Rescattering effects in jet–gap–jet processes

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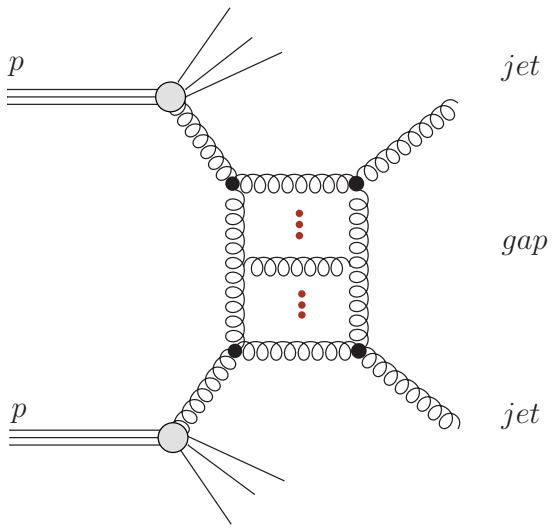
Motivation

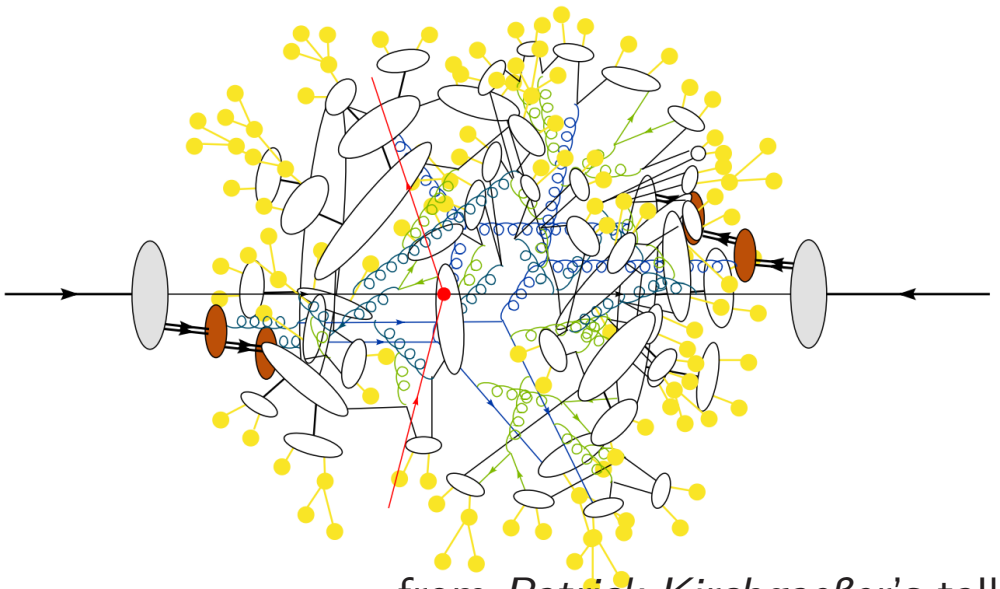
- Gap survival probability – a crucial element in understanding diffraction at hadron colliders
- Usually taken as a constant
  (for a given process, at a given $\sqrt{s}$)
- This is not sufficient (see talk by *Marta Łuszczak*)
- Several attempts to study kinematic-dependent gap survival
  - in several exclusive processes
  - hard diffraction in resolved pomeron model
- Aim of our work: study this problem for jet–gap–jet processes using the MPI framework

