arXiv:1204.1998

Modification of Hadron Spectra in p+A

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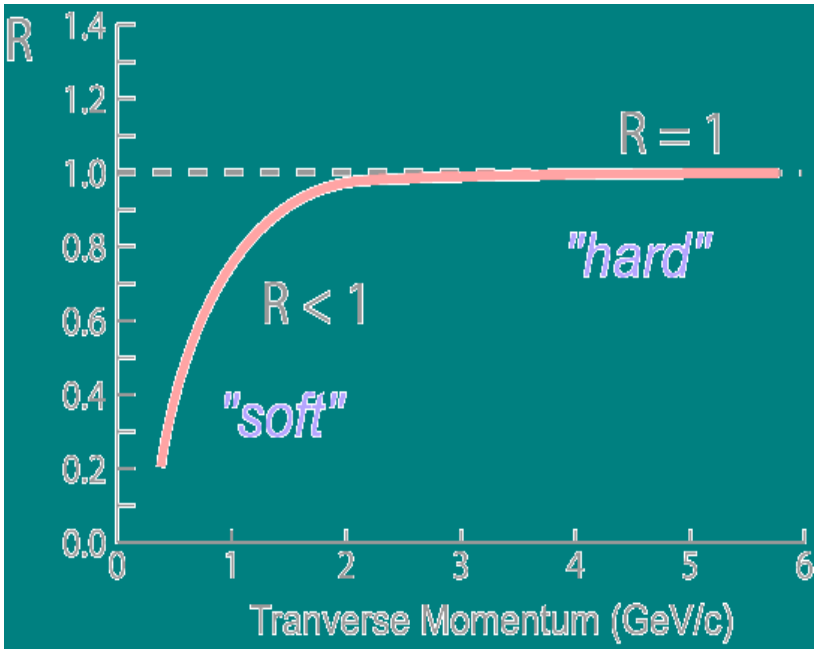
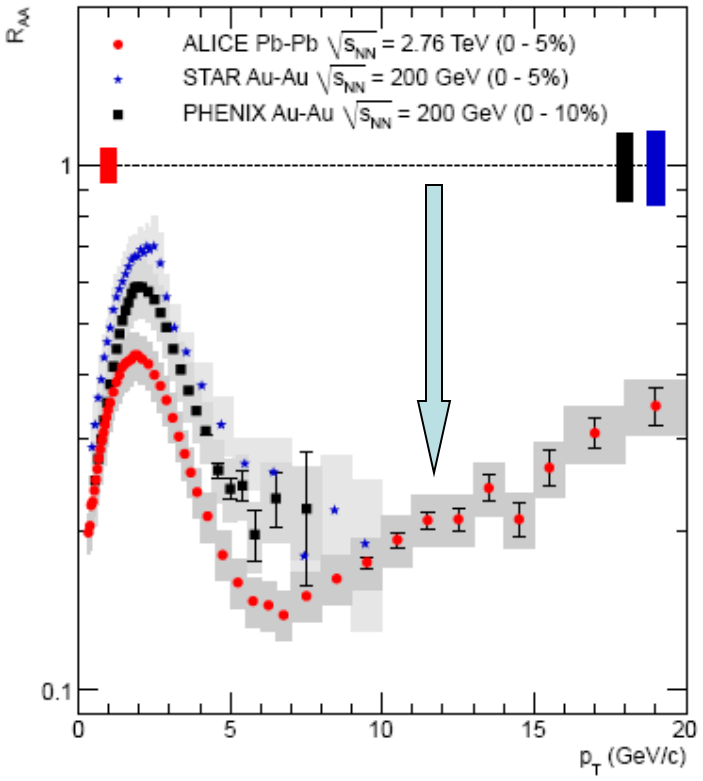
KEK
HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION

Nuclear Modification Factor:

$$R_{AA}(p_T) = \frac{d^2N^{AA}/dp_T d\eta}{< N_{bin} > d^2N^{NN}/dp_T d\eta}$$



If R = 1 here, no any nuclear modification



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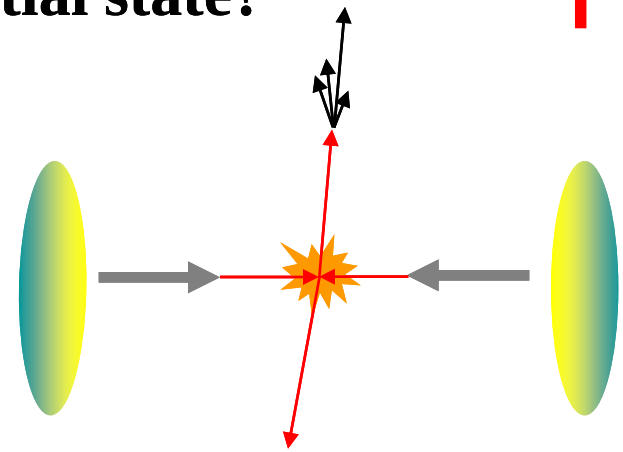
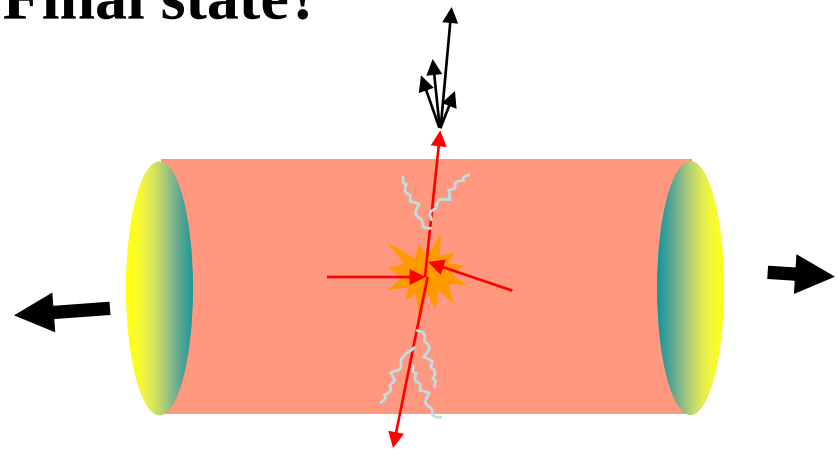
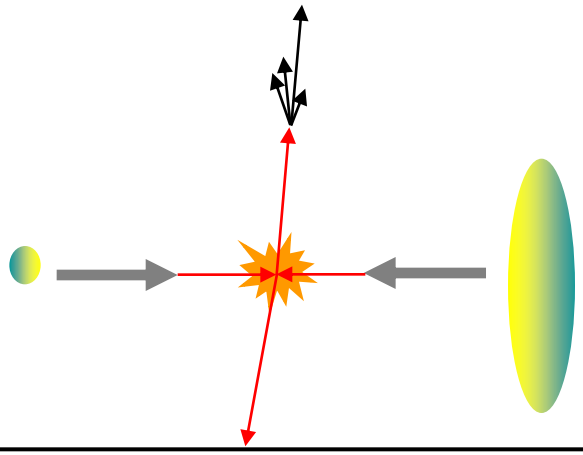
Suppression at High p_T

Initial state?



Final state?





