Ultra-peripheral heavy-ion collisions with the CMS experiment

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for the CMS Collaboration

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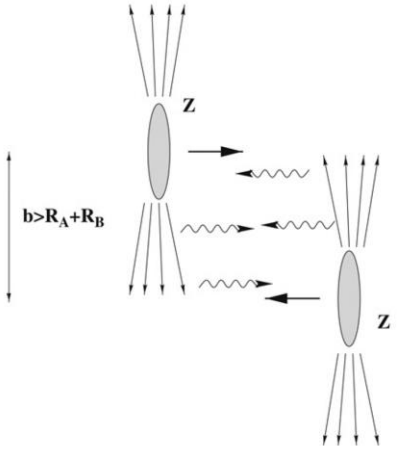
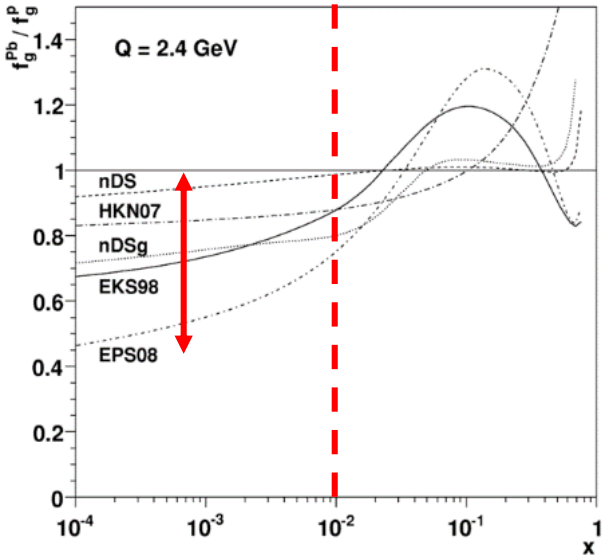
Introduction

- **Ultra-peripheral Collisions**
  - (the impact parameter b) > (sum of the radii R)
  - Due to their electric field, they exchange a photon.
  - A photon generated by one of these hadrons can interact with another photon, or with a parton inside hadron.



- **Photoproduction**
  - photo-nuclear interaction: exclusive vector meson production.
  - Occurs when a high energy photon interacts with partons of a hadron or with another photon.

- **Nuclear Shadowing**
  - The degree of gluon shadowing effects for $x < 0.01$ is poorly known.
  - Measurement in low x is crucial to constrain theoretical models and understand the CNM effects.
  - The data from UPCs have the potential to provide new constraints to nuclear PDFs.

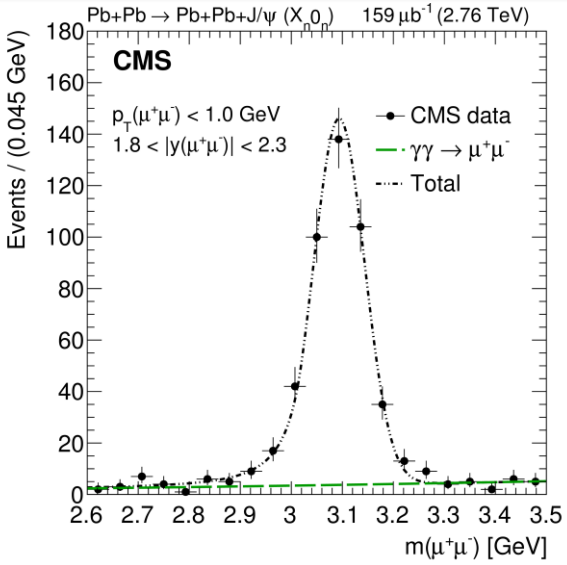


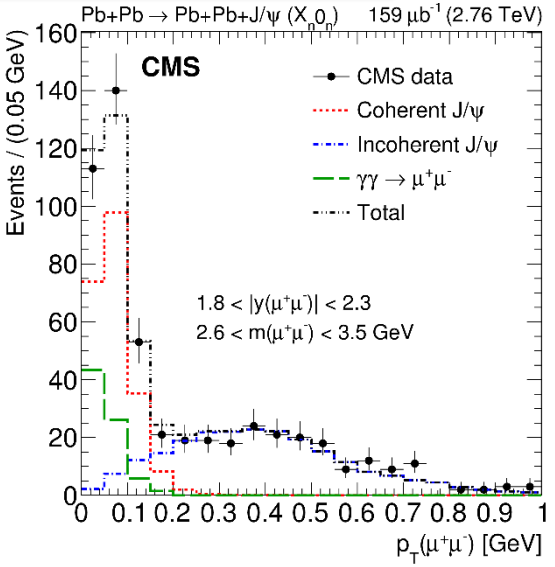
Introduction

- Two groups of the theoretical calculation which describe the nuclei
  - **Impulse approximation**
    - Neglects all nuclear effects(ex. Gluon density modification in the Pb nuclei)
  - **Leading twist approximation**
    - The theory includes the nuclear gluon shadowing

Pb-Pb Run1 J/ψ Measurement

- **Dimuon invariant mass & p_T distribution**
  - ❖ Coherent J/ψ
    - ➢ Photon couples to a whole nucleus
    - ➢ $p_T < 0.15$ GeV/c
  - ❖ Incoherent J/ψ
    - ➢ Photon couples to a single nucleon
    - ➢ 0.15 GeV/c $< p_T < 1.05$ GeV/c





