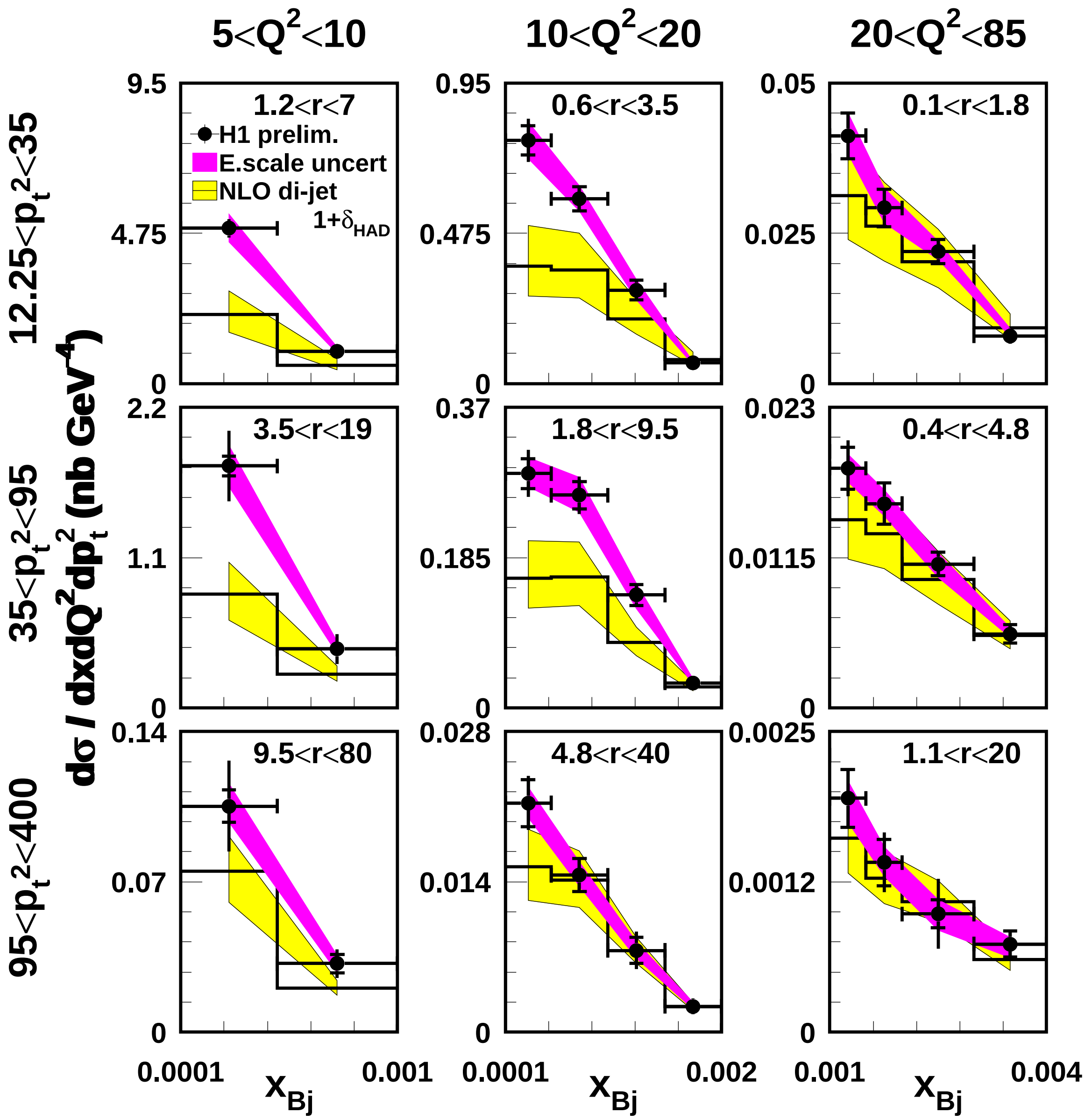
- No obvious observation of BFKL resummation or saturation effects in $F_2 \rightarrow$ look in final state...

