Two-dimensional distribution features of two-gluon correlations in pp collisions based on color glass condensate framework

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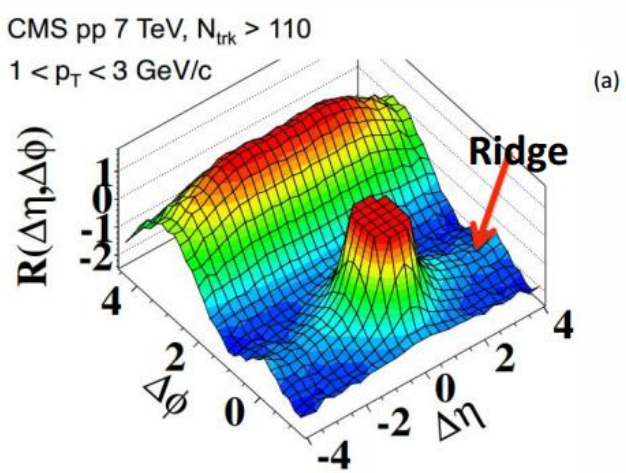
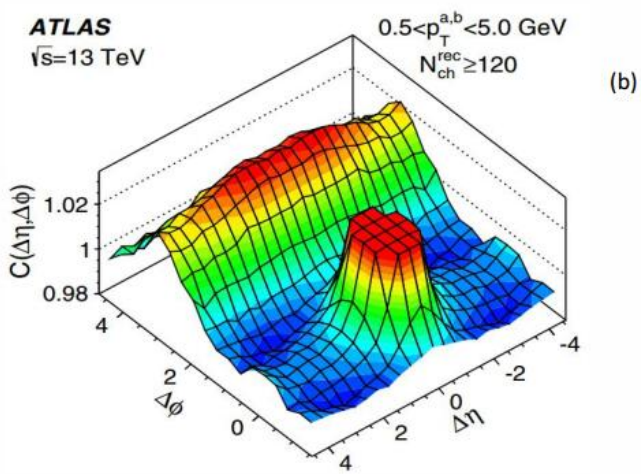
Outline

Motivation

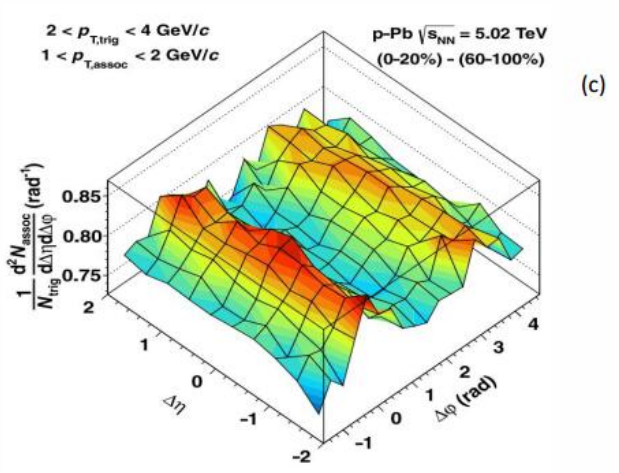
Two-particle correlation is an important physical observation to study the mechanism of particle production and interaction.



JHEP 09, 091(2010)



