QUARK MATTER 2015

Jet-induced medium excitation in heavy-ion collisions

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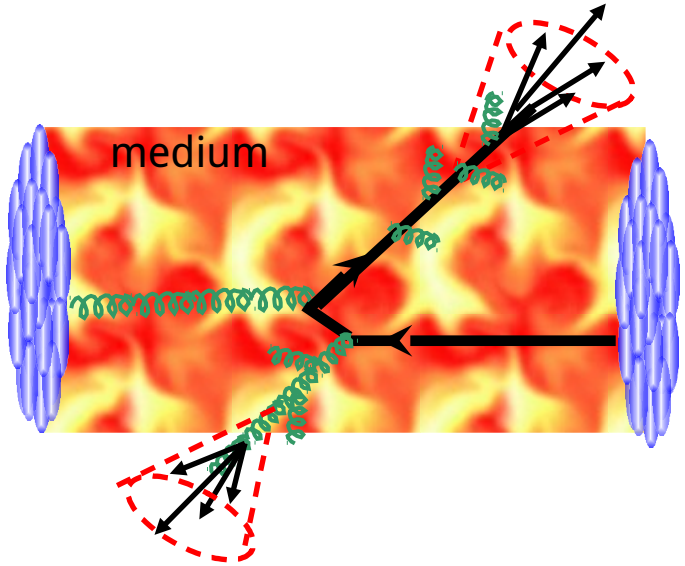
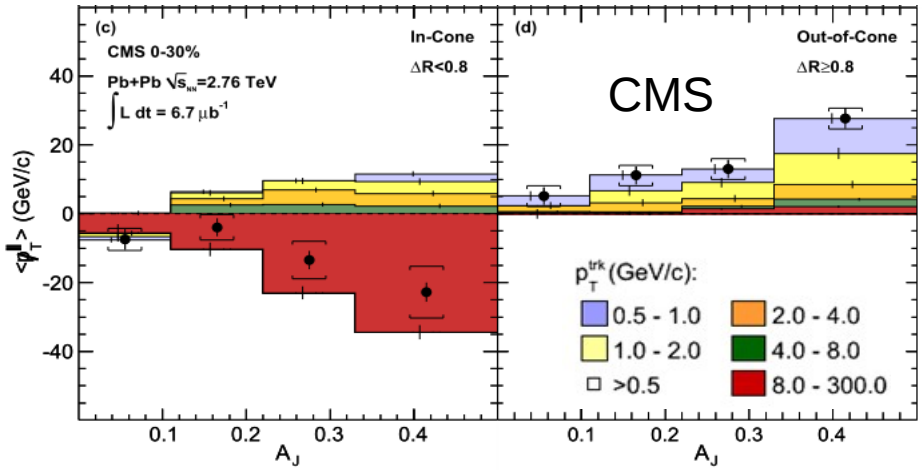
Outline

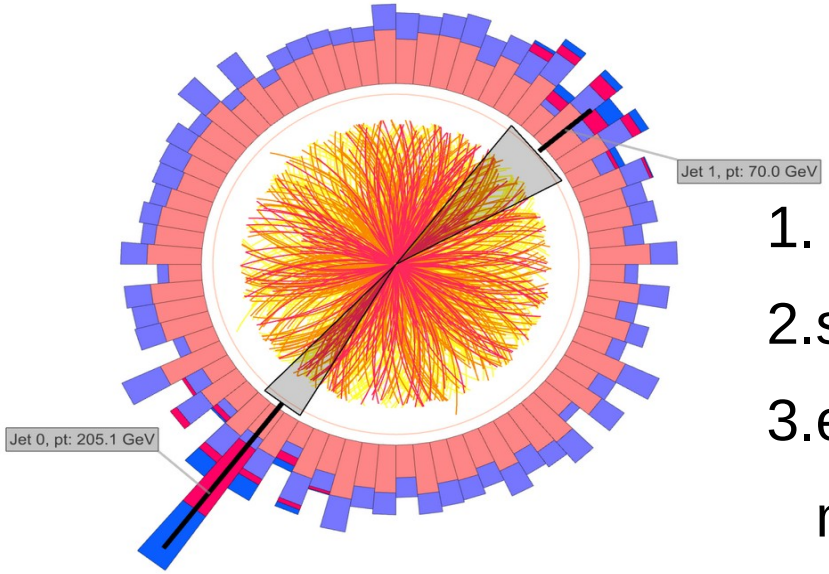
- Introduction
- Linear Boltzmann jet transport coupled with 3+1D hydrodynamic model
- Gamma-trigger jet propagation
- Results about jet supression + jet-induced medium excitation
- Summary and outlook