Introduction

Jet–gap–jet process



Proton–proton collision

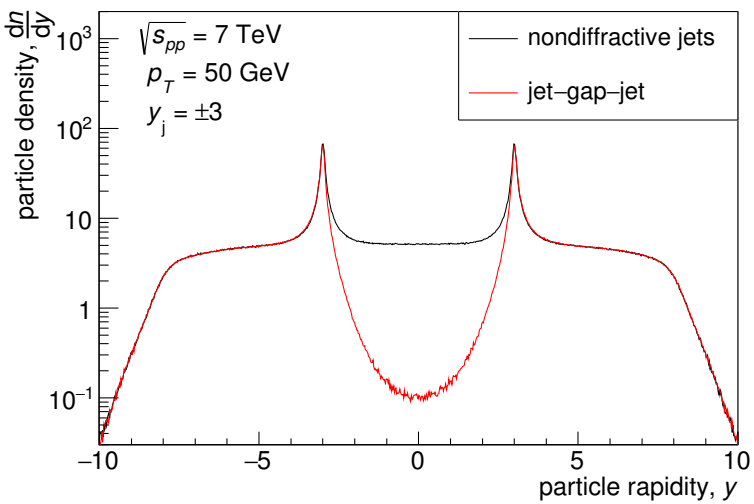


from *Patrick Kirchgaeßer*'s talk

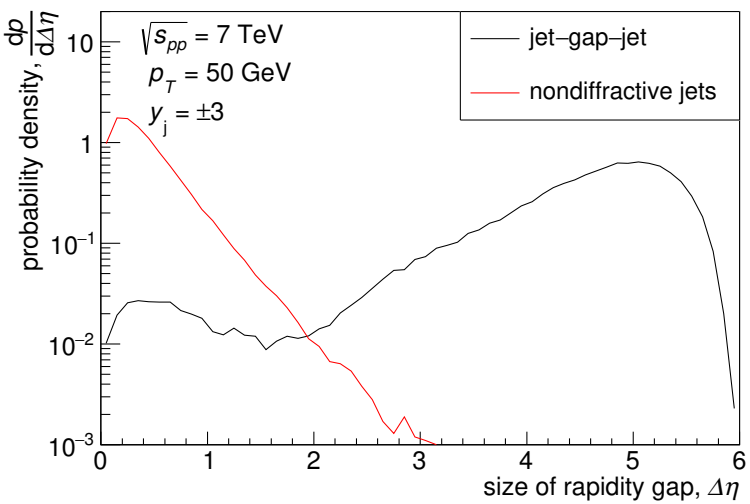
Jet–gap–jet process

- Using PYTHIA 8 for hadronisation of jet events
- $gg \to gg$ with fixed kinematics
- Two different colour flows:
  - colour octet (non-diffractive jets)
  - colour singlet (jet–gap–jet)

Particle density:



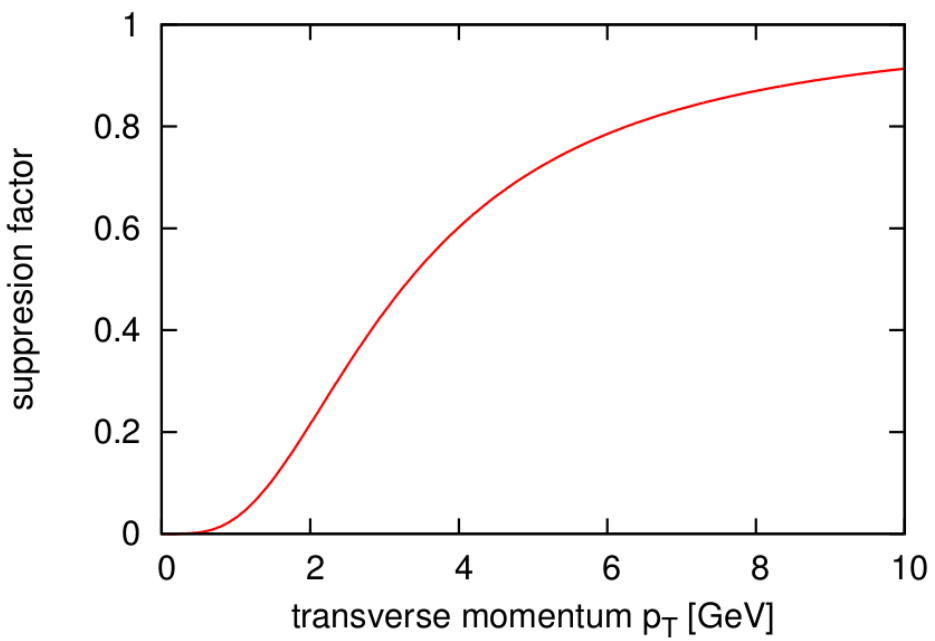
Rapidity gap:



MPI in Pythia

- mini-jets calculated in collinear factorisation
- suppression at low p_t

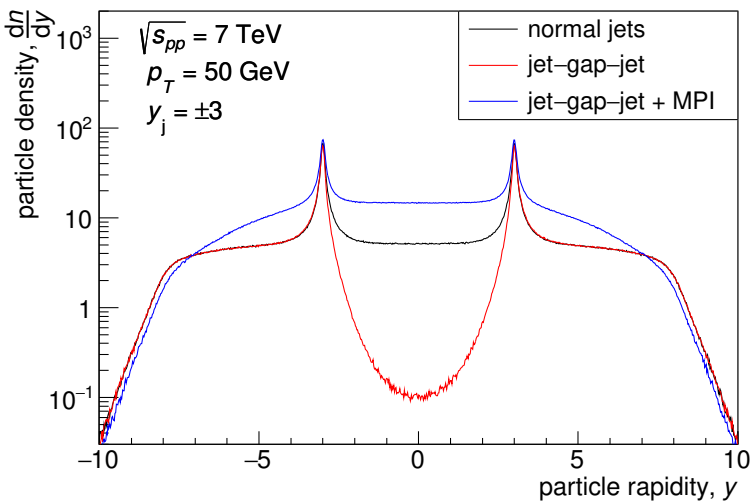
$$F_{\text{sup}}(p_t) = \frac{p_t^4}{(p_{t0}^2 + p_t^2)^2} \cdot \theta(p_t - p_{t,\text{cut}})$$



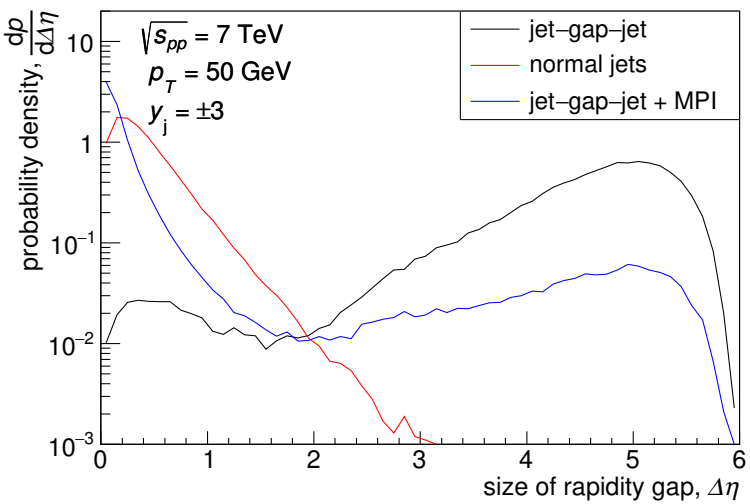
MPIs in jet–gap–jet event

- Working with fixed-kinematics events
- Using PYTHIA for:
  - MPI generation
  - hadronisation

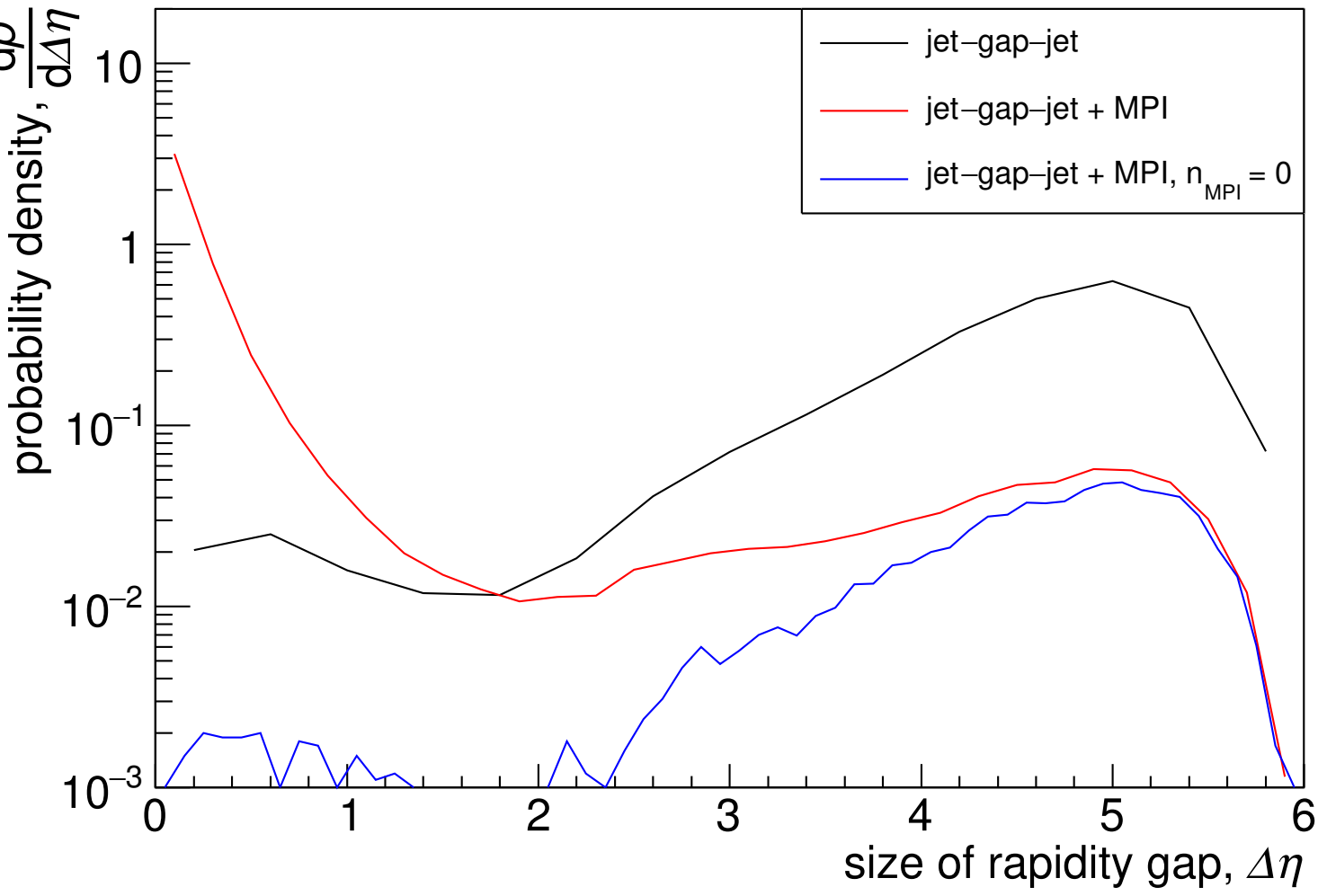
Particle density:



Rapidity gap:

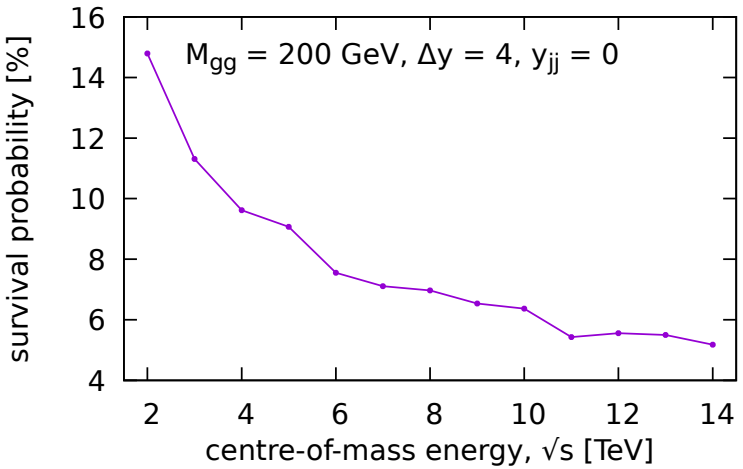


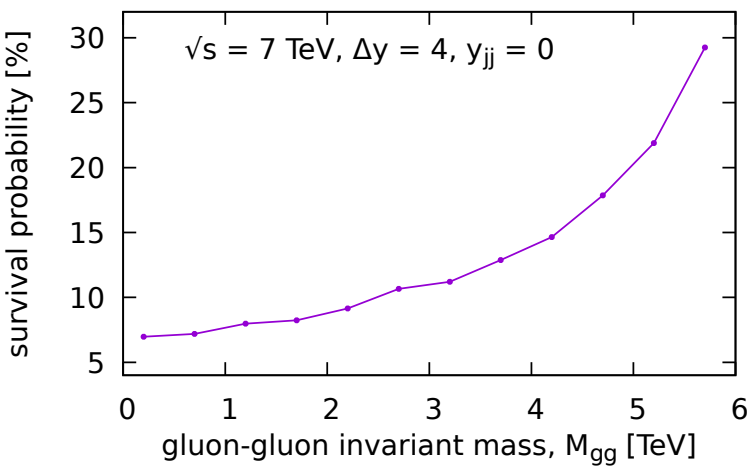
Definition of gap survival probability

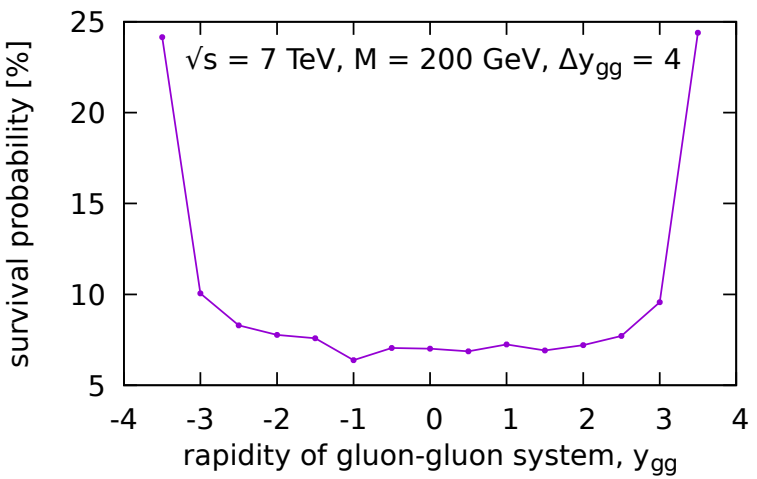


Gap survival probability

- MC $\rightarrow n_{\mathrm{MPI}}$ known
- Gap survival probability: fraction of events without additional MPIs
- Using fixed kinematics at parton level





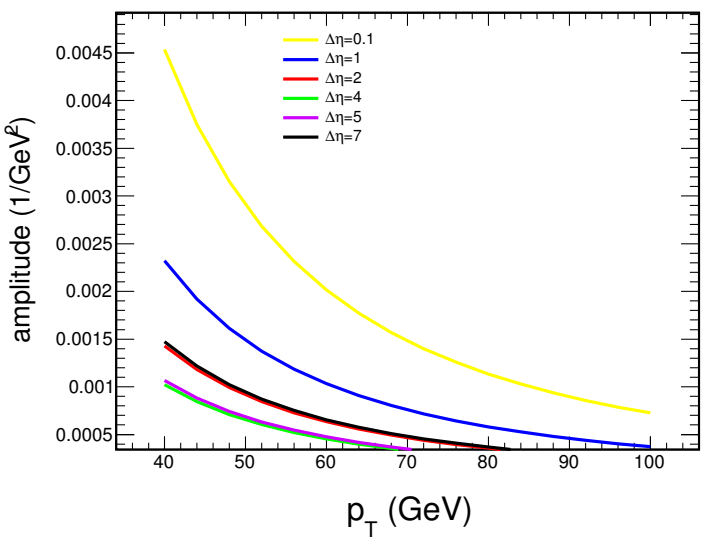


