



***Prospects for Measuring  
Coherent  $J/\psi$  Photoproduction in  
Ultra-Peripheral  $p$ -Pb Collisions***

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# Ultra-peripheral collisions (UPC)

## LHC: the world's largest photon collider

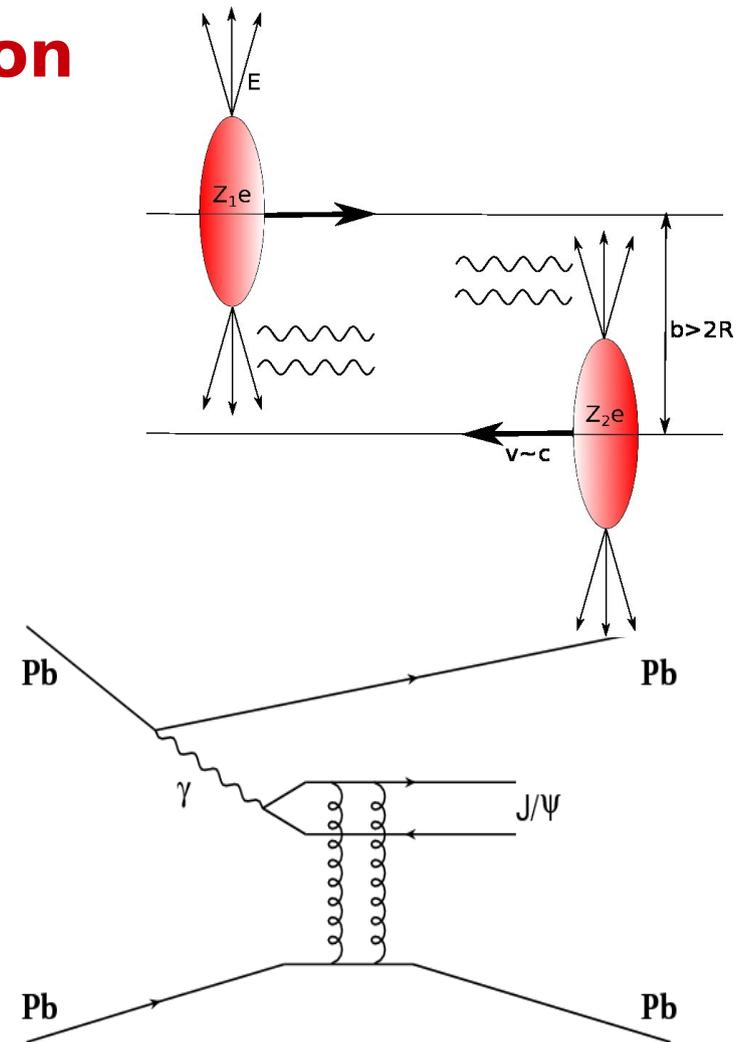
<http://alicematters.web.cern.ch/?q=LHCphotoncollider>

In ultra-peripheral collisions, the impact parameters of the nuclei are larger than the nuclear radii sum.

This separation strongly suppresses hadronic interactions.

The strong electromagnetic fields enhance **photonuclear interactions**

-The intensity of said interactions grows as the square of the nuclear charge.



