Single-diffractive dijet production at high energies within the k_t -factorization approach

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We discuss single-diffractive production of dijets. The cross section is calculated for the first time in the k_t-factorization approach, neglecting transverse momentum of the pomeron. We use Kimber-Martin-Ryskin unintegrated parton (gluon, quark, antiquark) distributions (UPDF) both in the proton as well as in the pomeron or subleading reggeon. The UPDFs are calculated based on conventional MMHT2014nlo PDFs in the proton and H1 collaboration diffractive PDFs used previously in the analysis of diffractive structure function and dijets at HERA. We try to describe the existing data from Tevatron and make detailed predictions for possible LHC measurements.

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1 Introduction

We discuss single-diffractive production of dijets. This process was discussed in the past for photo- and electro-production as well as for proton-proton or proton-antiproton collisions. The hard single diffractive processes are treated usually in the resolved pomeron picture with a pomeron being a virtual but composed (of partons) object. This picture was used with a success for the description of hard diffractive processes studied extensively at HERA. This picture was tried to be used also for hadronic collisions. A few processes were studied experimentally at the Tevatron including the dijet production. We propose the single-diffractive dijet production for the first time within the k_t-factorization approach, see [1]. Similar approach was used recently for the single-diffractive production of $c\bar{c}$ pairs [2]. In particular, we wish to compare results obtained within collinear-factorization and k_t-factorization approaches. A comparison with the Tevatron data and predictions for the LHC are presented.
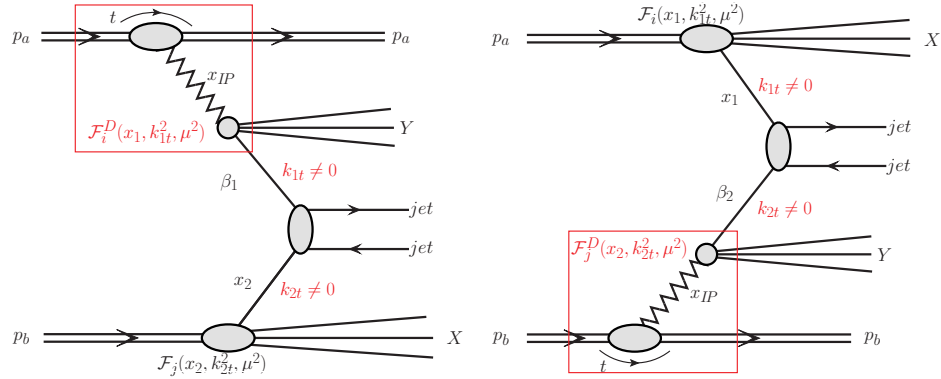
2 A sketch of the approach

Figure 1: A diagrammatic representation of the considered mechanisms of single-diffractive dijet production.

According to the approach sketched above in Fig. 1, the cross section for inclusive single-diffractive production of dijet, for both considered diagrams (left and right panel of Fig. 1), can be written as:

$$
\begin{aligned}
d\sigma^{SD(1)}(p_a p_b \to p_a \text{ dijet } XY) \;=\; & \sum_{i,j,k,l} \int dx_1 \frac{d^2 k_{1t}}{\pi} dx_2 \frac{d^2 k_{2t}}{\pi} \, d\hat{\sigma}(i^* j^* \to kl) \\
& \times \mathcal{F}_i^D(x_1, k_{1t}^2, \mu^2) \cdot \mathcal{F}_j(x_2, k_{2t}^2, \mu^2),
\end{aligned} \tag{1}
$$

$$d\sigma^{SD(2)}(p_a p_b \to \text{dijet } p_b \, XY) \;\; = \;\; \sum_{i,j,k,l} \int dx_1 \frac{d^2 k_{1t}}{\pi} dx_2 \frac{d^2 k_{2t}}{\pi} \, d\hat{\sigma}(i^* j^* \to kl)$$

$$\times \, \mathcal{F}_i(x_1, k_{1t}^2, \mu^2) \cdot \mathcal{F}_j^D(x_2, k_{2t}^2, \mu^2), \qquad (2)$$

where $\mathcal{F}_i(x, k_t^2, \mu^2)$ are the "conventional" unintegrated (k_t-dependent) parton distributions (UPDFs) in the proton and $\mathcal{F}_i^D(x, k_t^2, \mu^2)$ are their diffractive counterparts – which we will call here diffractive UPDFs (dUPDFs). Details of our new calculations can be found in [1].