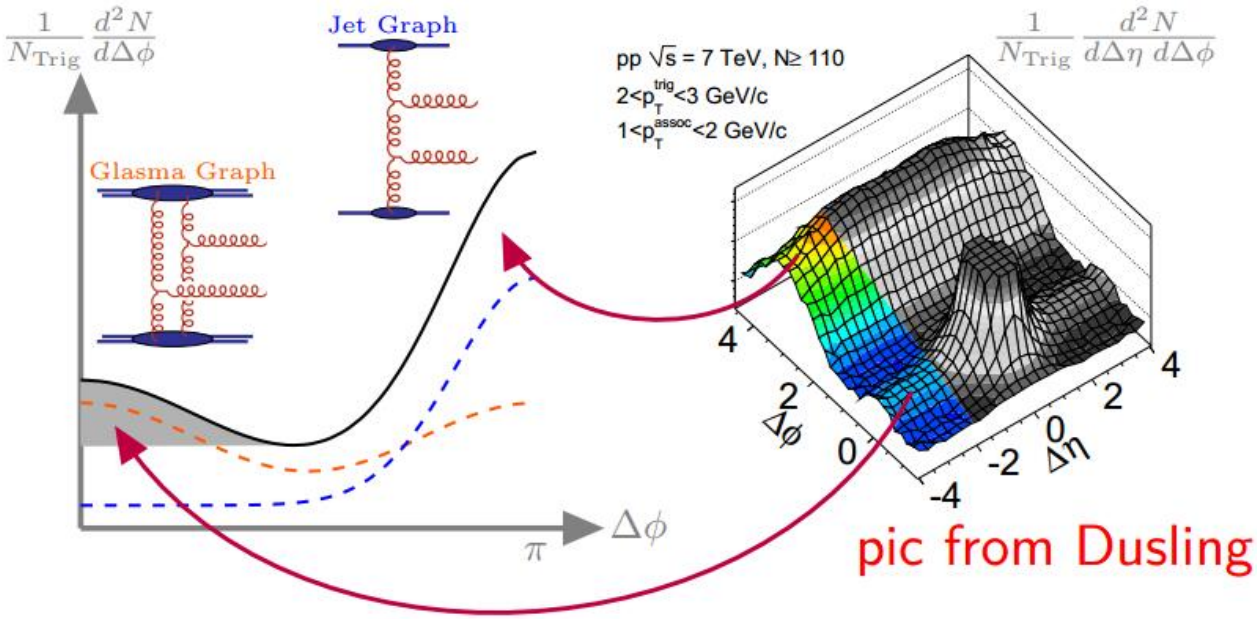
PRL 116, 172301 (2016)



PLB 719(2013)29–41

- Rapidity direction: The correlation of long-range rapidity region at near-side is enhanced (Ridge structure).