**UPC  $J/\psi$  is sensitive to the nuclear gluon density**

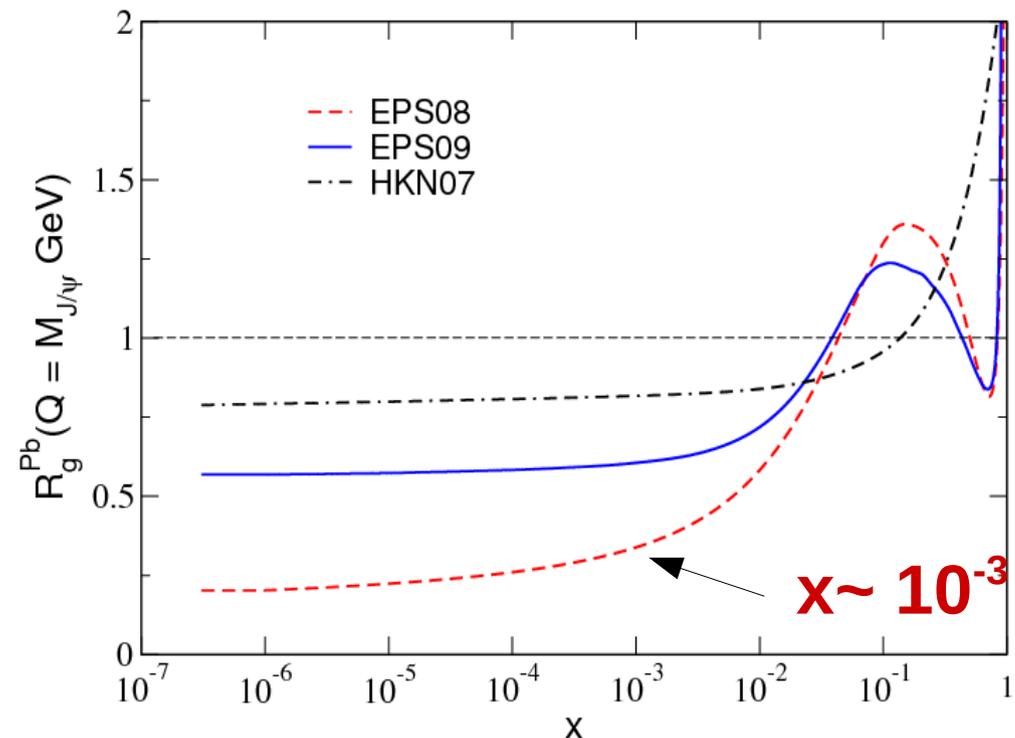
# Studying nuclear gluon distributions

From  $x \sim 10^{-3}$  the **nuclear gluon density** differs significantly from that of the proton. This effect could come from shadowing

The differences at small  $x$  constrain theoretical models of vector meson production

Shadowing should have an effect on the coherent photoproduction of  $J/\psi$  in **ultra-peripheral collisions**

**Nuclear gluon PDFs poorly known at low- $x$**



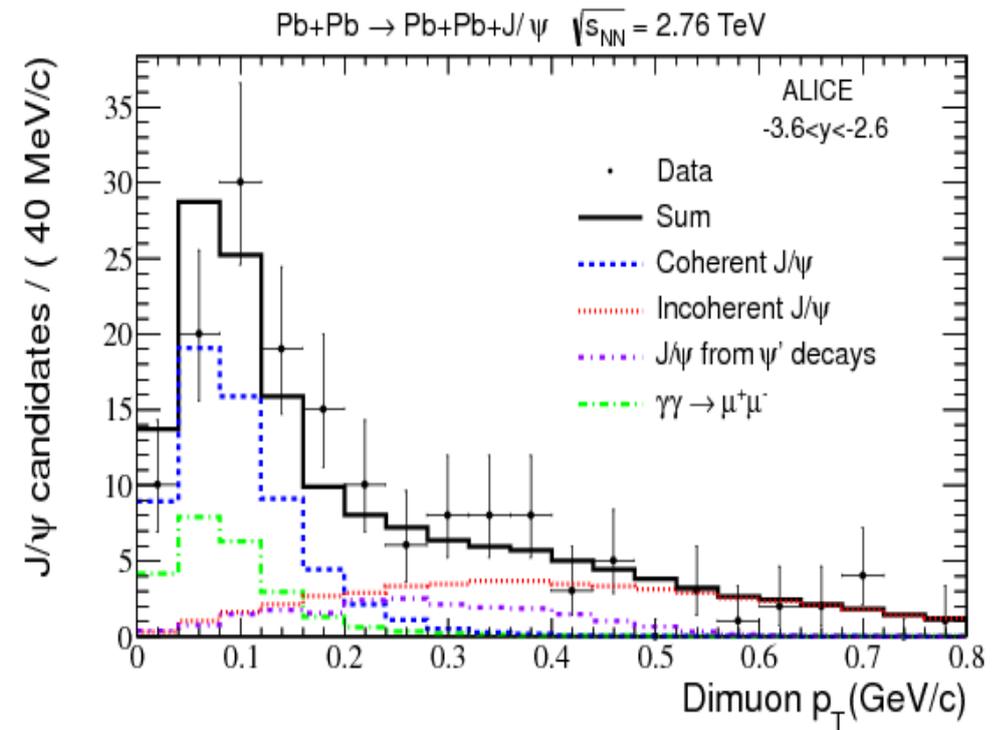
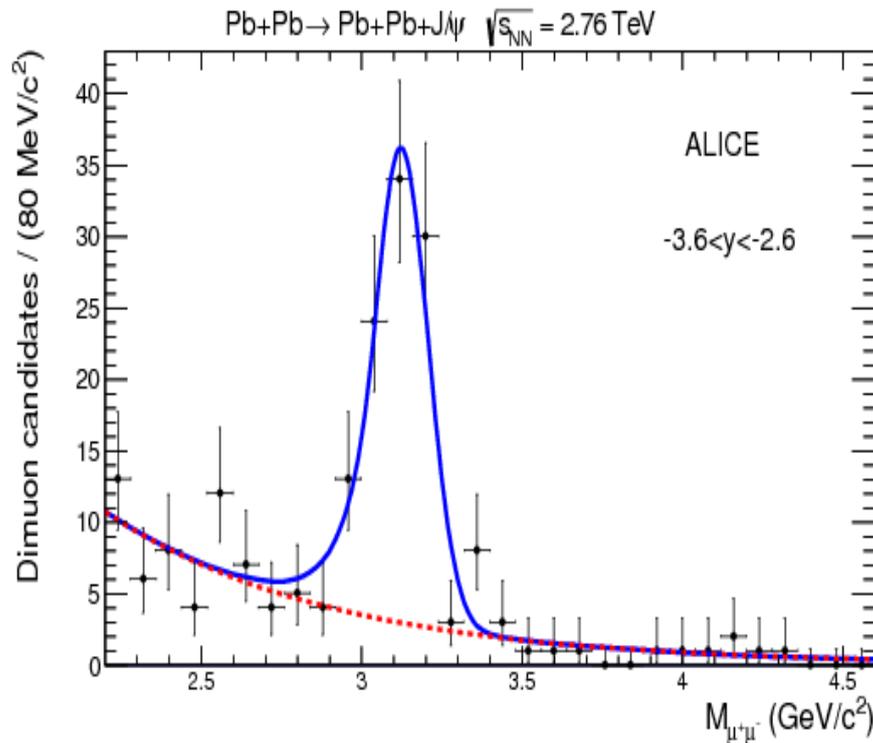
*A. Adeluyi and C.A. Bertulani,  
Phys.Rev. C85 (2012) 044904*

