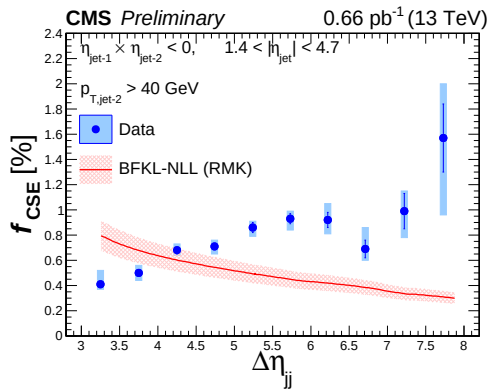
Small-x limit & diffraction, Cristian Baldenegro (University of Kansas, CMS member)

High-energy limit of QCD, expected to be described by Balitsky-Fadin-Kuraev-Lipatov (BFKL) evolution. Parton splitting at small-x $\rightarrow$ Rapid increase of gluon densities at small-x.

Typical experimental probes of small-x dynamics:

- PDFs at small-x, small $Q^2 > \Lambda^2_{\mathrm{QCD}}$.
- Exclusive vector meson production ($\gamma^* p \rightarrow Vp$).
- Mueller-Navelet jets ($\Delta y_{jj} \gg 1$, BFKL-like parton radiation pattern induces large azimuthal decorrelations between outermost jets).
- Jet-gap-jet ($\Delta y_{jj} \gg 1$ + rapidity gap between jets; expected to be described by BFKL pomeron exchange between interacting partons).

Jet-gap-jet @ 13 TeV



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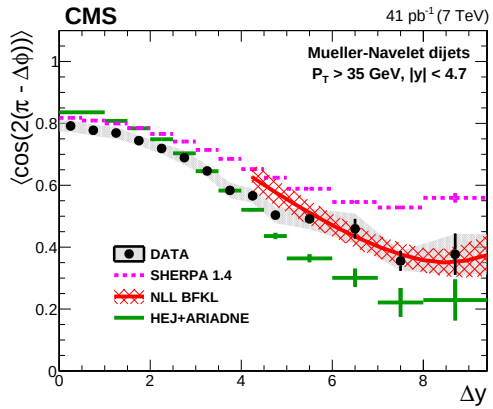
Mueller-Navelet @ 7 TeV



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Lesson from the last years: **very difficult to separate BFKL dynamics from DGLAP evolution**. Some hints of BFKL dynamics have been observed in data, but conclusions are very hard to draw.

It is crucial to clearly identify a set of observables that would conclusively tell us something about BFKL evolution. If we aim to search for parton saturation effects at the future EIC (parton splitting + parton recombination at small-x), we have to understand BFKL evolution.

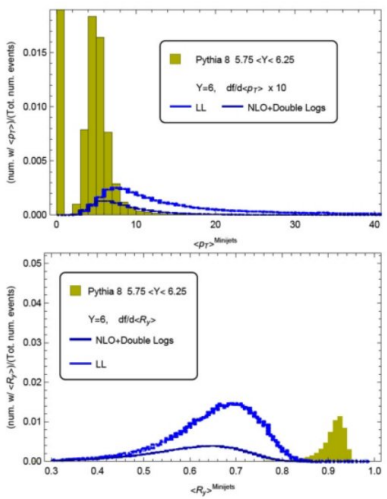
For instance: Mueller-Navelet minijet observables to isolate BFKL

Since Fourier coefficients of $\Delta\phi_{jj}$ distributions can be well described by DGLAP or BFKL based approaches (cf previous slide), it is interesting to consider observables that in addition look at the interjet activity. BFKLex generator (A. Sabio-Vera, G. Chachamis, JHEP02 (2016) 064), for instance, can be used to calculate these quantities.

BFKL dynamics: looking for less inclusive variables

$$\langle p_T \rangle = \frac{1}{N} \sum_{i=1}^{N} |p_{Ti}|$$

$$\langle R_y \rangle = \frac{1}{N+1} \sum_{i=1}^{N+1} \frac{y_i}{y_{i-1}}$$



- Looking for multiple gluon emission along ladder characteristic of BFKL: number, p_T, rapidity distributions of "minijets"
- Comparison between BFKL-ex MC and pythia/herwig to find best variables: collaboration with A. Sabio Vera, D, Gordo, G. Chachamis, F. Deganutti, T. Raben

Slide by C. Royon

$\langle R \rangle$ is the average of the ratio of rapidities of adjacent jets.
$\langle p_T \rangle$ is the average of transverse momentum of the minijets.
BFKL predictions in blue.
DGLAP predictions in yellow.

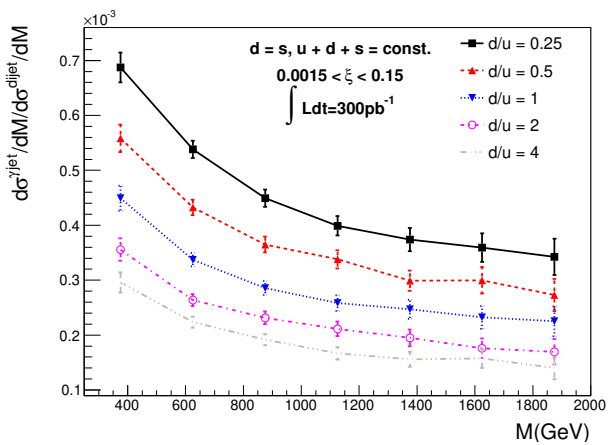
Hard diffraction at the LHC ($pp \to pX$ or $pp \to pXp$)

Diffractive PDFs (dPDFs): extracted from H1 and ZEUS inclusive diffractive DIS measurements. Important component of the proton structure.

At the LHC, we wish to:

- Test universality of pomeron exchange in e-p collisions and pp collisions.
- Constrain dPDFs at larger proton fractional momentum loss ξ at various $\sqrt{s} \to$ Coverage of larger $\beta = x/\xi$ fraction of pomeron momentum carried by interacting parton.
- Study of hard diffractive cross sections as function of square of four-momentum transfer at proton vertex $t \to$ Fourier conjugate is related to gluon PDFs in impact parameter space.
- Understanding the mechanism behind factorization breaking (survival probability).
- Can LHC data be used together with HERA data in order to extract dPDFs?

In the extraction of dPDFs at HERA, one assumes that quark densities share the same amount of momentum (i.e., $u = \bar{u} = d = \bar{d} = s = \bar{s} = q$). At the LHC, one could test this flavor symmetry hypothesis, for example by considering diffractive production of $W^{\pm}$ boson, γ+jet.



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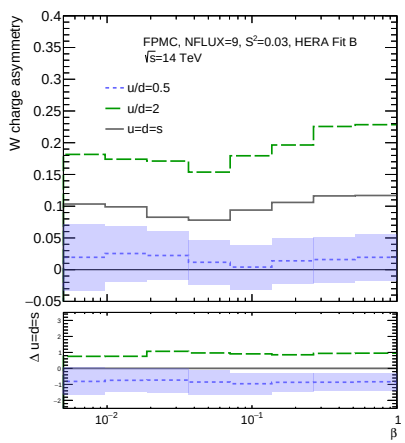

A. Chuinard, C. Royon, R. Staszewski JHEP 04 (2016) 092