Measurement of higher moments of $\cdots$

Ankan Mukherjee,[1, *] YYY,[1, †] and ZZZ[1, †]

[1] *Indian Institute of Technology Bombay, Mumbai, India*

(Dated: December 4, 2020)

Write a proper brief abstarct ...

I. INTRODUCTION

We shall be using the STAR definition.

$$\text{Mean Transverse Momentum} = \langle\langle p_T \rangle\rangle = \left\langle \frac{\Sigma_{i=1}^{N_{ch}} p_i}{N_{ch}} \right\rangle \tag{1}$$

$$\langle \Delta p_i \Delta p_j \rangle = \left\langle \left(\langle p_t \rangle - \langle\langle p_t \rangle\rangle \right)^2 \right\rangle \tag{2}$$

$$\text{Intensive Variance Of Transverse Momentum} = \sigma_{p_T} = \frac{\langle \Delta p_i \Delta p_j \rangle^{1/2}}{\langle\langle p_T \rangle\rangle} \tag{3}$$

II. EXPERIMENTAL OBSERVATIONS

A. Transverse Momentum and Mean Transverse Momentum for Each Multiplicity Class

In this section, we have plotted the histograms for the Transverse Momentum **pT** and the Mean Transverse Momentum ⟨**pT**⟩ of proton-proton collisions corresponding to each multiplicity class. The histogram for **pT** is then approximated using an **Exponential** fit, while that of ⟨**pT**⟩ has been approximated using a **Gaussian** fit. Both the quantities **pT** and ⟨**pT**⟩ have statistical fluctuations arising from the finite number of particles in each event. In each of the subsequent subsections corresponding to each of the 5 multiplicity classes, namely **pytree2040**, **pytree4060**, **pytree6080**, **pytree80100** and **pytree100**, the histograms and the corresponding fits have been plotted. A logarithmic scale has been used on the *y-axis* in order to emphasize the skewness of the data.

* 190260008@iitb.ac.in
† XXX@iitb.ac.in

1. *Multiplicity Class "pytree2040"*

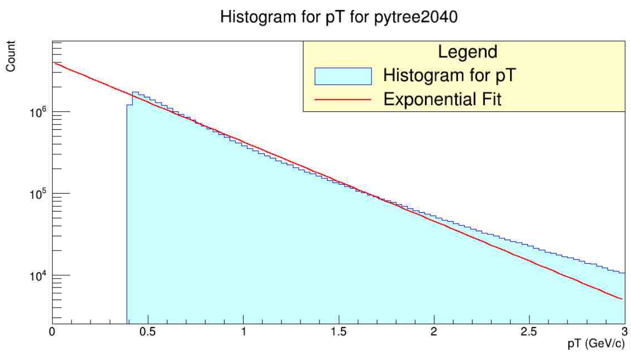

FIG. 1a. (Color Online) Distribution of **pT** for proton-proton collision in the multiplicity class **pytree2040**. The solid line is an Exponential fit to the data.

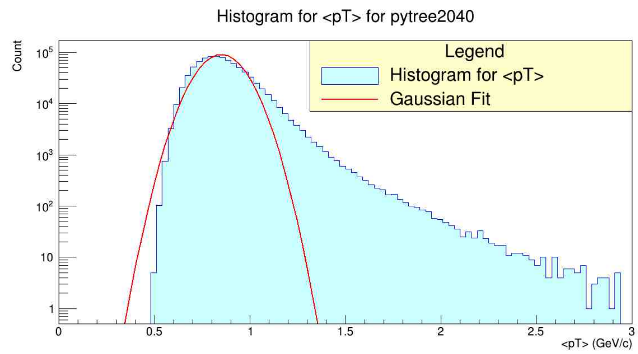

FIG. 1b. (Color Online) Distribution of $\langle \mathbf{pT} \rangle$ for proton-proton collision in the multiplicity class **pytree2040**. The solid line is a Gaussian fit to the data.