Only initial cold nuclear effect

RHIC d+Au 200GeV
LHC p+Pb 5TeV
within HIJING

Cold Nuclear Effect in p+A

parton level

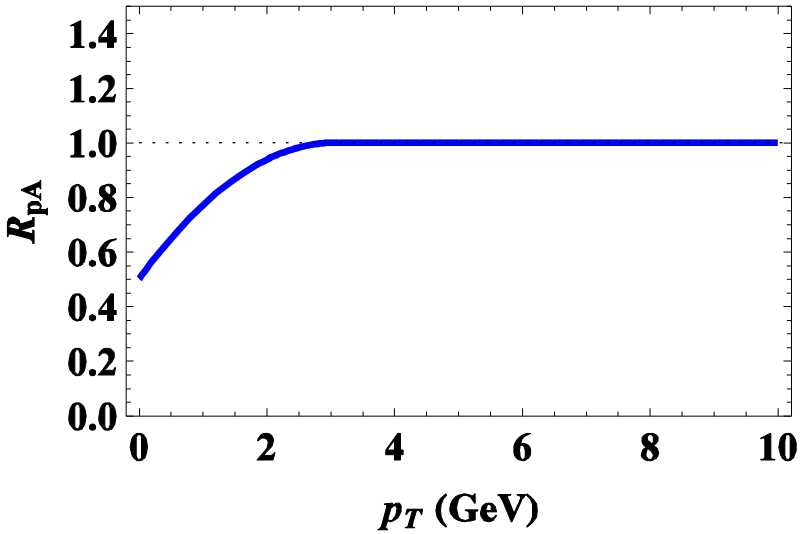
- Cronin effect
- Shadowing for nPDF
- Energy-Momentum conservation
- Parton flavor composition

Final hadron

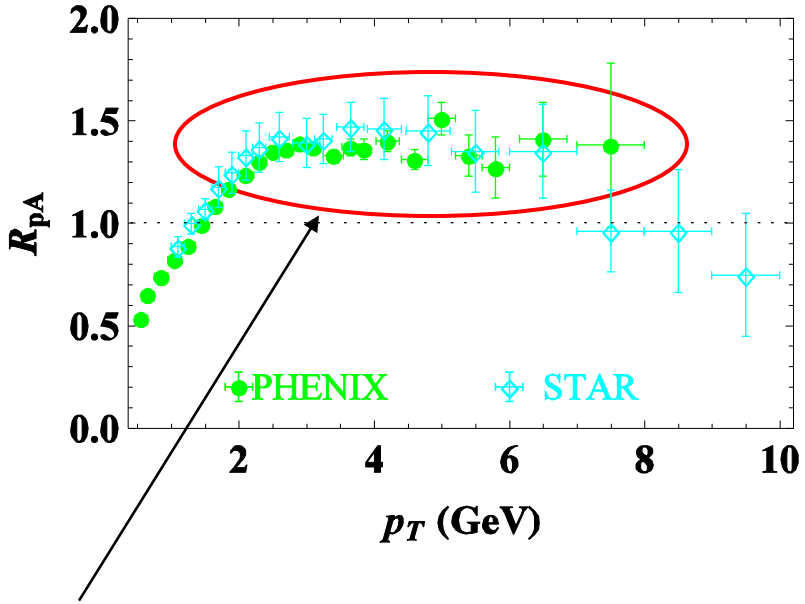
- Fragmentation
- ……

Cronin Effect

Nuclear modification:



If no nuclear modification



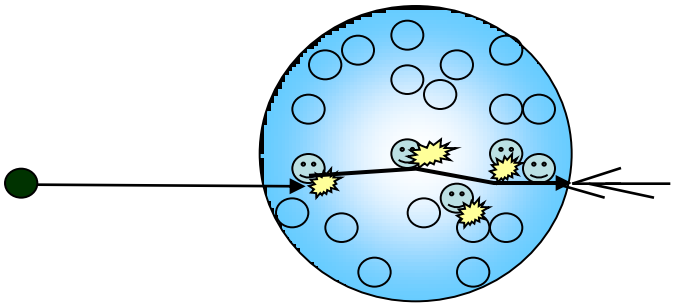
Cronin Effect

P.R.L. 91, 072303
PHENIX

P.R.L. 91, 072304
STAR

KT Broadening in HIJING

kT kick in p+A collisions:



Multiple inelastic scattering

KT broadening of initial and final partons, with Gaussian distribution

Energy dependence of the width in Gaussian distribution

$$\langle k_T^2 \rangle = a \ln^2(s) + b$$

Shadowing in HIJING

Nuclear shadowing:

$$R_a^A(x,Q^2) = \frac{f_a^A(x,Q^2)}{A f_a^N(x,Q^2)}$$

Phys.Lett.B 527, 85 (2002)

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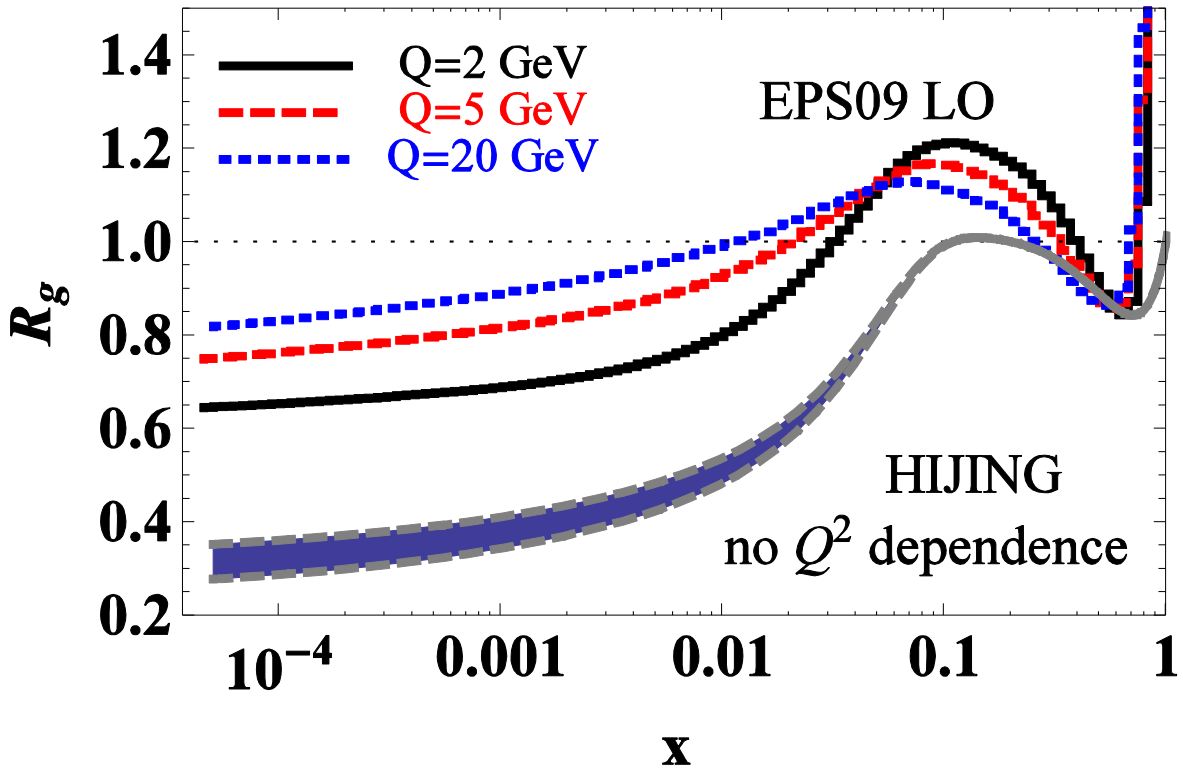
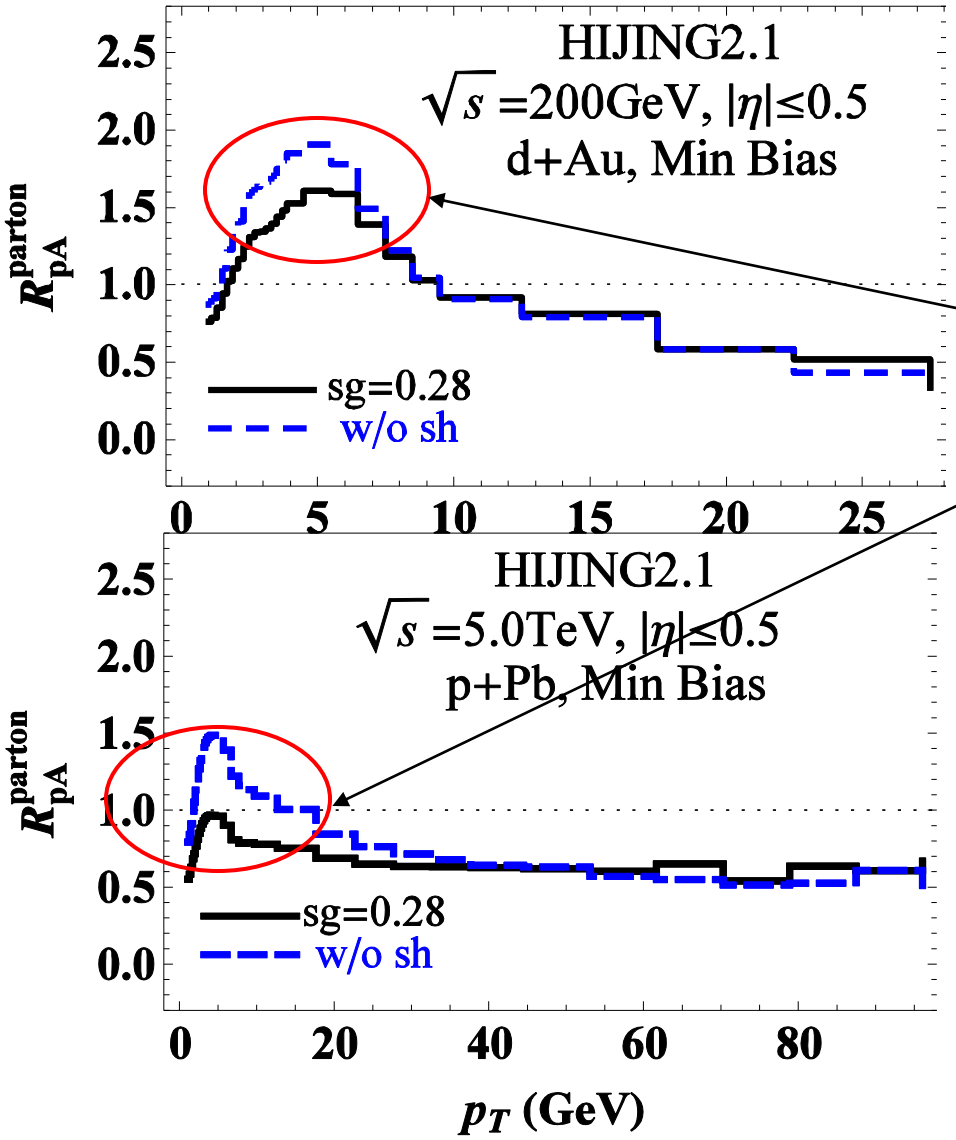


