Jet Energy Loss at LHC

Vineet Kumar*

Nuclear Physics Division, Bhabha Atomic Research Center, Mumbai, India

Prashant Shukla

Nuclear Physics Division, Bhabha Atomic Research Center, Mumbai, India and
Homi Bhabha National Institute, Anushakti Nagar, Mumbai, India

(Dated: July 10, 2020)

In this work, the jet energy loss is analyzed using a monte carlo method. The data from LHC at $\sqrt{s_{\mathrm{NN}}} = 2.76$ TeV and 5.02 TeV is used to extract the perameters for specific energy loss of jets inside QGP. Our calculations give good discription of the nuclear modification factor and asymmetry measurements at LHC.

I. INTRODUCTION

II. JET ENERGY LOSS

The Jet p_T distribution in pp collisions is measured by CMS and ATLAS experiments at LHC. We fit the jet p_T distribution with Hegedorn function.

$$f(p_T) = \frac{dn}{dy}(1 + \frac{p_T}{p_0})^{-n} \tag{1}$$

The Jet p_T is generated from the fitted function. Now the QGP medium is assumed as a static sphere. The radius of the medium is related to the centrality of the collision as

$$R = R_A\sqrt{\frac{\mathrm{N_{part}}}{2A_m}} \tag{2}$$

here R_A and A_m are the radius and Atomic mass of the Pb nucleus. The $\mathrm{N_{Part}}$ is the number of participant in that particular collison class.

The cordinate r and ϕ are then generated randomly. The maximum value of the cordiante r is the radius R of the system formed. We assume that both partons move back to back before fragmenting to jets.

The pathlenghts d_1 and d_2 can be calculated as follows

$$\begin{aligned} d_1 &= \sqrt{R^2 - r^2\,sin(\phi)} - r\,cos(\phi) \\ d_2 &= \sqrt{R^2 - r^2\,sin(\pi + \phi)} - r\,cos(\pi + \phi) \end{aligned} \tag{3}$$

The specific energy loss (energy loss per unit length), dE/dx have following relation with the p_T of jet

$$\frac{dE}{dx} = Mp_T^{\alpha} \tag{4}$$

Here M and α are two parameters. We want to constrain these parameters with the help of LHC measurements and see their variations as a function of collision centrality and per nucleon energy.

