

Multiplicity and \sqrt{s} dependent study of jet properties in pp collisions at LHC energies

Prottoy Das^{1,*}, Abhi Modak¹, Rathijit Biswas¹, S. K. Prasad¹, Supriya Das¹, S. K. Ghosh¹, and S. Raha¹
¹Bose Institute, Kolkata, INDIA

Introduction

Jets are collimated bunches of hadrons produced from fragmentation and hadronization of hard scattered partons (quarks and gluons) in high energy collisions. Due to the different color charges of quarks and gluons, jets originating from quarks and gluons, are predicted to have different properties [1]. Experimental measurements of inclusive jets have contributions from both types of partons. The gluonic contribution increases with increasing \sqrt{s} due to an increase in gluon density inside the hadron [2]. Gluonic contribution is argued to vary with event multiplicity as well [3]. Jet properties are therefore expected to depend on \sqrt{s} and event multiplicity. In this work, we present a detailed study to estimate the change in the inclusive jet properties as a function of \sqrt{s} and event multiplicity for proton-proton (pp) collisions using Monte Carlo simulations at LHC energies.

Analysis Details

The analysis is performed with 100 million Monte Carlo (MC) events in pp collisions at $\sqrt{s} = 2.76, 7$ and 13 TeV obtained using

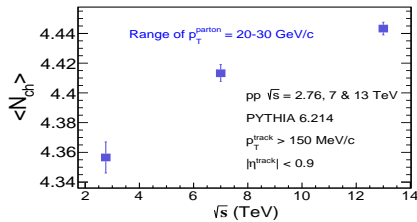


FIG. 1: $\langle N_{ch} \rangle$ as a function of \sqrt{s}

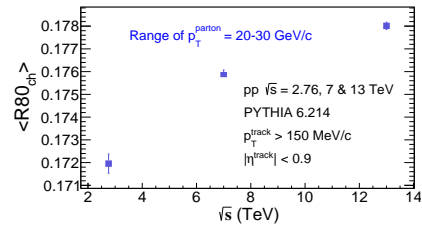


FIG. 2: $\langle R80_{ch} \rangle$ as a function of \sqrt{s}

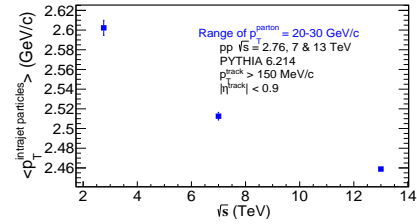


FIG. 3: $\langle p_T^{intrajetparticles} \rangle$ as a function of \sqrt{s}

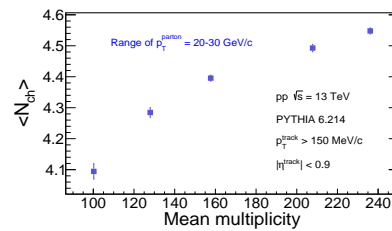


FIG. 4: $\langle N_{ch} \rangle$ as a function of mean multiplicity

PYTHIA 6.214 (Perugia-2011). Events are classified into five event multiplicity classes 0-5%, 5-10%, 30-50%, 60-80% and 80-100% for multiplicity dependent study. Jets are reconstructed with charged particles ($p_T > 0.15$ GeV/c, $|\eta| < 0.9$) using FastJet Anti- k_T algorithm for jet resolution parameter (R) = 0.4.

*Electronic address: dasprottoy000@gmail.com

Jets with $p_T^{jet} > 5$ GeV/c and $|\eta| < 0.5$ are accepted for the analysis.

We have studied the evolution of $\langle N_{ch} \rangle$ (average no. charged of particles within a jet), $\langle R80_{ch} \rangle$ (average radius of a jet [with charged particles only] which contains 80% p_T of the jet) and $\langle p_T^{intrajetparticles} \rangle$ (average p_T of the charged particles in a jet) with \sqrt{s} and event multiplicity.

Results and Discussions

Figs– 1, 2 and 3 show $\langle N_{ch} \rangle$, $\langle R80_{ch} \rangle$ and $\langle p_T^{intrajetparticles} \rangle$ respectively as a function of \sqrt{s} and Figs– 4, 5 and 6 show those respectively as a function of mean multiplicity. $\langle N_{ch} \rangle$ and $\langle R80_{ch} \rangle$ are found to increase whereas $\langle p_T^{intrajetparticles} \rangle$ is found to decrease with increasing \sqrt{s} and multiplicity providing a clear indication of jet softening and broadening. These effects can also be observed due to medium formation in heavy-ion collisions. However, in this analysis the observed softening and broadening of jets are possibly due to increase in gluonic contribution in jets. We have studied the evolution of gluon fraction (f_g , the fraction of total jets originated from gluons) with \sqrt{s} and mean multiplicity. As expected, the gluon fraction increases with \sqrt{s} (Fig.– 7) and mean multiplicity (Fig.– 8).

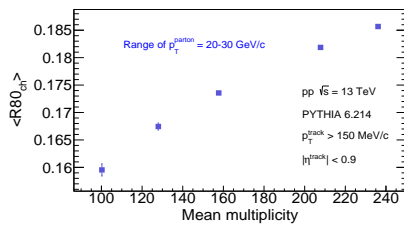


FIG. 5: $\langle R80_{ch} \rangle$ as a function of mean multiplicity

Summary and Conclusion

We presented the evolution of jet properties with \sqrt{s} and event multiplicity in pp collisions using PYTHIA. The jets are found to soften and broaden with increasing \sqrt{s} and event multiplicity due to increased gluonic contribution in jets. This observation in pp colli-

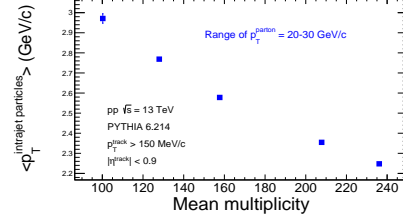


FIG. 6: $\langle p_T^{intrajetparticles} \rangle$ as a function of mean multiplicity

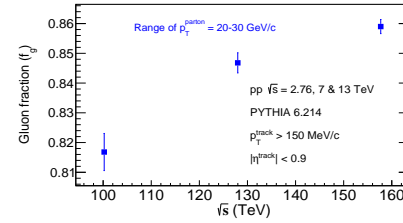


FIG. 7: Gluon fraction (f_g) as a function of \sqrt{s}

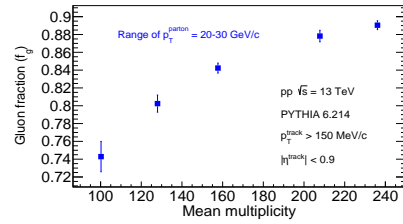


FIG. 8: Gluon fraction (f_g) as a function of mean multiplicity

sions in PYTHIA in absence of medium formation suggests that the experimental measurement of jet modification in high multiplicity pp events requires a careful interpretation.

References

- [1] Dissertori, G. et al, Differences Between Quark And Gluon Jets. In Quantum Chromodynamics: High Energy Experiments and Theory, Oxford University Press, 2009.
- [2] Eur. Phys. J. C 49, 155162, 2007.
- [3] arXiv:1803.11093v1, 2018.