The study on the medium parton distribution from momentum kick model in Heavy-Ion Collisions

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KoALICE

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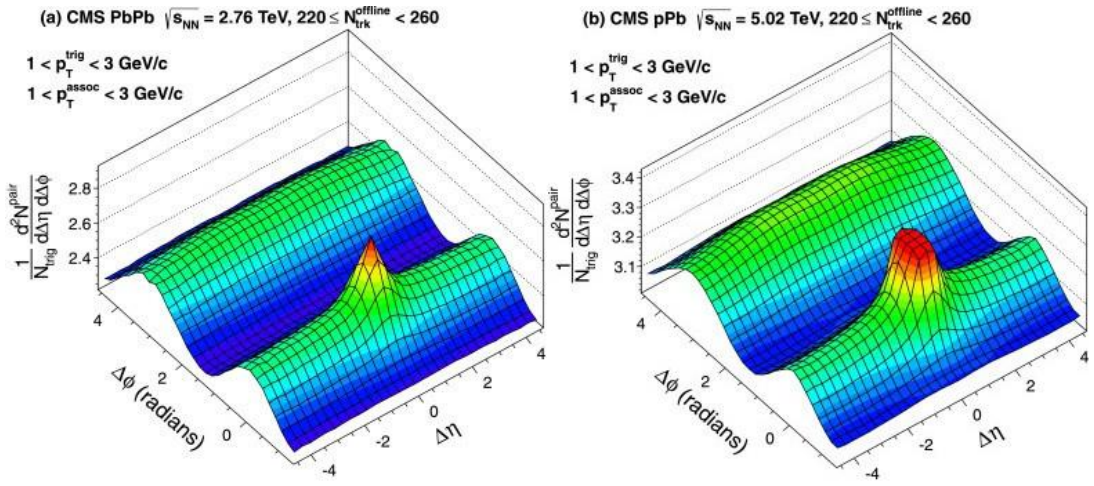
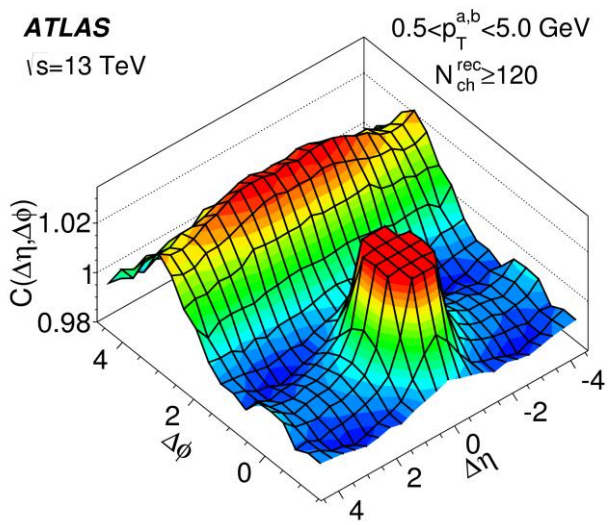
Ridge structure





Understanding via elliptic and higher-order flow

How about in high-multiplicity small systems?

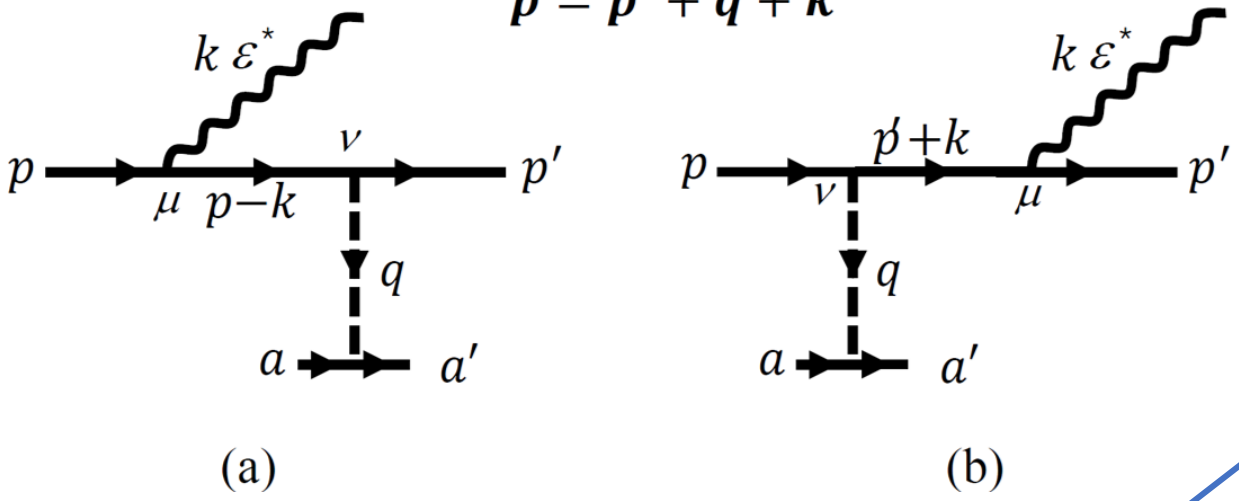
Try to explain through kinematics between Jet & Medium