2. *Multiplicity Class "pytree4060"*

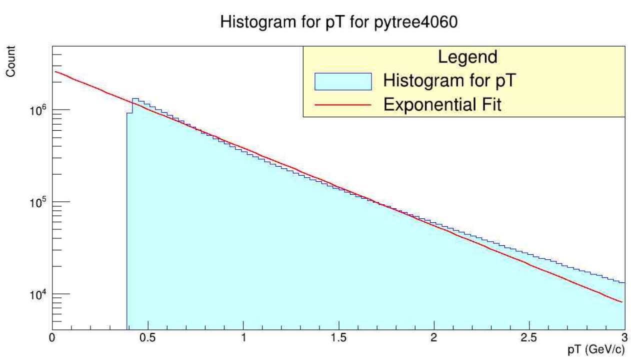

FIG. 2a. (Color Online) Distribution of **pT** for proton-proton collision in the multiplicity class **pytree4060**. The solid line is an Exponential fit to the data.

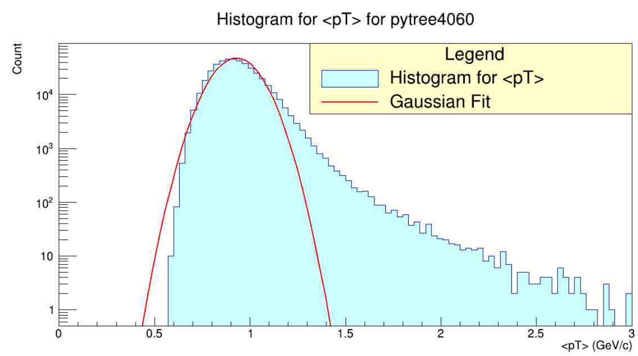

FIG. 2b. (Color Online) Distribution of $\langle \mathbf{pT} \rangle$ for proton-proton collision in the multiplicity class **pytree4060**. The solid line is a Gaussian fit to the data.

3. *Multiplicity Class "pytree6080"*

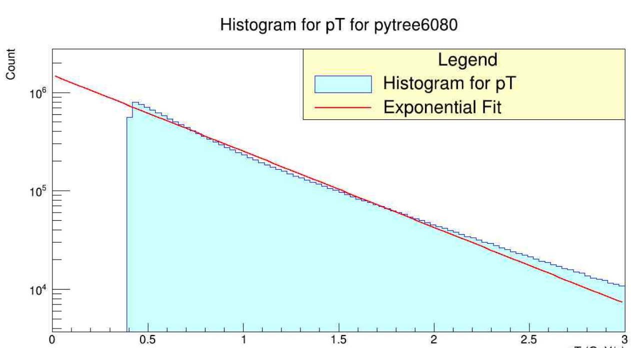

FIG. 3a. (Color Online) Distribution of **pT** for proton-proton collision in the multiplicity class **pytree6080**. The solid line is an Exponential fit to the data.

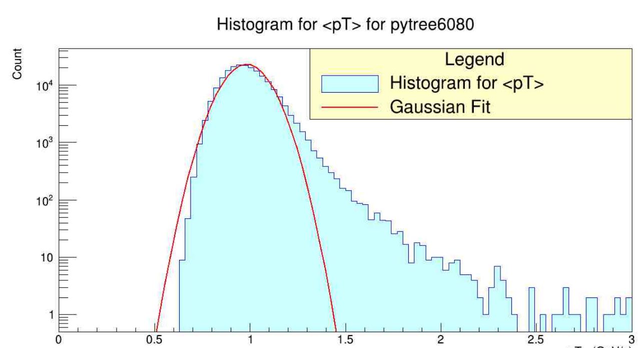

FIG. 3b. (Color Online) Distribution of $\langle \mathbf{pT} \rangle$ for proton-proton collision in the multiplicity class **pytree6080**. The solid line is a Gaussian fit to the data.