RpA on Parton Level



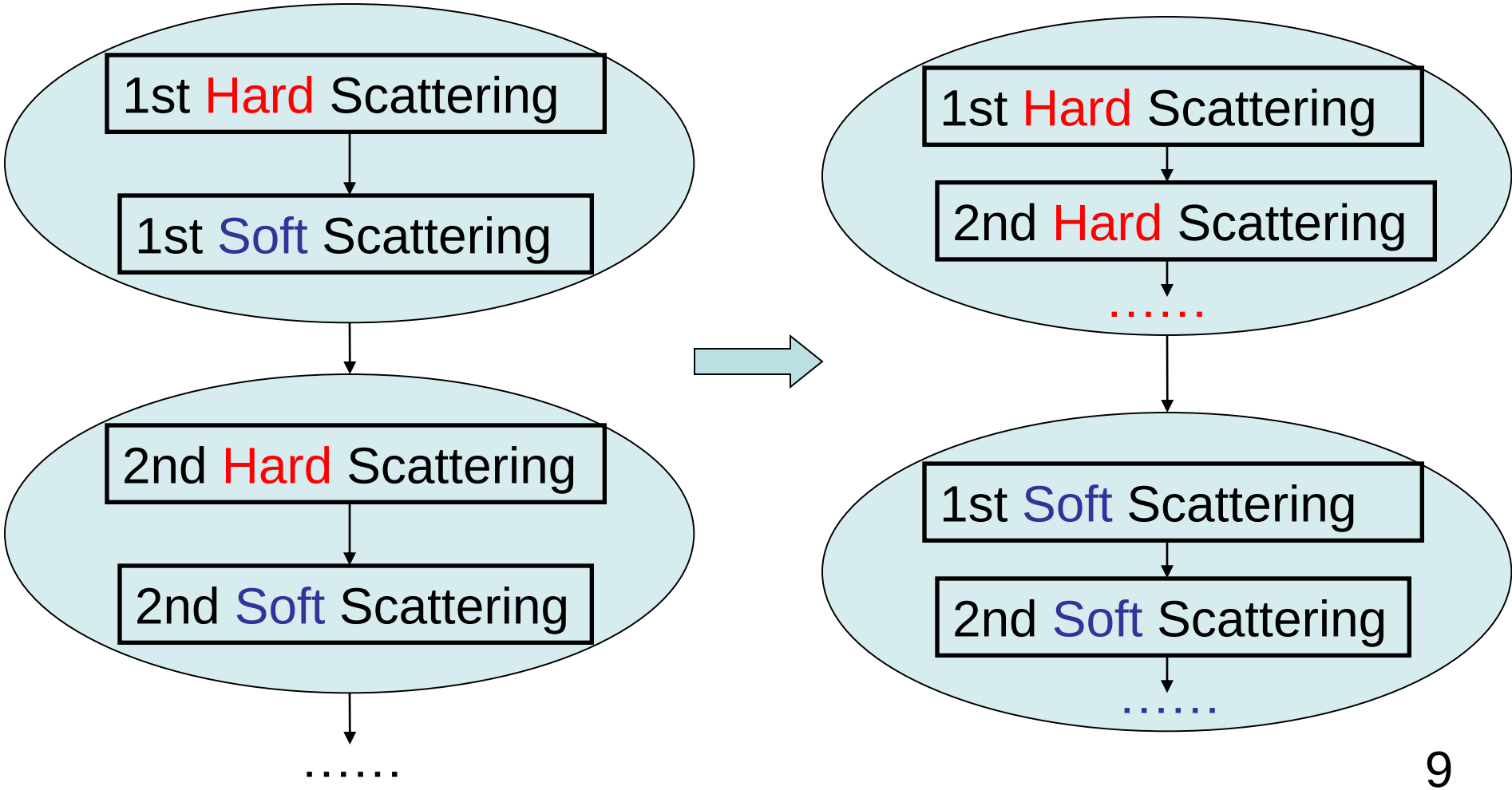
Cronin Effect at fix PT

Shadowing suppress RpA at low pT region (small x region)