Introduction





PRC 84 (2011) 024906



1. jet supression in PbPb
2. significant energy flow out of cone
3. energy flow is carried mostly by low transverse momentum hadrons at larger angle

Linear Boltzmann Jet Transport model(LBT)

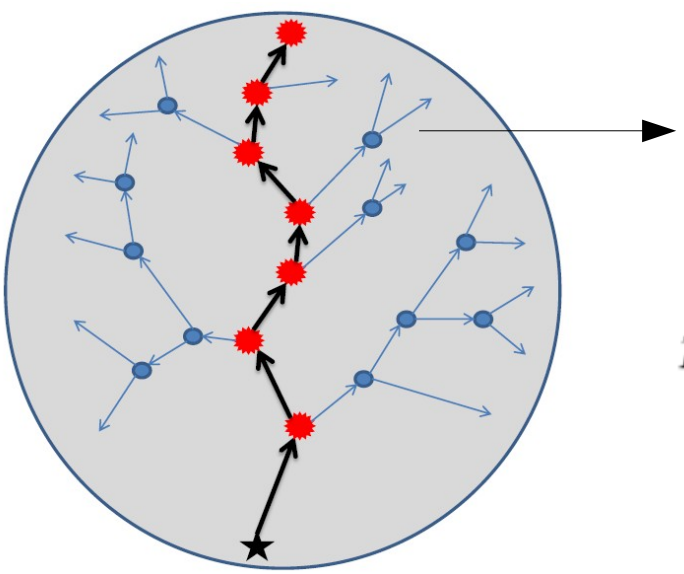
1.study: jet propagation in QGP medium. Tan Luo's talk in the firtst section

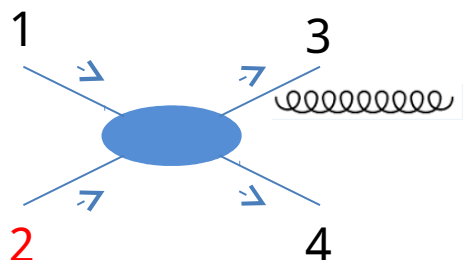
2.keep track of both jet shower parton and thermal recoiled parton.

3.elastic and inelastic process

4.neglect interaction between jet shower partons and recoiled partons.

Hanlin Li, Fuming Liu, Guo-liang Ma, Xin-Nian Wang, Yan Zhu **Phys.Rev.Lett. 106, 012301**
Xin-Nian Wang, Yan Zhu **Phys.Rev.Lett. 111, 062301**
Yayun He, Tan Luo, Xin-Nian Wang, Yan Zhu **Phys.Rev. C91 (2015) 054908**





Boltzmann equation:

$$p_1 \cdot \partial f_a(p_1) = -\int \frac{d^3p_2}{(2\pi)^3 2E_2} \int \frac{d^3p_3}{(2\pi)^3 2E_3} \int \frac{d^3p_4}{(2\pi)^3 2E_4} \sum_{b(c,d)} \left[f_a(p_1) f_b(p_2) - f_c(p_3) f_d(p_4) \right] |M_{ab\to cd}|^2 \times S_2(s,t,u)(2\pi)^4 \delta^4(p_1 + p_2 - p_3 - p_4),$$

+radiation

CoLBT_Hydro model

(Linear Boltzmann jet transport coupled with 3+1D hydrodynamical model)

Motivation:

linear approximation : jet-induced medium excitation is much smaller than thermal background $\delta f \ll f$

LBT model is not valid because of a lot of soft partons produced.

simulate both the transport of jet shower partons and jet-induced medium excitation.