CMS collaboration, Physical Letters B 724, 213{240 (2013)

ATLAS collaboration, Physical Review Letters 116, 172301 (2016)

Bremsstrahlung process

$$\boldsymbol{p = p' + q + k}$$



$$d\sigma \sim \left|M_{(a)} + M_{(b)}\right|^2 = \left|M_{(a)}\right|^2 + \left|M_{(b)}\right|^2 + (\boldsymbol{Interference})$$

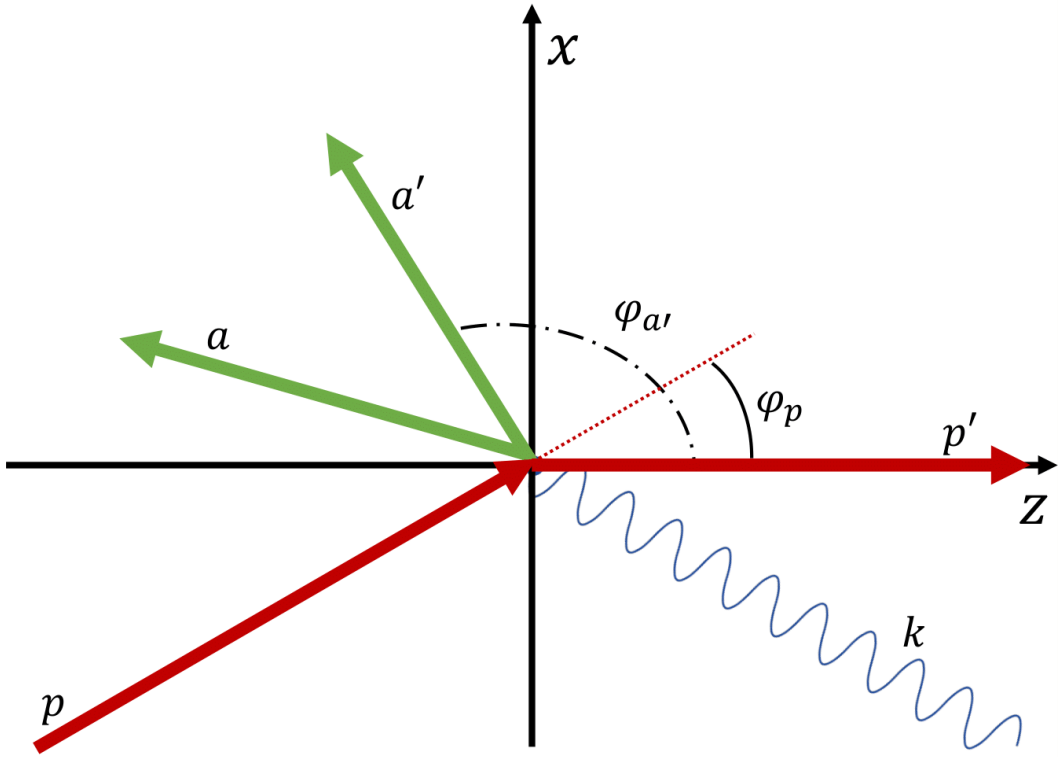
- Kinematics between Jet & Medium
  - Jet's energy loss with radiation
    - **Photon** (Bremsstrahlung)
- According to previous study
  - Medium partons aligned along the jet
  - Collective motion
- We expect…
  - Might interfere constructively
  - Explain Ridge structure