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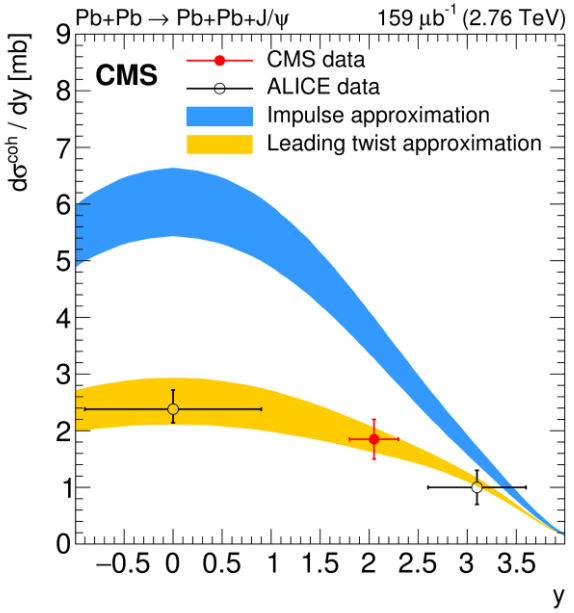
- **Differential cross section vs. rapidity for coherent J/ψ**
  - ➢ An **impulse approximation** model prediction is strongly disfavored.
  - ➢ The **leading twist approximation**, which includes nuclear gluon shadowing, is consistent with the data.



p-Pb Run1 ϒ Measurement

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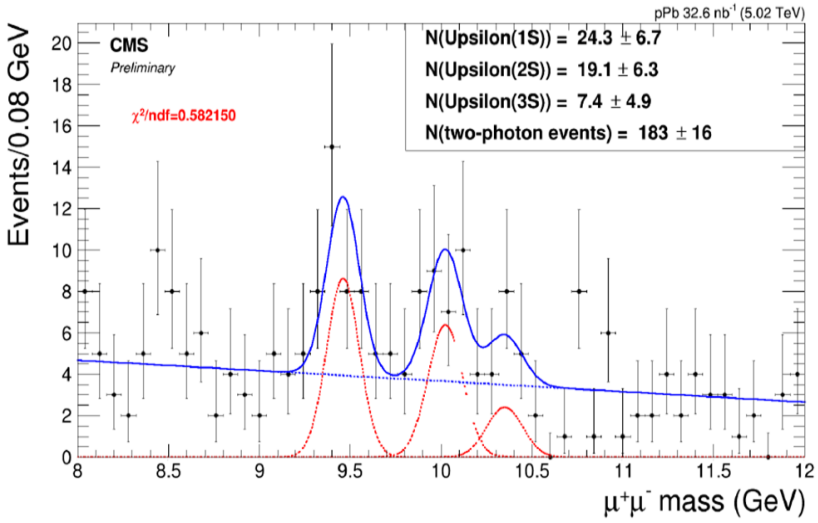
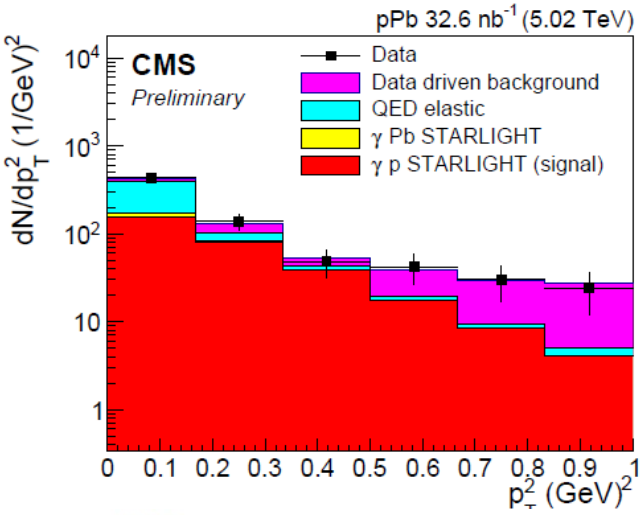
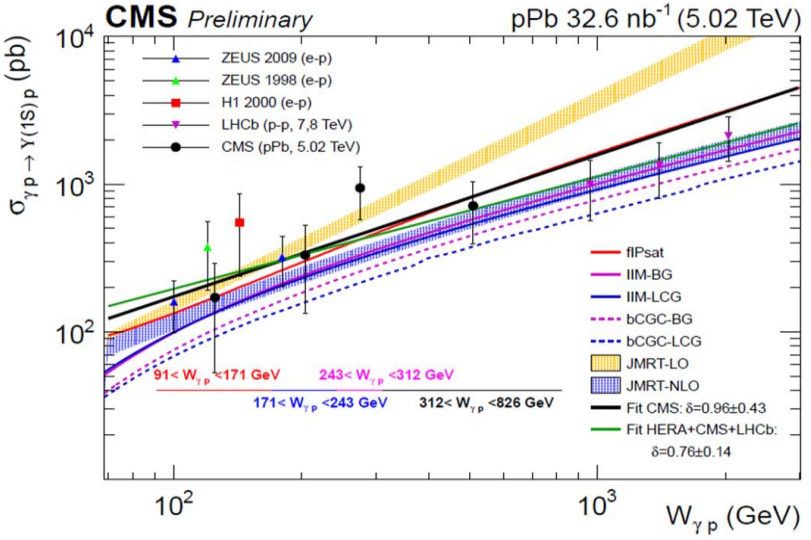
- **Dimuon invariant mass & p_T distribution**





- **Cross section vs. photon-proton center-of-mass energy for exclusive $\Upsilon(1S)$**
  - ➢ In agreement with earlier measurements
  - ➢ Consistent with predictions based on pQCD models.



Summary

- Pb-Pb Run1 J/ψ photoproduction result
  - Strong agreement with the leading twist approximation
- p-Pb Run1 Υ photoproduction result
  - Agree with earlier measurements
  - Consistent with pQCD models
- We expect the interesting result with Pb-Pb Run2 data.

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