Basic Idea:

The energy-momentum conservation equations with source term can be expressed as :

$$\partial_\mu T^{\mu\nu} = j^\nu$$

The source term can be expressed as:

$$j^\nu = \sum_{i=1}^{n} \frac{(dP_i^\nu)_{soft}}{d\tau} \delta^3(\vec{X} - \vec{X}_i)$$

Soft parton: parton with energy below Ecut in the comoving frame

Similar work : Yasuki TachiBana's talk in first section.

CoLBT_Hydro model

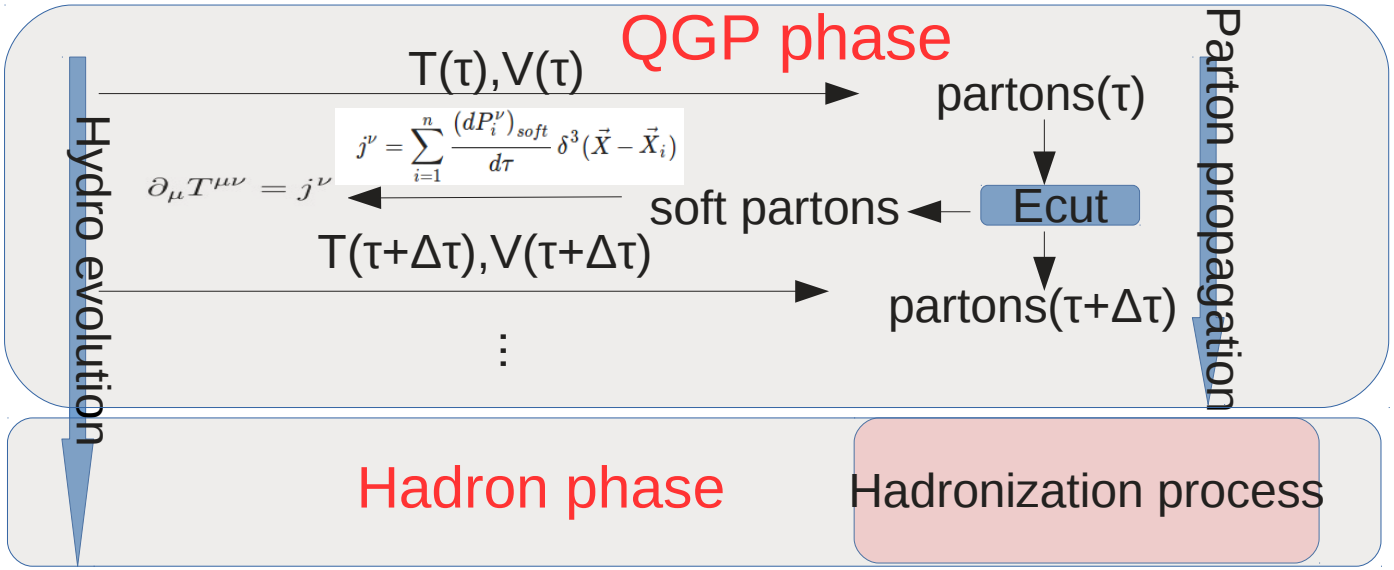
(Linear Boltzmann jet transport coupled with 3+1D hydrodynamical model)

Initial condition:

- **Event by event**

jet shower partons + 3+1D hydrodynamic model with fluctuating initial condition from AMPT model

Longgang Pang,Qun Wang,X-N Wang 10.1103/PhysRevC.86.024911



Evolution:

- **Time step by step**

at any given time,hydro provide bulk information.

soft parton from LBT as source term induce medium excitation and update bulk information