C. Y. Wong, Physical Review C 85, 064909 (2012)

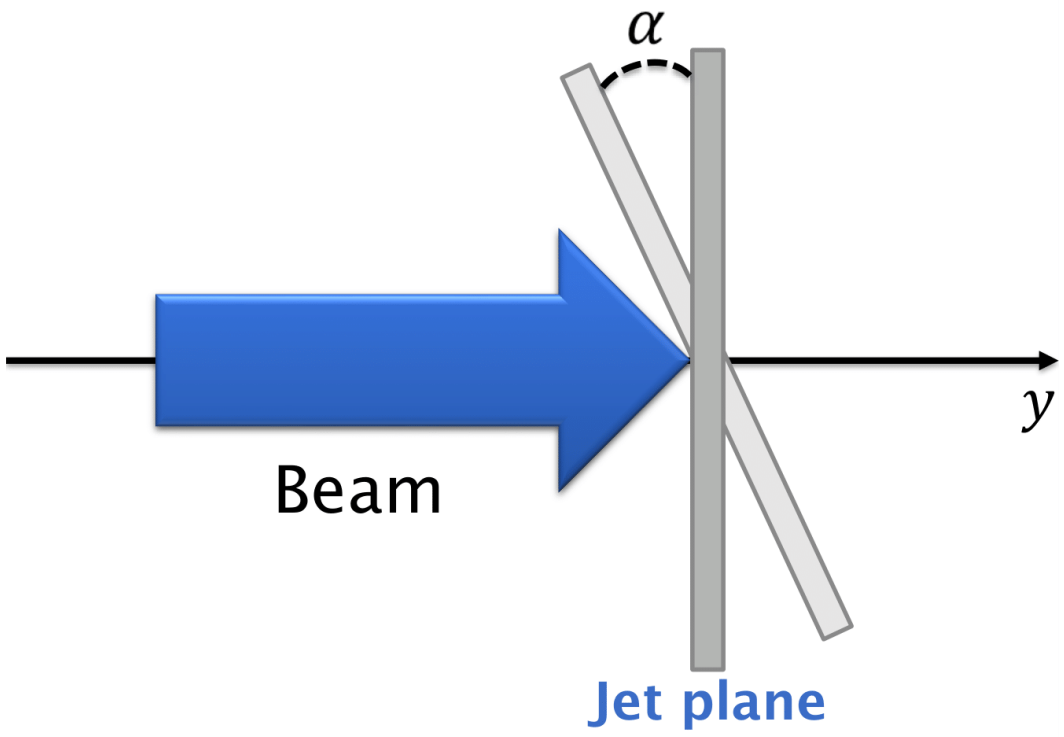
Coordinates

Jet plane

: independent to beam



Jet plane + Beam direction



Distribution for initial medium partons

- We consider all possible initial medium parton's momentum

$$\int d^3\vec{a} \rightarrow \int f(y_a, a_T) \times |J| dy_a a_T \varphi_a$$

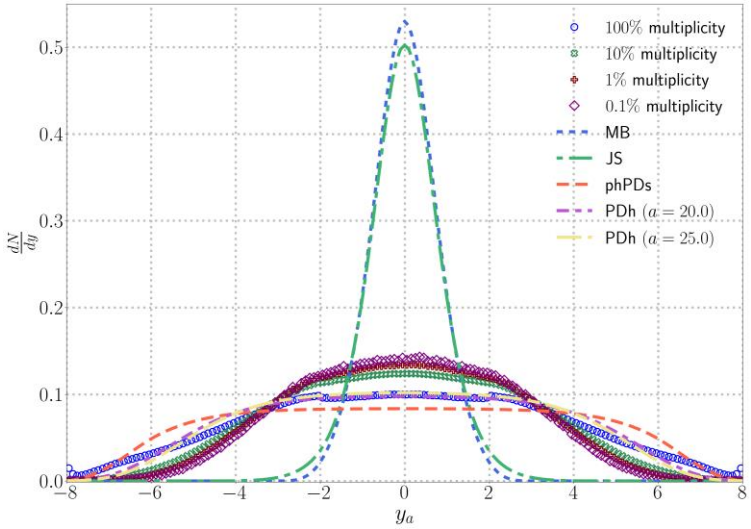
- Adopt distribution function for describing
  - Maxwell-Boltzmann distribution (**MB**)
  - Juttner-Synge distribution (**JS**)
  - Phenomenological Parton Distribution from Soft scattering model (**phPDs**)
  - Phenomenological Parton Distribution from Hard scattering model (**phPDh**)

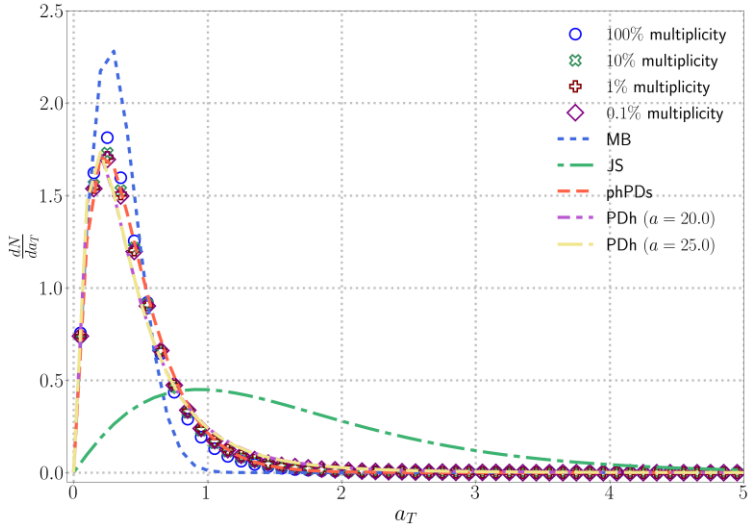
C.-Y. Wong, G. Wilk, L.J. Cirto and C. Tsallis, PRD 91 114027 (2015)

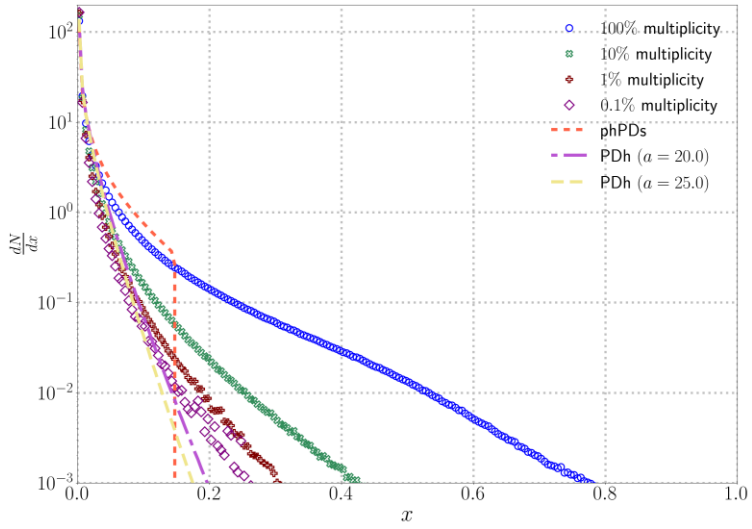
R. Hagedorn,Nuovo Cimento 6 , 1 (1983)