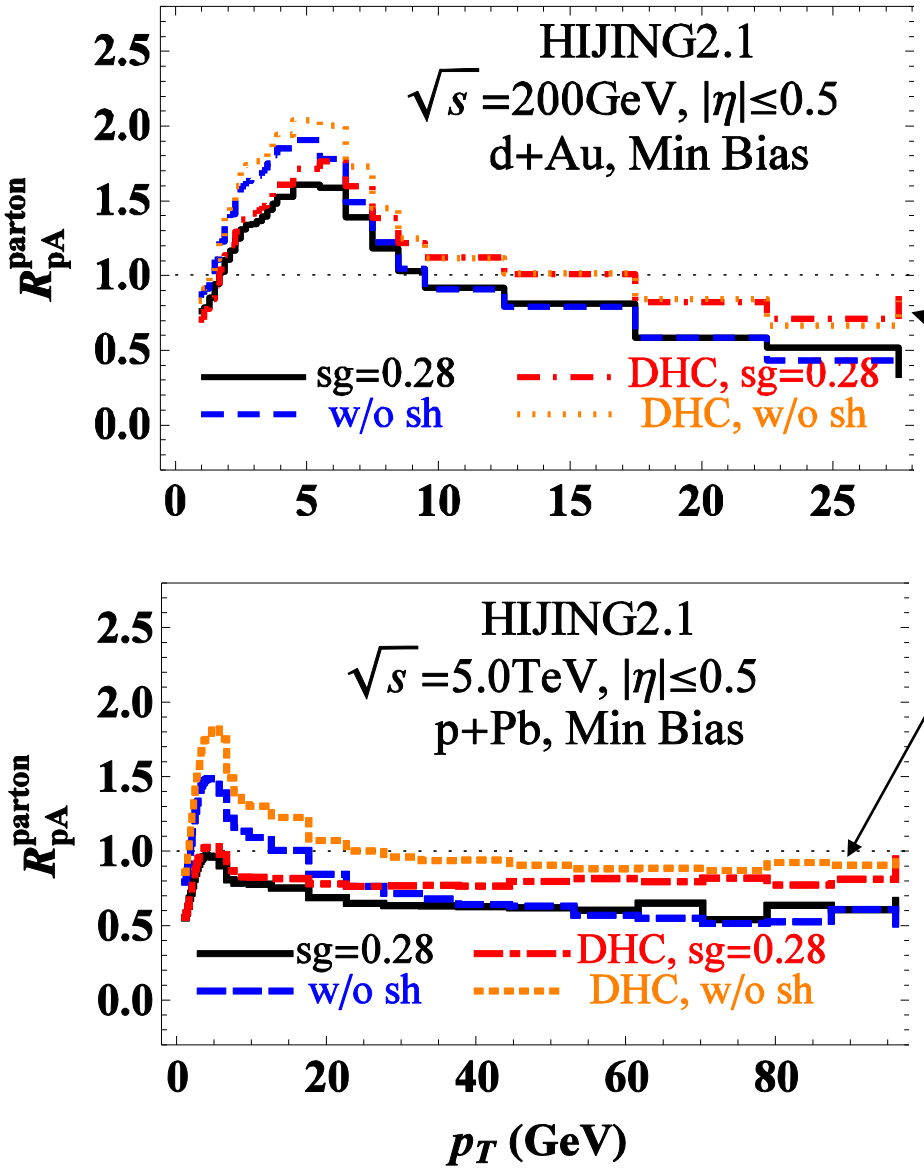
There is suppression on large pT, why?

Momentum Correlation

De-coherent Hard Collision (DHC) means: Soft-Hard is de-coupled in multiple scattering in HIJING



RpA on Parton Level



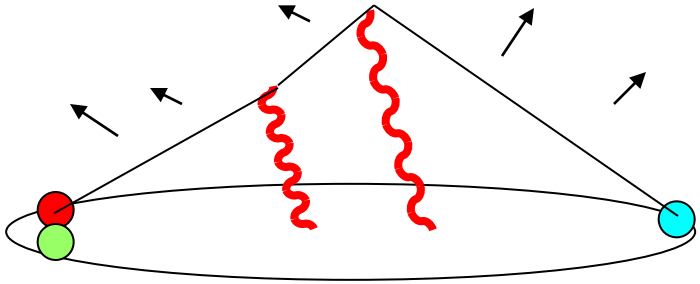
For DHC without shadowing, RpA is 1 at large pT

Soft-Hard coupling suppress RpA at large pT

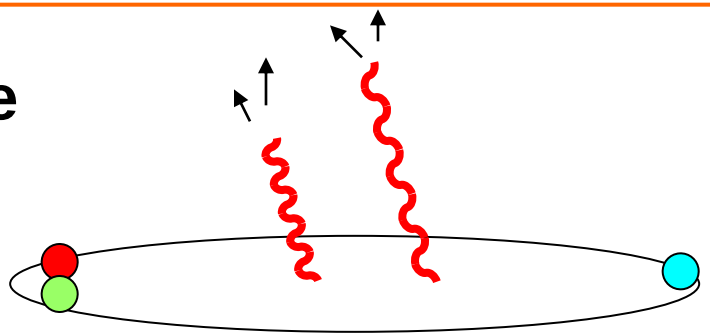
Lund Frg Vs. Independent Frg

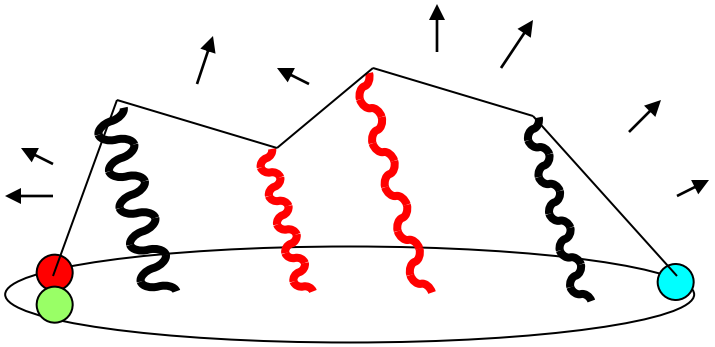
Hard gluons are attached on the excited participants as kinks

