Jet propagation within a Linearized Boltzmann Transport Model

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Boltzmann Equation:

$$p_1 \cdot \partial f_1(p_1) = -\int dp_2 dp_3 dp_4 (f_1 f_2 - f_3 f_4)|M_{12\to34}|^2 \times (2\pi)^4 \delta^4(P_1 + P_2 - P_3 - P_4)$$

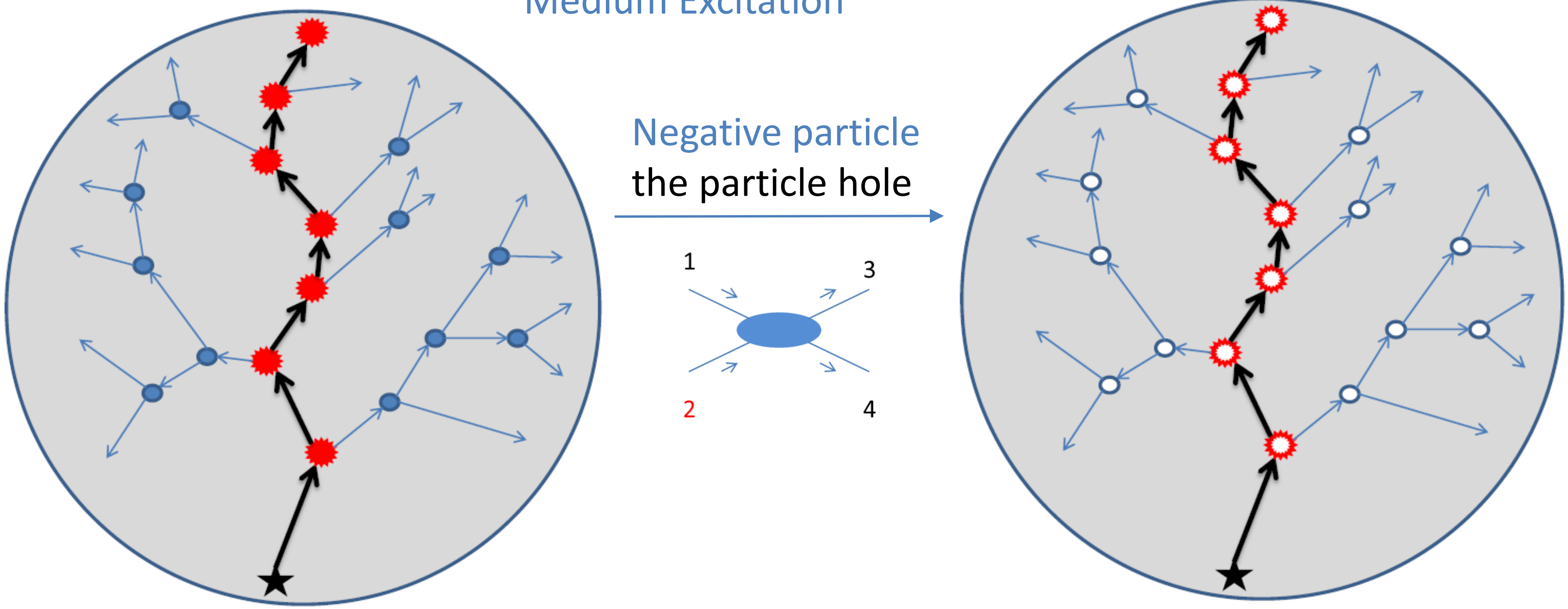
$$dp_i \equiv \frac{d^3 p_i}{2E_i(2\pi)^3}, \; |M_{12\to34}|^2 = Cg^2(s^2+u^2)/(t+\underline{\mu}^2)^2$$

$$f_i = 1/(e_i^{p.u/T} \pm 1)(i=2,4), \; f_i = (2\pi)^3\delta^3(\vec{p}-\vec{p}_i)\delta^3(\vec{x}-\vec{x}_i)(i=1,3)$$


Leading parton-----thermal parton scattering


recoiled parton-----thermal parton scattering

Medium Excitation



Linearized Boltzmann jet transport

neglect scatterings between recoiled medium partons.

It's a good approximation when the jet induced medium excitation δf<<f.

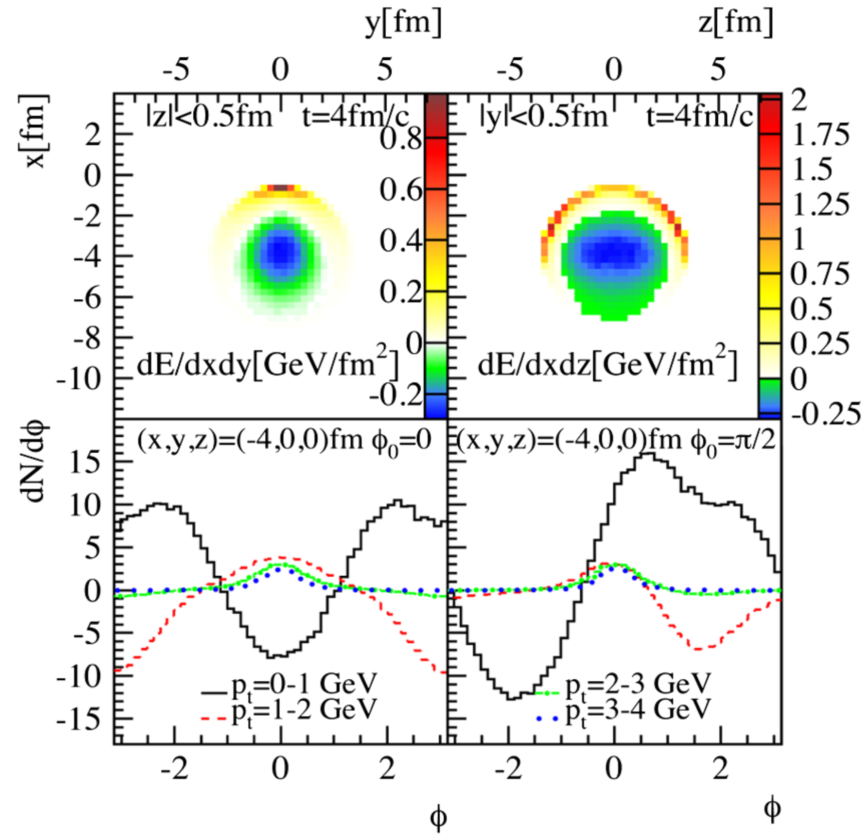
Deflection of different phase space.