C. Michael and L. Vanryckeghem J. Phys . G 3 , L151 (1977)

Distribution for initial medium partons







- Rapidity distribution
  - MB and JS are too narrow to explain $|y_a| > 2$ regions
- Transverse momentum distribution
  - JS have wide shapes from others
- Lightcone variable distribution
  - phPDs is prohibited at $x > 0.15$

Expression of phPDh

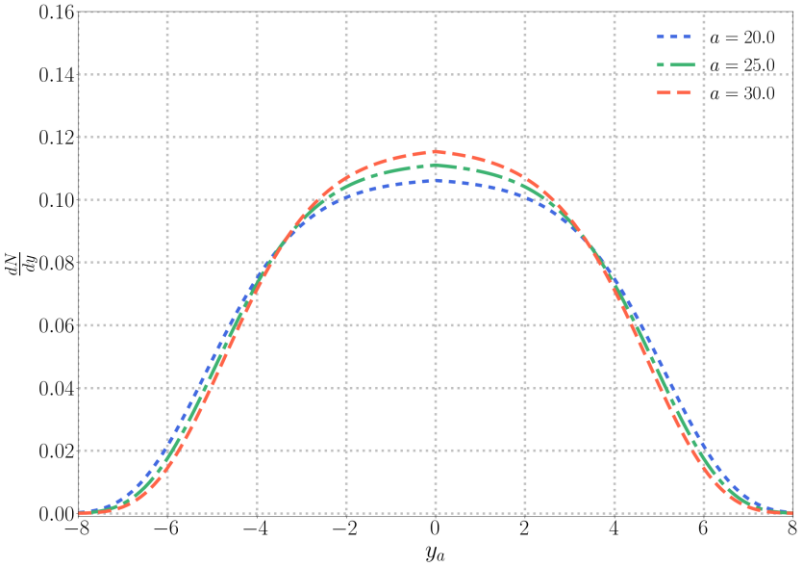
$$f(y_a, a_T) = A(1-x)^a \left[1 - (1-q)\frac{m_T}{T}\right]^{\frac{1}{1-q}}$$

- Free parameters
  - a : Fallout parameter which decide shape of rapidity distribution
  - q : Non-extensive parameter which Phenomenologically equivalent to the quasi-power law
  - T : Temperature of system
- Lightcone variable

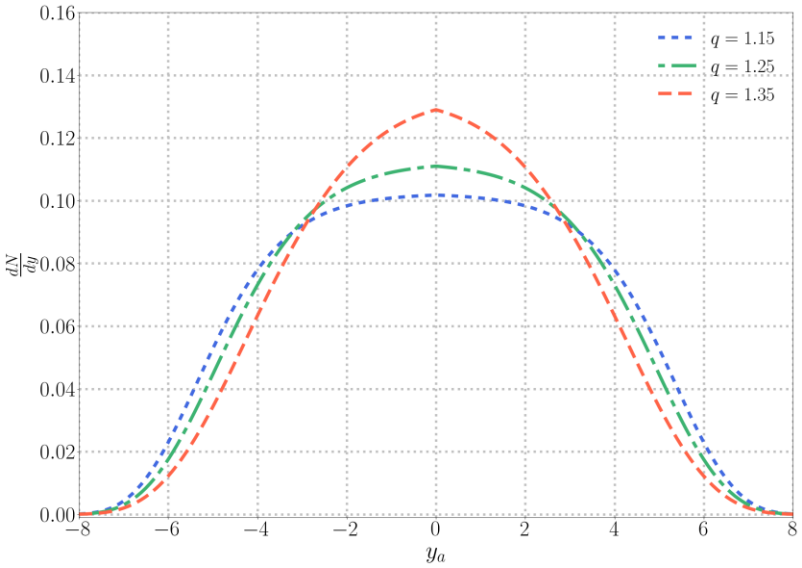
$$x = \frac{\sqrt{m_\pi^2 + a_T^2}}{m_p} e^{|y_a| - y_b}$$