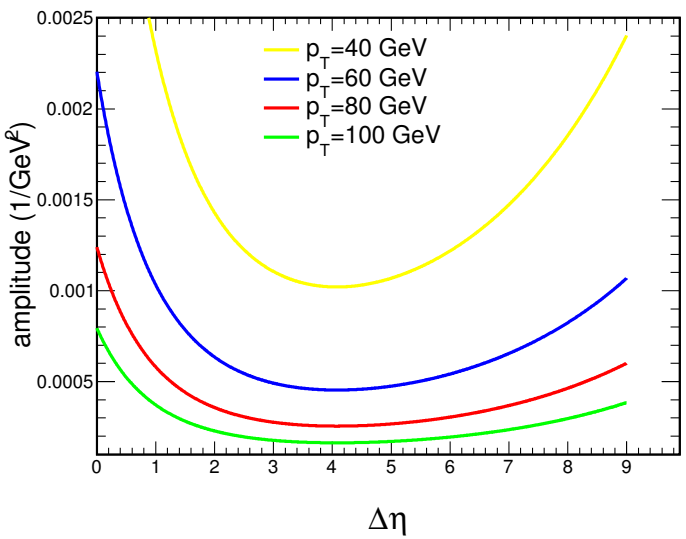
Scattering amplitude: BFKL

Following O. Kepka, C. Marquet, C. Royon, Phys. Rev. D 83 (2011) 034036.

$$A(\Delta\eta, p_T^2) = \frac{16 N_C \pi \alpha_s^2}{C_F p_T^2} \sum_{p=-\infty}^{\infty} \int \frac{d\gamma}{2i\pi} \frac{[p^2 - (\gamma - 1/2)^2] \exp(\bar{\alpha}\chi_{\text{eff}}[2p, \gamma, \bar{\alpha}]\Delta\eta)}{[(\gamma - 1/2)^2 - (p - 1/2)^2][(\gamma - 1/2)^2 - (p + 1/2)^2]},$$

