J/ψ Photoproduction in ultra-peripheral Au+Au collisions measured by RHIC-PHENIX

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Ultra Peripheral collision is defined as heavy ion collision its impact parameter twice larger than the nuclear radius. Then there are no nuclear overlap. Strong interaction is impossible. Relativistic moving ions should emit quasi real photons to transverse direction with maximum energy γ/R. Ions can interact through photon-Ion (coherent) and photon-nucleus (incoherent), and photon photon collisions,

Measurement of vector meson photo production is a sensitive probe of gluon distribution in nuclei. At RHIC energy, measurement of J/ψ photo production corresponds to x $\cong$ 0.015 and Q^2 =2.5 GeV/c^2. In the kinematic region, nuclear shadowing plays an important role and that still have large uncertainty.

PHENIX measured J/ψ photo production in Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV in 2004, 2007 and 2010. PHENIX has detectors at central (0.35> $|y|$) and forward (1.2< $|y|$ <2.2) rapidity. The 2004 integrated cross section result at central rapidity was already published. 2004 integrated cross section result is consistent with all theoretical predictions within 1σ statistical error.

2007 and 2010 higher statistics data make it possible to measure differential cross section and to improve statistical error associated with integrated luminosity Moreover improvement of trigger arrows forward rapidity UPC measurement. In this talk, integrated and differential cross section of UPC J/ψ at central rapidity preliminary results in 2007 and forward rapidity in 2010 will be shown.

1 Introduction

We present measurements of the photoproduction of J/ψ in ultra-peripheral Au+Au collisions at $\sqrt{s_{NN}} = 200$ GeV at RHIC. An Ultra-Peripheral Collision (UPC) is a collision in which an impact parameter is greater than the sum of nuclear radii. Measurement of J/ψ in UPC serves as a considerable role for determining gluon density in nuclei at small Bjorken x, where the gluon density is expected to be suppressed due to gluon shadowing effect and has not been constrained by the theoretical calculation [1, 2, 3]. PHENIX has measured integrated cross section of J/ψ in UPC in 2004 [4]. However, due to small statistics, it was very difficult to constrain the theoretical calculations on gluon distribution in nuclei. In 2007 and 2010, PHENIX collected 527.45 ± 23 μb^{-1} and 1390.05 ± 37.3 μb statistics of Au+Au collisions, respectively. Measurement of J/ψ photoproduction in UPC as a function of transverse momentum p_T and rapidity y has been done by using data taken in 2007 and 2010, where 3 and 9 times larger statistics were achieved compared to that in 2004.

2 Analysis

The requirement of UPC events selection are that there are only two electron (muon) tracks in central arms (forward muon spectrometer) and that at least one neutron is detected. Figure 1, 2 shows invariant mass spectra of dielectrons and dimuons in UPC events, respectively. The number of measured J/ψ is corrected by the detection efficiency, trigger efficiency, and integrated luminosity to extract the invariant cross section.

Figure 3 shows the preliminary results of the p_T distribution of J/ψ cross section in UPC, where black, blue and red correspond to the cross section at mid-rapidity with one neutron tagged by zero degree calorimeter(ZDC), -2.2<y<-1.2 and 1.2<y<2.2 with two neutron tagged at both sides of ZDC, respectively. From Fig.3 , cross section at mid-rapidity in low p_T is very large compared to that at forward-rapidity. This is due to the dominance of coherent J/ψ production at low p_T in mid-rapidity, while incoherent production is dominated at forward rapidity. The upper limit of integrated cross section for coherent J/ψ production was extracted to be 46.7±13±15 μb^{-1}. The value was found by integration from 0 to 0.4.

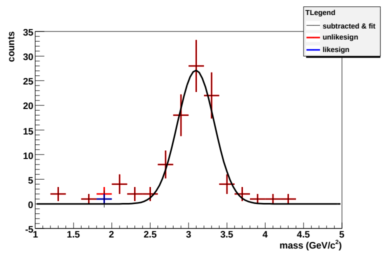

Figure 1: 2010 North arm (dimuon) invariant mass yields.

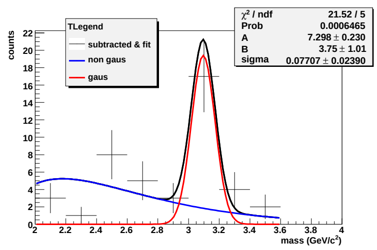

Figure 2: 2007 central arm (dielectron) invariant mass yields.

Since the cross section without any nuclear effects such as gluon shadowing is expected to be 118μb [5]. Figure 4 shows the cross section as a function of y, where both side neutrons are tagged. The comparison with the theoretical calculations is underway.

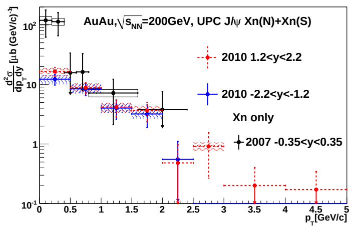

Figure 3: PHENIX 2010 dimuon (Red and Blue) and 2007 dielectron(black) UPC J/ψ $\frac{d^2\sigma}{dp_T dy}$. Dielectron distribution has significant 0 p$_T$ peak, but same peak can't be find from dimuon distribution.

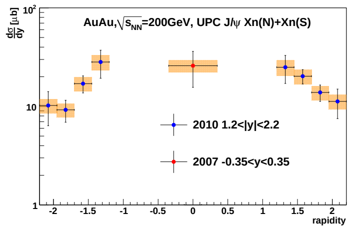

Figure 4: PHENIX 2010 RUN UPC J/ψ $\frac{d\sigma}{dy}$ distribution

3 Summary

Measurement of J/ψ in UPC has been performed by using 2007 and 2010 data. From the cross section as a function of p$_T$, the coherent production of J/ψ can be seen and integrated cross section is suppressed by a factor of 0.6 compared to the value without any nuclear effects. Further studies for both neutron tagging and theoretical understanding are on going.

4 Bibliography

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