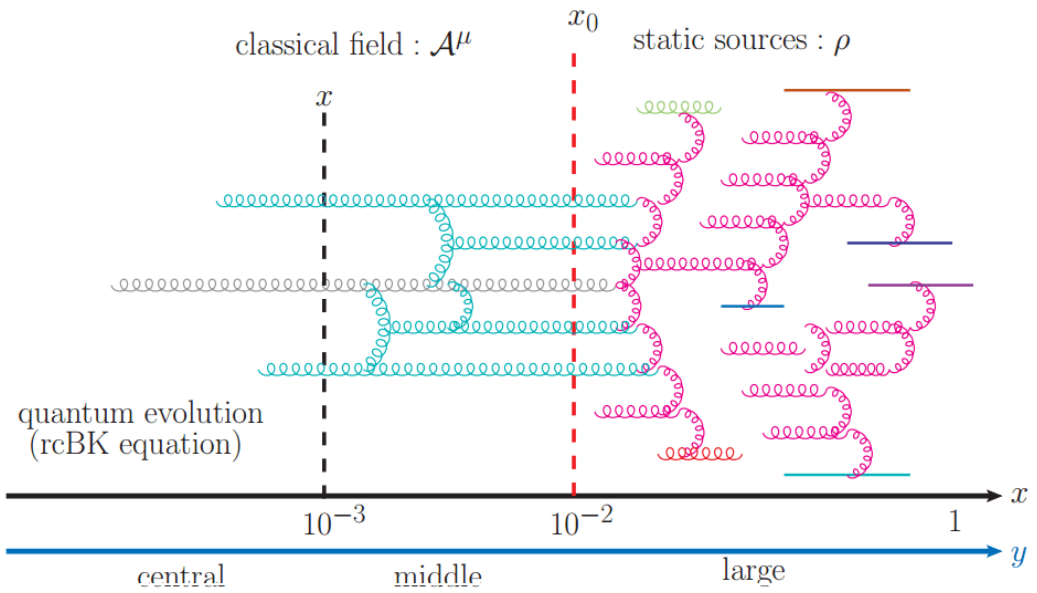
BFKL graph and Glasma graph

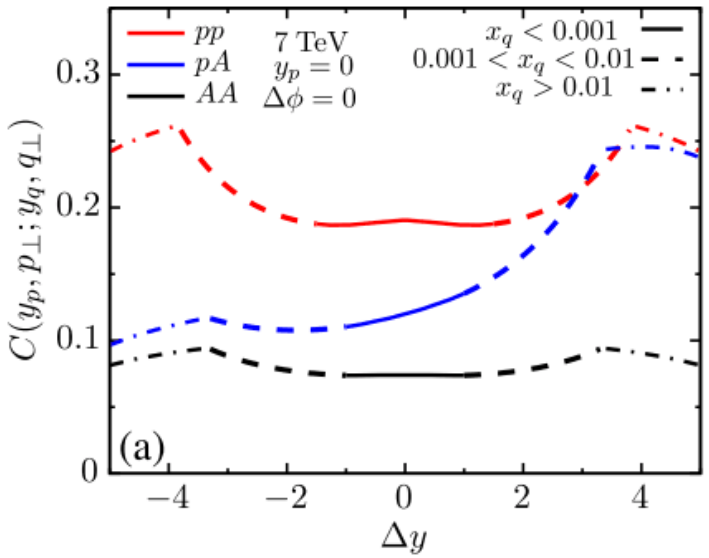


- The near- and away-side azimuthal—Glasma+BFKL[PRL 108,262001]

However, the longitudinal dynamics is **UNCLEAR**

The degree freedom of CGC





Partons are divided into (the fraction of longitudinal momentum: $x = k^+/P^+$) :

- Fast (large-x) partons $\longrightarrow$ static source ρ
- Slow (small-x) partons $\longrightarrow$ field $\mathcal{A}_\mu$ $\Longleftarrow$ CYM

- The rapidity of gluon is related to its x, $x = \frac{p_\perp}{\sqrt{s}} e^{\pm y}$.
- Ridge structure indicated the strong correlation of small- and large-x.

Integrated correlation function

The associated yield per trigger particle is defined as:

$$Y(\Delta\phi, \Delta y) = \frac{1}{N_{\mathrm{Trig.}}} \frac{d^2 N_{\mathrm{Assoc.}}}{d\Delta\phi d\Delta y}.$$

Where

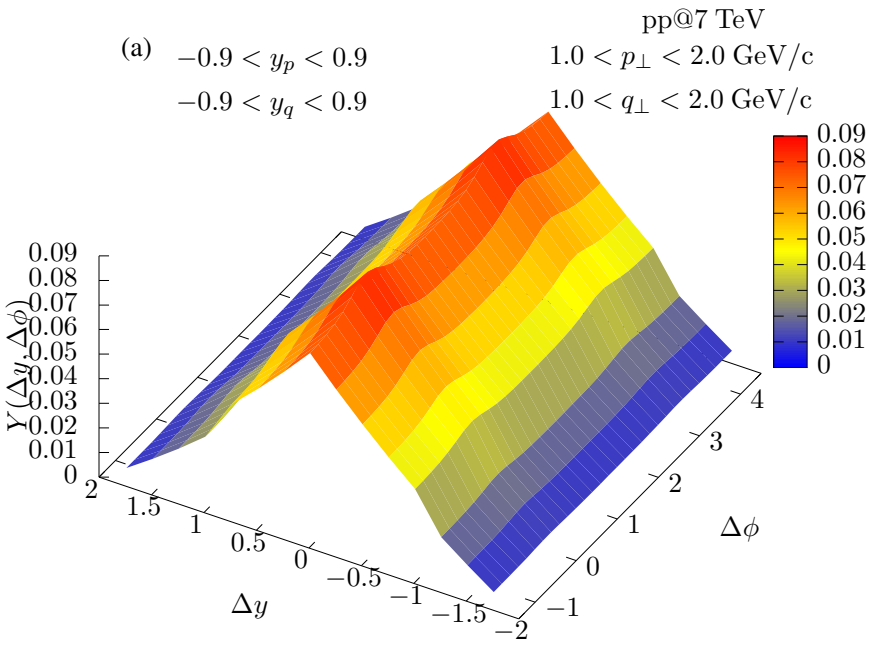
$$\begin{aligned} \frac{d^2 N_{\mathrm{Assoc.}}}{d\Delta\phi d\Delta y} &= \int dy_p \int dy_q \delta(y_q - y_p - \Delta y) \int d\phi_p \int d\phi_q \delta(\phi_q - \phi_p - \Delta\phi) \\ &\times \int_{p_\perp^{min}}^{p_\perp^{max}} \frac{dp_\perp^2}{2} \int_{q_\perp^{min}}^{q_\perp^{max}} \frac{dq_\perp^2}{2} \frac{dN^{\mathrm{corr}}_{2,\mathrm{Glasma}}}{d^2\mathbf{p}_\perp dy_p d^2\mathbf{q}_\perp dy_q}, \end{aligned}$$

