



Coherent J/ψ photoproduction in ultra-peripheral Pb-Pb collisions with ALICE at the LHC

XII Latin American Symposium of High Energy Physics

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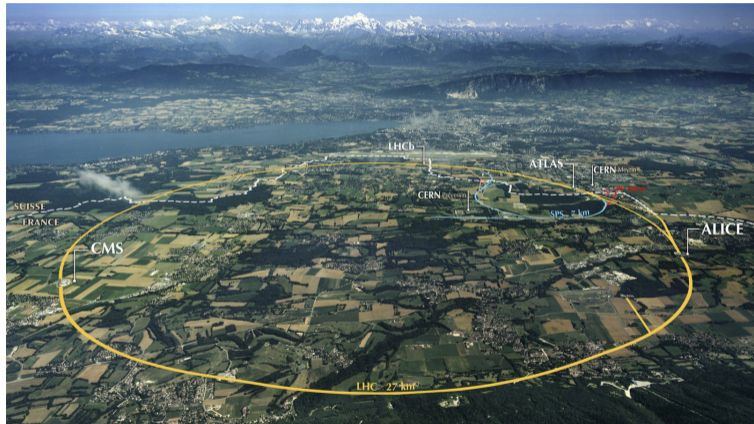
FNSPE CTU in Prague

Nov 27, 2018, Lima

Content



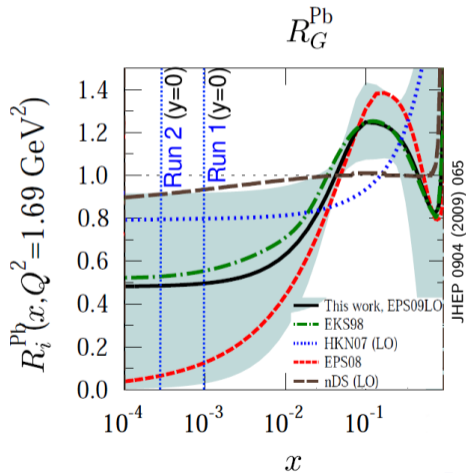
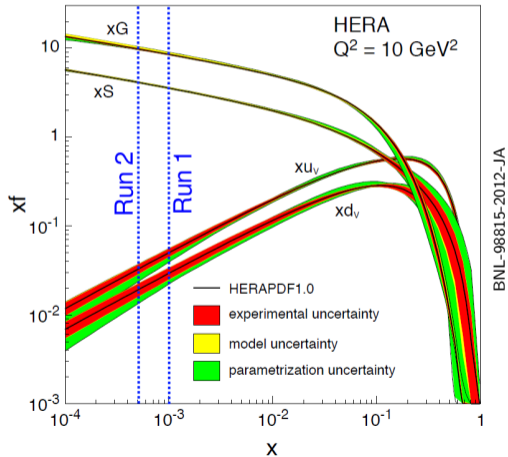
- 1 Motivation
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Motivation

Where QCD is now

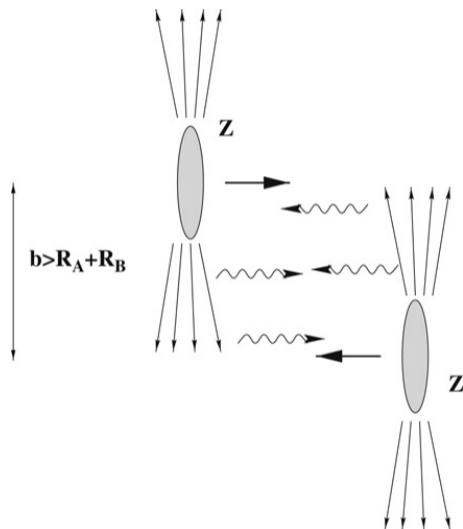
- Proton is mainly occupied by gluons for Bjorken $x < 10^{-2}$ (HERA).
- LHC gives the possibility to study the gluonic structure of **lead** nuclei at small Bjorken x .



Ultra-peripheral collisions

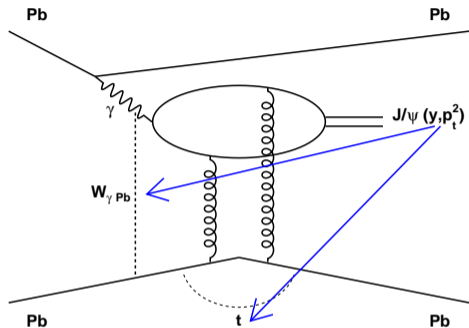
- Collisions with impact parameter $b > R_A + R_B$.
 - Hadronic interactions suppressed.
 - EM induced interactions remain.

- EM field of ultra-relativistic electrically charged particle \sim flux of photons.
 - Flux intensity increasing with Z^2 .



Phys.Rept. 458 (2008) 1-171

Tool to use light to study gluons



- Coherent J/ψ photoproduction.
 - Hard scale (pQCD test).
 - Large cross section.
 - Clean experimental signal.