The total energy loss for a jet then can be calculated as

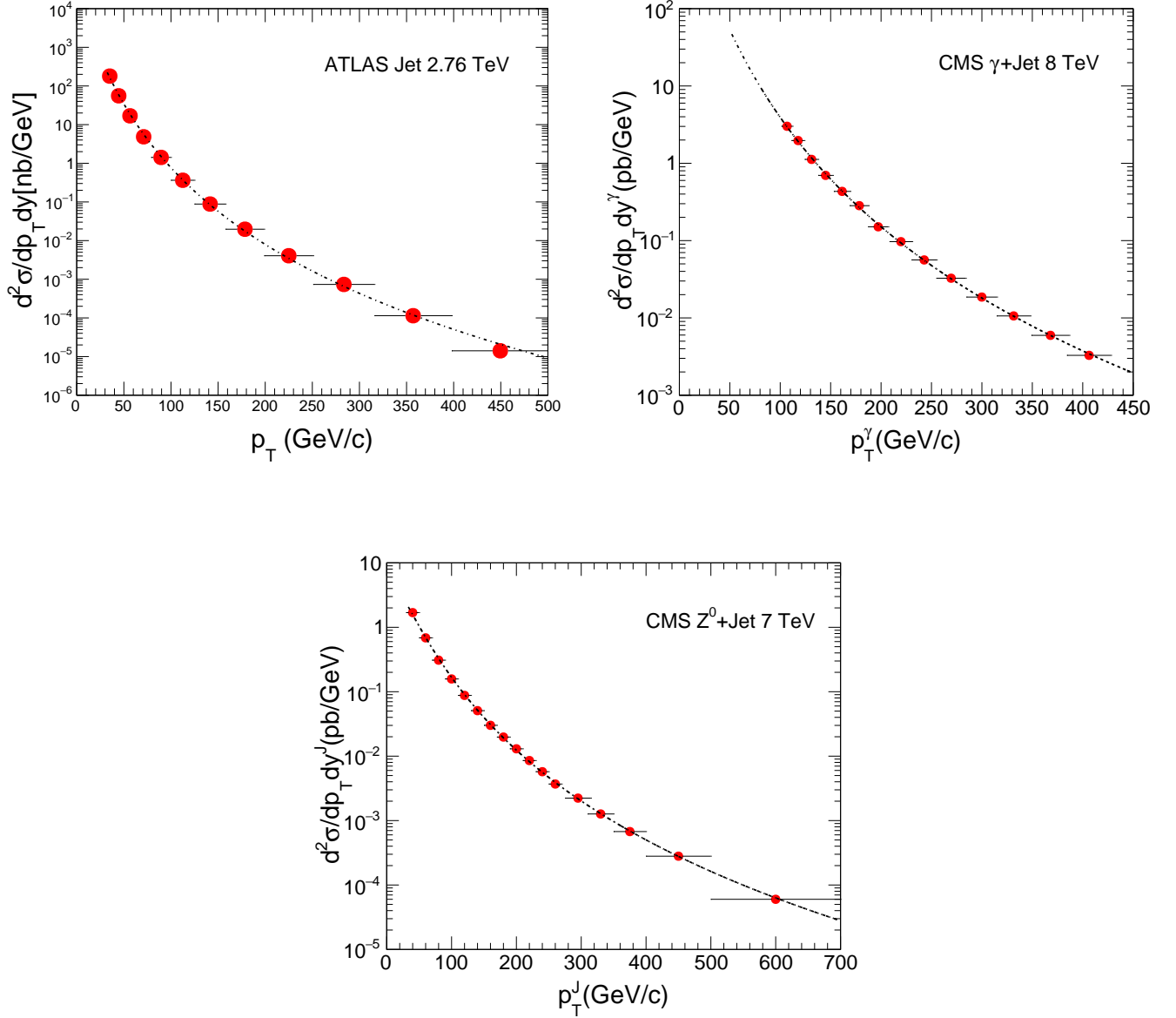―――――

*Electronic address: `vineetk@barc.gov.in`

FIG. 1: (Color online) Jet yields as a function of jet p_T measured by ATLAS and CMS experiments. These yields are used in our calculations to generate the pp spectrum.

$$\Delta E = \frac{dE}{dx} \times d \tag{5}$$

where d is the pathlenght of the jet inside the medium. If ΔE_1 and ΔE_2 are the energy loss for both the jets respectively we can get the final jet energies as

$$
\begin{aligned}
p_{T1} &= p_T - \Delta E_1 \\
p_{T2} &= p_T - \Delta E_2
\end{aligned}
$$

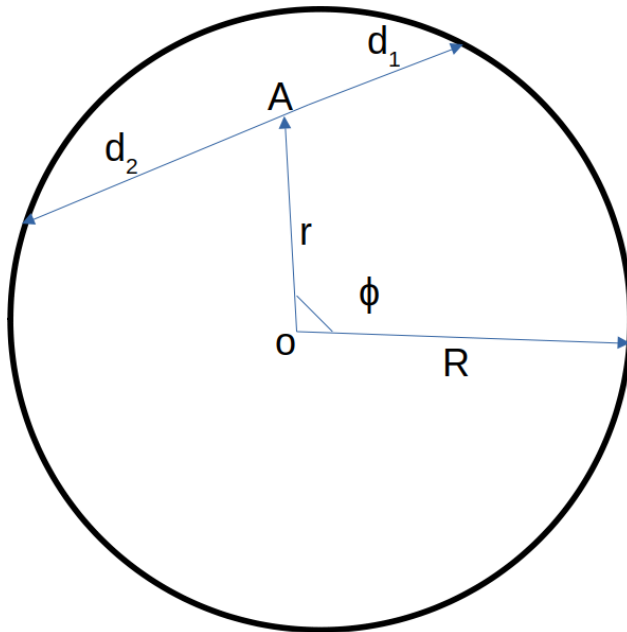and the Jet asymmetry can finally be calculated as

