



Results and future prospects of the CMS experiment in photon-induced interactions in p-Pb collisions

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Outline

- Motivation
- CMS detector
- Exclusive photoproduction of Upsilon in pPb collisions at $\sqrt{s}=5.02$ TeV
 - \bullet estimate the |t| dependence of the cross-section
 - photonuclear cross-section
- Ongoing analyses and future prospects

Motivation: Exclusive vector meson production

- The exclusive production is studied in ultraperipheral pPb collisions
- Ions interact via photons
- The photon flux grows with the square of the charge, Z^2



Motivation: Exclusive vector meson production

- The exclusive production is studied in ultraperipheral pPb collisions
- Ions interact via photons
- The photon flux grows with the square of the charge, Z^2
- Photoproduction process is sensitive to the gluon density squared in the nucleon (nucleus)

$$\frac{d\sigma_{\gamma p,A \rightarrow V p,A}}{dt}\Big|_{t=0} = \frac{\alpha_s^2 \Gamma_{ee}}{3\alpha M_V^5} 16\pi^3 [xG(x,Q^2)]^2$$

$$\sigma_{\gamma p \to Y p} = \frac{1}{b} \frac{d \sigma_{\gamma p, A \to V p, A}}{dt} \Big|_{t=0}$$

- Probe gluon distributions in the proton at low x (10⁻⁴ to 2 · 10⁻²) $x = (M_{y}/W_{yp})^{2}$
- Photonuclear cross-section shows power law dependence with $W_{\gamma p}$ $\sigma \propto W_{\gamma p}^{\delta}$





Motivation: Exclusive Y production

• Energy of the photon-proton collision



	CMS	HERA	LHCb
E_p [GeV]	4000	820	3000, 4000
y-range	(-2.2;2.2)	(-1.5;1.5)	(2;4.5)
$W_{\gamma p}$ [GeV]	91-826	60-220	900-2000

The CMS Experiment



Exclusive upsilon production

- 2013 pPb data at 5.02 TeV with 32.6 nb^{-1}
- Offline exclusive $pPb \to \Upsilon(\gamma p) \to \mu^+\mu^-$ signal selection
 - Invariant mass (μμ): 9.12 10.64 GeV
 - Opposite-sign $\mu\mu$ pair (final state) originating from common primary vertex
 - No extra tracks at primary vertex to remove non-exclusive background
 - Upsilon p_T : 0.1-1 GeV to suppress QED and proton dissociation
 - Upsilon |y| < 2.2 high muon finding efficiency



CMS-FSQ-13-009

Exclusive upsilon production

- Data compared to simulation (contains different contributions)
- Low p_T : QED elastic background, estimated by STARLIGHT
- High p_T : Non-exclusive background estimated from data
- Starlight MC: γPb (small contribution) and reweighted γp contribution



Good agreement between data and MC

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Photoproduction cross-section as a function of |t|



ZEUS for Y(1S)

b = 4.3^{+ 2.0}_13 (stat)

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Data is in agreement with ZEUS measurements and consistent with predictions based on pQCD models

Cross-section as a function of $W_{\gamma p}$



- Rapidity distribution of Y(1S+2S+3S) used to estimate $\sigma_{\Upsilon(1S)}$ vs $W_{\gamma p}$
- The cross-section is corrected for muonic branching ratio, feed-down, upsilon (1S) fraction



A fit with power-law **A X** (**W**/400)^{δ} to the CMS data $\delta = (0.96 \pm 0.43)$, **A = 655 ± 196** Data compatible with power-law dependence of $\sigma(W_{\gamma p})$, disfavours LO pQCD predictions

> ZEUS δ = 1.2 ± 0.8 PLB 680(2009) 4-12 10

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Future prospects: cross-section as a function of $W_{\gamma p}$

• Energy of the photon-proton collision

 $W_{\gamma p}^2 = 2 \cdot E_p \cdot M_{VM} \cdot exp(-y)$ Work in E_p - proton beam energy progress M_{VM} - Mass of the Vector meson y – Rapidity of the vector meson J/v • The proton beam energy at LHC is much higher compared to HERA. ALICE CMS Run-I and Run-II data γ - LHCb extend measurements performed CMS at HERA. CMS Run-II • CMS covers both forward and 10² backward rapidity regions. It is a unique possibility to cover the energy region between HERA experiments and LHCb data.

Future prospects: |t|-distributions

Appearance of diffractive dips are signature of gluon saturation according to b-CGC and IP-Sat models

Both H1 and ZEUS measured only low |t| region

It is necessary to extend the measurement to higher t-values.



Summary

- The first measurement of exclusive Υ photoproduction in pPb collisions at 5.02 TeV has been presented
- Data compatible with power-law dependence of $\sigma_{\Upsilon(1S)}(W_{\gamma p})$, disfavours HERA and LO pQCD predictions
- The differential cross-section $d\sigma/dt$ in agreement with earlier measurements and consistent with predictions based on pQCD models
- Good prospect for further measurements of vector meson production in ultraperipheral pPb collisions in the CMS Experiment using existing and upcoming data have been discussed

Thank you for your attention!