Hard gluons fragment into hadron independently

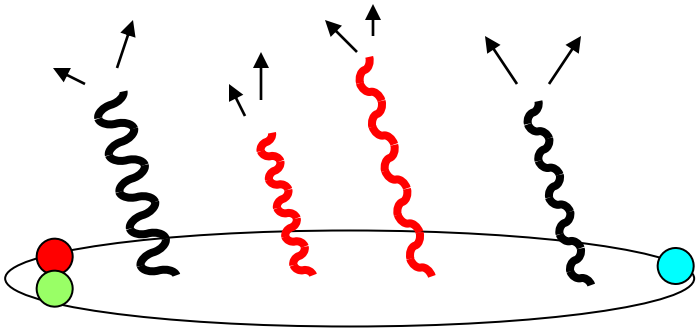


Projectile in p+p

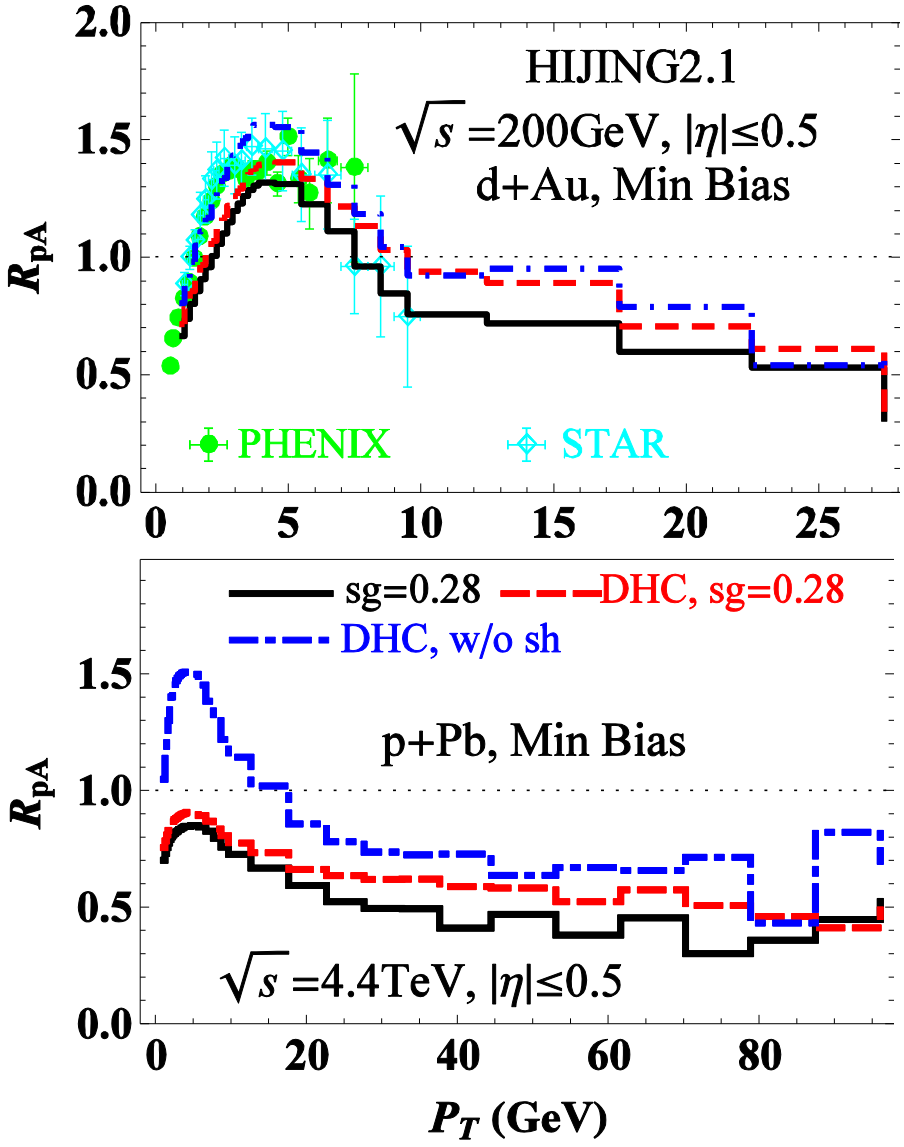




Projectile in p+A



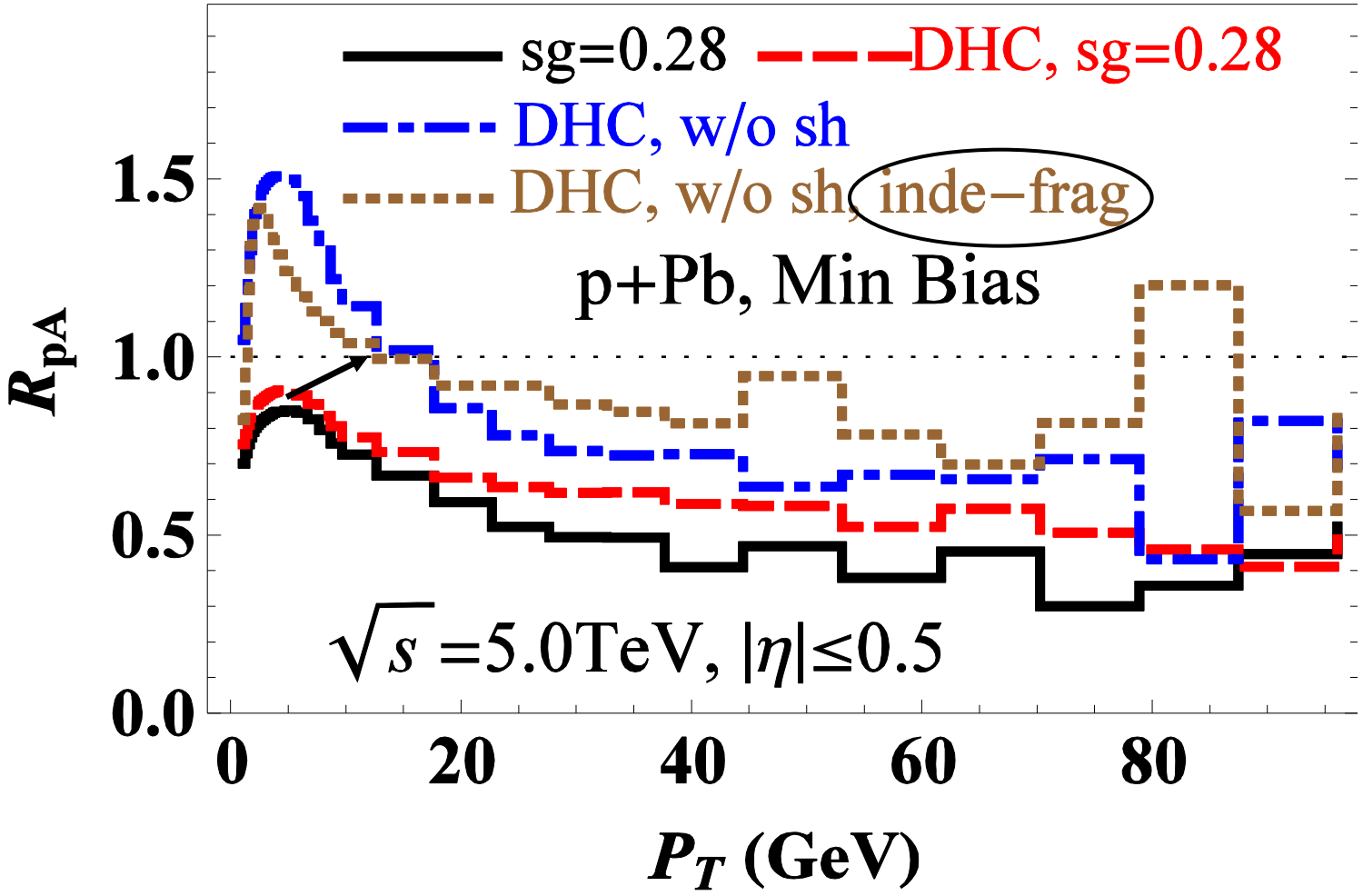
RpA for Final Hadron



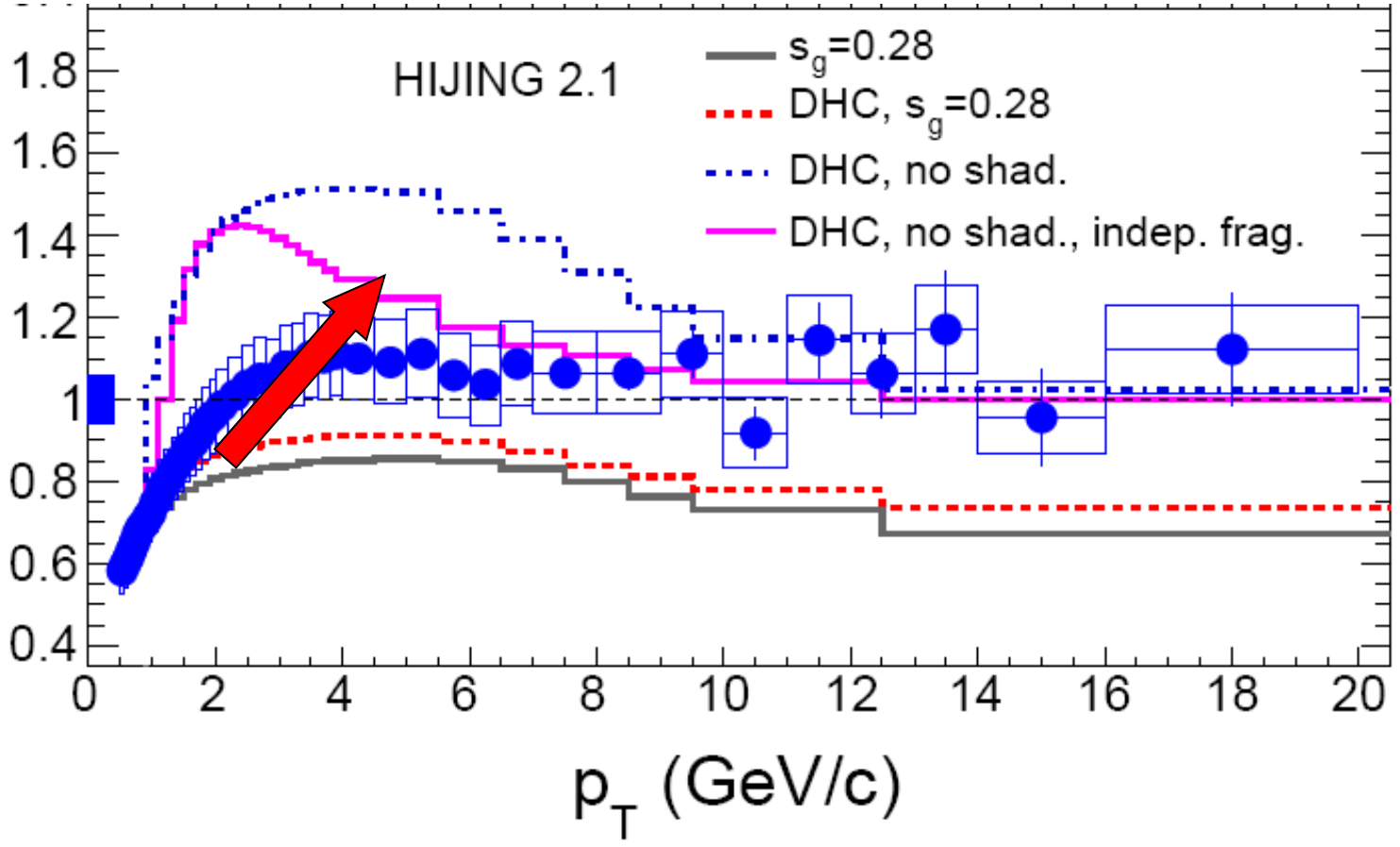
Lund Fragmentation

R_{pA} for Final Hadron

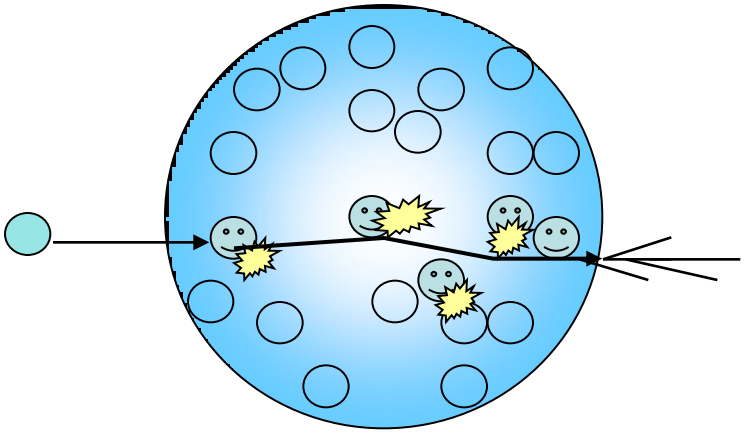
hadron spectra in Lund frag is softer than Independent frag.



arXiv:1210.4520 ALICE



Flavor Correlation in Projectile



Valence Quark Number Conservation

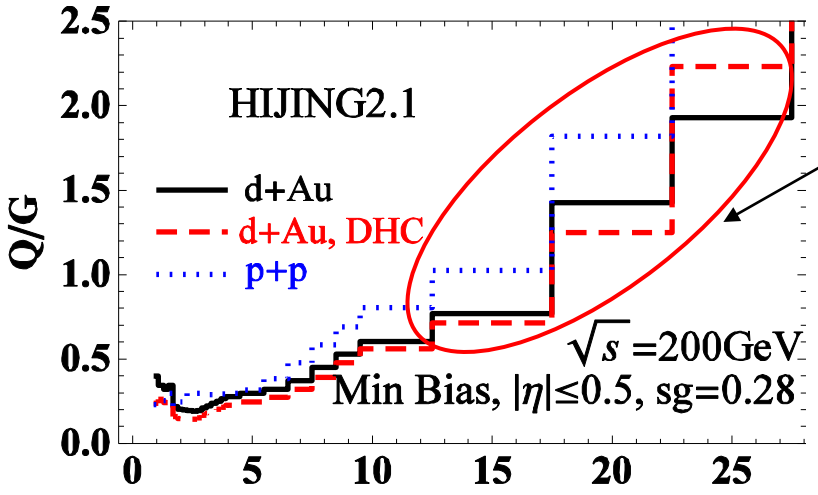
