Signal Extraction and Unfolding of Upsilon in pPb collisions with CMS at $\sqrt{s}_{NN} = 5.02$ TeV

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Introduction

Photonuclear interactions at unprecedentedly high energies can be studied in ultra-peripheral collisions (UPC) at LHC. The recent results of exclusive photoproduction of dileptons with CMS [1] in pp collisions, photoproduction of J/ψ in UPC pPb [2] collisions with ALICE, confirmed the expectations [1] that UPCs are a very promising probe to study the gluon distributions in nucleons and in nuclei at small x. The exclusive production of vector mesons, occurs by γp or γPb interactions which has been successfully modelled in perturbative QCD in terms of exchange of two gluons with no net colour transfer.The Photoproduction cross-section is proportional to the gluon distribution in a proton or nucleus. The relevant x region in CMS is $\approx 10^{-2} - 10^{-4}$ at central rapidities ($|y| < 2.5$). Studies of the exclusive photoproduction of vector mesons have shown that the t dependence of the differential cross section may be approximated in the region of small t ($|t| < 1GeV^2$) with a single exponential d$\sigma/d|t|$, is proportional to $exp(b|t|)$, where t is the four-momentum-transfer squared at the proton vertex. The slope parameter b is measuresd at HERA [3], In this study we will report the signal extraction and unfolding of of t slope for exclusive photo production of Upsilon and in pPb collisions at $\sqrt{s}_{NN} = 5.02$ TeV using data from 2013 run.

Data and Event selection

The data set corresponds to the muons collected for pPb collisions at $\sqrt{s}_{NN} = 5.02$ TeV with CMS detector with integrated luminos-

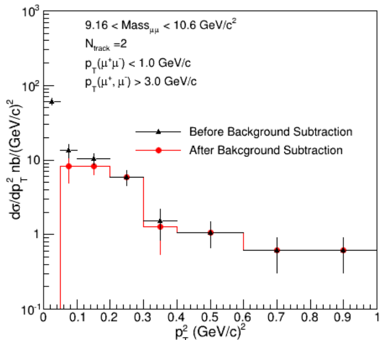

FIG. 1: $p_T^2 \approx |t|$ distribution: Before and After background subtraction

ity of 32.65 nb^{-1}. The events which pass the UPC trigger used in the analysis, require both muons to have minimum transverse momentum of $3GeV/c$ and dimuon $p_T < 1GeV/C$. The $\mu^+\mu^-$ pair with invariant mass between 8 GeV/c^2 $< M_{\mu^+\mu^-} <$ 12 GeV/c^2 are considered. To select exclusive process, events with zero additional tracks associated to the $\mu^+\mu^-$ vertex are considered.

MC Simulations

The simulations of the signal events for the and the background $\mu^+\mu^-$ due to QED $\gamma\gamma \rightarrow \mu^+\mu^-$ processes is performed with Starlight event generator [4]. Additionally, the parton induced background events from Drell-Yan (DY) and Inclusive Υ production of $\mu^+\mu^-$ pairs are simulated with PYTHIA6 with Tune Z^2 and scaled for pPb collisions.

Sideband Background Subtraction Procedure

To find the background contribution, invariant mass spectrum was fitted with polynomial in signal region,$9.12 < M_{\mu^+\mu^-} < 10.64$ and two sideband reagions, $8 < M_{\mu^+\mu^-} < 9.12$ and

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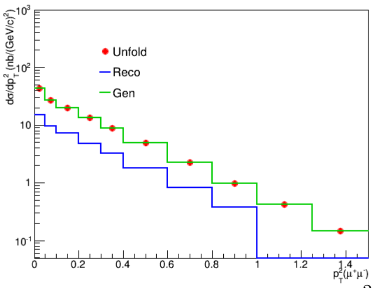

FIG. 2: Unfolding of measured(reco) p_T^2 for MC

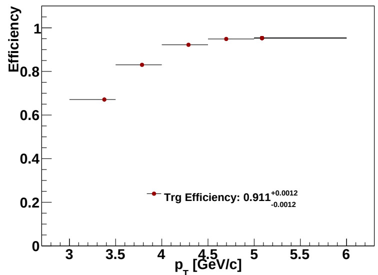

FIG. 3: Comparison of Single muon trigger efficiency as a function of p_T for MC

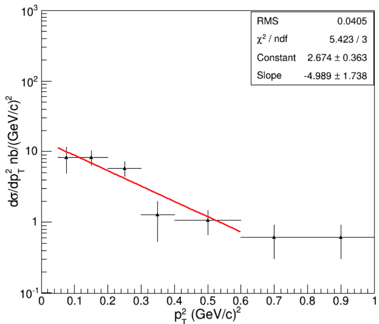

FIG. 4: Background subtracted p_T^2 fit

$10.64 < M_{\mu^+\mu^-} < 12$. A scale factor for sidebands is found from the no. of background events from fit. Background subtracted p_T^2 (Fig.1) distribution is obtained by deducting the scaled sidebands from the signal.

Unfolding

Due to the finite detector resolution, limited acceptance and other reasons the measurement of a cross section does not give the true result. Measured data is related to the Generated data by migration, distortions and transformations which involves inefficiencies and biases the measured data because of smearing. A correction of the measured distribution is necessary, to obtain a result with a direct physical meaning, without the specific effects of the detector. Unfolding is a technique to obtain the true result. There are different unfolding methods: Bin by Bin, Bayesian, SVD. Using generated and reconstructed MC, a response matrix is created which is used to unfold the reconstructed data (Fig.2).

Tag and Probe

We use Tag and Probe(TnP) method to estimate the single-muon trigger, identification and tracking efficiencies for both data and MC. The MC sample used is $\Upsilon(1S)$.TnP is a data driven technique used to calculate efficiencies by exploiting di-object resonances like Υ. These resonance is reconstructed as pairs with one leg passing a tight identification(tag) and one passing a loose identification(probe). We calculated the efficiency for HLT_PAUpcSingleMuOpenFull_TrackVeto7_v1 trigger for MC Tag: tracker muon with quality cut and matching to single muon triggers, Probe: tracker muon with quality cut without trigger matching, Passing probe:probe that can be matched to (one leg of) trigger

Results

Fig.4 shows the background subtracted p_T^2 distribution which is fitted by exponential function. Slope parameter comes out to be $b = 4.989 + -0.30$. This slope will be corrected by trigger efficiency obtained by T&P method and other efficiencies.

References

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