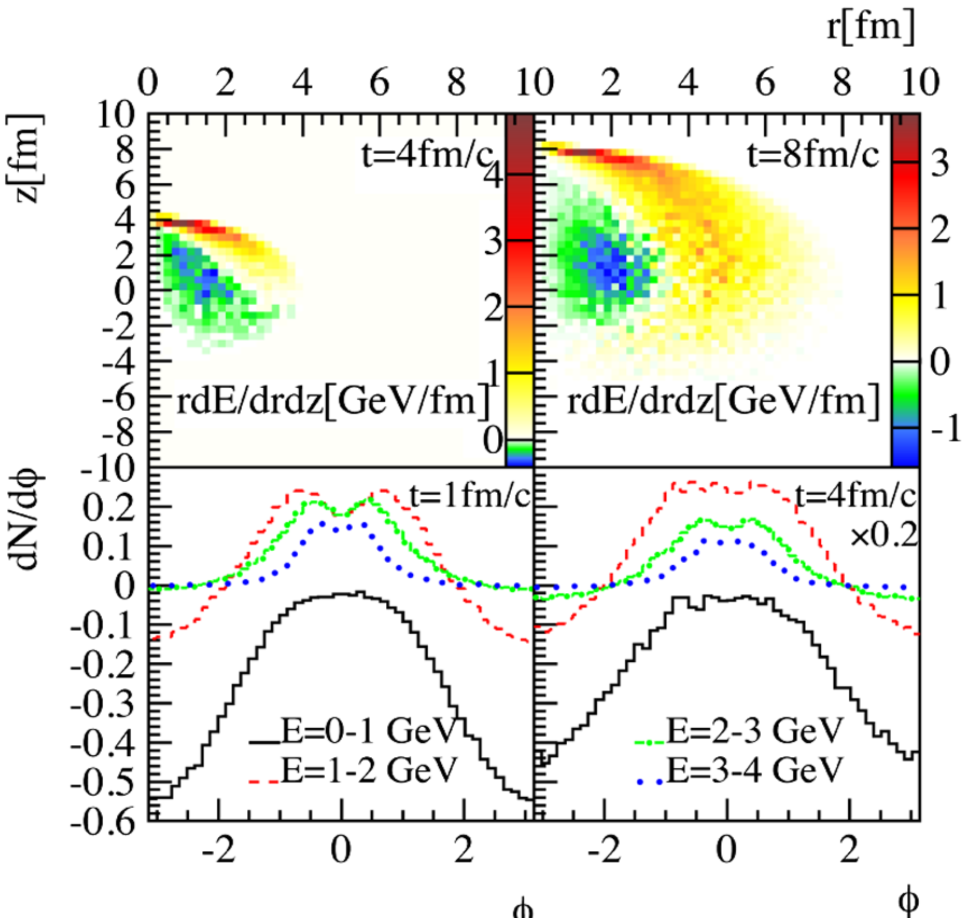
One has to subtract the 4-momentum of negative particle when combine it to jet.

