J/ψ production at forward rapidities in ultra-peripheral collisions in ALICE

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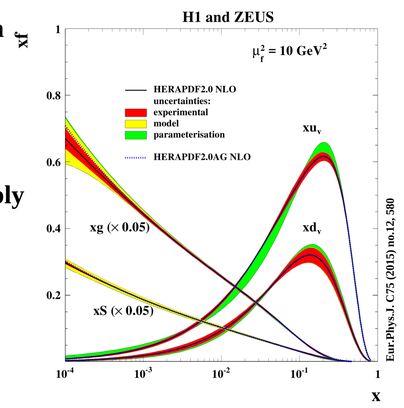
Proton and Nucleus Structure

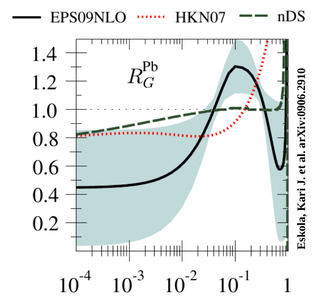
- The **structure of the proton** in DIS is described by the parton distribution functions $xf(x, Q^2)$
- At **low x** the **gluon** distribution function is **steeply rising** due to gluon splitting
- Eventually gluons will recombine and split at the same rate



Saturation

- Predicted by pQCD, but not yet conclusively observed
- **Nucleus structure**

$$R_{F_2}^A(x, Q^2) = \frac{F_2^A(x, Q^2)}{AF_2^{\text{nucleon}}(x, Q^2)} \neq 1$$



Nuclear shadowing

- At low x: $R_{F_2}^A(x, Q^2) < 1$
  - **Saturation** is expected to be one of the **contributions**
  - **Saturation** is expected to set in **at higher x in nuclei** w.r.t. nucleons

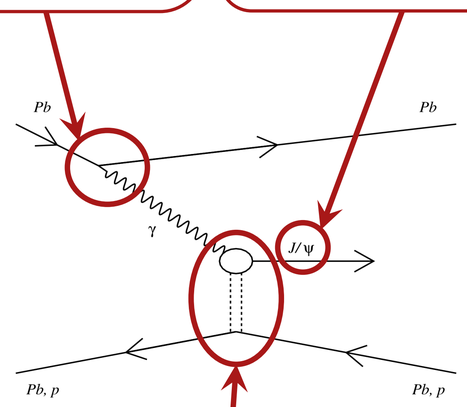
Coherent J/ψ Photoproduction

Photon emission

- Photon flux intensity
  - Proportional to Z^2
- Maximum photon energy
  - Given by the Pb ion Lorentz boost

J/ψ

- Vector meson
  - Quantum numbers of γ
- Perturbative calculations
  - Large mass
- Clear experimental signal
  - Large dimuon branching ratio
  - Small decay width



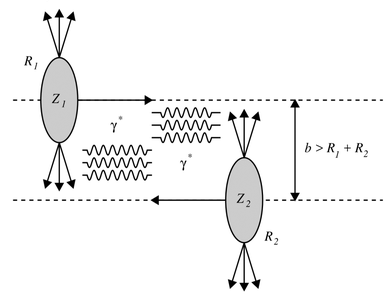
Photon target interaction

- In LO pQCD
  - Cross section ∝ **gluon density squared**[1]
- Vector dominance model
  - γ fluctuates into a J/ψ
- Colour dipole model
  - γ fluctuates into quark-antiquark dipole

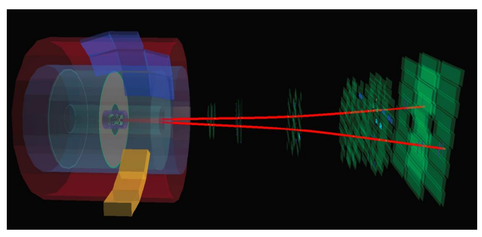
[1] M.G. Ryskin, Z.Phys. C57 (1993) 89-92

Ultra-Peripheral Collisions

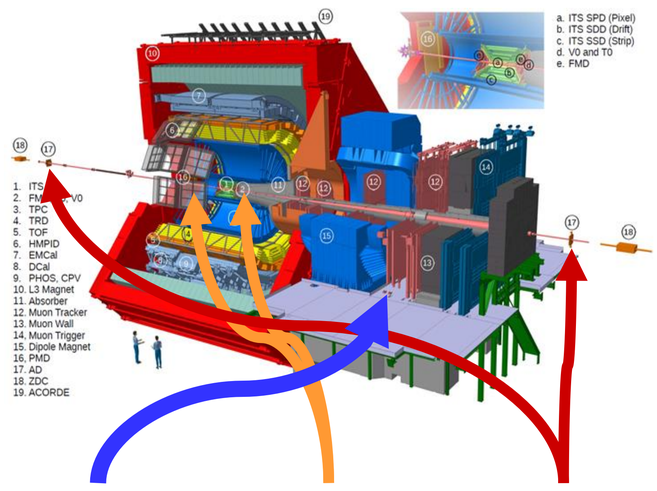
- Hadronic interactions are suppressed in **ultra-peripheral collisions (UPC)**



- This provides us with a clear J/ψ signal in the detector



ALICE Detector



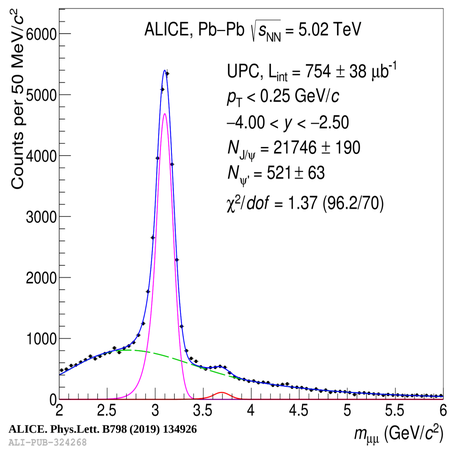
Muon Spectrometer
- Track reconstruction