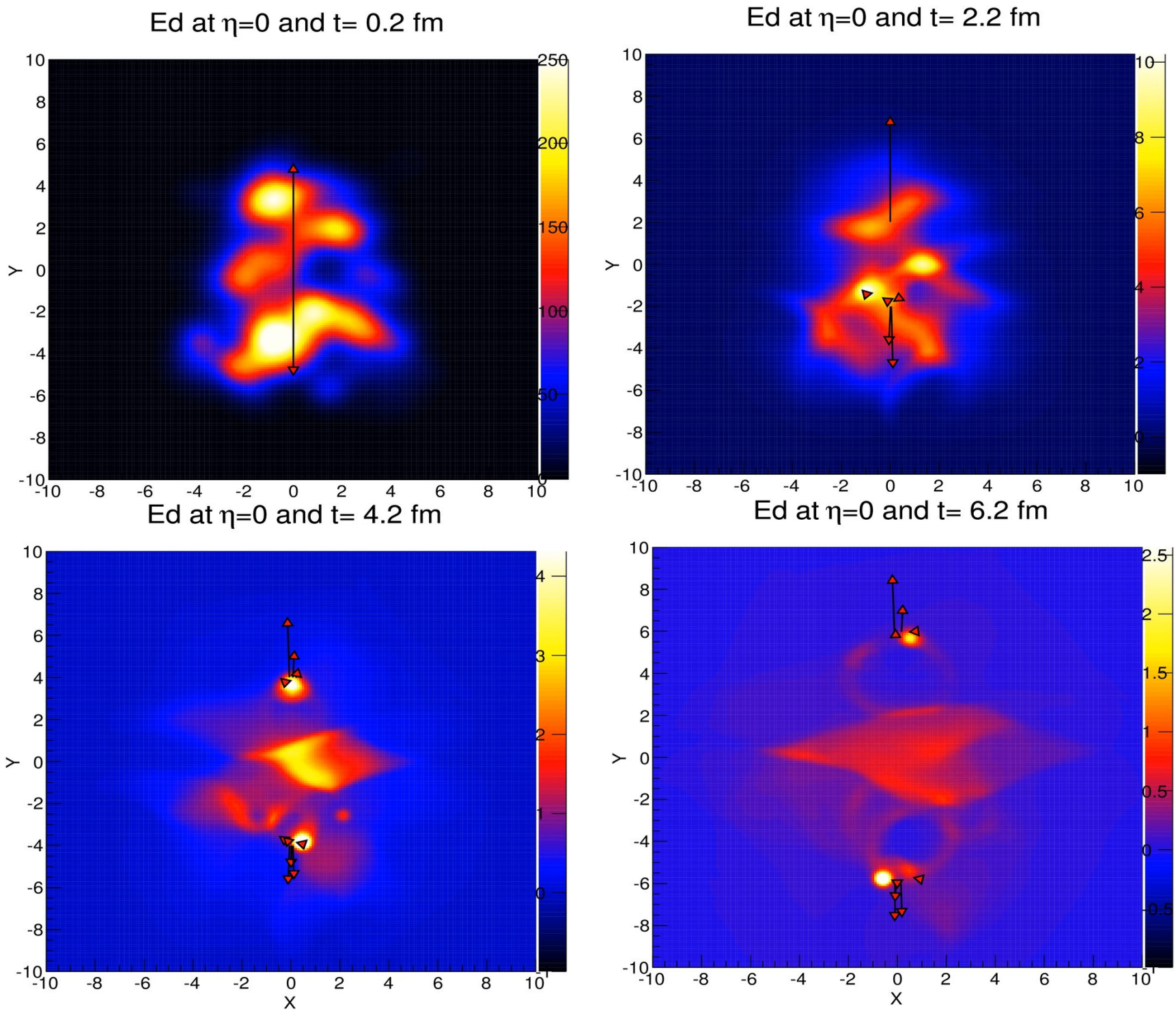
Hadronization:

Using recombination model from Texas A-M group

Kyong Chol Han, Rainer J. Fries, Che Ming Ko J.Phys.Conf.Ser. 420 (2013) 012044

Time consumption : one event , more than 7 hours in CPU, less than 7 minutes in GPU