Jet induced Mach Cone in HIC

I. No conic distribution of the final partons in an uniform medium.

II. Double-peak correlation of the final partons in 3+1D medium .

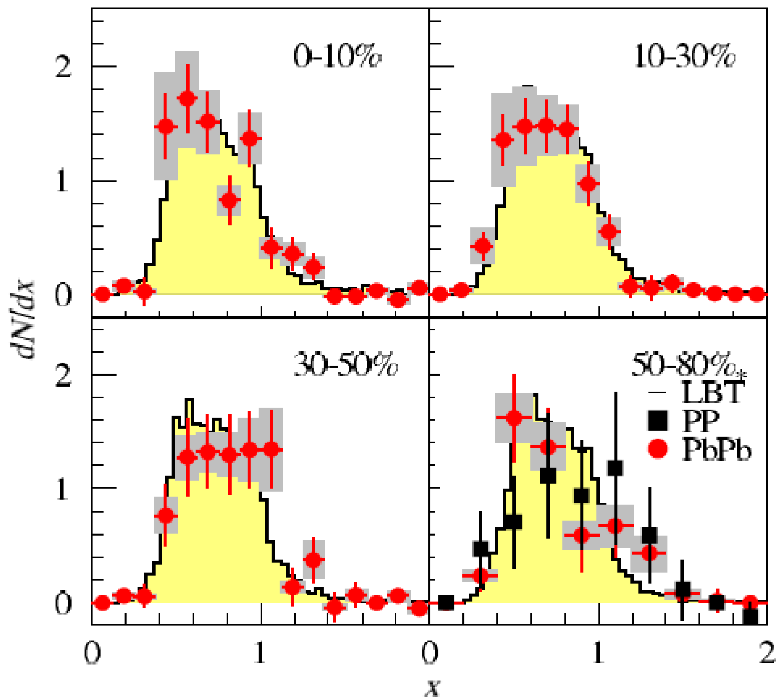




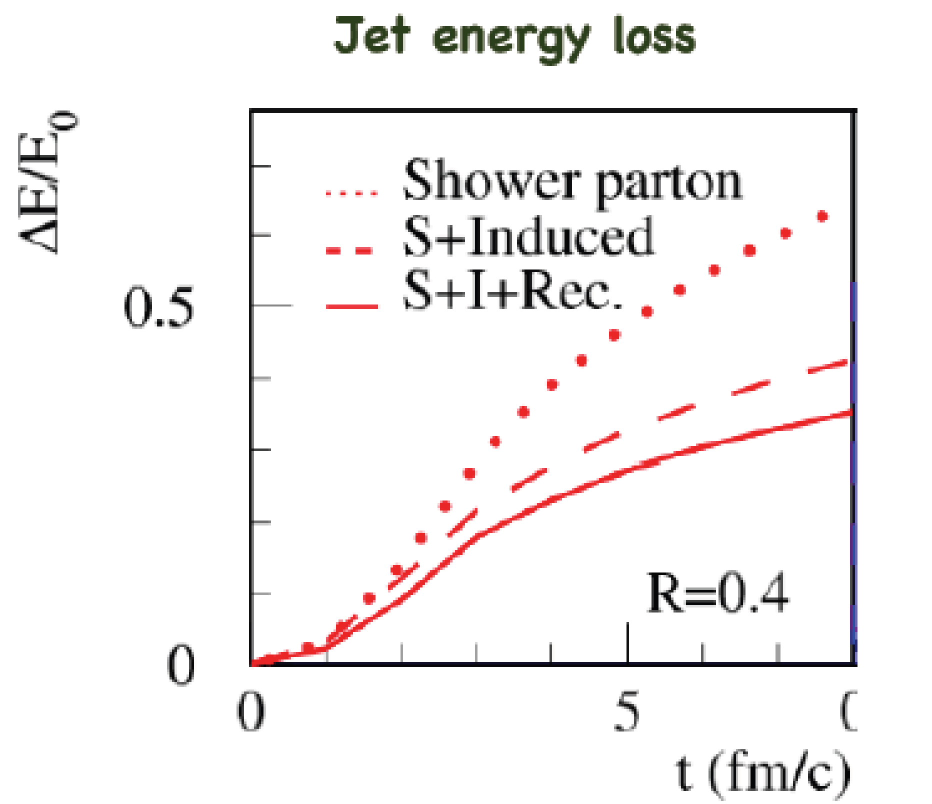
Hanlin Li, Fuming Liu, Guo-liang Ma, Xin-Nian Wang, Yan Zhu