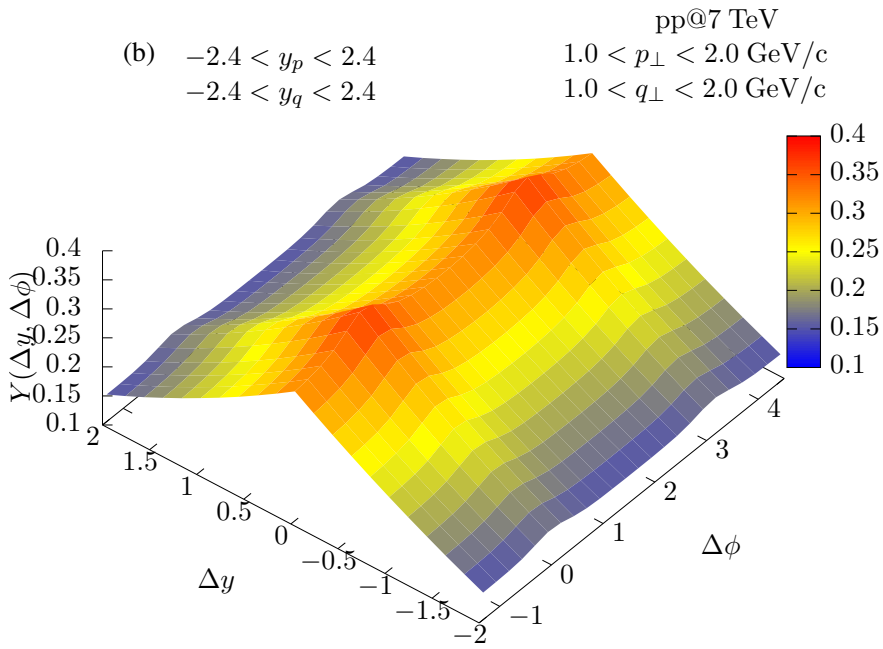
and

$$N_{\mathrm{Trig.}} = \iiint_{\mathrm{Acceptance}} dy d^2\mathbf{p}_\perp \frac{dN_1}{d^2\mathbf{p}_\perp dy_p}.$$

Here we denote particle p and q as trigger and associated particles, and $\Delta y = y_q - y_p$.