FIG. 2: (Color online) Figure showing the diagram of a diJet system.

$$A_J = \frac{p_{T1} - p_{T2}}{p_{T1} + p_{T2}} \qquad (6)$$

III.   RESULTS AND DISCUSSIONS

IV.   SUMMARY

[1] J. SOllfrank, P. Huovinen, M. Kataja, P.V. Ruuskanen, M. Prakash and R. Venugopalan, Phys. Rev. C**55**, 392 (1997).
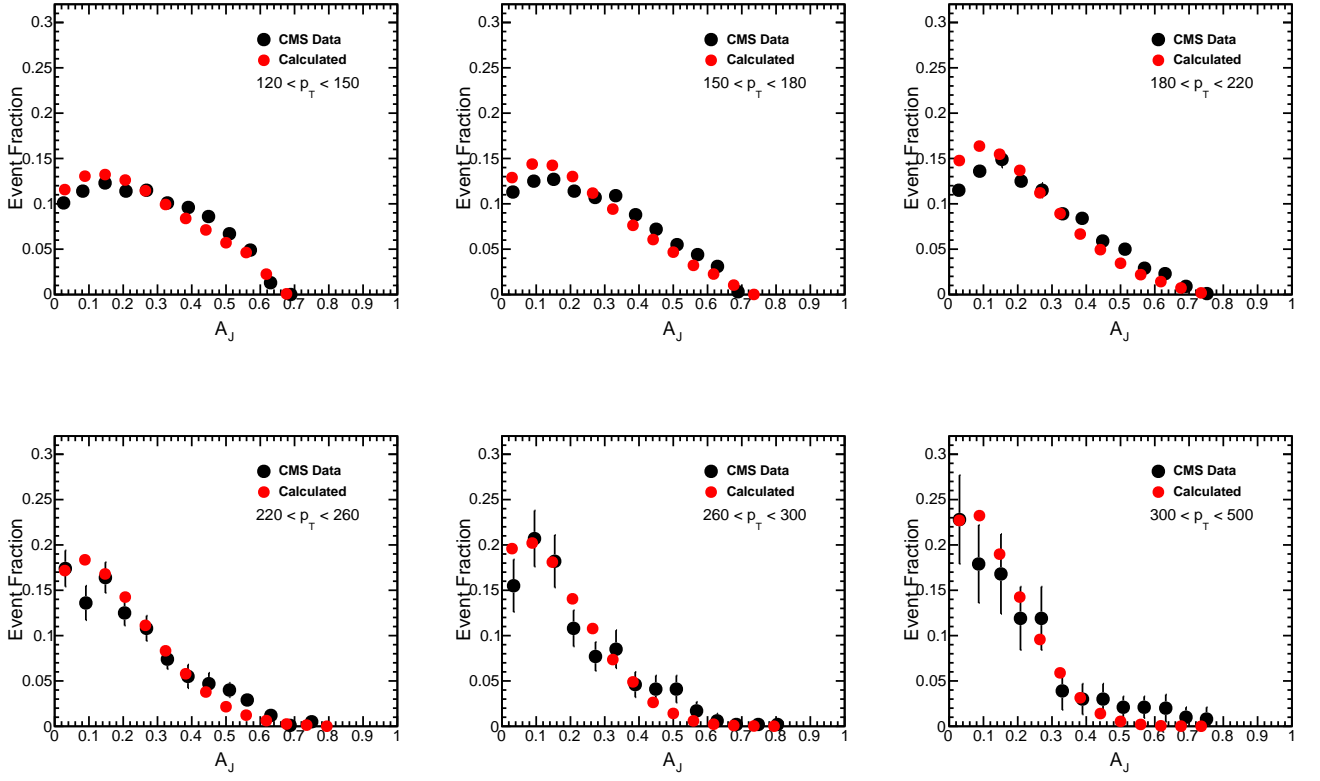
FIG. 3: (Color online) DiJet asymmatry as a function of jet p_T measured by CMS experiment compared with our calculations.
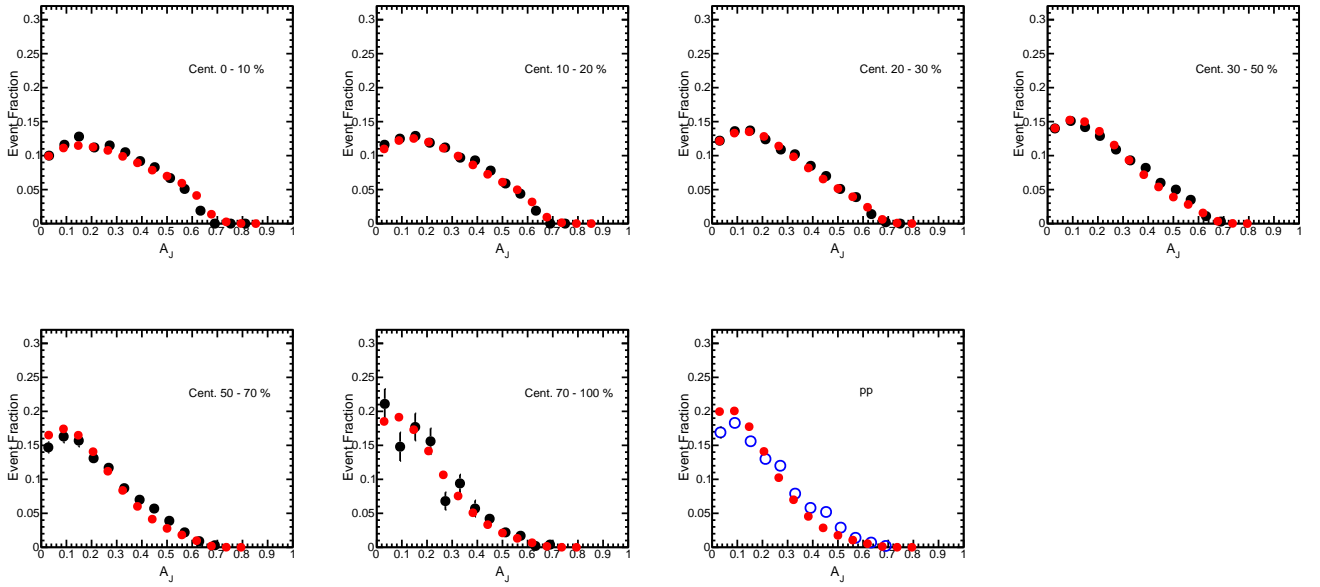