Phys. Rev. Lett. 106, 012301

Medium Modification of Jets in HIC

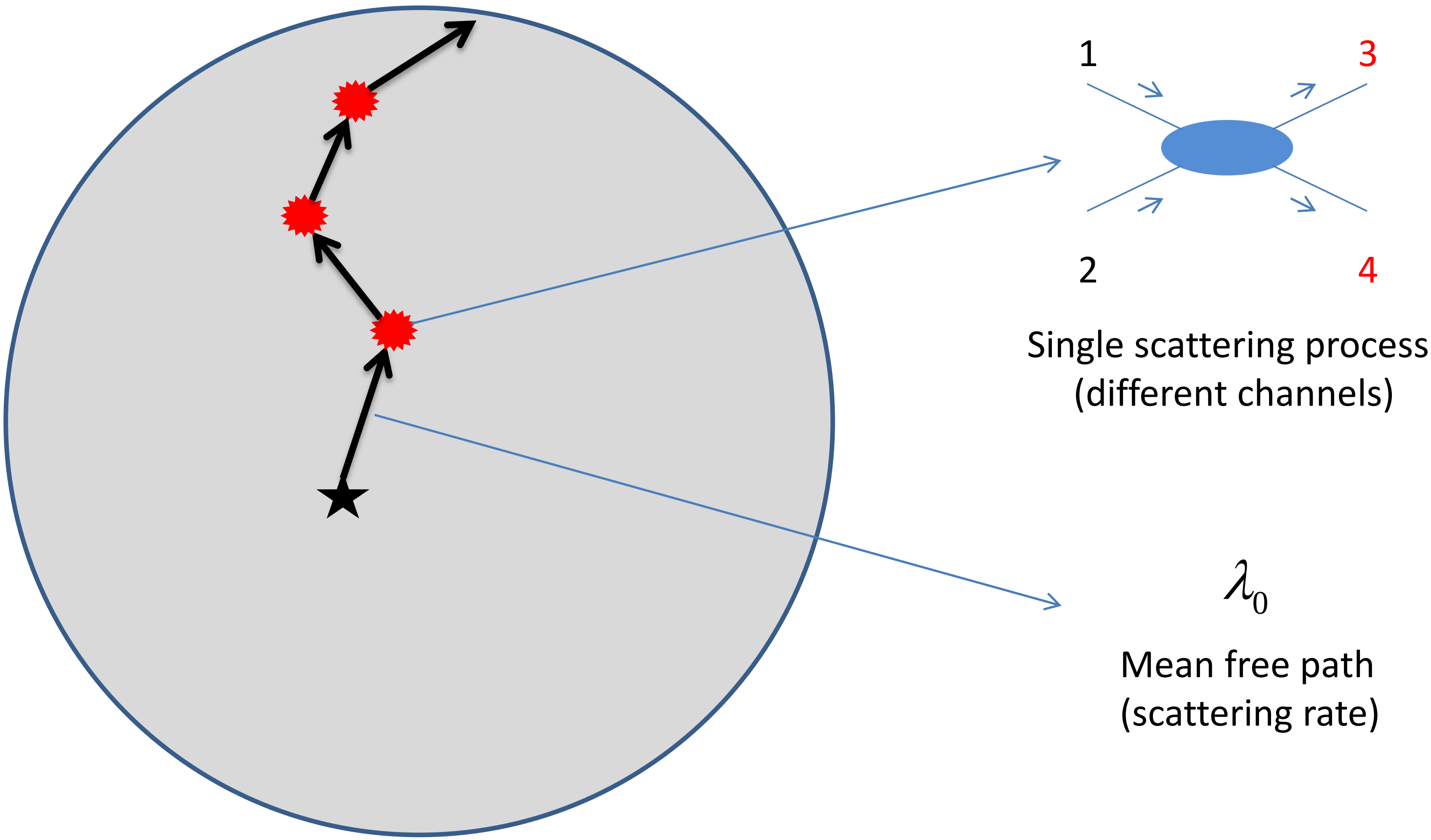


Radiation process is included



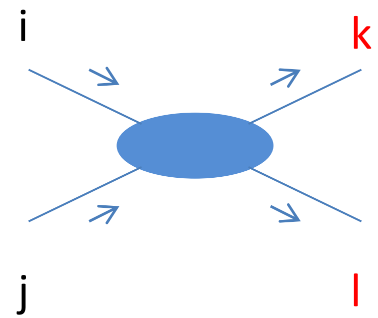
Simulation results for gamma-jet correlation describe the experiment data successfully.

The Monte-Carlo Simulation : a hard parton traversing an uniform medium



a static, homogeneous and infinite QGP

Single scattering



$$i, j = g, u, d, s, \bar{u}, \bar{d}, \bar{s}$$

Jussi Auvinen, Kari J. Eskola, Thorsten Renk

Phys.Rev. C82 024906

- Scattering rate for a process $ij \to kl$ in the local rest frame of the fluid