# J/ψ photoproduction in UPC Pb-Pb

The ALICE Collaboration recently measured coherent J/ψ

- Very clear invariant mass signal with almost no background
- Easily discernible Pt-peak for coherent J/ψ

## J/ψ from γ+Pb interactions



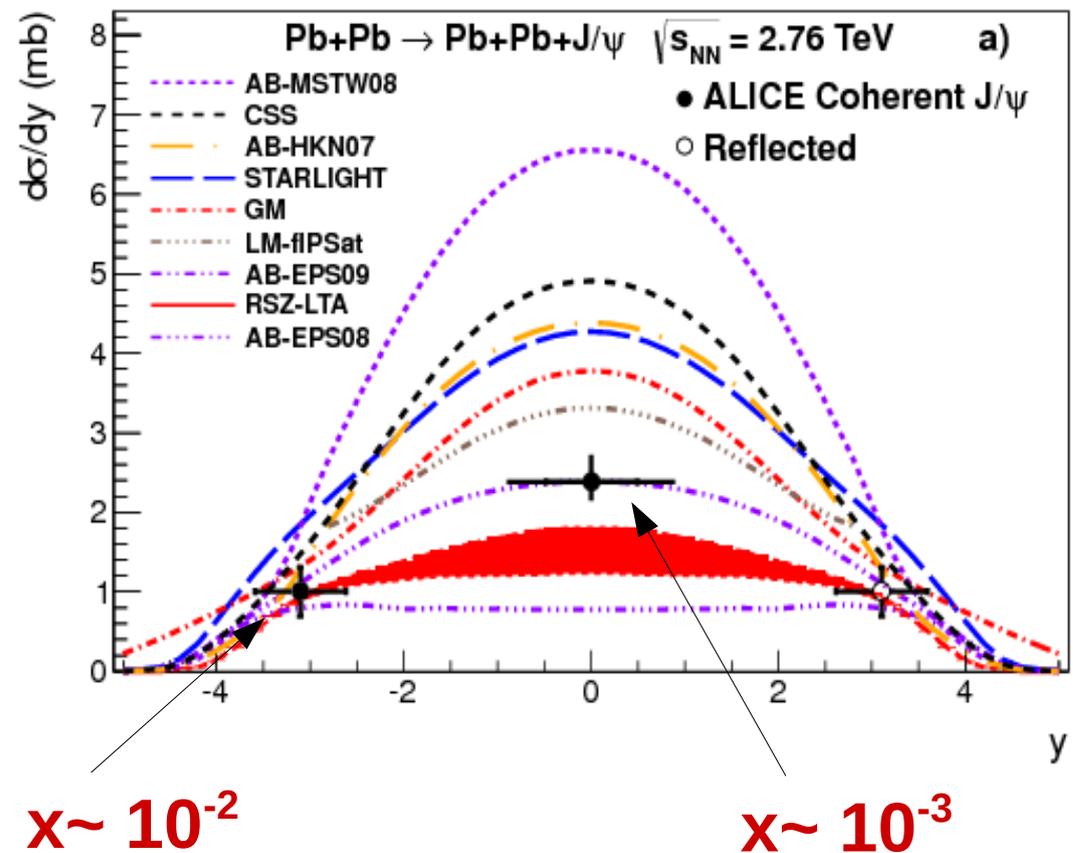
*B. Abelev et al. [ALICE Collaboration],*