Dependency of phPDh

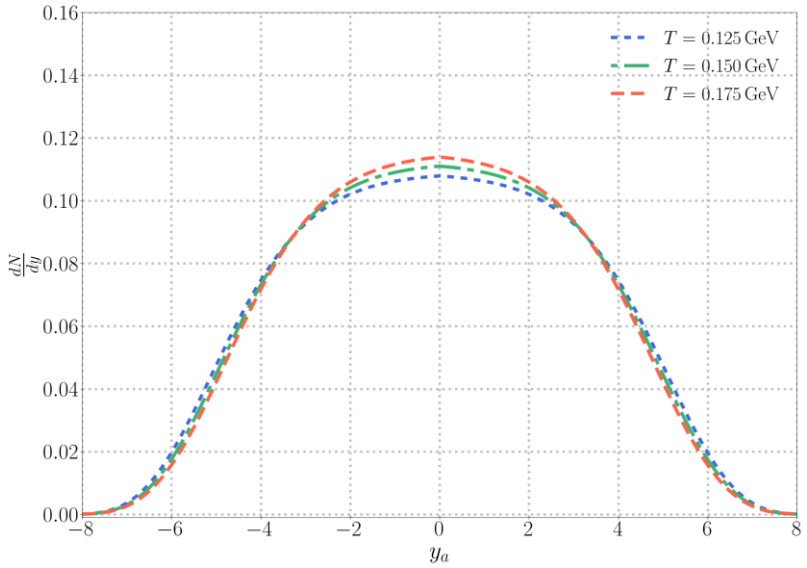
Fixed $q = 1.15$, $T = 0.15$ GeV



Fixed $a = 25$, $T = 0.15$ GeV



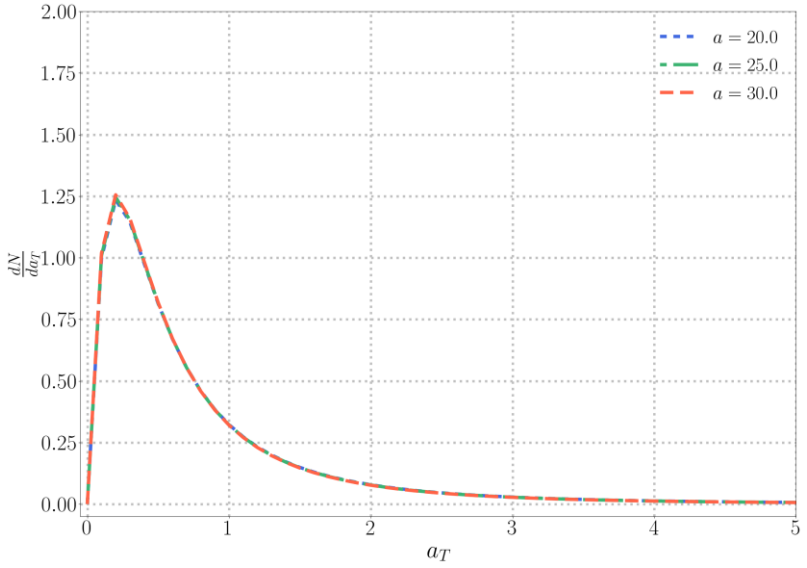
Fixed $a = 25$, $q = 1.15$



- a increases, scales of rapidity increase
- q increases, the shape of rapidity become shaper
- T increases, scales of rapidity slightly increase

Dependency of phPDh

Fixed $q = 1.15$, $T = 0.15$ GeV



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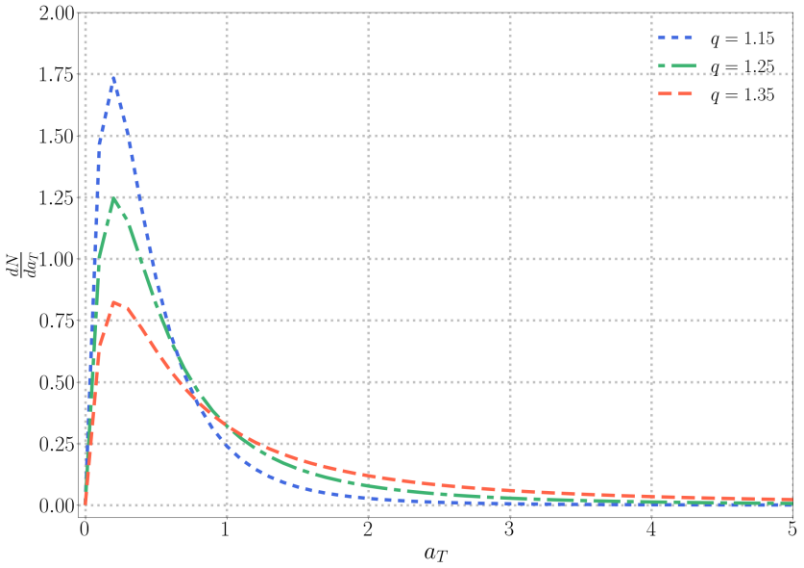

