Dynamical survival factor in jet-gap-jet processes

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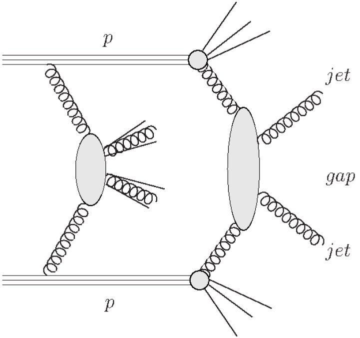
Introduction

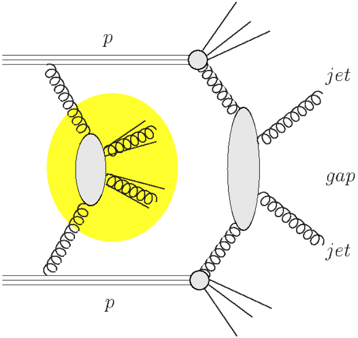
The jet-gap-jet process is an example of the diffractive jet production, in which the pomeron is exchanged between the produced jets.

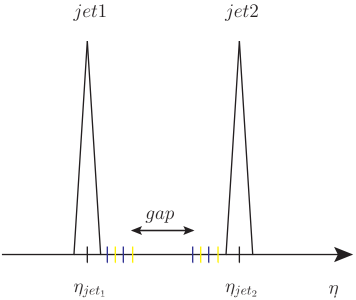


Jet-gap-jet event can be understood as an process where particle production in the rapidity region between the jets is suppressed.

Measurments of the jet-gap-jet process where done by collaborations: D∅,CDF (disscussed in *O. Kepka, C. Marquet, and C. Royon,Phys. Rev. D 83, 034036*) and CMS (*Dijet production with a large rapidity between jets,CMS-PAS-FSQ-12-001*)

MPI- suppressing mechanism

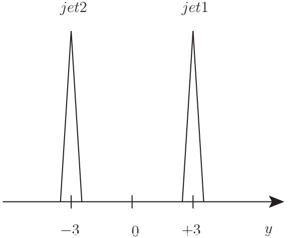




Mechanism of destroying rapidity gap, here this will be Multi-Parton Interactions (MPI)

Particle production in jet events

We selected the following example:

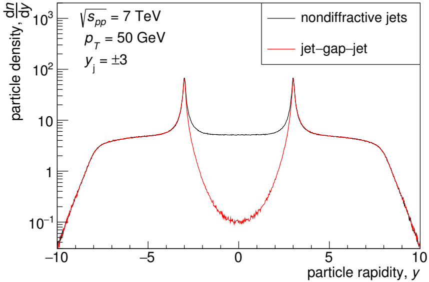


with fixed position of jets and fixed $p_T = 50 GeV$

The diffrence between nondifractive and jet-gap-jet:

- nondifractive (gg→gg), normal flow of colour charges
- jet-gap-jet, no colour flow - color singlet

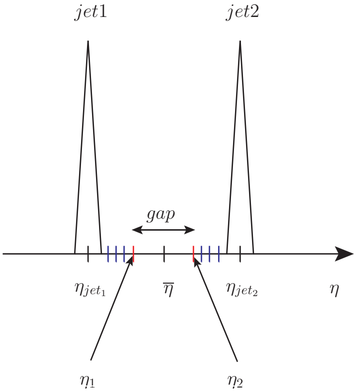
Hadronisation process was obtained with Pythia 8.



The density of produced particles is reduced by two orders of magnitude, when no colour is transfered between the jets.

Particle production in jet events

We define gap between the jets as follows:



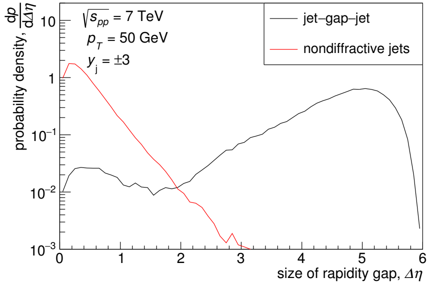
Rapidity gap distributions for

the selected kinematical configuration.

$\overline{\eta} = 0$

$\eta_{jet_1} = -3$

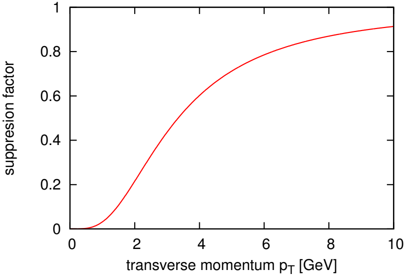
$\eta_{jet_2} = +3$



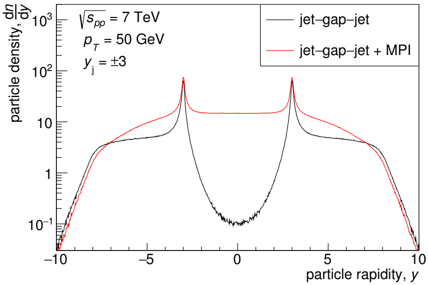
Multi-parton interaction

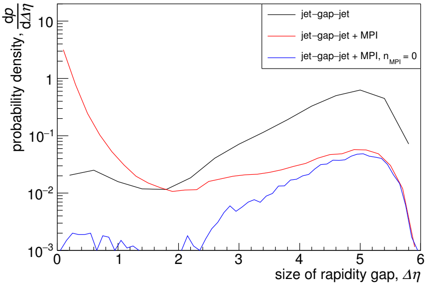
The MPIs are modeled in Pythia with the help of minijets calculated in collinear factorization approach with a special treatment at low transverse momenta by multiplying standard cross section by a suppression factor $F_{sup}(p_t)$.