Jet propagation and jet-induced medium excitation



Gamma-jet propagation in CoLBT_Hydro model

1. Gamma-jet:

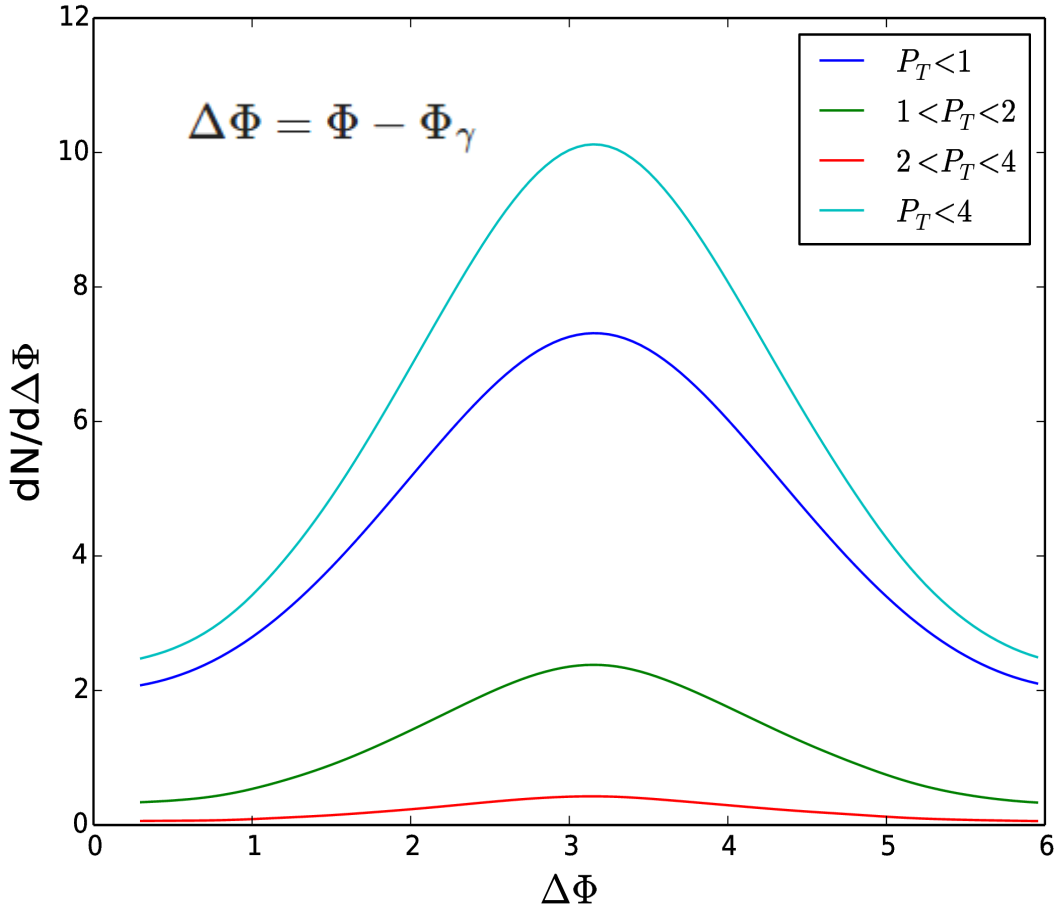
- a clean, unbiased sample

- Gamma does not interact with medium and
provide initial information about jet

2.Gamma jet initial configuration comes from Hijing

3.Initial distribution of gamma_jet is from binary collision probablity .