Quark availability is less in multiple scattering

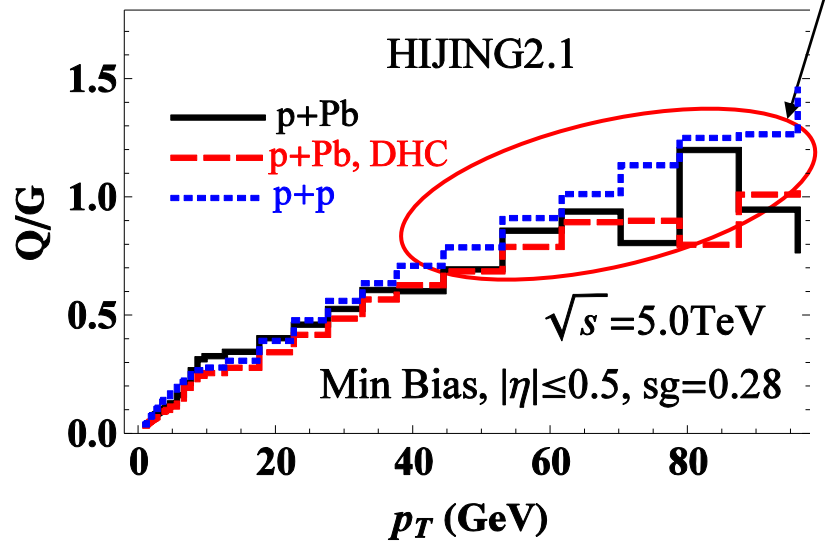
$$f_{qq}(x,Q^2) < f_q(x,Q^2) f_q(x,Q^2)$$

In HIJING, we push to the limit:

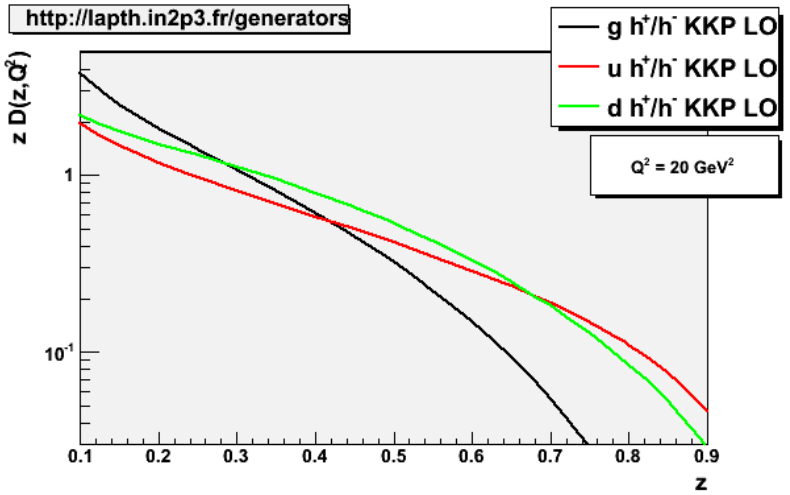
If a quark has been scattered once, only gluon available for latter scattering

Flavor Correlation





the Q/G ratio in p+A is smaller at large p_T.



Dissertation

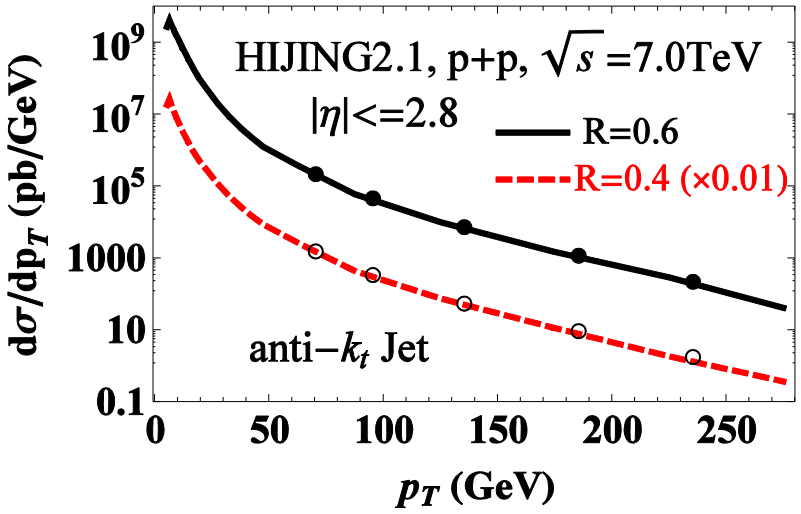
More gluon give softer hadron spectrum

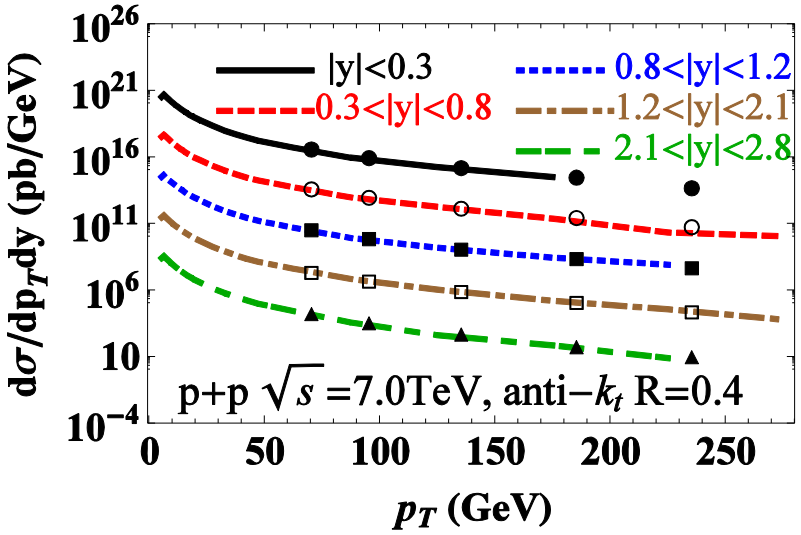
RpA for Jets

Anti-kt algorithm in FastJet.