$$\Gamma_{ij\to kl} = \frac{1}{2E_1}\int \frac{d^3p_2}{(2\pi)^3 2E_2}\int \frac{d^3p_3}{(2\pi)^3 2E_3}\int \frac{d^3p_4}{(2\pi)^3 2E_4} \times f_j(p_2 \cdot u, T)$$
$$\times |M|^2_{ij\to kl}(s,t,u) \times S_2(s,t,u) \times (2\pi)^4 \delta^4(P_1 + P_2 - P_3 - P_4)$$

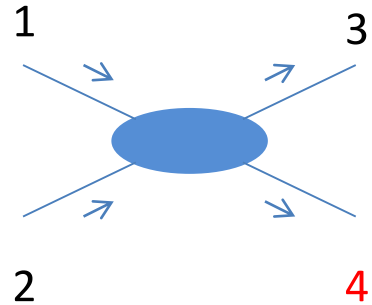
- The regularization

$$S_2(s,t,u) = \theta(s \geq 2\mu_D^2)\theta(-s + \mu_D^2 \leq t \leq -\mu_D^2) \qquad \mu_D^2 = (\frac{3}{2})4\pi\alpha_s T^2$$

- The mean free path

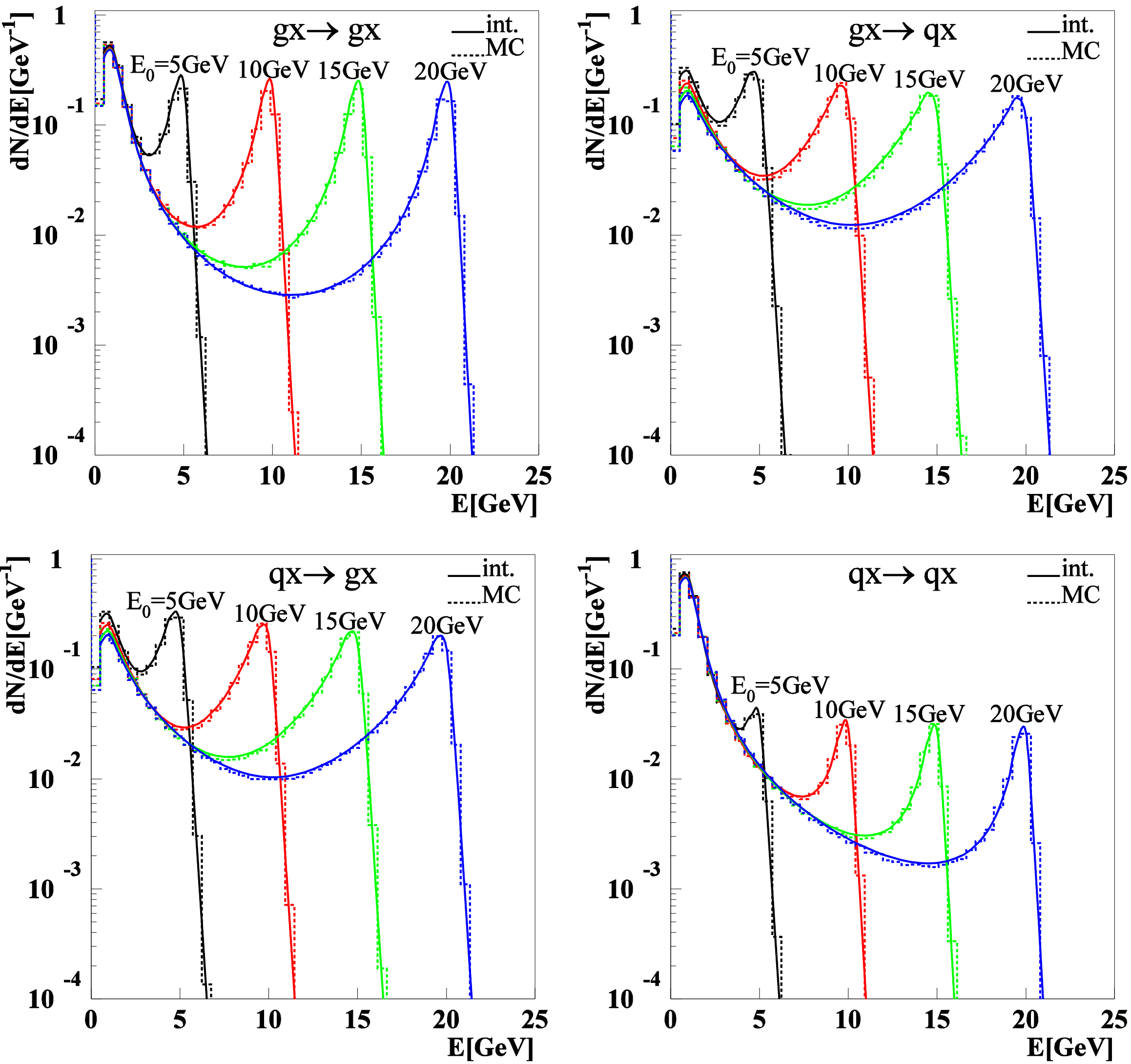
$$\Gamma_i = \sum_{j,(kl)} \Gamma_{ij\to kl} = 1/\lambda_0 \qquad P(\Delta t) = 1 - e^{-\Gamma_i \Delta t} \qquad P(ij \to kl) = \frac{\Gamma_{ij\to kl}}{\Gamma_i}$$

