Multiplicity and pseudo-rapidity distributions of photons at forward rapidity in STAR at RHIC energies

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Introduction

One of the goals of the STAR experiment at Relativistic Heavy Ion Collider (RHIC) is to study the properties of the QCD matter at extremely high energy density and parton density, created in the heavy ion collisions. The particle multiplicity measurements provide information on particle production mechanisms. The variation of particle density in pseudo rapidity (η) with collision centrality can shed light on the relative contribution of soft and hard (perturbative QCD jets) processes in particle production [1]. Multiplicity measurements can provide tests of ideas on initial conditions in heavy-ion collisions based on parton saturation. The pseudorapidity distributions are found to be sensitive to the effects of re-scattering, hadronic final-state interactions, and longitudinal flow [2]. We study the centrality and energy dependence of photon multiplicity away from mid-rapidity to explore if the longitudinal scaling observed for Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV and 62.4 Gev holds at lower energy also. At these energies, in the rest frame of one of the colliding nuclei, a universal limiting curve could describe the data for rapidity range, which extended beyond the original beam rapidity. For photon, this scaling was found to be independent of collision energy, event centrality as well as system size. The longitudinal scaling was also observed for different collision energy for charged particles by PHOBOS though the scaling observed was not independent of the centrality of event [3].

Analysis Details and Results

The photon multiplicity is measured in the STAR experiment at RHIC energies by a Photon Multiplicity Detector (PMD) in pseudorapidity region $-3.7 < \eta < -2.3$. It has been studied for Au+Au collisions at $\sqrt{s_{NN}}$ = 200 GeV and 62.4 GeV [3,4]. Here we intend to measure the same for $\sqrt{s_{NN}}$ = 39 GeV and 19.6 GeV and compare with published results from 200 GeV and 62.4 GeV. The data corresponding to 0 - 80% of Au+Au cross section will be presented. The multiplicity of photons like signals are measured for different event centrality for Au+Au collisions at 39 and 19.6 GeV and corrected for efficiency and purity using simulated data. The resulting pseudo-rapidity distributions of the photons are studied for different collision centralities and are compared to the expected multiplicity from HIJING. We will study the scaling on the photon multiplicity to the number of participants and also to the number of wounded nucleons. At 200 and 62.4 GeV the photon multiplicity has shown scaling with number of participants [4]. A similar trend is observed at least for higher centrality collision at 39 GeV.

We compare the photon pseudorapidity distributions from Au+Au collsions at $\sqrt{s_{NN}}$ = 39 GeV with those at Au+Au $\sqrt{s_{NN}}$ = 200 GeV and 62.4 GeV [3,4]. Figure 1 shows the result for 39 GeV along with results for 200 and 62.4 GeV as a function of $\eta - y_{beam}$ for 10-20% centrality. Where y_{beam} is the beam rapidity. The solid line is a second order polynomial fitted to the data. The results demonstrate that the longitudinal scaling for produced photons is independent in the measured energy region.

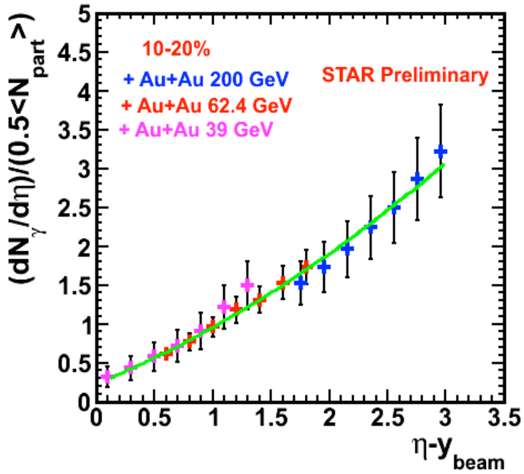

Fig1: - Photon pseudorapidity distributions normalized by the average number of participating nucleon pairs for different collision centralities are plotted as a function of pseudorapidity shifted by the beam rapidity. The solid line is a second order polynomial fit to the data. The error bars on 39 GeV data are statistical. The error bars for 200 GeV and 62.4 GeV are only systematic, statistical errors are negligible in comparison.

References

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