M. Cacciari, G.P. Salam and G. Soyez, Eur.Phys.J.C72(2012)

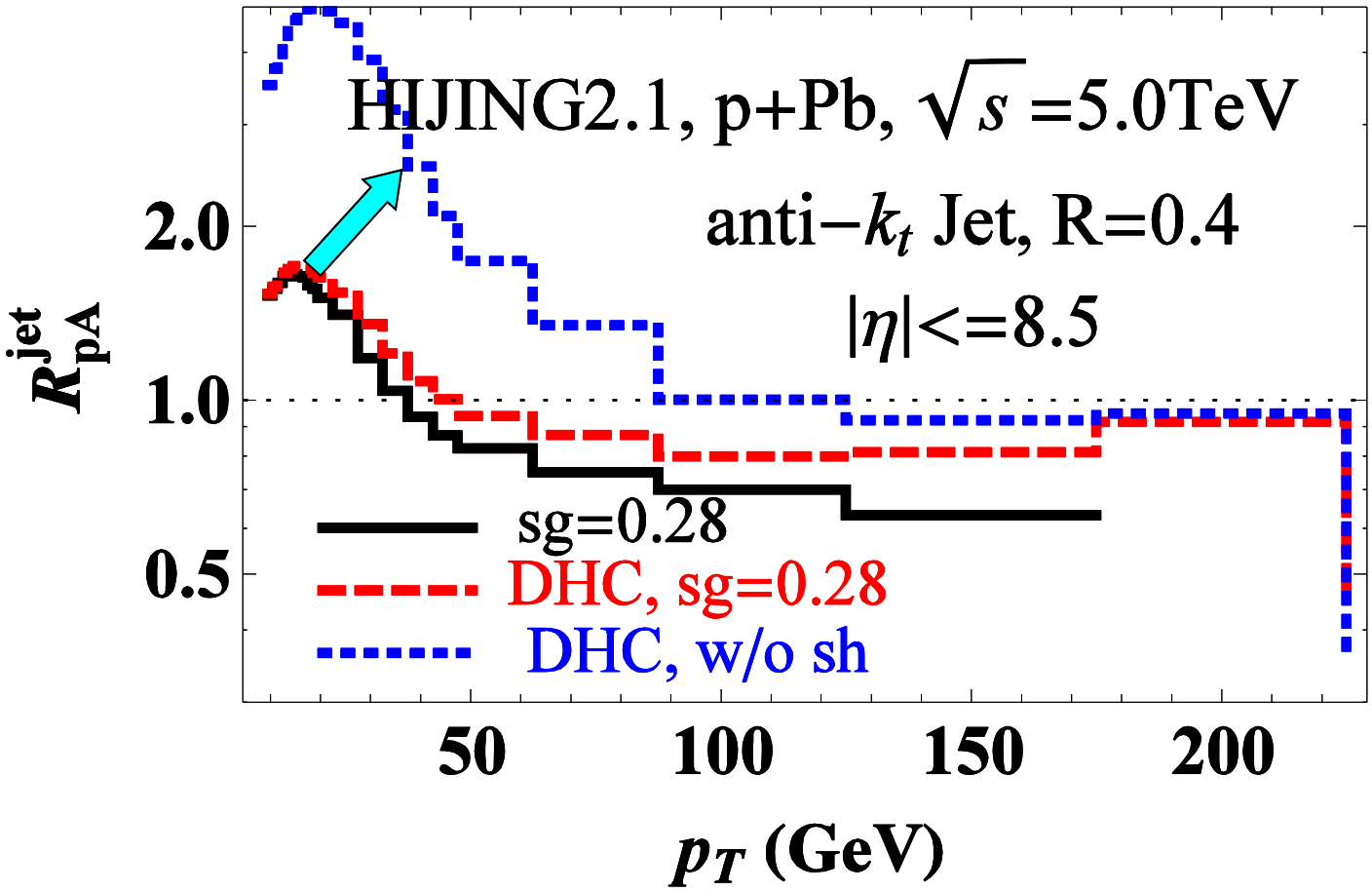
$$\mathcal{R} = \sqrt{h^2 + f^2}$$





Eur.Phys.J. C71 (2011) 1512 ATLAS

RpA for Jets


HIJING2.1, p+Pb, $\sqrt{s}$ =5.0TeV
anti−k_t Jet, R=0.4
|η|<=8.5
sg=0.28
DHC, sg=0.28
DHC, w/o sh
R_{pA}^{jet}
2.0
1.0
0.5
50
100
150
200
p_T (GeV)

Summary

We studied the p+A collision within HIJING model.

- **Cronin effect at intermediate p_T due to K_T broadening through multiple scattering.**

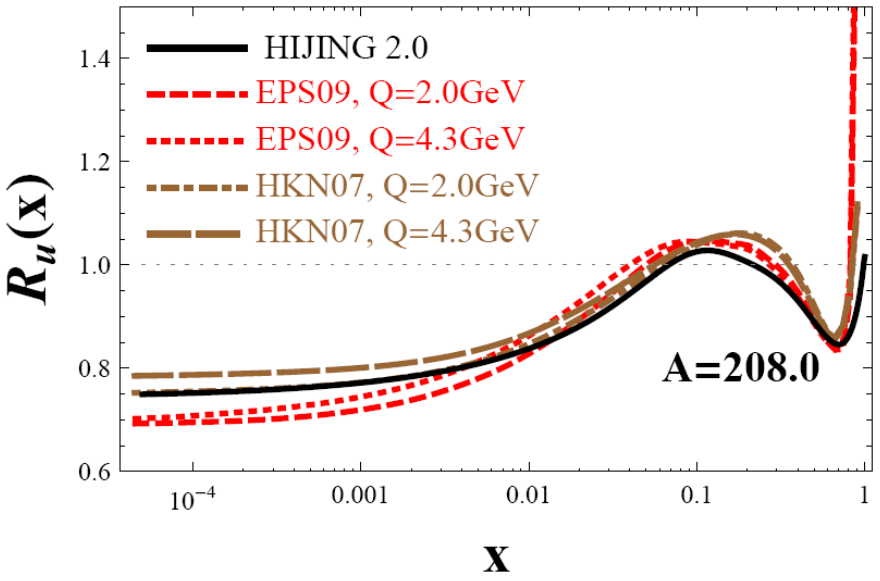
- **High p_T suppression from cold nuclear effects:**
  - **parton shadowing,**
  - **soft-hard coupling,**
  - **enhanced gluon jets due to valence quark conservation**
  - **Fragmentation method**