Hadron spectrum from jet-induced medium excitation



$\Delta\Phi$: angle between hadron and gamma

$$\frac{dN}{d\Phi P_T dP_T d\eta} = \frac{dN}{d\Phi P_T dP_T d\eta}_{\gamma jet} - \frac{dN}{d\Phi P_T dP_T d\eta}_{no-\gamma jet}$$

Using same hydro initial condition in one event

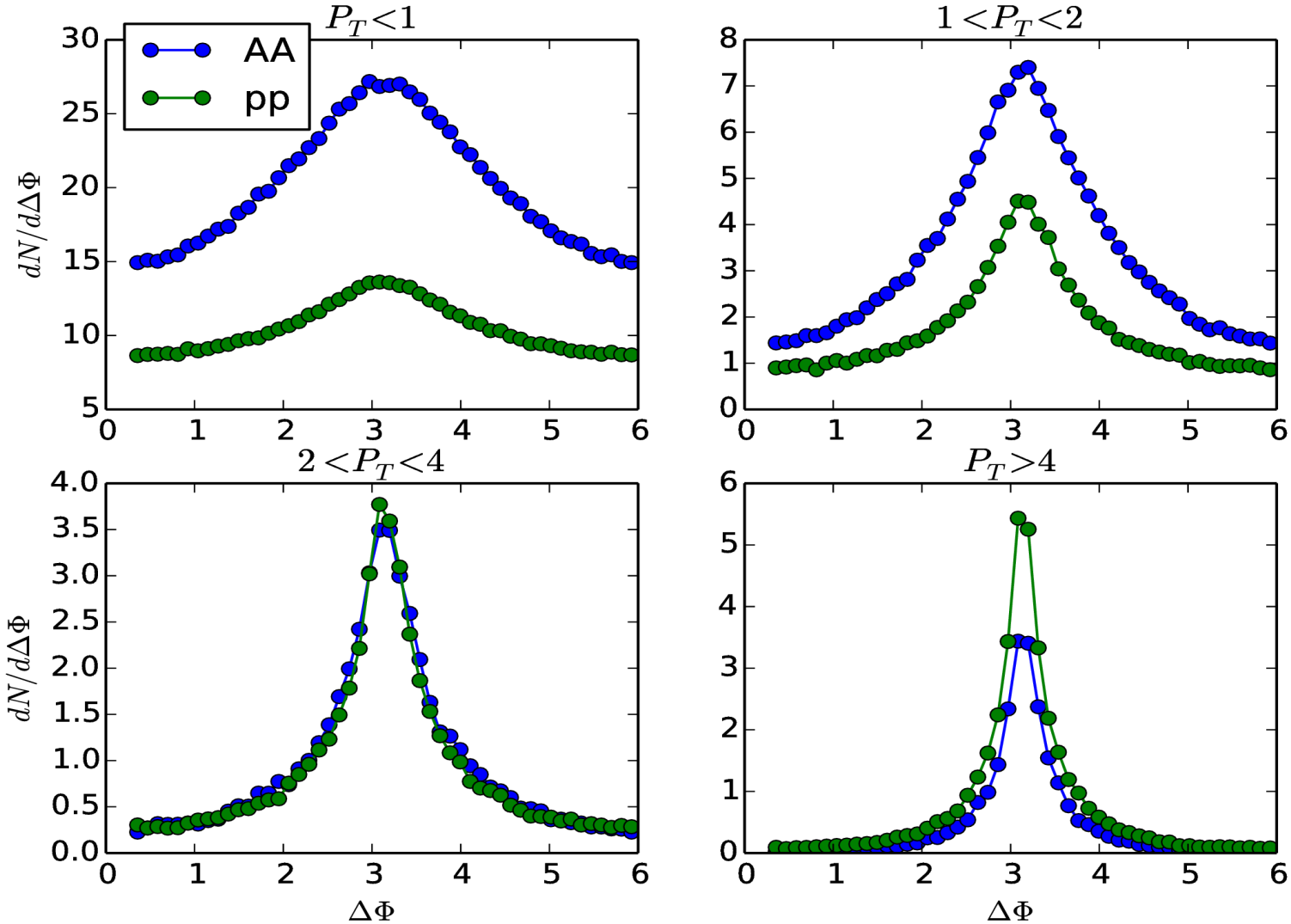
$$dN/d\Phi_{no\_\gamma jet} \approx 2200$$