3 Results

We start by showing our results for $\overline{E}_T = \frac{E_{1T} + E_{2T}}{2}$ and $\overline{\eta} = \frac{\eta_1 + \eta_2}{2}$ distributions, see Fig. 2. In this calculation the pomeron/reggeon longitudinal momentum fraction was limited as in experimental case [3, 4] to $0.035 < x_{IP,IR} < 0.095$. We show both naive result obtained with the KMR UGDF (dashed line) as well as similar results with limitations on parton transverse momenta $k_T < p_T^{sub}$ (solid line) and $k_T < 7$ TeV (dash-dotted line). Above p_T^{sub} is transverse momentum of the subleading jet. The first limitation was proposed for standard nondiffractive jets [5]. A large difference can be seen close to the lower transverse momentum cut. In Fig. 3 we show distribution
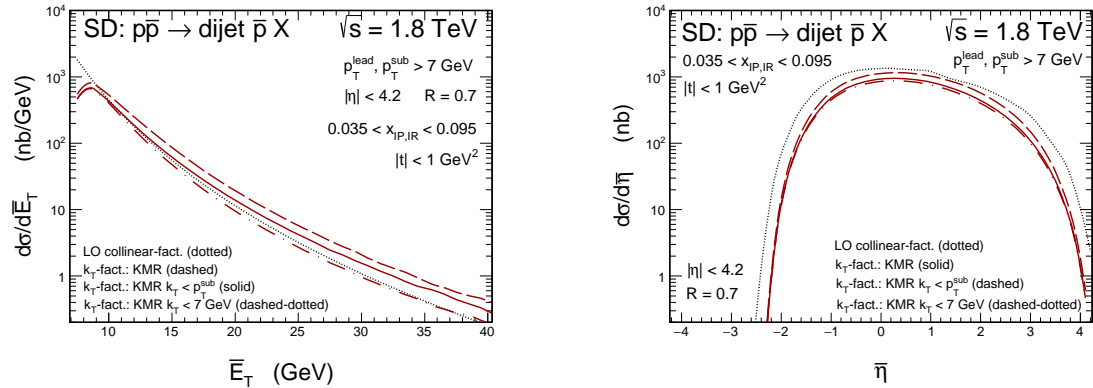

Figure 2: Distribution in average $\overline{E}_T$ (left panel) and in average $\overline{\eta}$ (right panel). Here S_G = 0.1 was assumed.

in $\overline{E}_T$ for two collision energies. While the k_t-factorization approach gives a better description of the data close to the lower experimental cut on jet transverse momenta, the collinear-factorization approach seems to be better for larger transverse momenta.

In Fig. 4 we show distributions in average jet rapidity again for the two collision energies. Here the k_t-factorization result better describes the experimental data than
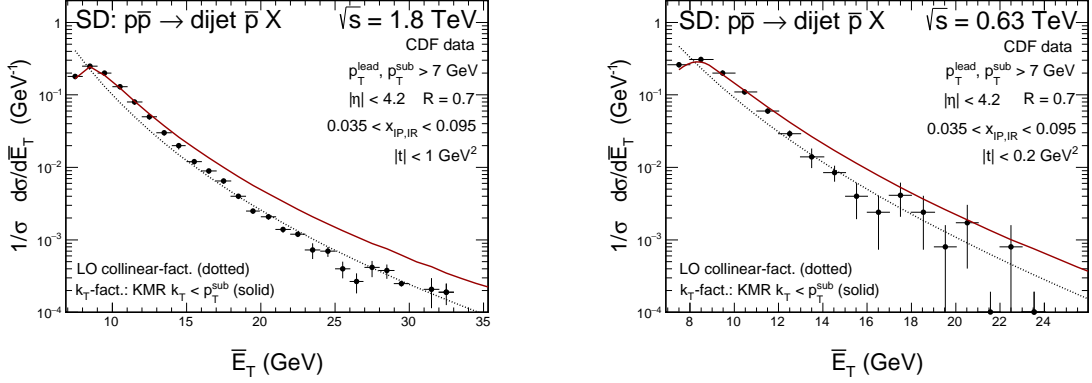
Figure 3: The average transverse energy distribution for $\sqrt{s} = 1.8$ TeV (left panel) and for $\sqrt{s} = 630$ GeV (right panel).