Single scattering



the selection of the jet parton

T=0.2GeV



$$gg \to gg$$

$$gg \to q\bar{q}$$

$$gq \to gq + g\bar{q} \to g\bar{q}$$

$$q_i g \to q_i g$$

$$q_i q_j \to q_i q_j$$

$$q_i q_i \to q_i q_i$$

$$q_i \bar{q_i} \to q_j \bar{q_j}$$

$$q_i \bar{q_i} \to q_i \bar{q_i}$$

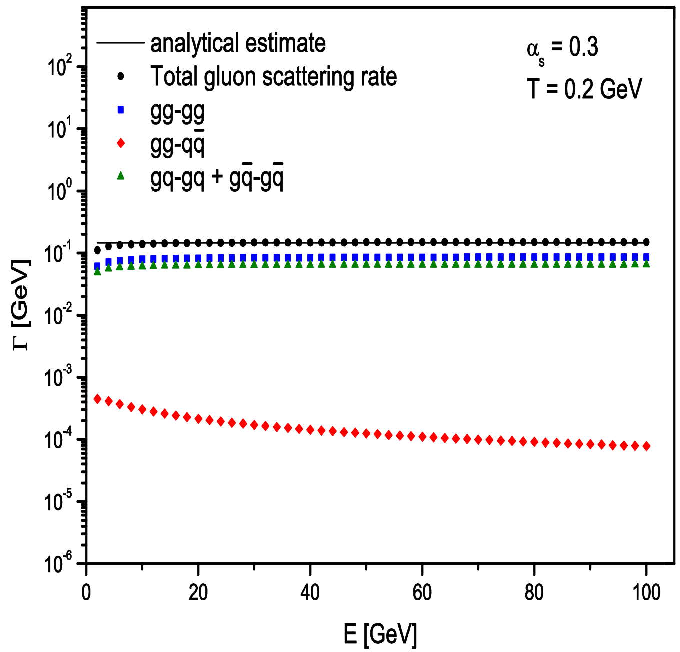
$$q_i \bar{q_i} \to gg$$

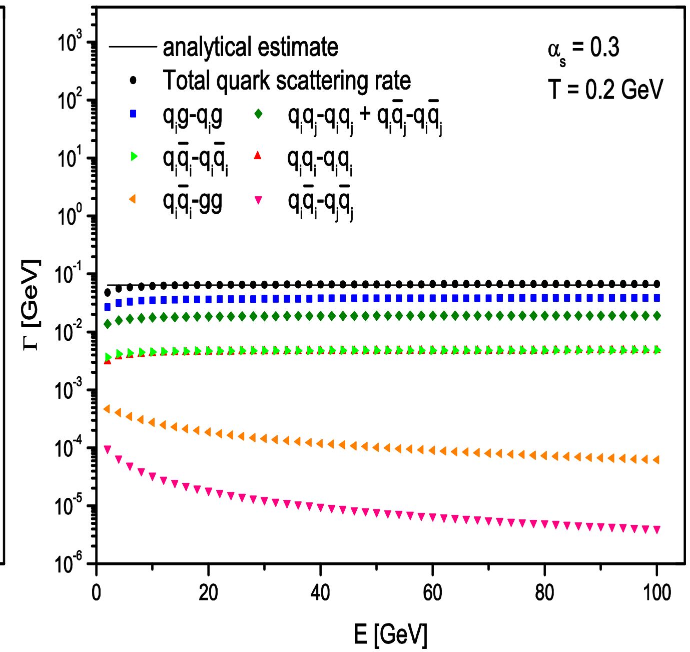
Scattering rate

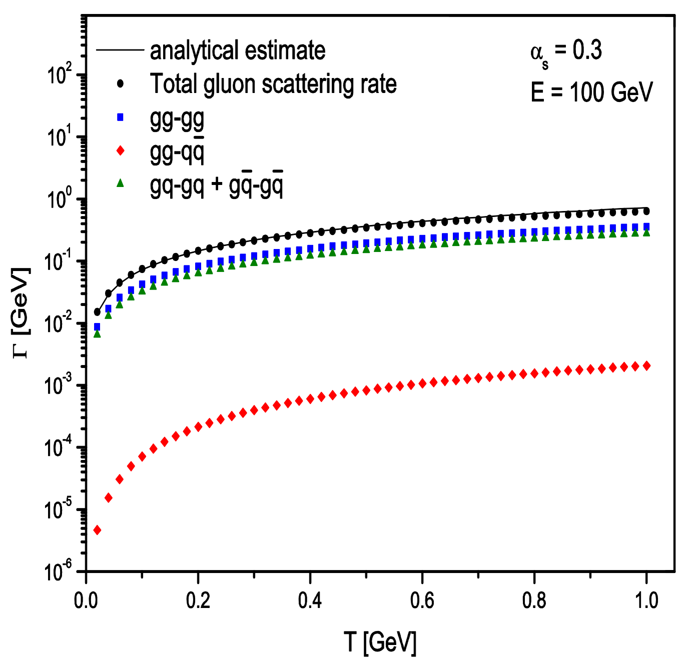
Contribution of different processes on scattering rate as functions of energy and temperature

