A generalized approach to study low as well as high pT regime of transverse momentum spectra

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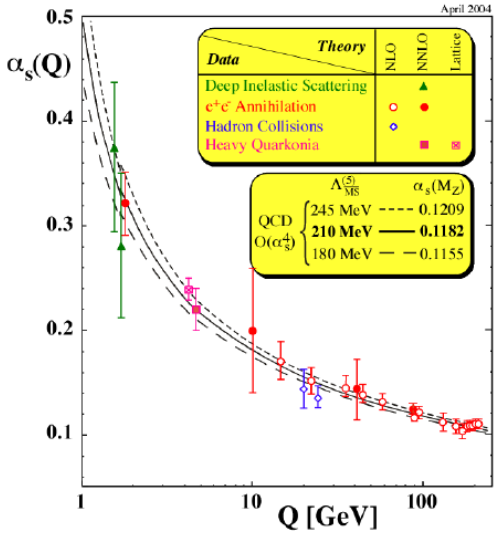
Introduction

- Transverse momentum (p_T) spectra is an important observable to understand the evolution dynamics of QCD matter produced during heavy ion collision.

- Asymptotic freedom constrain us from applying perturbative QCD theories to study the p_T spectra in low p_T region.
- Hence we rely on the phenomenological models with most common being statistical thermodynamics based models.



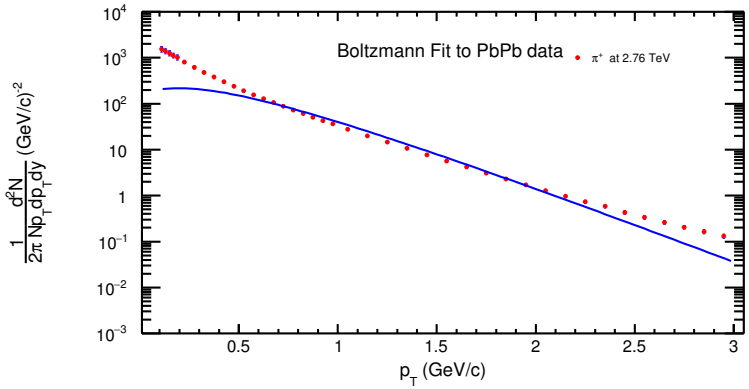
Conventional Approach

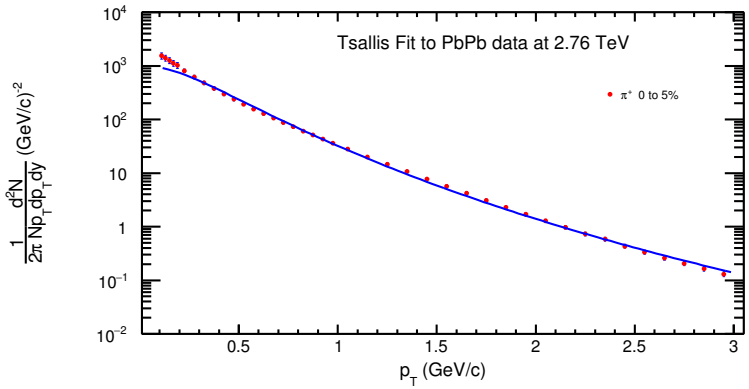
- Considering the fireball produced in HIC as a thermal system, natural choice is that it will follow Boltzmann-Gibbs (BG) statistics.

$$E\frac{d^3N}{dp^3} = \frac{1}{2\pi p_T}\frac{d^2N}{dp_T dy} = \frac{gVm_T}{(2\pi)^3} exp\left(\frac{-m_T}{kT}\right)$$

- Since BG statistics does not explains the data well, so we move to a more generalized distribution. Tsallis statistics is a generalised BG statistics which also takes into account non-extensivity in the system.
- Tsallis fit deviates from data towards higher p_T corresponding to particle from hard processes.

$$E\frac{d^3N}{dp^3} = \frac{1}{2\pi p_T}\frac{d^2N}{dp_T dy} = \frac{gVm_T}{(2\pi)^3}\left[1+(q-1)\frac{m_T}{T}\right]^{\frac{-q}{q-1}}$$





Pearson Distribution

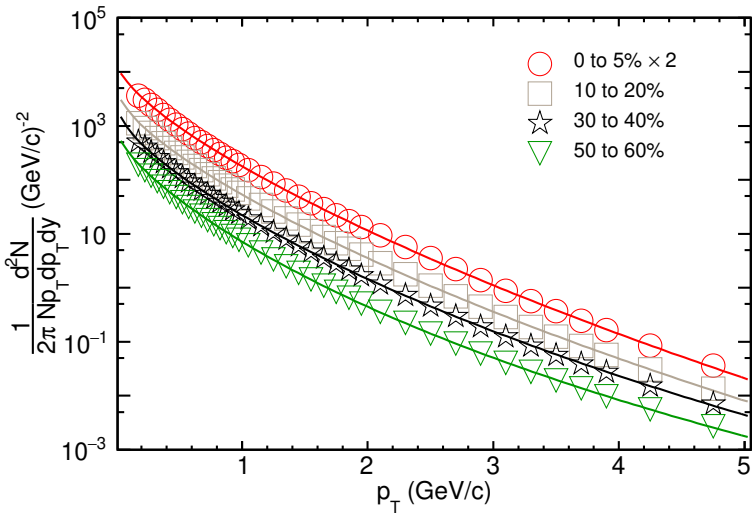
- We have constructed a unified model to explain both soft as well hard part of transverse momentum spectra.

- It is a generalised form of many probability distribution functions like gaussian, exponential, gamma distributions etc.

$$\frac{1}{p(x)}\frac{dp(x)}{dx} + \frac{a+x}{b_0 + b_1 x + b_2 x^2} = 0$$

$$p(x) = C(e+x)^f (g+x)^h$$

$$f(p_T) = B\left(1+\frac{p_t}{p_0}\right)^{-n}\left(1+(q-1)\frac{p_t}{T}\right)^{-\frac{q}{q-1}}$$



- We also observed the indication of initial geometric effects in the Pearson parameter.

Reference: S. Jena and R. Gupta, Phys. Lett. B807, 135551 (2020)