2-D distribution features of two-gluon correlations

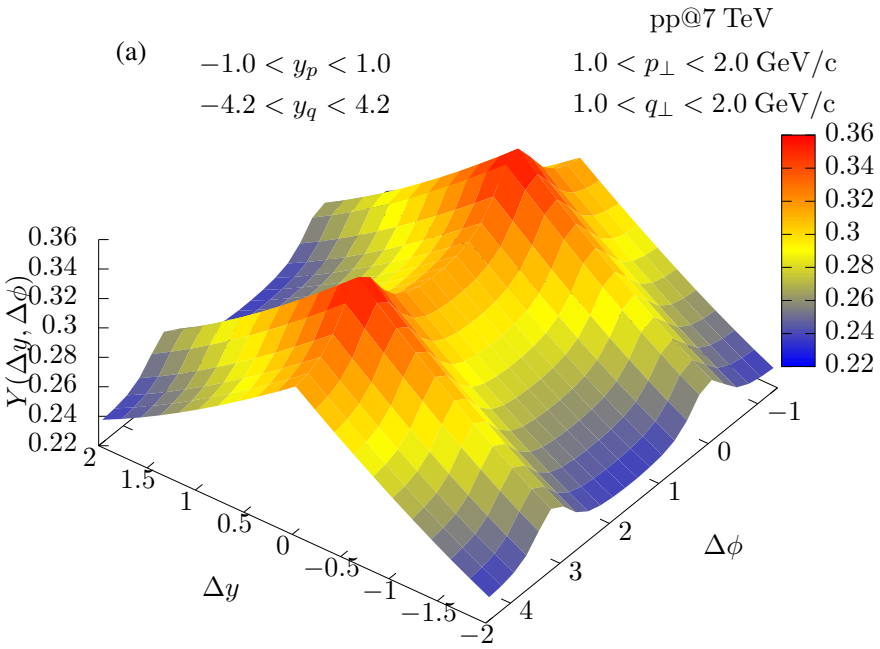


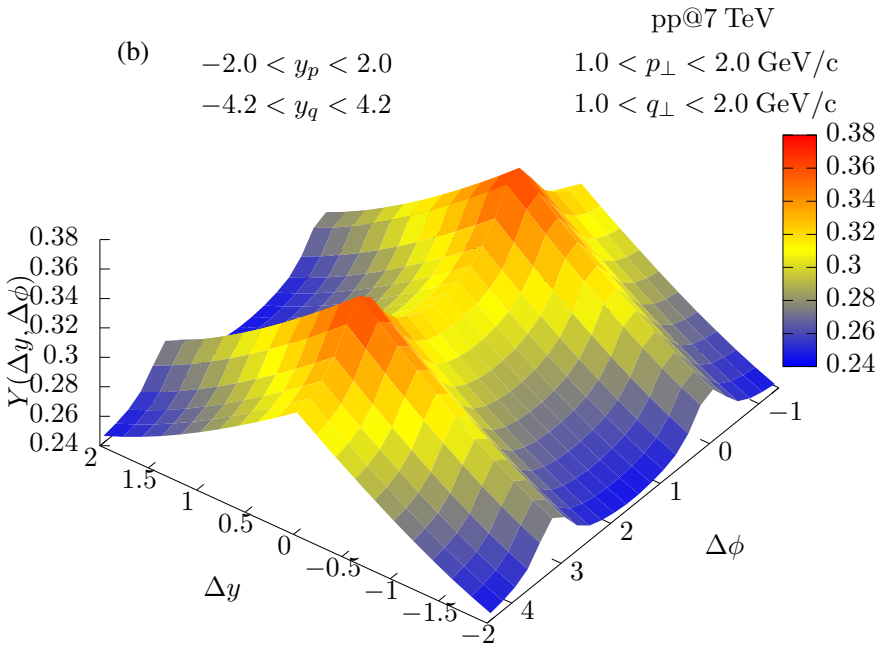


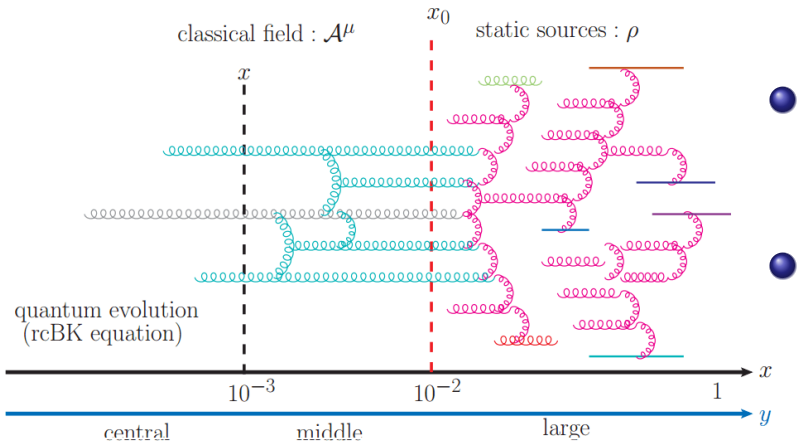
The calculation results are compared with the experimental results:

Rapidity direction: The trend of the two is different. The short-range correlation is significant, however the experimental result is relatively flat.