- Very simple idea: look for jets with $k_T^2 \sim Q^2(\gamma)$ to favour BFKL equation, and look for saturation as a function of rapidity: the increase of cross section will be slower than for the linear one



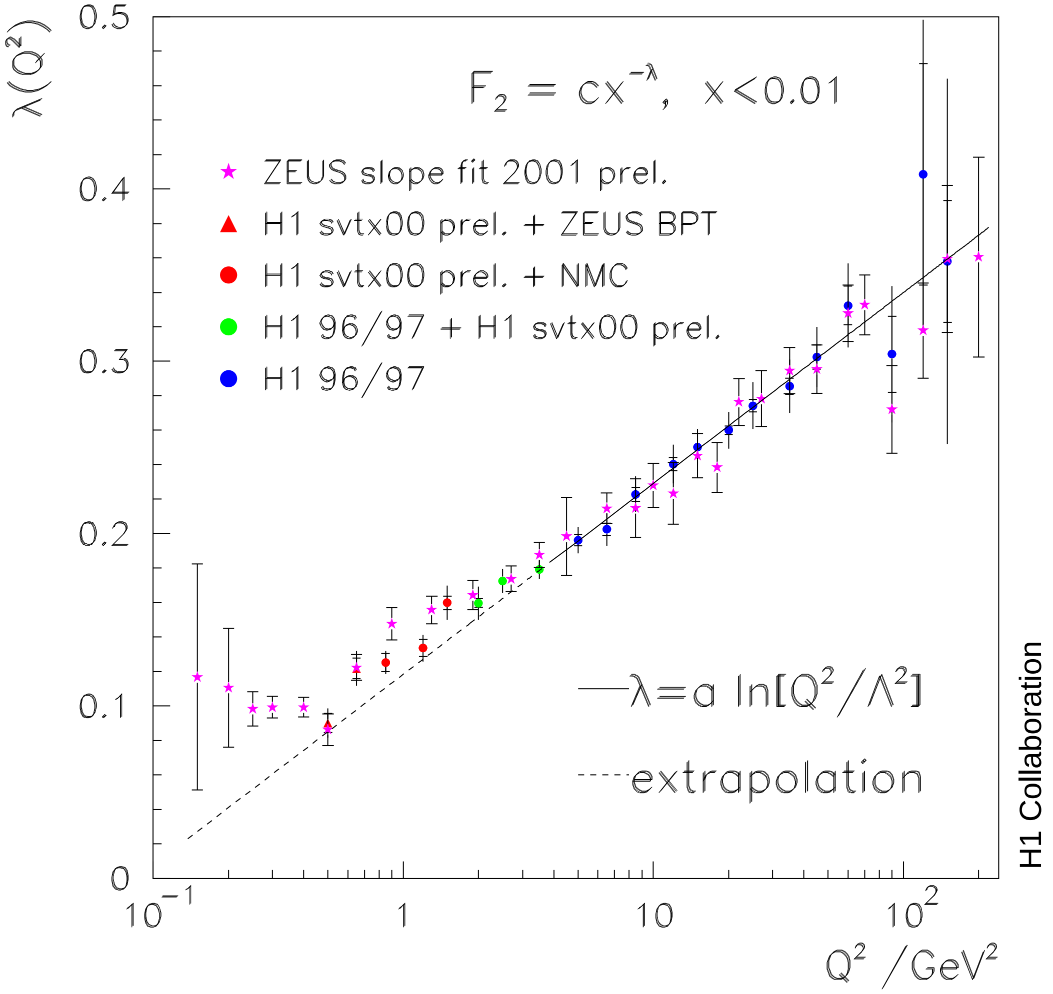
BFKL: look for forward jets at HERA

Measurement in different bins of x, Q^2, $r = p_T^2/Q^2$: measurement higher than NLO DGLAP prediction! (H1 Coll., ICHEP 2004)