- **Such effects in AA collisions need to be investigated.**

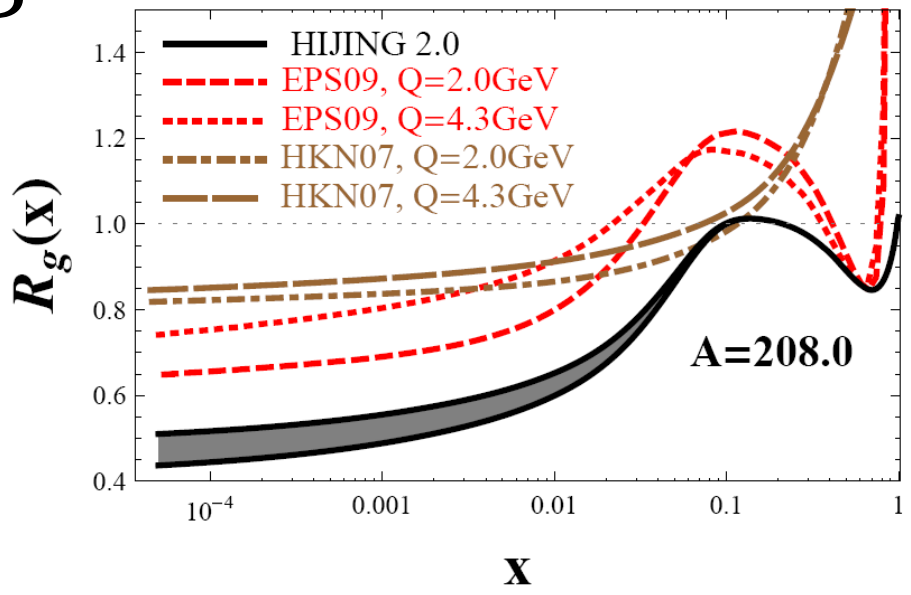
Shadowing in HIJING

Nuclear shadowing:

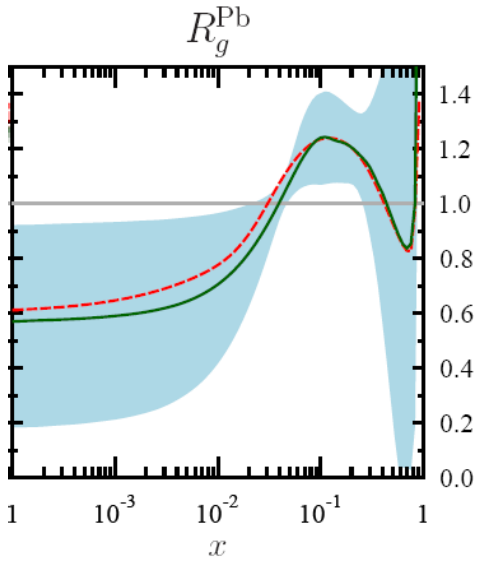
$$R_a(x,Q^2) = \frac{f_a(x,Q^2)}{A\,f_a(x,Q^2)}$$



Quark, fixed on DIS



Gluon, fit to the RHIC



Gluon uncertainty in EPS09

Phys.Lett.B 527, 85 (2002)

S.Y. Li & X.N. Wang

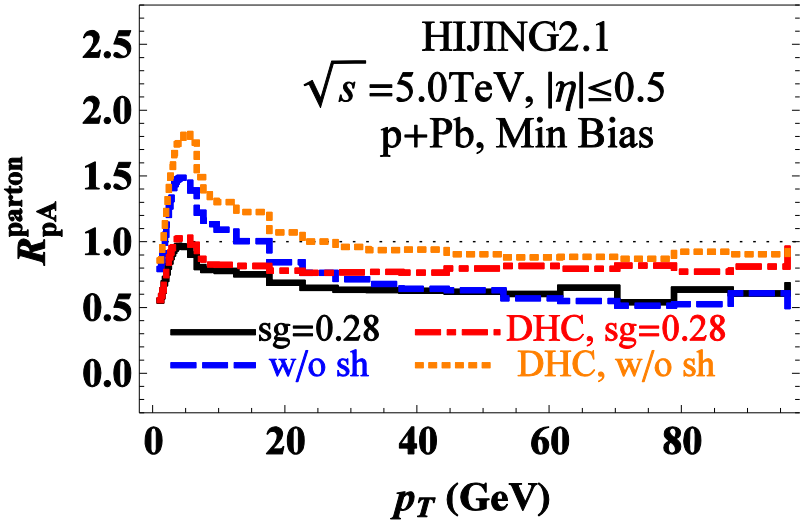
arXiv: 1205.5359

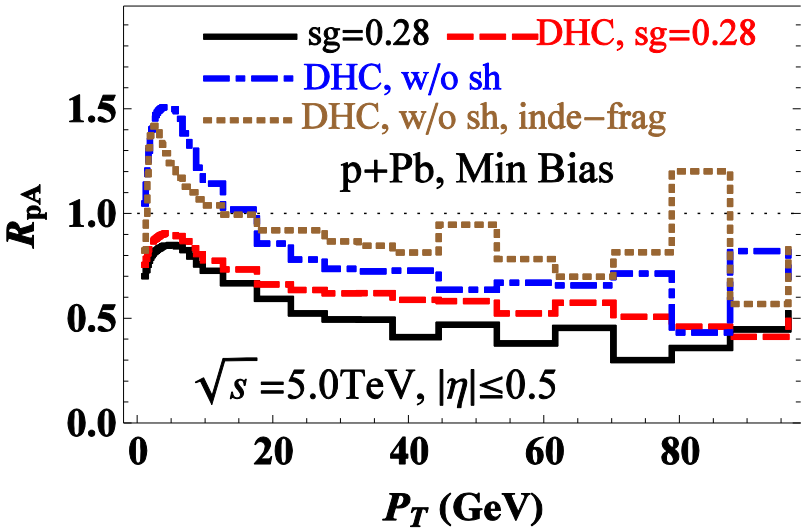
The suppression of High pT hadron comes from fragmentation mainly:

•More gluon jets

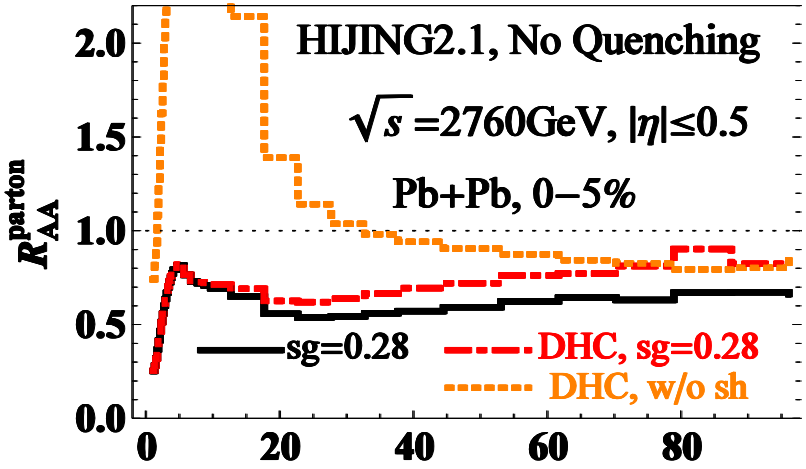
•Multiple gluon fragmentation model

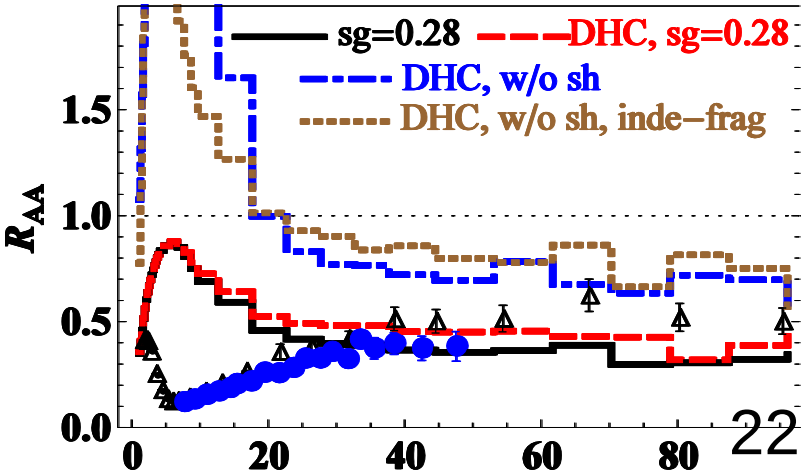
pA:





AA:





RpA for Final Hadron