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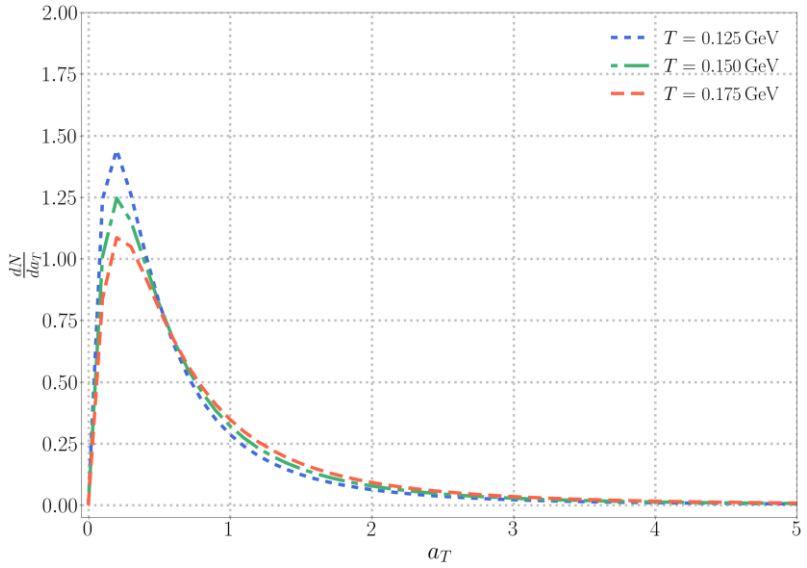
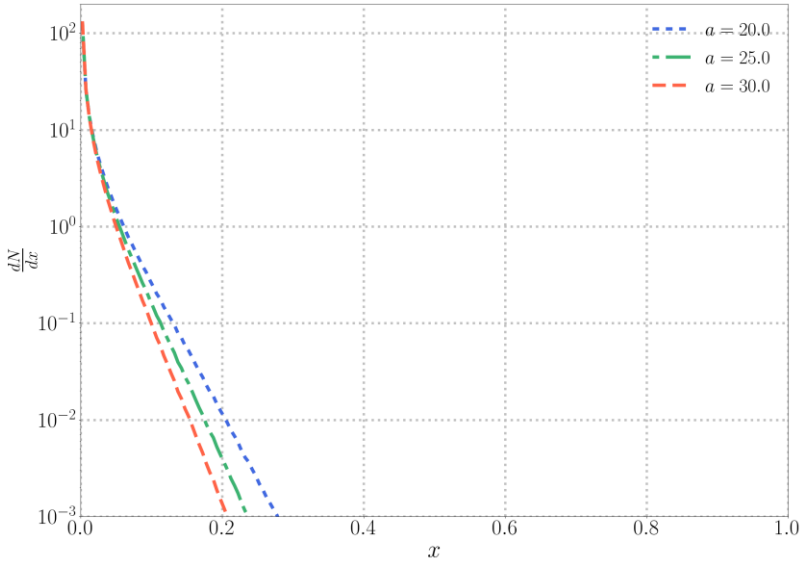


- q increases, transverse momentum distribution is spread wider
- T increases, transverse momentum distribution is slightly spread

Dependency of phPDh

Fixed $q = 1.15$, $T = 0.15$ GeV



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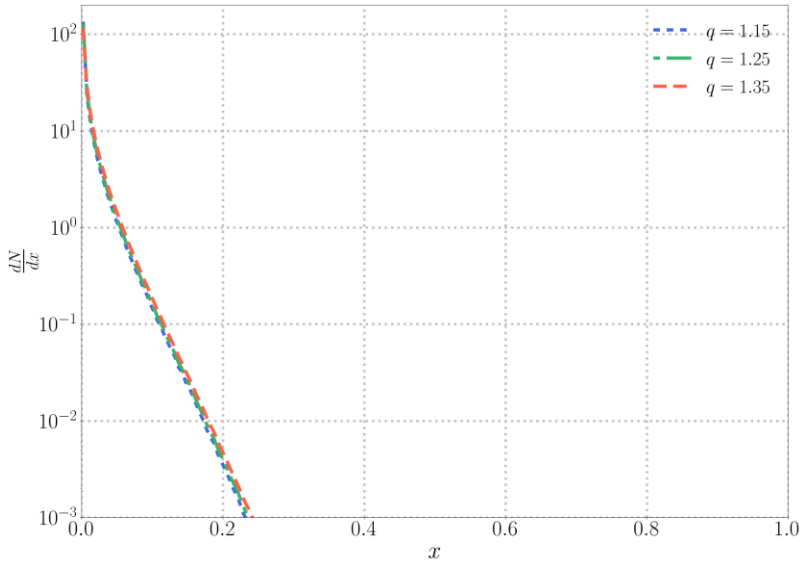