*Phys. Lett. B718 (2013) 1273-1283*

# J/ψ photoproduction in UPC Pb-Pb

Experiments at ALICE have measured the J/ψ photoproduction cross-section at both central and forward rapidity

The coherent J/ψ cross section is found to be in good agreement with the model which incorporates the nuclear gluon shadowing according to EPS09 parameterization (AB-EPS09)



E. Abbas et al. [ALICE Collaboration],  
Eur. Phys.J. C73 (2013) 2617

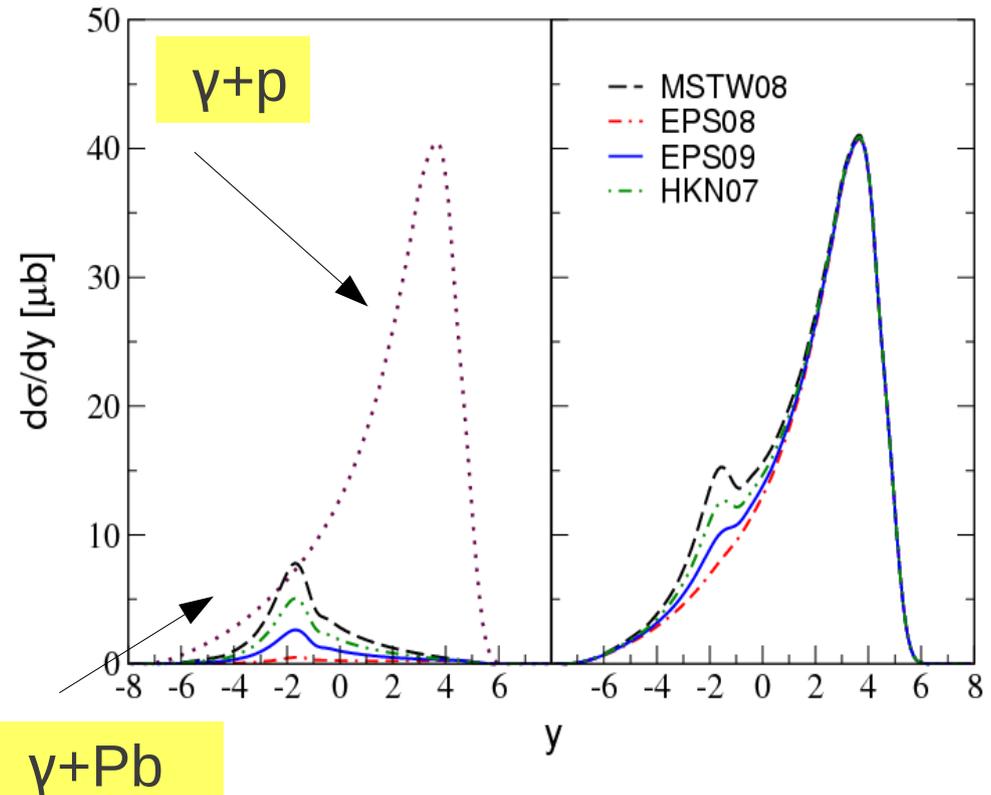
# The study of $\gamma$ +Pb also possible in UPC pPb

In UPC p-Pb, it is more likely to produce  $\gamma$ +p interactions but  $\gamma$ +Pb are also possible

The  $J/\psi$  signal is easy to distinguish from the other processes

Because these photons are very energetic, we reach low- $x$  values

CMS reconstruct  $J/\psi$  in the forward region, by looking in UPC p-Pb we can read lower- $x$  values than in UPC Pb-Pb