$$F_{sup}(p_t) = \frac{p_t^4}{(p_{t0}^2 + p_t^2)^2}\theta(p_t - p_{t,cut})$$



Multi parton interactions in jet-gap-jet events

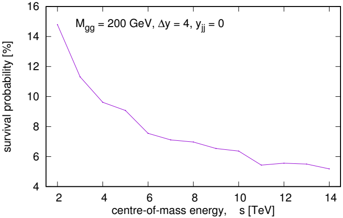


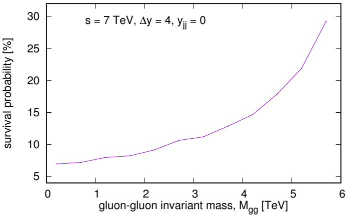


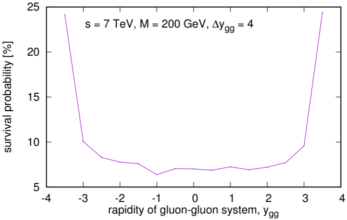
- additional particles are produced in the region where gap was expected
- the blue curve contains MPI effects but only for events without additional interactions
- gap greater than 5 - no additional interactions occured

Rapidity gap survival probability

Kinematics depedence of gap survival probability, defined as a fraction of events in which any additional parton-parton interactions occured.







$$S_G = \frac{\text{result with MPI}, n_{MPI}=0}{\text{result without MPI's}}$$

Process dynamics and MPI modeling

More realistic situations - integration over phase space (Monte Carlo simulations).

We impose only cuts on transverse momentum $200 GeV > p_T > 40 GeV$.

For illustration process dynamics we take LL BFKL amplitude as disscussed in *O. Kepka, C. Marquet, and C. Royon,Phys. Rev. D 83, 034036*

$$A(\Delta\eta, p_T^2) = \frac{16 N_C \pi \alpha_s^2}{C_F p_T^2}$$

$$\sum_{p=-\infty}^{\infty} \int \frac{d\gamma}{2i\pi} \frac{[p^2 - (\gamma - 1/2)^2] exp(\alpha \chi_{eff}[2p, \gamma, \alpha]\Delta\eta)}{[(\gamma - 1/2)^2 - (p - 1/2)^2][(\gamma - 1/2)^2 - (p + 1/2)^2]}$$

BFKL amplitude for gg→gg with color singlet exchange

$$A(\Delta\eta, p_T^2) = \frac{16 N_C \pi \alpha_s^2}{C_F p_T^2}$$

$$\sum_{p=-\infty}^{\infty} \int \frac{d\gamma}{2i\pi} \frac{[p^2 - (\gamma - 1/2)^2] exp(\alpha \chi_{eff}[2p, \gamma, \alpha]\Delta\eta)}{[(\gamma - 1/2)^2 - (p - 1/2)^2][(\gamma - 1/2)^2 - (p + 1/2)^2]}$$

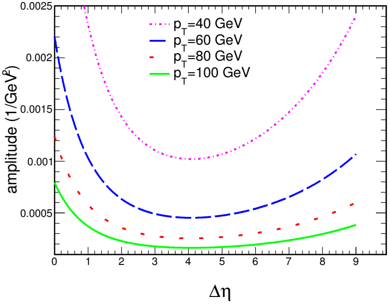
with the normalization: $\frac{d\sigma}{dt} = \frac{|A_{gg\to gg}|^2}{16\pi}$

$$\chi_{eff} = 2\psi(1) - \psi\left(1 - \gamma + \frac{|p|}{2}\right) - \psi\left(\gamma + \frac{|p|}{2}\right)$$