the result obtained in the collinear approach. The outgoing antiproton is at $\eta \approx$ -6.05 for $\sqrt{s} = 1.8$ TeV and $\eta \approx$ -5.53 for $\sqrt{s} = 630$ GeV, respectively.
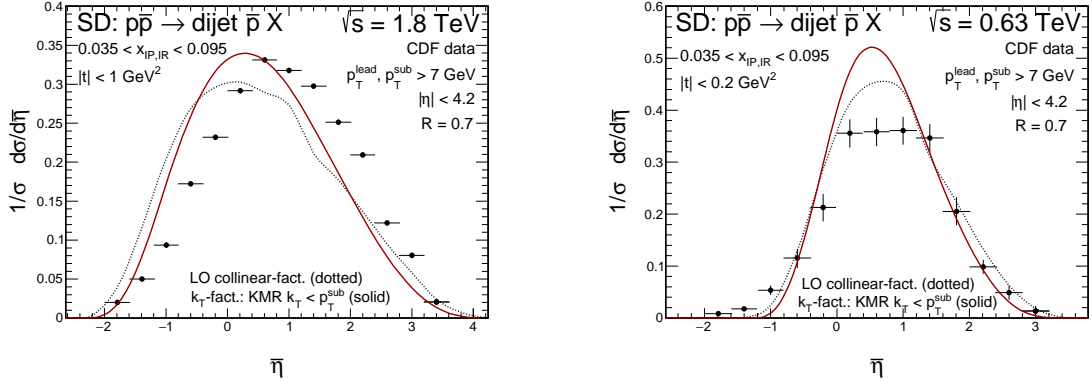

Figure 4: The average rapidity dsistribution for $\sqrt{s} = 1.8$ TeV (left panel) and for $\sqrt{s} = 630$ GeV (right panel).

In Fig. 5 we show distribution in jet transverse momentum, for leading (left panel) and subjeading (right panel) jets. As for the Tevatron we discuss the role of extra cuts on parton transverse momenta. The cuts have bigger efect on leading jets.

4 Conclusion

We have presented results for the single-diffractive production of dijets within k_t-factorization approach. Results of our calculations were compared with the Tevatron
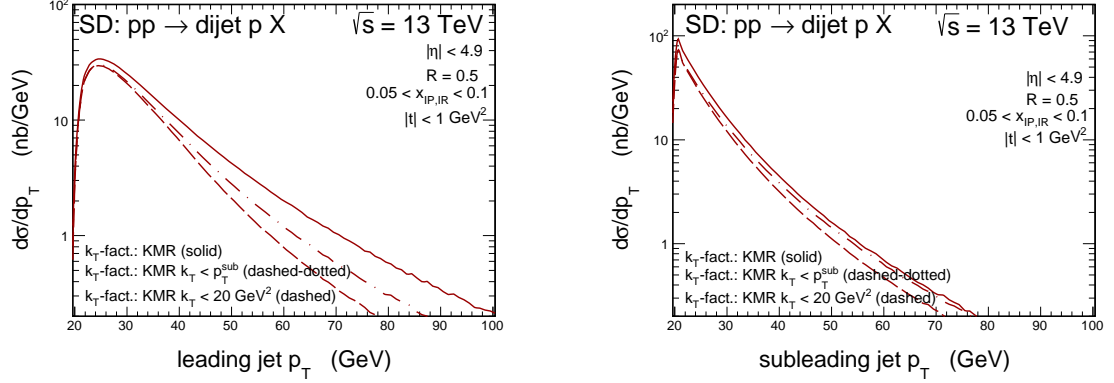
Figure 5: Distribution in the jet transverse momentum for leading (left panel) and subleading (right panel) for $\sqrt{s} = 13$ TeV and for the ATLAS cuts. Here $S_G = 0.05$.

data where forward antiprotons and rapidity gaps were measured. We have calculated distributions in $\overline{E}_T$ and $\overline{\eta}$. A resonable agreement has been achieved. We have compared results obtained within collinear and k_t-factorization approaches. The k_t-factorization leads to a better description in E_T close to the lower transverse momentum cut.

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