4. Multiplicity Class "pytree80100"

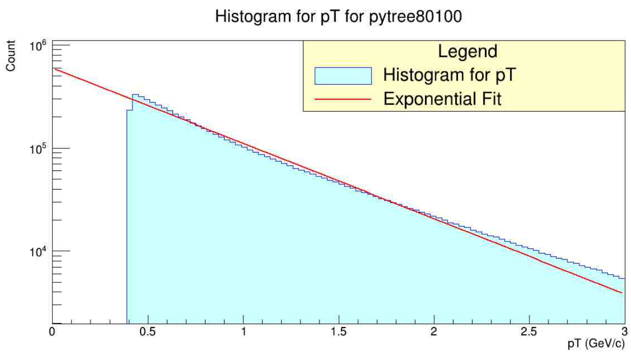

FIG. 4a. (Color Online) Distribution of **pT** for proton-proton collision in the multiplicity class **pytree80100**. The solid line is an Exponential fit to the data.

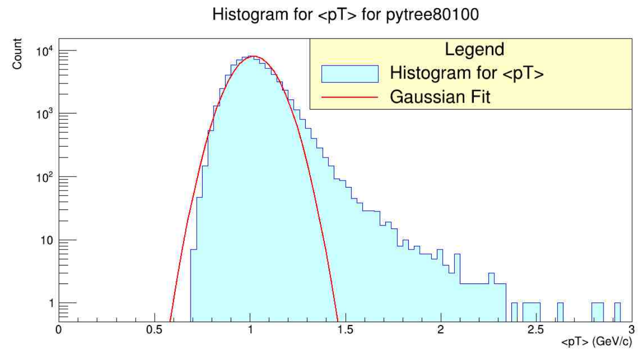

FIG. 4b. (Color Online) Distribution of $\langle \mathbf{pT} \rangle$ for proton-proton collision in the multiplicity class **pytree80100**. The solid line is a Gaussian fit to the data.

5. Multiplicity Class "pytree100"

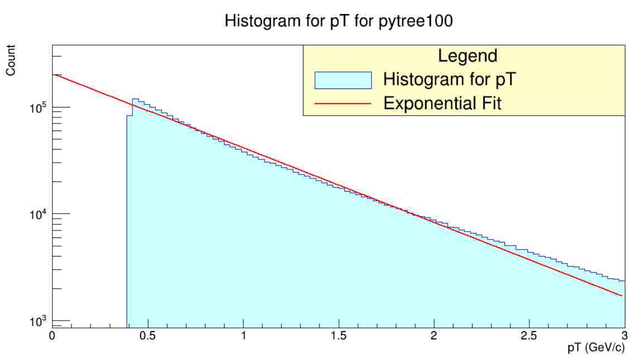

FIG. 5a. (Color Online) Distribution of **pT** for proton-proton collision in the multiplicity class **pytree100**. The solid line is an Exponential fit to the data.

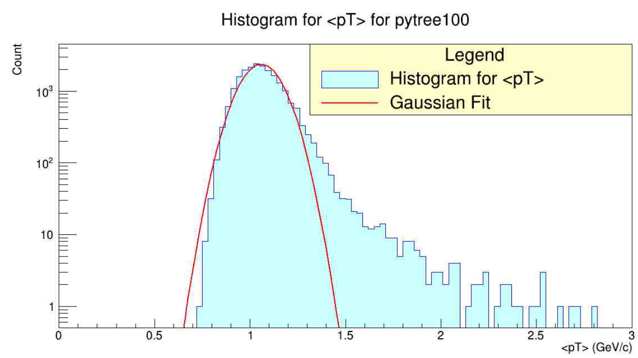

FIG. 5b. (Color Online) Distribution of $\langle \mathbf{pT} \rangle$ for proton-proton collision in the multiplicity class **pytree100**. The solid line is a Gaussian fit to the data.