1. Soft hadron spectra(pT<1 GeV) from jet-induced medium excitation

2.Hadrons from jet-induced medium excitation are in the direction of jet propagation

hadron spectrum between AA and pp

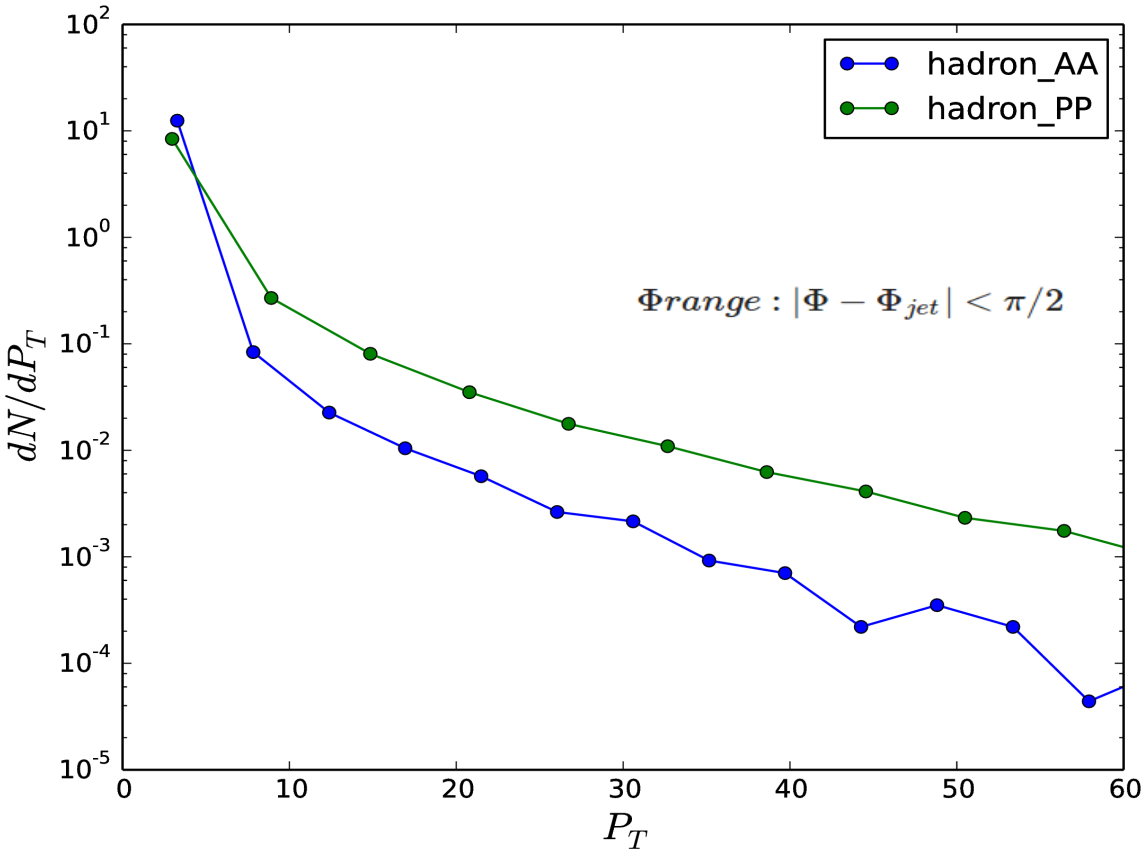
Hadron spectrum of AA contributed from : jet-induced medium + modified jet shower



1.A huge enhancement for soft hadrons not only in the direction of jet but also in the direction of gamma.

2. there is a supression in high pt

Pt distribution along jet direction



1.Enhancement at low transverse momentum
2. supression at high pt range

Summary and Outlook

1.We use Linear Boltzmann jet transport model coupled with 3+1D hydrodynamics model to simulate both the transport of jet shower partons and jet-induced medium excitation.

2.With this coupled approach we investigate hadrons spectrum in both low and high transverse momentum region. We also study hadron-jet and gamma-hadron correlation to study the effect of jet-induced medium excitations

A lot of work needed to do...