*A. Adeluyi and C.A. Bertulani,  
Phys.Rev. C85 (2012) 044904*

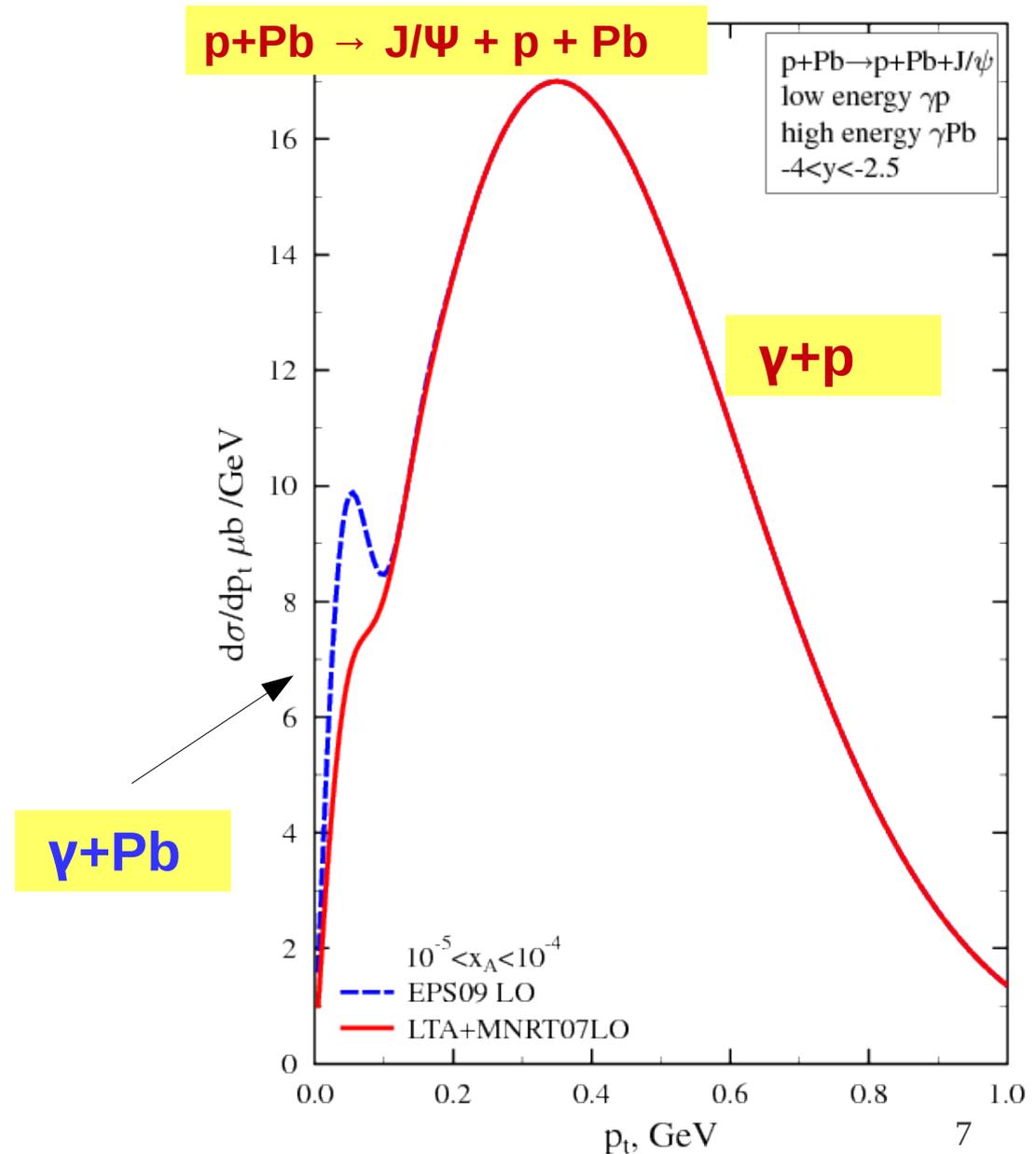
# J/ψ photoproduction in p-Pb

In p-Pb UPC, photons interacting with the Pb nucleus should produce a distinct peak in the coherent J/ψ p<sub>t</sub> distribution.

Confirming this behavior, and so further constraining our models of shadowing, requires:

- 1) resolving the coherent J/ψ transverse momentum peak
- 2) separating at the significant background of low p<sub>t</sub> events.