V0 Scintillator
- Background suppression

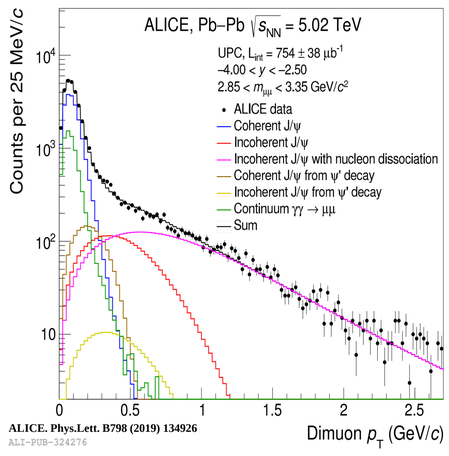
AD Scintillator
- Background suppression

Data Analysis

- **Mass distribution:** J/ψ yield and feed-down contribution from ψ'

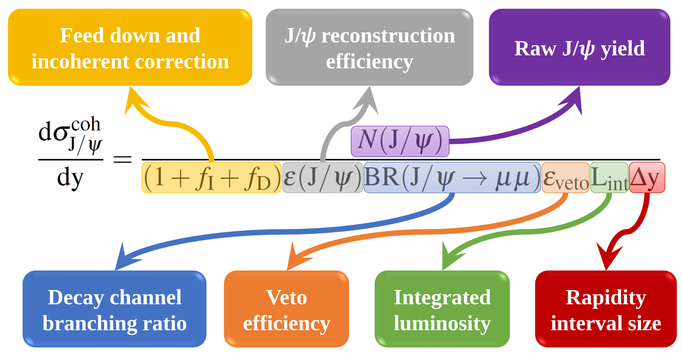


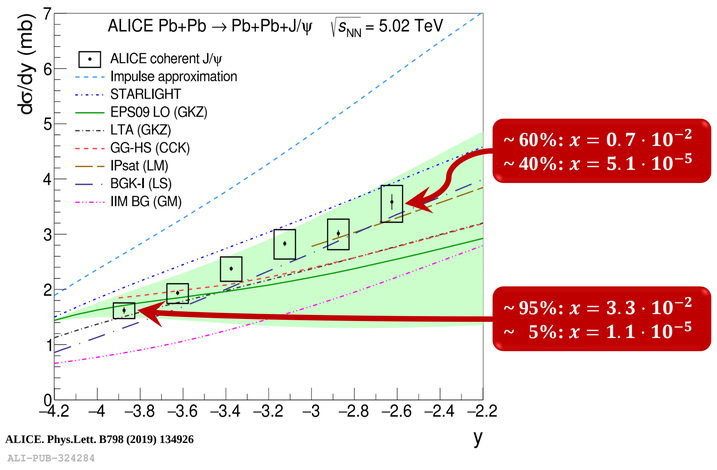
- **p_T spectrum:** incoherent J/ψ contribution



Results

- The rapidity differential coherent J/ψ photoproduction **cross section**

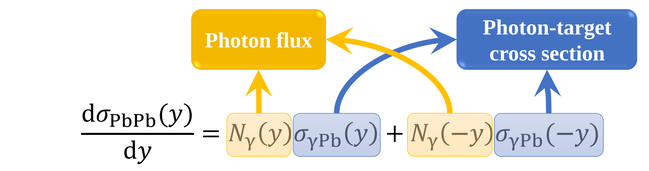


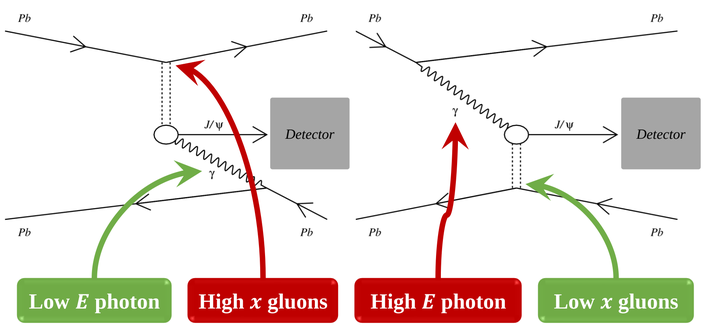


- Results show presence of **nuclear shadowing**
  - Impulse approximation (without nuclear effects) is rejected by data
- **Colour dipole** models with **saturation** describe the data best
  - IPsat (LM), BGK-I (LS)

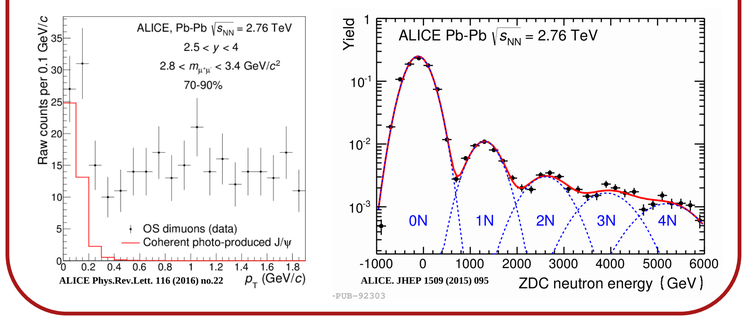
Outlook

- At forward rapidity
  - There are **two different contributions**
  - They **cannot be separated** with just one measurement





- **Possible solutions**
  - Forward neutron emission classes - measured with ZDC
  - Ultra-peripheral and peripheral collisions



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