Expectation of photon multiplicity in p-p collisions at LHC energies

Subhash Singha[1],* Sudipan De[1],† Bedangadas Mohanty[1], and Tapan Kumar Nayak[1]
[1] *Variable Energy Cyclotron Centre, Kolkata-700064, INDIA*

Introduction

The measurements of pseudorapidity distributions of produced particles are important to understand the particle production mechanisms, the scaling laws and the limiting fragmentation behavior. The Large Hadron Collider (LHC) at CERN can provide proton-proton collisions at center of mass energies 0.9 TeV to 14 TeV. The measurements of pseudorapidity distribution of produced particles can be used to test the particles production mechanism implemented in different models like PYTHIA [1], PHOJET [2]. In this article We have compiled the data on pseudorapidity distribution of inclusive photons of UA5 [3] experiment. The pseudorapidity distribution of photons is parameterazied using a function with same physical motivation and it is used to predict [4] the distribution at higher LHC energies.

Results and Discussions

The pseudorapidity distribution of photons from the data at $\sqrt{s} = 200$, 546 and 900 GeV of UA5 experiment can be described by the following 3-parameter formula:

$$\frac{dN_\gamma}{d\eta} = \frac{C}{1 + exp^{\frac{\eta - \eta_0}{\delta}}} \tag{1}$$

This formula is chosen to describe the central plateau and the fall off in the fragmentation region of the distribution by means of the parameters η_0 and δ respectively. The magnitude of the distribution is described by the parameter C. The values of the parameters C, η_0 and δ are obtained by fitting the available data using Eqn. 1. The parameter values are given in the TABLE I and the fits to data are shown in Fig. 1. The values of the parameter C and η_0 are found to increase with increasing $\sqrt{s}$. The value of the parameter δ is found to be approximately independent of $\sqrt{s}$ within errors. This feature is another way to describe the concept of limiting fragmentation behavior of photons [5].

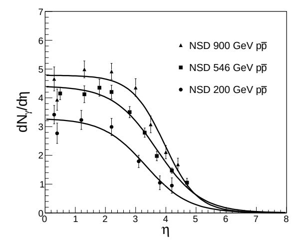

FIG. 1: Pseudorapidity distribution of photons in p-$\bar{p}$ collisions. solid lines show the fit with the Eqn. 1

TABLE I: Parameters C, η_0, δ at different $\sqrt{s}$ for p-$\bar{p}$ collisions

$\sqrt{s}$ (GeV)	C	η_0	δ
200	3.288 ± 0.231	3.33 ± 0.178	0.711 ± 0.18
546	4.413 ± 0.174	3.698 ± 0.086	0.725 ± 0.075
900	4.784 ± 0.178	3.955 ± 0.085	0.549 ± 0.087

The expected values of these parameters at $\sqrt{s} = 7$, 10 and 14 TeV for photon can be obtained by extrapolating the C and η_0 values given in TABLE I. The functional forms for this extrapolation are given below.

$$C = 4.98 + 1.174ln(\sqrt{s}) + 0.1ln(\sqrt{s})^2 \tag{2}$$

*Electronic address: `subhash.singha@vecc.gov.in`
†Electronic address: `sudipande@vecc.gov.in`

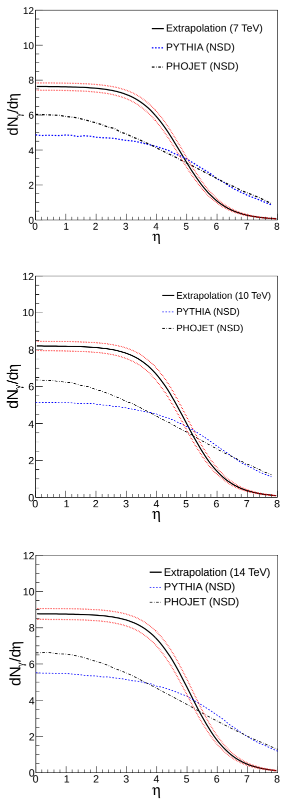

FIG. 2: Solid line is the expected pseudorapidity distribution of photons for p-p collisions which is obtained from extrapolating the existing data of p-$\bar{p}$ at lower energies. Doted red lines are uncertainties associated with the extrapolation. Comparison is made with the PYTHIA(blue dotted line) and PHOJET(black dashed line).upper: 7 TeV, middle: 10 TeV, lower: 14 TeV

$$\eta_0 = 3.98 + 0.429 ln(\sqrt{s}) \qquad (3)$$

The values of C and η_0 obtained are 7.64 $\pm$ 0.209, 8.21 $\pm$ 0.254, 8.77 $\pm$ 0.298 and 4.81 $\pm$ 0.067, 4.96 $\pm$ 0.074, 5.11 $\pm$ 0.80 for $\sqrt{s}$ = 7, 10 and 14 TeV respectively. If we assume Eqn. 1 is valid for $\sqrt{s} = 7$, 10 and 14 TeV, we can predict the pseudorapidity distribution of photons at these energies taking the average value of parameter δ and using the values of the parameters C and η_0 obtained above.

The predicted pseudorapidity distribution of photons at $\sqrt{s}$ = 7, 10 and 14 TeV are

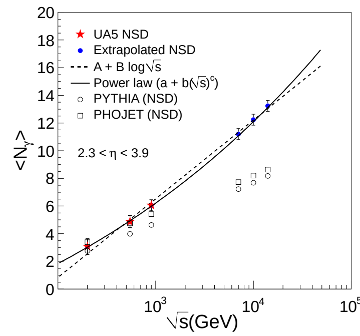

FIG. 3: Energy dependence of average photon multiplicity at forward rapidity. Red star: UA5 data, blue solid circle: extrapolated data, open circle: PYTHIA, open square: PHOJET, solid line: logarithmic function, dotted line: power law

shown in Fig. 2. It is compared with the models PYTHIA and PHOJET. It is observed that at both the energies our predicted distributions are above the model predictions.
The energy dependence of average photon multiplicity at forward rapidity ($2.3 < \eta < 3.9$) is shown in Fig. 3. We have compared the average photon multiplicity from UA5 data and extrapolated data with the models PYTHIA and PHOJET. The data is well described by both power law and logarithmic functions. The Photon Multiplicty Detector (PMD) in ALICE at LHC could provide the experimental data [6] at forward rapidity in LHC energies to compare our predicted values.

References

[1] arXiv:hep-ph/0610012 (2006),D6T(109) tune.
[2] Phys Rev. D52, 145 (1995).
[3] Z. Phys. C - Particles and Fields 43, 75-89 (1989).
[4] J. Phys. G Nucl. Part. Phys. 37, 025102 (2010).
[5] Phys Rev. C73, 034906 (2006).
[6] Quark Matter 2011 Poster: “Inclusive photon production at forward rapidities for pp collisions at $\sqrt{s}$ = 0.9 TeV and 7 TeV in ALICE at the LHC” (ALICE collaboration).