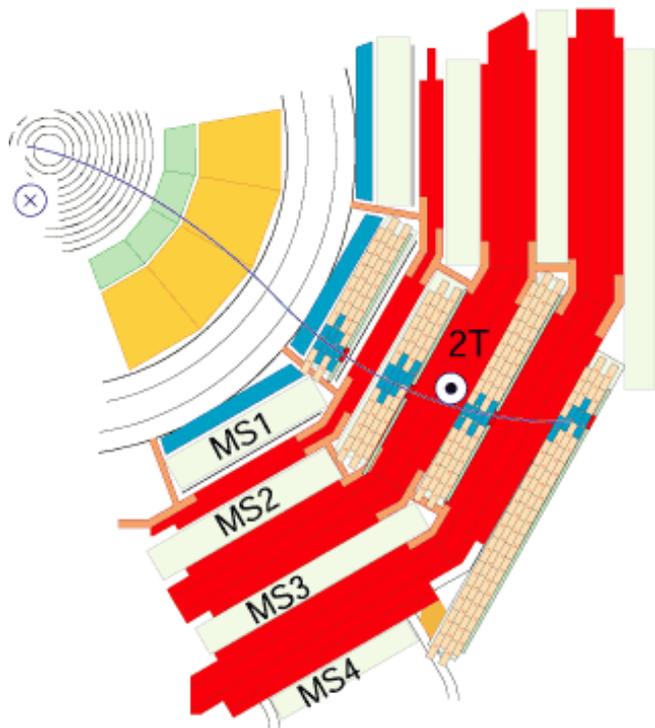
V. Guzey and M. Zhalov,  
*JHEP* 1402 (2014) 046



# UPC physics at CMS

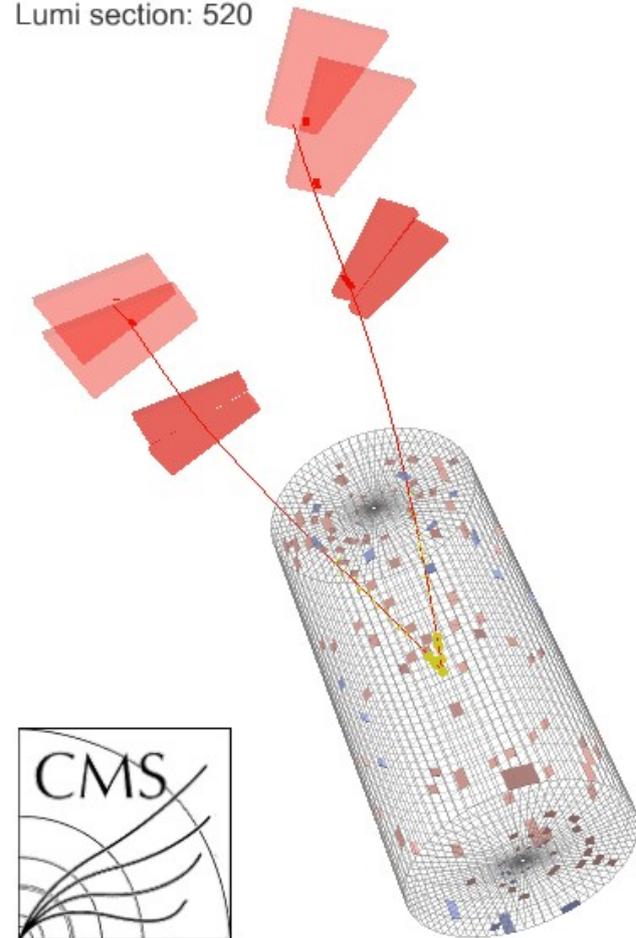
## In UPC p-Pb collisions

- CMS has access to Bjorken-x values on the order of  $10^{-3}$  and  $10^{-4}$ .



## Two tracks in an otherwise empty detector

CMS Experiment at LHC, CERN  
Data recorded: Fri Nov 18 03:24:41 2011 CEST  
Run/Event: 181969 / 18812570  
Lumi section: 520



# Summary

Ultra-peripheral heavy-ion collision is a new exciting topic at LHC

Coherent  $J/\Psi$  is sensitive to the nuclear gluon density

Recent results from ALICE indicate that there is a significant modification to the nuclear gluon density using UPC Pb-Pb collisions

In UPC p-Pb, we can study both photon-proton and photon-lead interactions

CMS can study coherent  $J/\Psi$  in UPC p-Pb collisions in a novel kinematic region, and will provide constraints to theoretical models