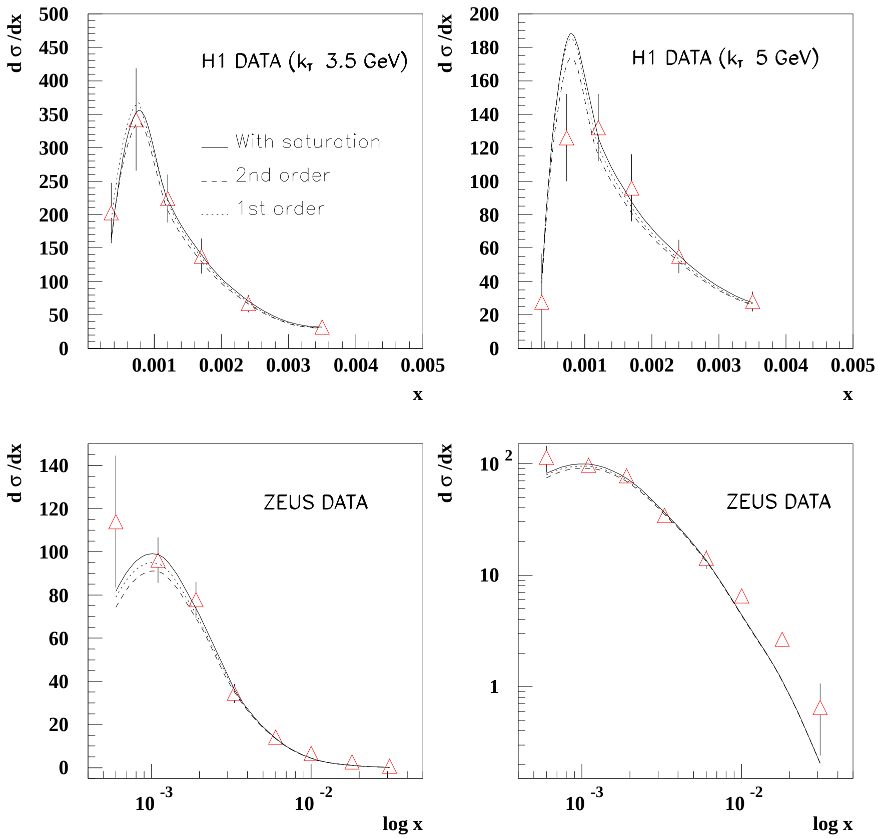
Saturation: what to learn from HERA?

Measurement of the slope of F_2 $(\frac{dlogF_2}{dlog1/x})$ as a function of Q^2: change of slope at very low Q^2, saturation? or outside the domain of perturbative QCD?



Saturation: look for forward jets at HERA

Fit of H1/ZEUS forward jet data using saturation (full saturation, or only first corrections (2nd order) or not (1st order): No difference observed (Marquet, Peschanski, Royon, Phys.Lett.B599 (2004) 236)