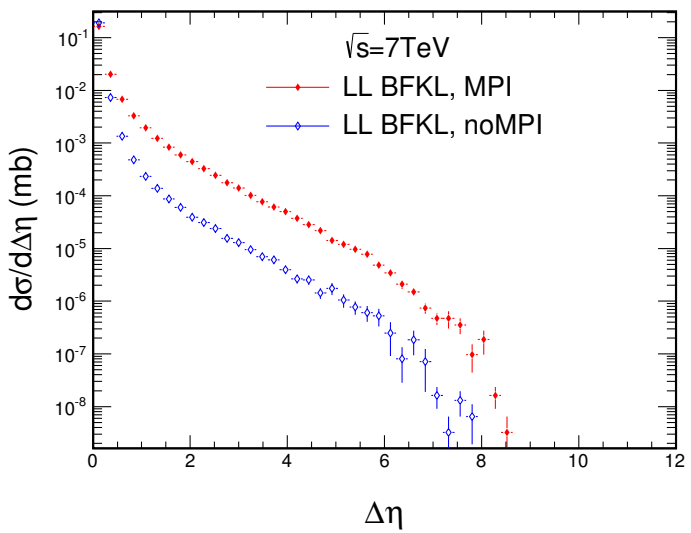
$$\chi_{\text{eff,LL}} = 2\psi(1) - \psi\left(1 - \gamma + \frac{|p|}{2}\right) \psi\left(\gamma + \frac{|p|}{2}\right), \quad \psi(\gamma) = d \log \Gamma(\gamma)/d\gamma.$$