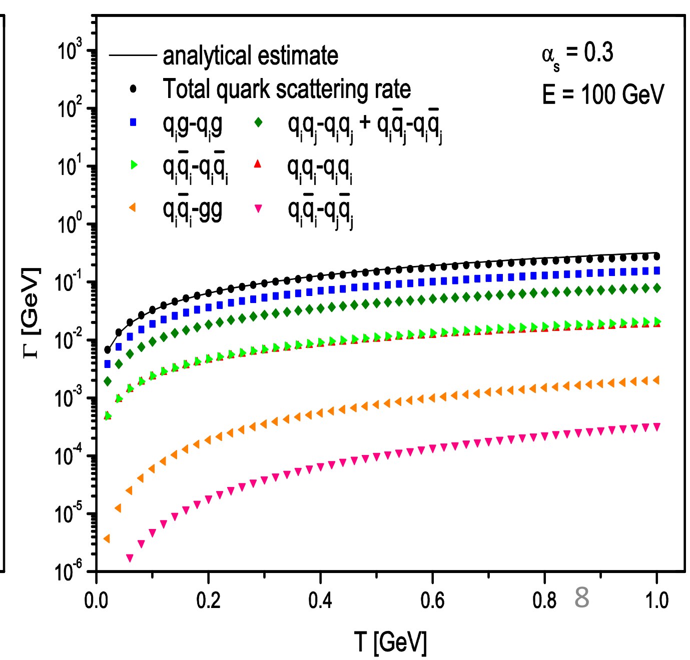
gluon

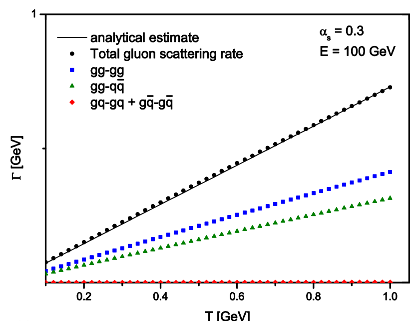
quark

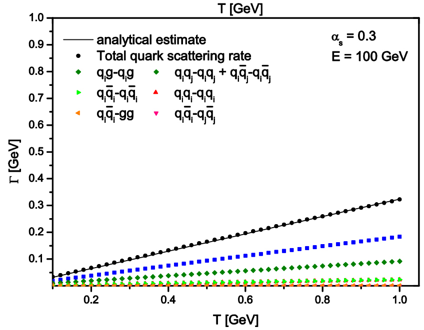












Multiple scattering

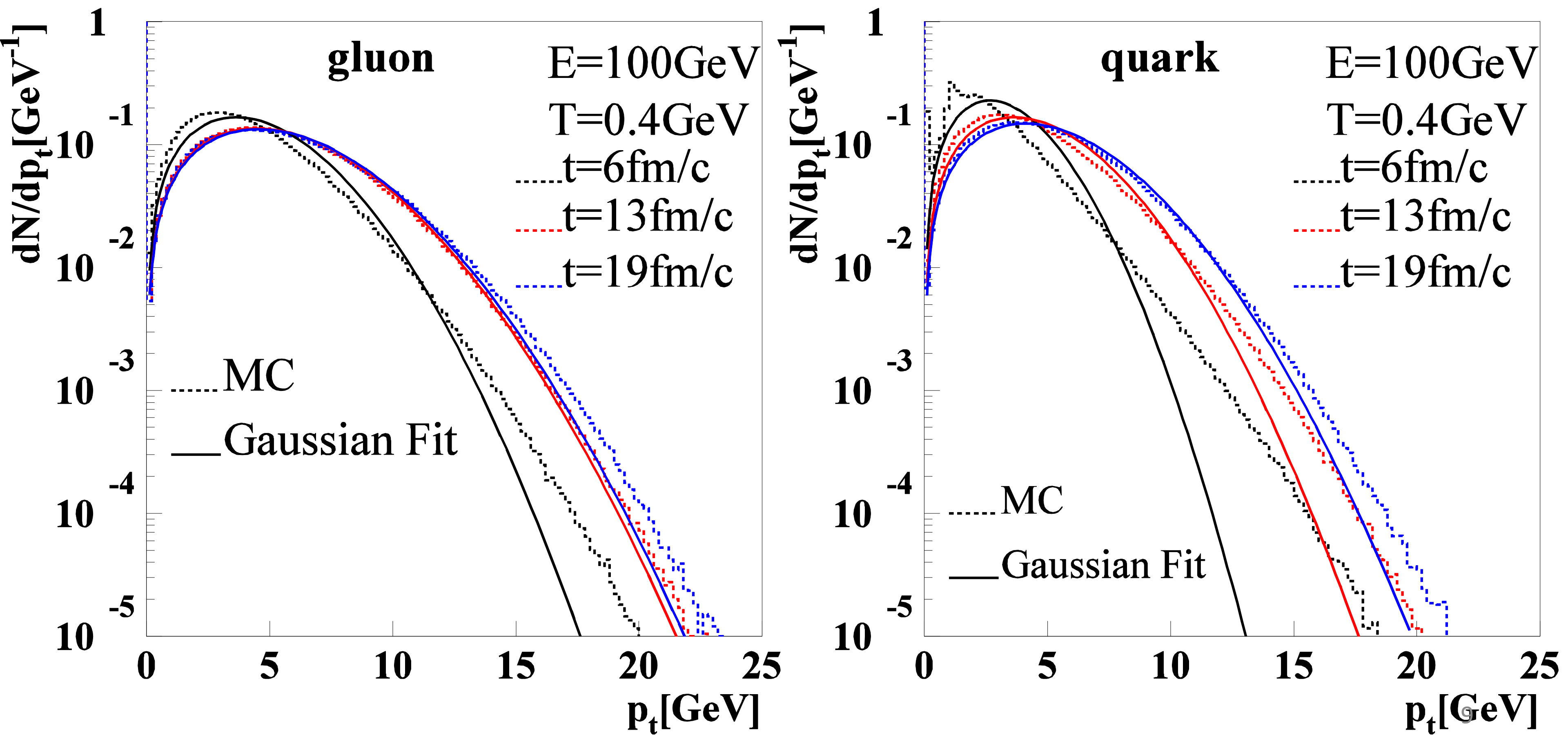
dn/dpt as a function of time

F. D'Eramo, M. Lekaveckas, Hong Liu and K. Rajagopal
arXiv:1211.1922

Gaussian fit $$\frac{dn}{dp_t} = \frac{2p_t}{\langle p_t^2 \rangle} e^{-\frac{p_t^2}{\langle p_t^2 \rangle}}$$