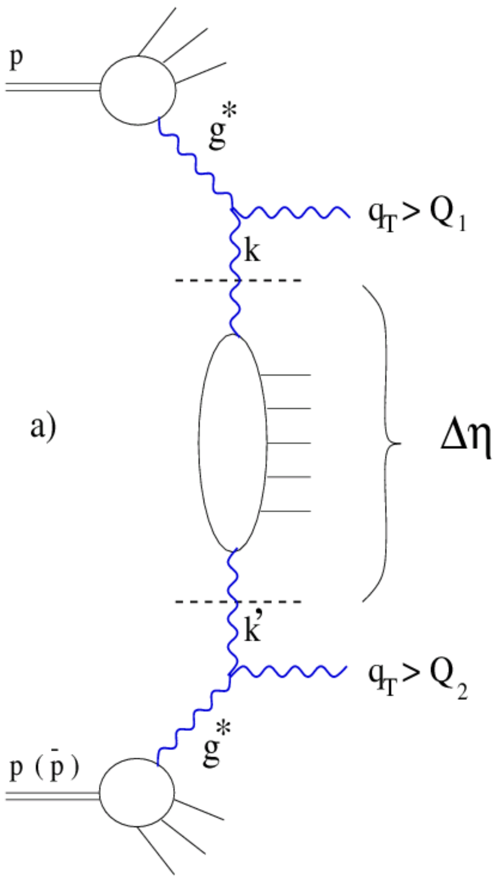


NB: Predictions in more differential observables under way

What about Tevatron? Mueller-Navelet jets

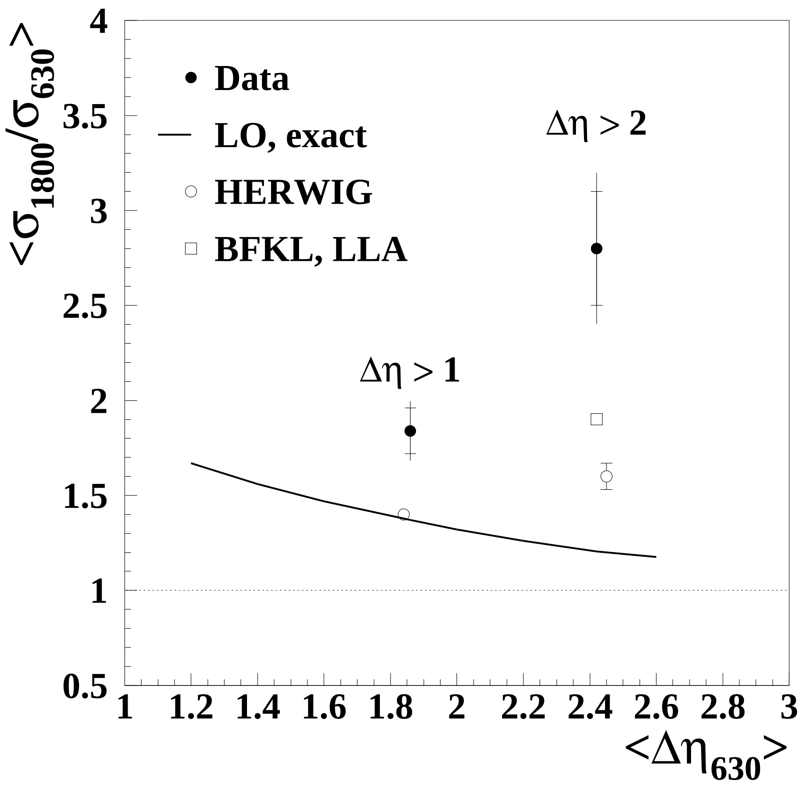
Measure the dijet cross section as a function of the rapidity interval between the two jets -

Consider $q_{T1} \sim q_{T2}$ to suppress DGLAP evolution (jet q_T ordering), and $\Delta\eta$ large enough to allow for BFKL gluon emission



Mueller-Navelet jets at DØ

Test of the BFKL evolution equation using two different center-of-mass energies (DØ Coll, Phys. Rev. Lett. 84, 5722 (2000))



BFKL LO evolution equation leads to $\alpha_{eff} = 1.6$ using the integral over γ (Peschanski, Royon)

Mueller-Navelet jets: test of saturation

Marquet, Peschanski, Royon, Phys.Lett.B599 (2004) 236

- Use Mueller-Navelet processes: BFKL evolution vs BFKL + saturation (benefit from the high gluon density)
- Necessary to go to high rapidities: Compute the cross section ratios $\sigma(\Delta\eta \sim 10)/\sigma(\Delta\eta \sim 2)$ to be sensitive to BFKL resummation effects and test BFKL.
- Use different center-of-mass energies to test for saturation effects

Mueller-Navelet jets: saturation?

Compute

$$R = \sigma(k_{T1}, k_{T2}, \Delta\eta_i = 10)/\sigma(k_{T1}, k_{T2}, \Delta\eta_j = 2)$$