$\psi(\gamma) = d \log \Gamma(\gamma)/d\gamma$ is derivative of Gamma function

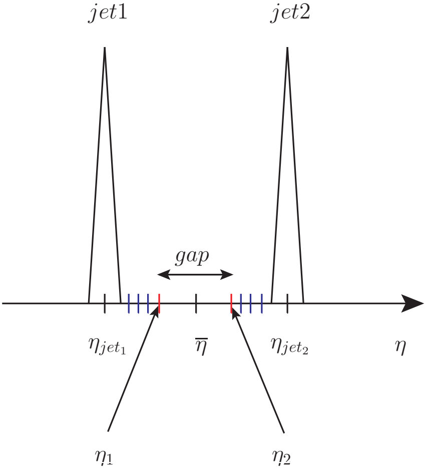
α_s in leading-logarithmic calculations is taken as a constant value

p is called conformal spin

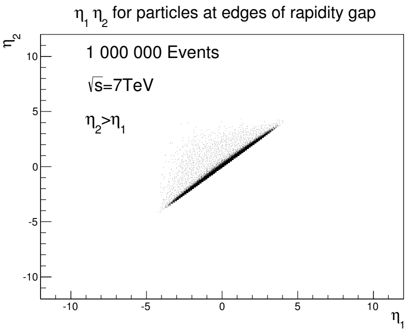


The gap between jets

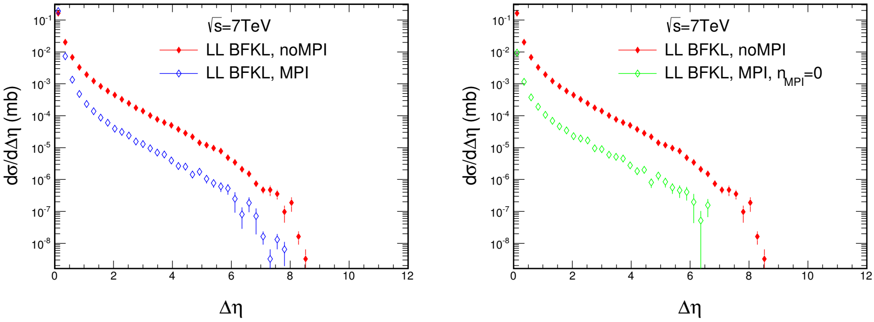
We find gaps between jets as follows: $\overline{\eta} = \frac{\eta_{jet_1} + \eta_{jet_2}}{2}$



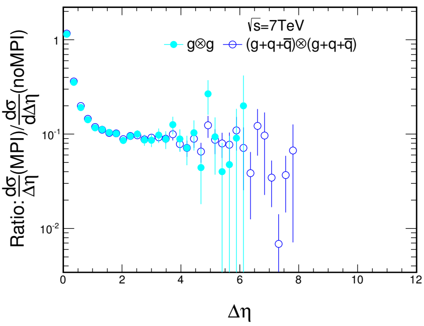
$$\Delta\eta_{gap} < \left|\eta_{jet_1} - \eta_{jet_2}\right|$$

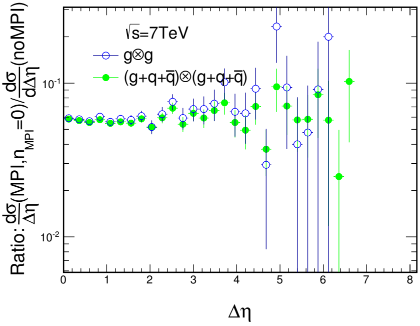


Results

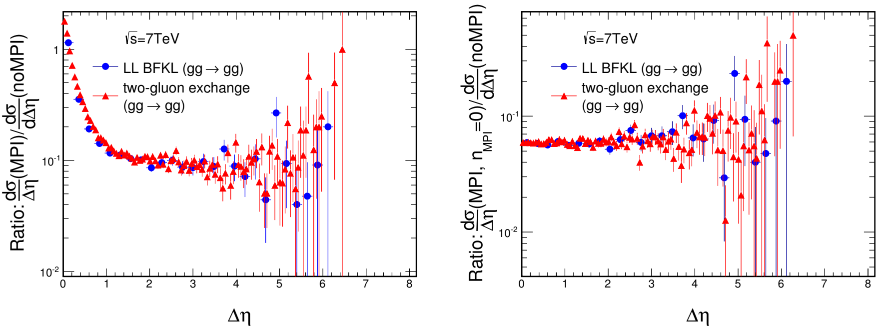

√s=7TeV
LL BFKL, noMPI
LL BFKL, MPI
dσ/dΔη (mb)
Δη
√s=7TeV
LL BFKL, noMPI
LL BFKL, MPI, n_{MPI}=0
dσ/dΔη (mb)
Δη

Results


√s=7TeV
g⊗g
(g+q+q̄)⊗(g+q+q̄)
Ratio: dσ/Δη(MPI)/dσ/dΔη(noMPI)
Δη


√s=7TeV
g⊗g
(g+q+q̄)⊗(g+q+q̄)
Ratio: dσ/Δη(MPI,n_MPI=0)/dσ/dΔη(noMPI)
Δη

Jet-gap-jet vs two-gluon color singlet exchange



Conclusions

- The role of multi parton interactions in jet-gap-jet processes was discussed.
- Fixed kinematical configurations were done.
- LL BFKL framework was used to describe dynamics of jet-gap-jet process.
- The two-gluon simple approximation was performed for comaprison.
- The subprocess amplitudes for the color singlet exchange was implemented in PYTHIA 8.

The MPI effects lead to depedence on kinematical variables of the gap survival factor, in contrast what is ussally assumed in the literature.

Thank you for your attention.

Backup - single diffraction