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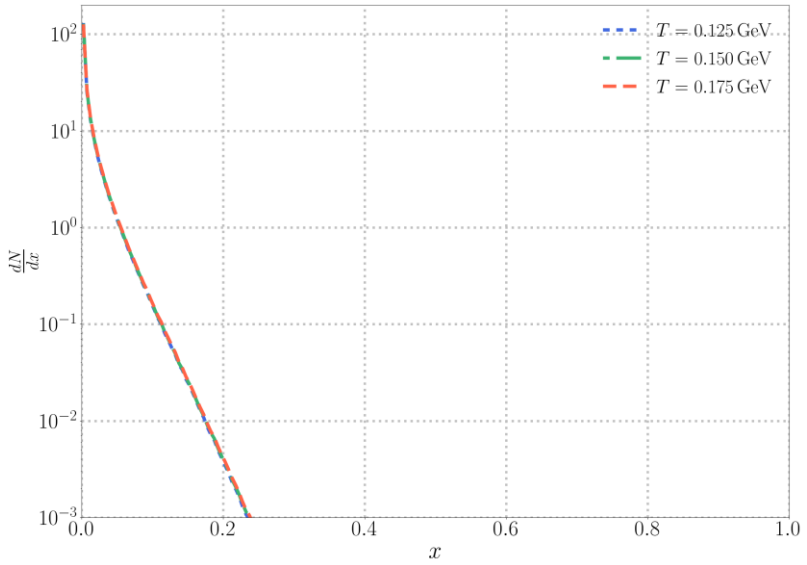
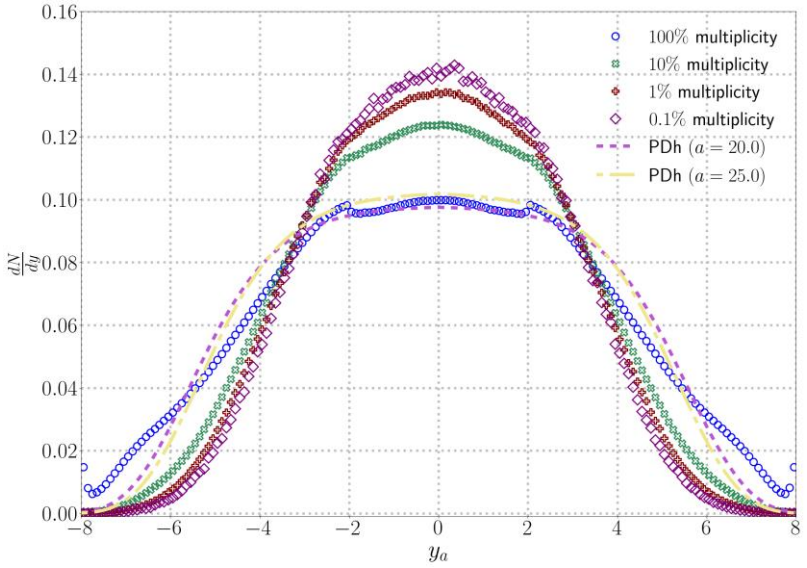
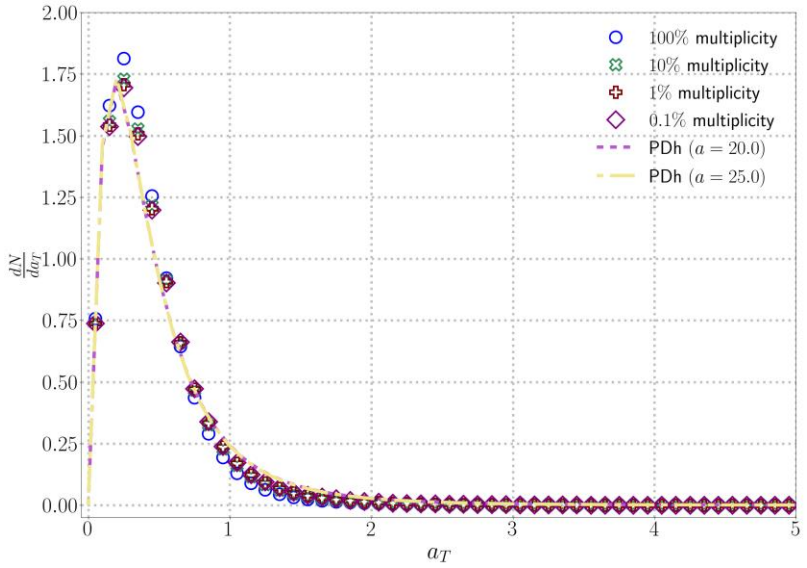
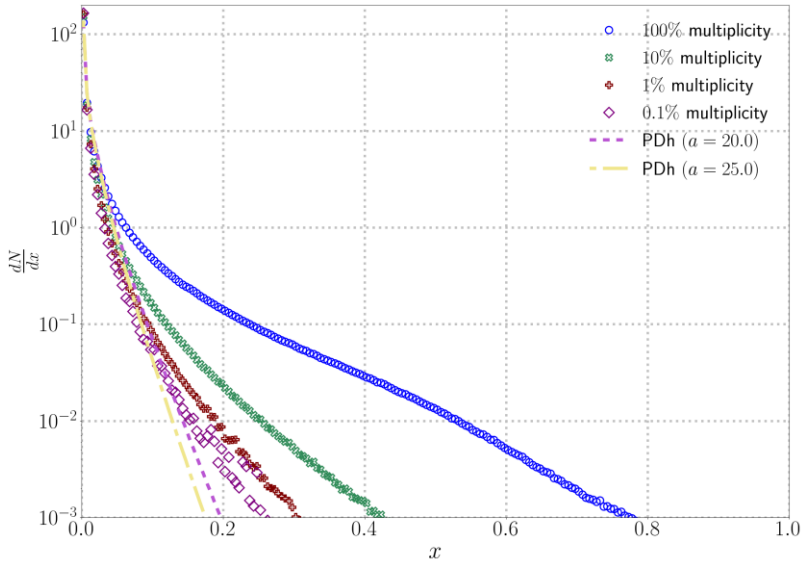