FIG. 4: (Color online) DiJet asymmatry as a function of collision centrality measured by CMS compared with our calculations.
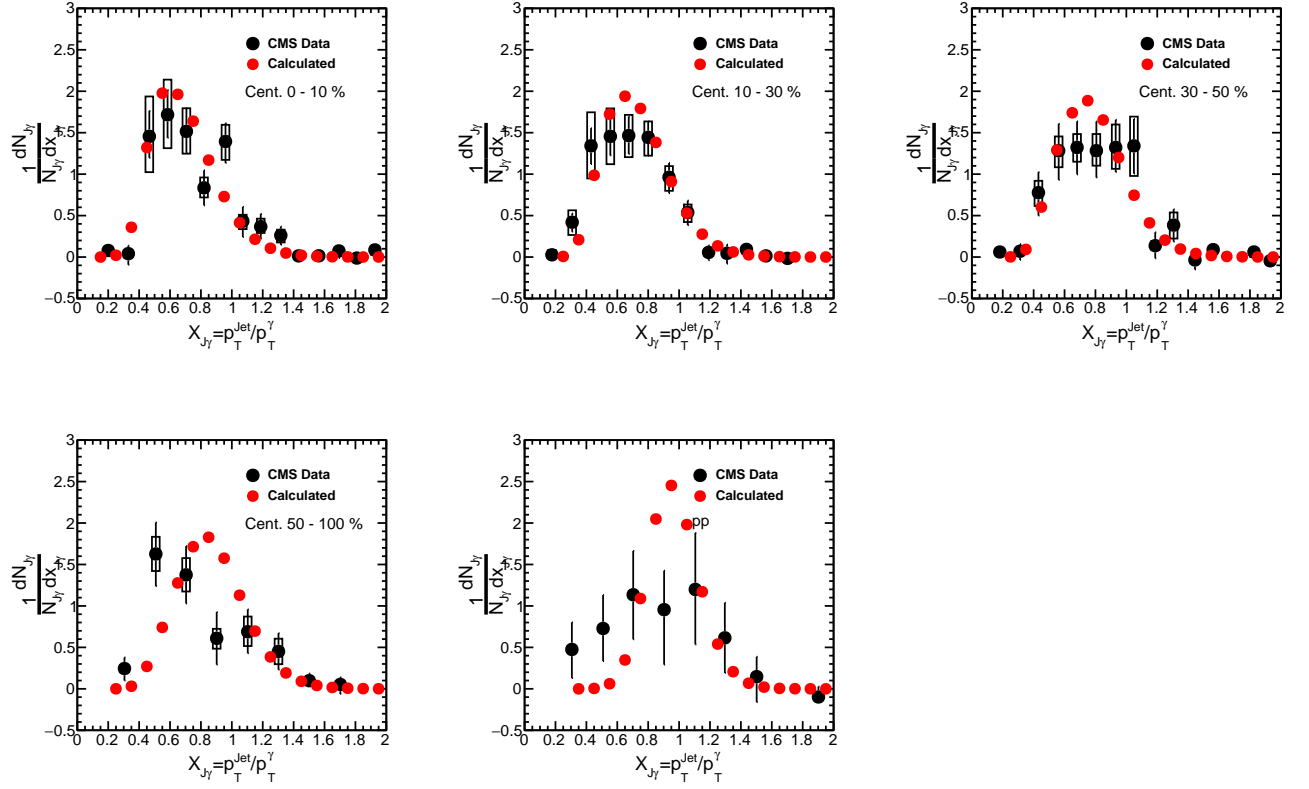
FIG. 5: (Color online) Jet asymmatry as a function of collision centrality in gamma + Jet events as measured by CMS experiment. The data is compared with our calculations.