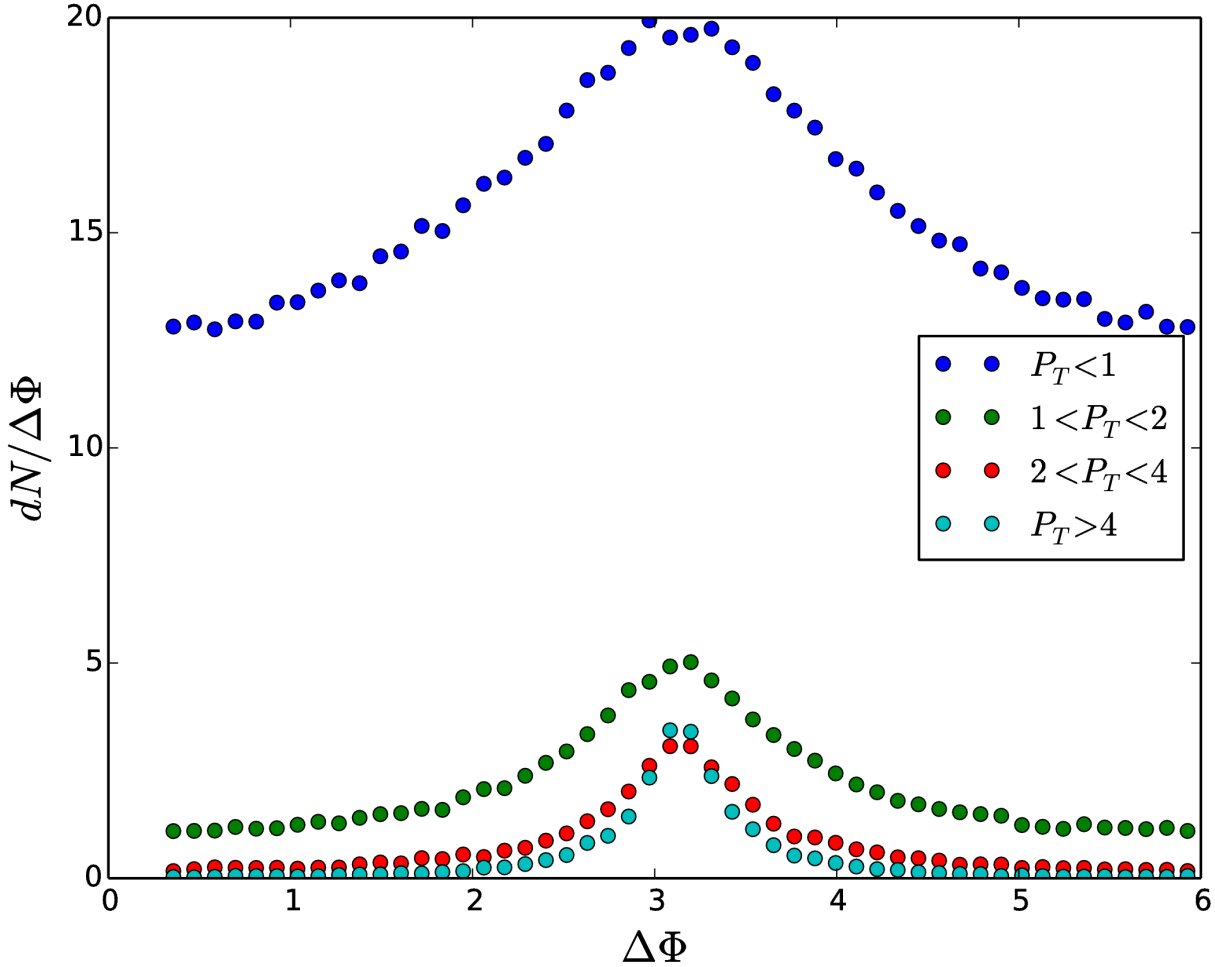
1. jet reconstruction

2. different centrality

3.different jet type

Backup

Hadron spectrum from LBT part



Jet parton showers from Hijing.

↓ CoLBT_hydro

Final partons

↓ Recombination

Hadrons