B. Analysis of Mean, Variance and Skewness Versus Multiplicity Class

From the graphs in FIG. 1a., FIG. 2a., FIG. 3a., FIG. 4a. and FIG. 5a., it is clear that the Transverse Momenta of the particles produced in a proton-proton collision follows approximately an **exponential distribution**. Graphs in FIG. 1b., FIG. 2b., FIG. 3b., FIG. 4b. and FIG. 5b. reveal that there is some **positive skew** in the distribution of the Mean Transverse Momentum.
In this section, we shall analyse the moments of the distribution of Transverse Momentum. We shall calculate the Mean, Variance and Skewness of the Transverse Momenta for each multiplicity class and study its relation with the multiplicity class. For each of the multiplicity classes, the Mean Transverse Momentum, the Intensive Variance of the Transverse Momentum, the Standardized Skewness of the Transverse Momentum and the Intensive Skewness of the Transverse Momentum, calculated using formulae 1, 3 respectively have been summarised in the table below.

1. *Summary of Data*

The table below summarizes the data.

SUMMARY OF DATA					
Multiplicity Class	**Events**	$\langle \mathbf{p_T} \rangle$ **(GeV/c)**	$\sigma_{\mathbf{p_T}}$	$\gamma_{\mathbf{p_T}}$ **(GeV/c)**	$\boldsymbol{\Gamma}_{\mathbf{p_T}}$
pytree2040	873322	0.869307	0.174974	1.77742	10.1582
pytree4060	445805	0.940521	0.144591	1.80884	12.51
pytree6080	207990	0.99074	0.130471	3.11451	23.8714
pytree80100	71263	1.03006	0.122603	1.64507	13.4178
pytree100	20981	1.07257	0.132207	4.11805	31.1485

TABLE I. Table Summarizing the Data of Transverse Momenta

2. *Mean Transverse Momentum versus Multiplicity Class*

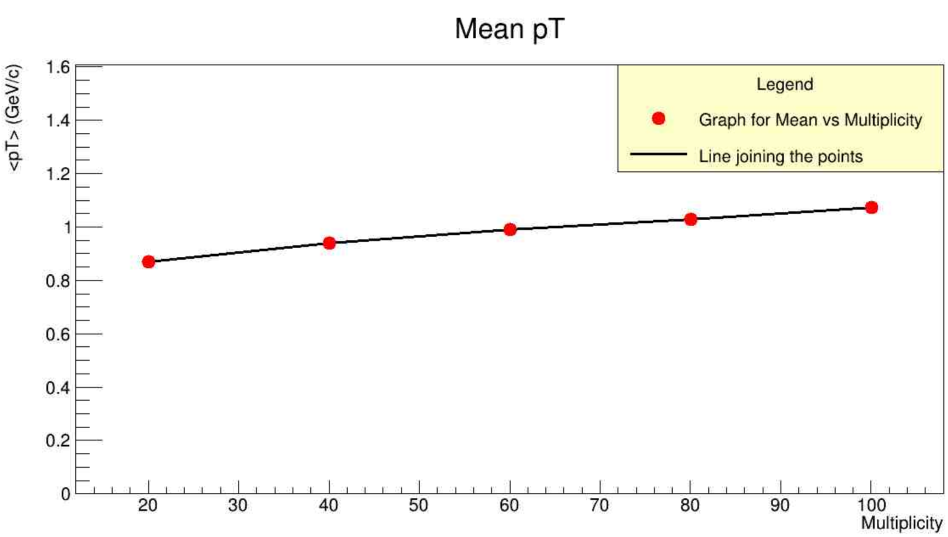

FIG. 6. (Color Online) A plot of mean transverse momenta versus multiplicity class.

FIG. 12. (Color online) Put proper captions

III. SUMMARY

The study of $\cdots$

[1] J. Adams *et al.*, (ALICE Collaboration), Nature Physics**13**,535-539 (2017).