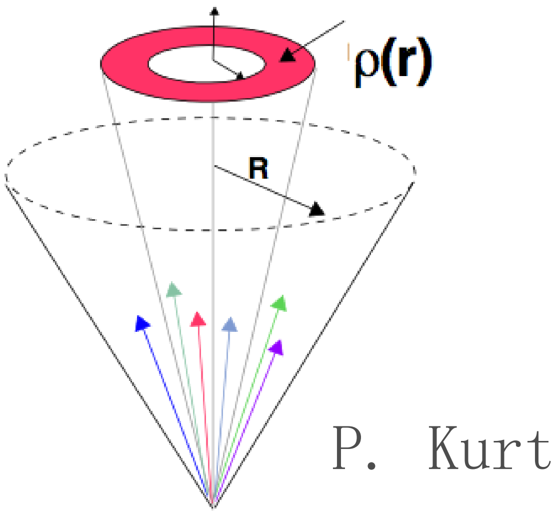
Pt broadening

The <pt^2> comes from the MC simulation

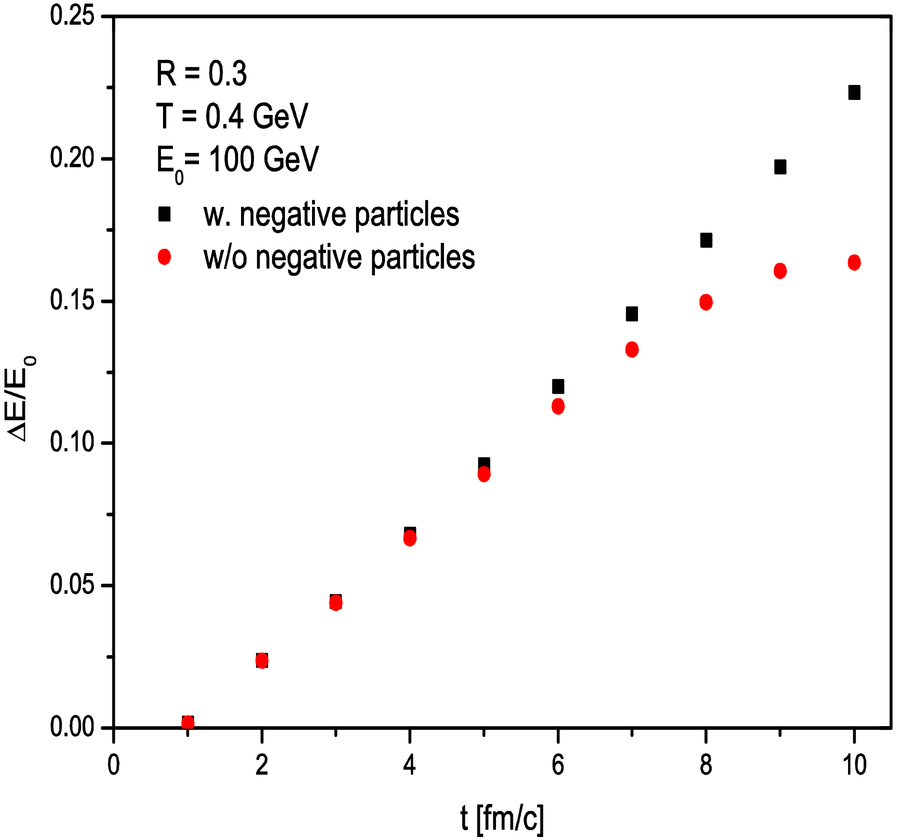


Reconstructed jet

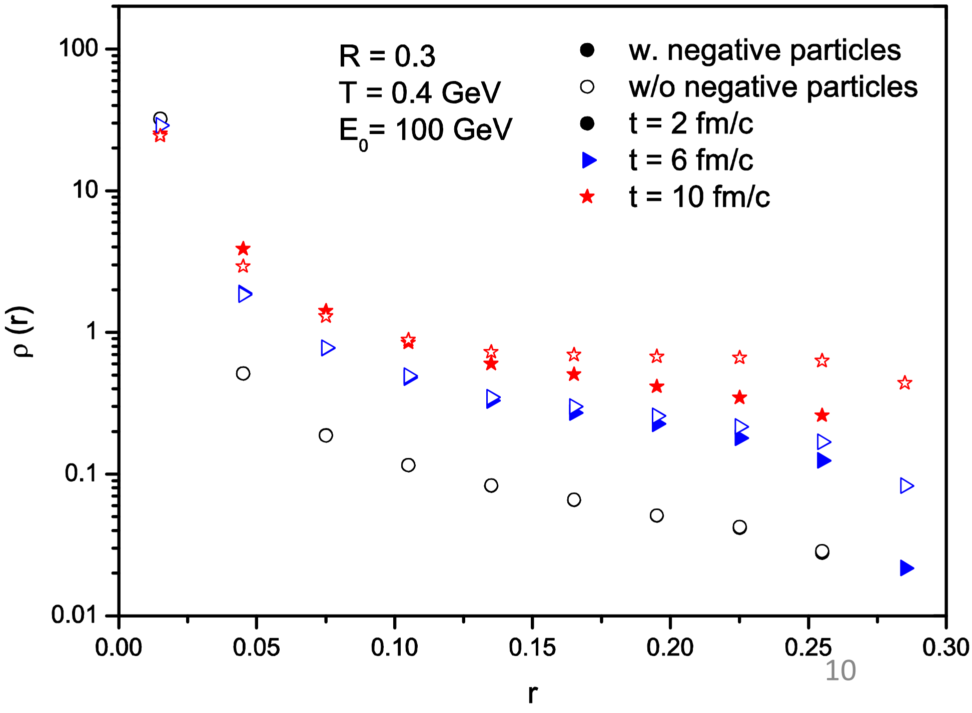
$$\rho(r) = \frac{1}{\Delta r}\frac{1}{N_{jet}}\sum_{jets}\frac{p_t(r-\frac{\Delta r}{2}, r+\frac{\Delta r}{2})}{p_t(0,R)}$$



Energy loss



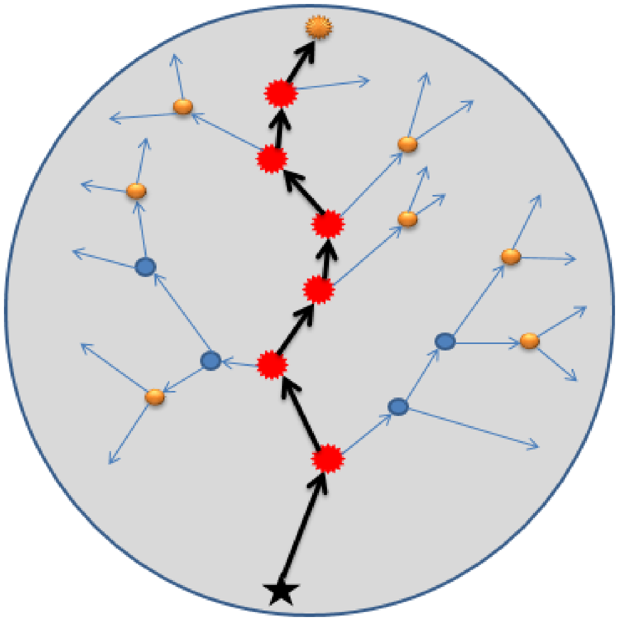
transverse profile



Summary

- We present a computation of elastic energy loss of the leading parton traversing the uniform medium.
- The FASTJET program is used to reconstruct jets, the leading jet structure is distorted by the interaction with thermal partons.

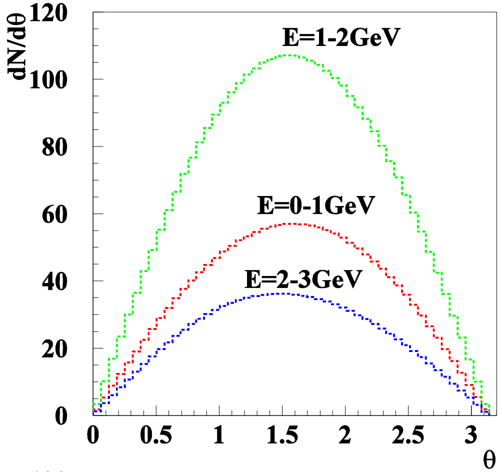
- Graphics Processing Unit(GPU) parallel computing.



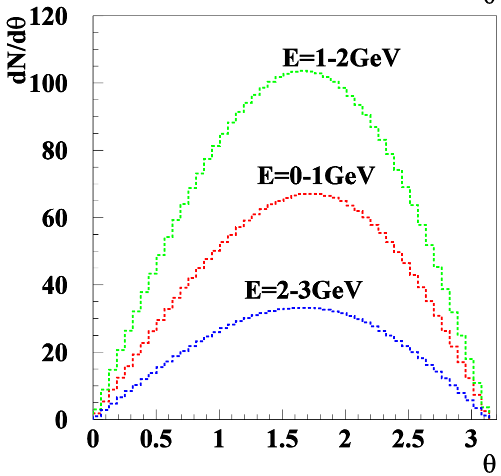
In a typical event

20000particles At t=8fm

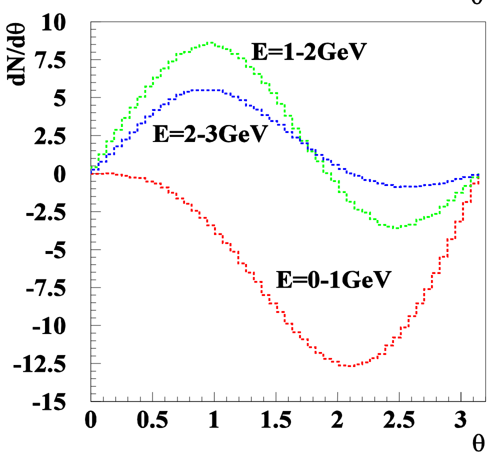
t=9fm



positive



negative



combine