2-D distribution features of two-gluon correlations





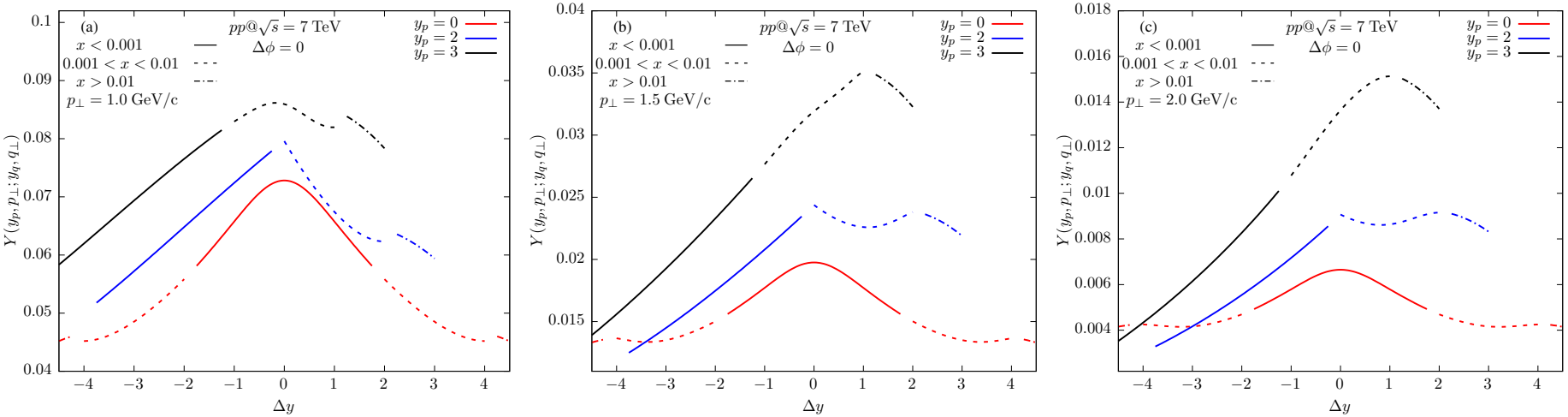


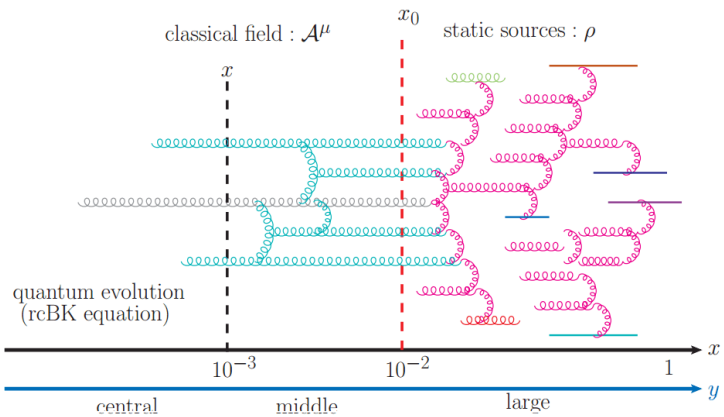
- Increasing the rapidity interval, the ridge structure in the rapidity direction is slightly enhanced.
- $x = \frac{p_\perp}{\sqrt{s}} e^{\pm y}$, the rapidity of gluon is directly related to its x.

Differential correlation function

The differential correlation function corresponding to Associated Yield is

$$Y(\mathbf{p}_\perp, y_p; \mathbf{q}_\perp, y_q) = \frac{1}{\frac{dN_1}{d^2\mathbf{p}_\perp dy_p}} \frac{dN^{\rm corr}_{2,\rm Glasma}}{d^2\mathbf{p}_\perp dy_p d^2\mathbf{q}_\perp dy_q}.$$





- The integrated correlation distribution is the result of the overall superposition of its differential correlation.

Summary and Outlook

1. In the CGC theory, based on the Glasma graph, the experimental results are compared with the results of the rapidity acceptance window consistent with the detector:
   The trend of the two is different in the rapidity direction. The short-range correlation of the calculation results is significant, but the experimental result is relatively flat.
   In addition, after adding the fragmentation function, there is no significant change in the trend of the rapidity correlation.

2. Rapidity correlation is directly related to x degree of freedom. The difference of correlation strength between different x gluon is different.
   If no small- and moderate-x degree of freedom – **No** ridge.

3. Compared with the Hydrodynamics, the CGC prediction results are not perfect, but we only consider the correlation of the gluon-gluon here. Further consideration should be given to the correlation of more channels in the future.