- a increases, the range of lightcone becomes narrow

Select values of free parameters





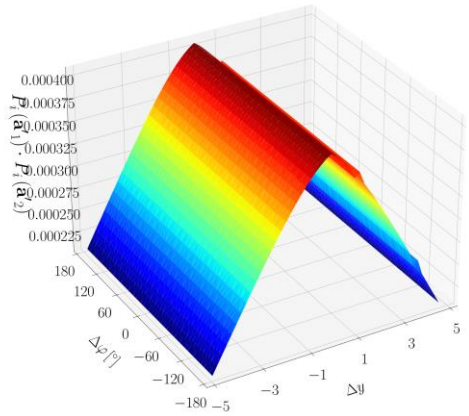


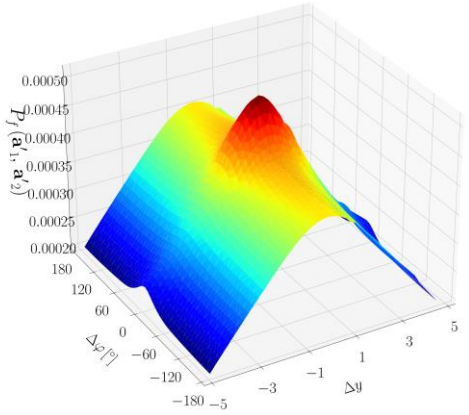
- Through comparing to PYTHIA monash simulation…
  - $a = 20 \sim 25$
  - $q = 1.15$
  - $T = 0.15\ \mathrm{GeV}$

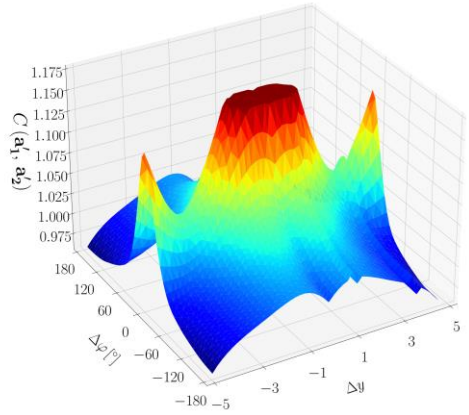
Correlation

Background | Signal | Correlation

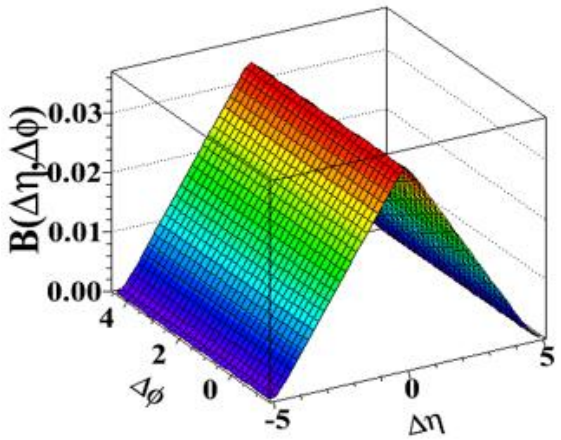
Calculation

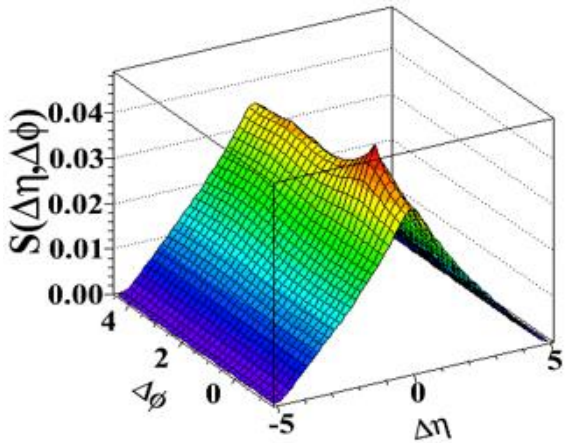


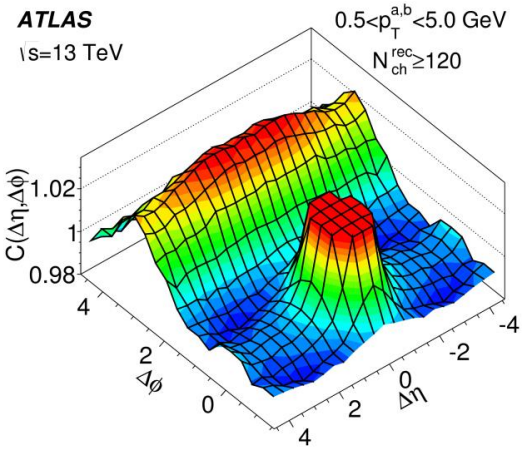




Experiment







- Range of Δy is enough to express the Ridge structure
- Peaks in marginal Δy are high : Need to investigate

Summary

- Introduce new distribution function, phPDh

$$f(y_a, a_T) = A(1-x)^a \left[1 - (1-q)\frac{m_T}{T}\right]^{\frac{1}{1-q}}$$

  - Check characteristics for each free parameter, a, q, T
  - Compare to PYTHIA simulation and choose free parameters
  - Calculate correlation with selected values
- Need to investigate at $\Delta y \sim 5$
- Consider to include jet components