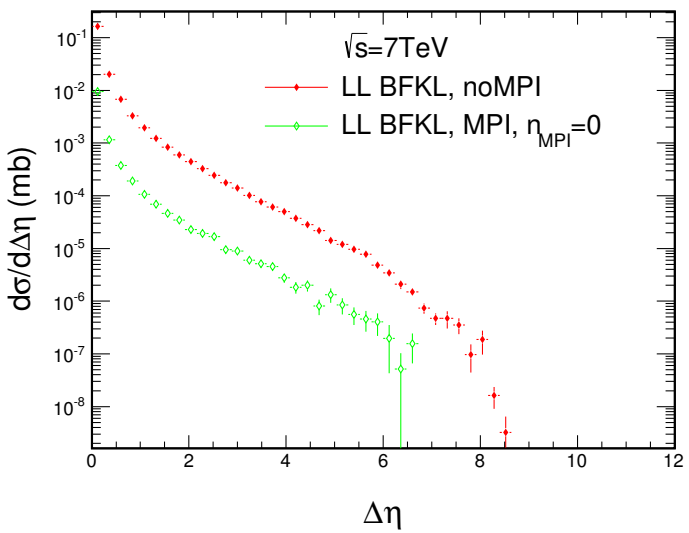




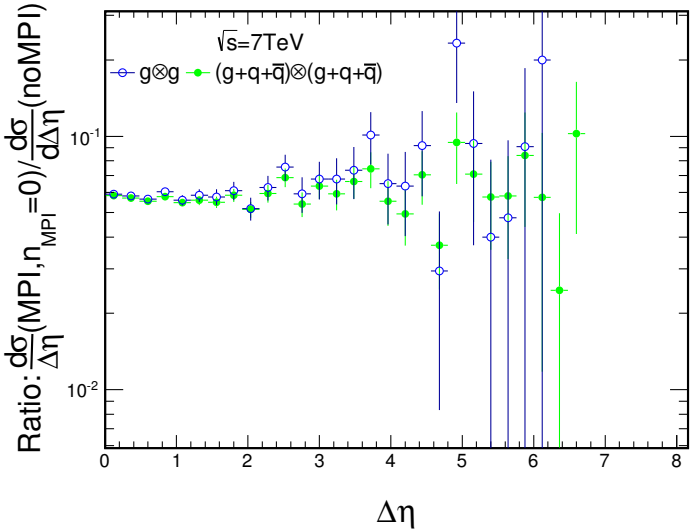
Simulation with BFKL dynamics

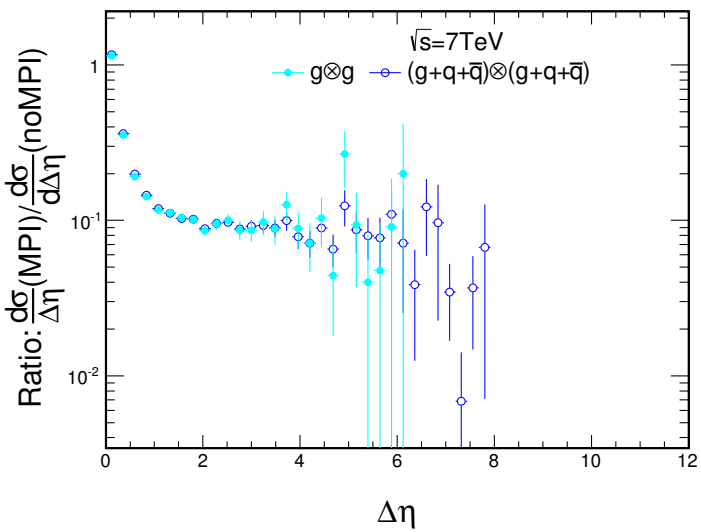
- A new process defined in PYTHIA:
  - BFKL amplitude
  - no colour flow
- Gap around the midpoint between scattered partons
- $gg \to gg$, $qq \to qq$, $qg \to qg$, ...

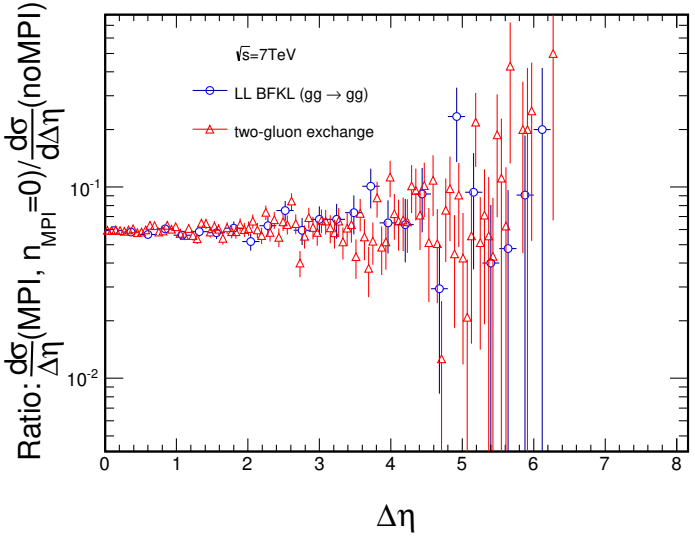


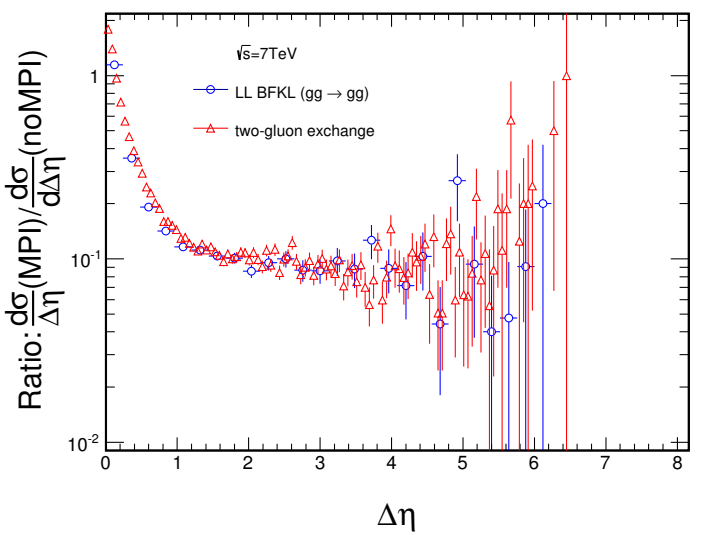


Different definitions of gap survival









Summary and conclusions

- Rescattering effects studied in jet–gap–jet processes
- PYTHIA used for simulation of MPI and hadronisation
- Kinematic dependence of probability of no MPIs observed
- Not clear how to define gap survival probability
- Additional interactions do not destroy events
- They (may) change the gap size
- A single number (even kinematic-dependent one) does not take into account effect of changing the gap size