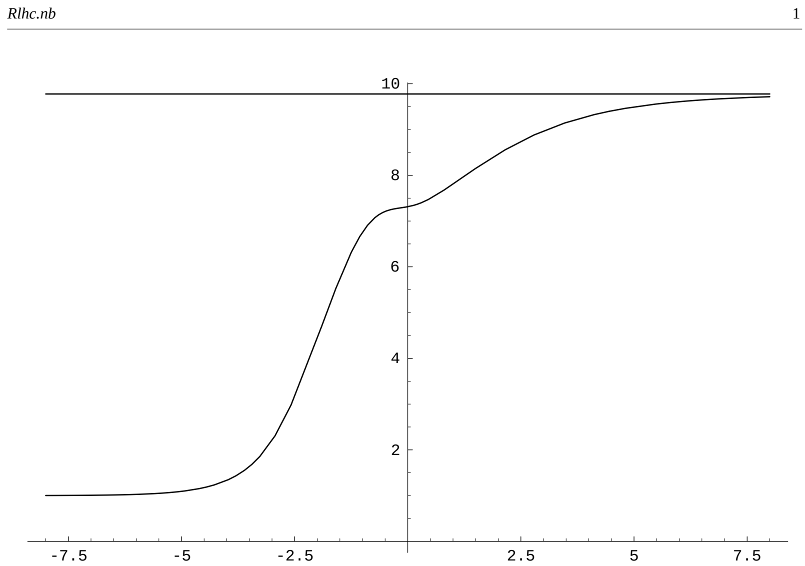


Figure 1: Cross section ratios for two intervals in rapidity - BFKL prediction: flat, saturation : full line

For $k_T \sim 8$ GeV, gives a difference of about 10%, DIFFICULT TO SEE SATURATION EFFECTS AT THE TEVATRON, BUT POSSIBILITY TO SEE BFKL EFFECTS...

<u>Saturation at the LHC?</u>

Cross-section ratios $\mathcal{R}_{i/j}$ between two intervals in rapidities (2 and 8 for the LHC), for two different saturation models , without saturation: flat (Marquet, Peschanski, Royon)

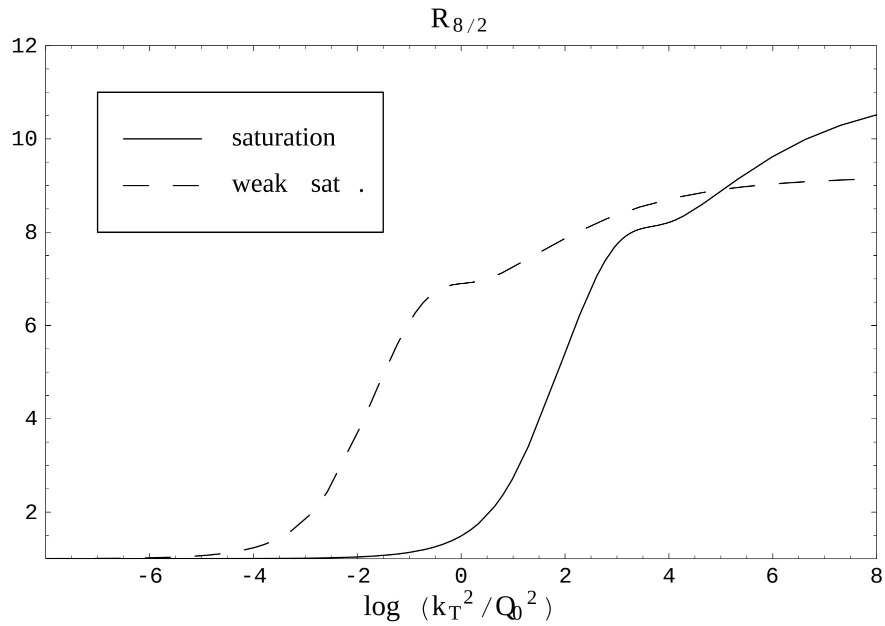


Figure 2: Cross section ratios between two intervals in rapidity at the LHC (BFKL: flat, saturation: full line)

Noticeable effects at the LHC if one probes low p_T jets

Conclusion: Mueller-Navelet jets

- Tevatron: Possibility to study BFKL effects using Mueller-Navelet jets and cross section ratios with two intervals in rapidity, and different center-of-mass energies
- LHC: Possibility to study saturation effects
- Other observables using Mueller-Navelet jets: E_{T1}/E_{T2} dependence of the cross section (which enhances BFKL effects, and saturation), being studied (avoids having two center-of-mass energies)
- Other processes: Vector mesons... allowing to reduce the p_T scale, under study