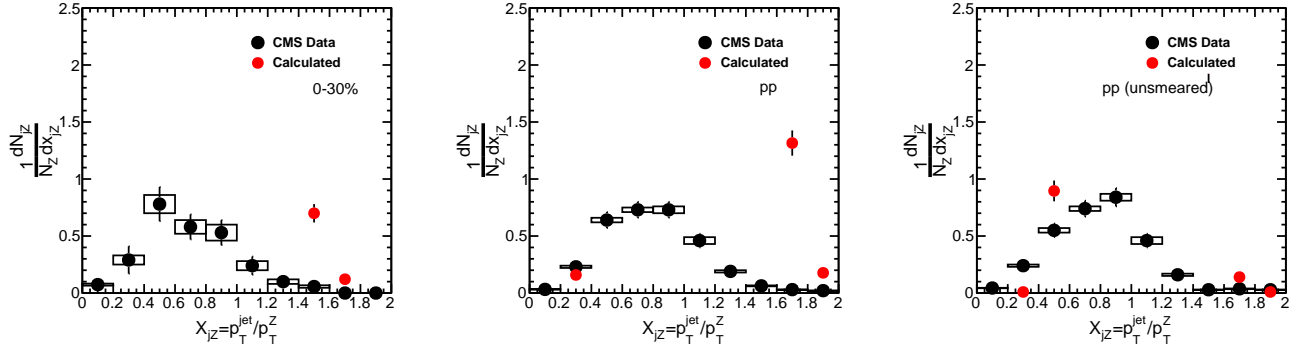FIG. 6: (Color online) (Color online) Jet asymmatry as a function of collision centrality in Z^0 + Jet events as measured by CMS experiment. The data is compared with our calculations.