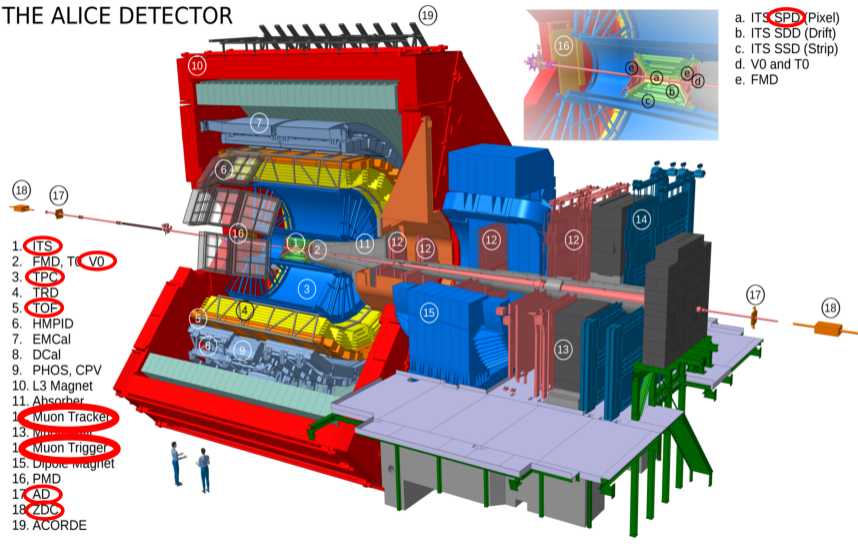
- Provides information on gluon shadowing in nuclei at low- x .

$$\left. \frac{d\sigma_{\gamma A \rightarrow J/\psi A}}{dt} \right|_{t=0} = \frac{M_{J/\psi}^3 \Gamma_{ee} \pi^3 \alpha_s^2(Q^2)}{48 \alpha_{em} Q^8} \left[x g_A(x, Q^2) \right]^2$$

Ryskin: Z. Phys. C 57, 89 (1993)

Experimental setup

THE ALICE DETECTOR



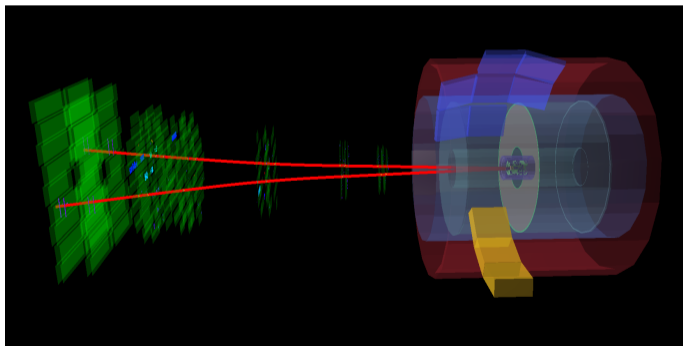
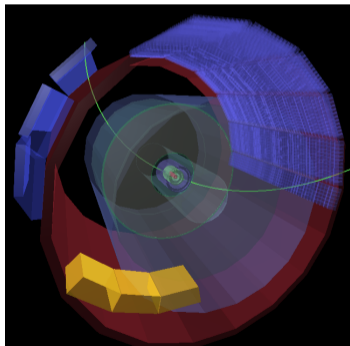
What we look for in a collision

- Central rapidity events:

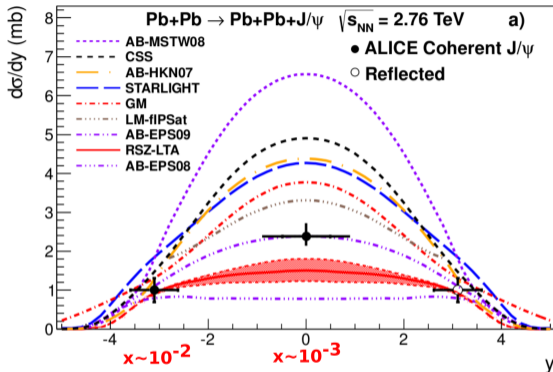
- VETOs in forward detectors,
- 2 back-to-back leptons (ITS/TPC/TOF).

- Forward rapidity events:

- VETOs in forward/central detectors,
- 2 muons (Muon chambers).

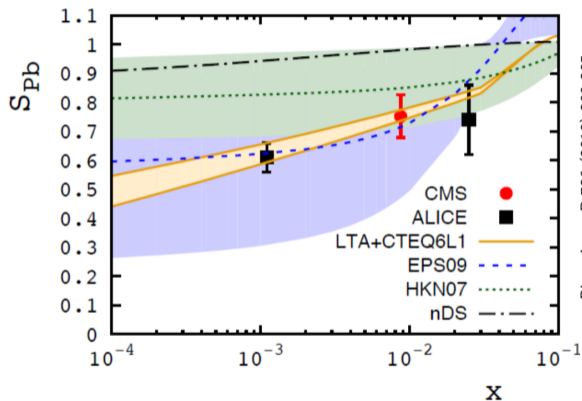


Results overview



Eur.Phys.J. C73 (2013) no.11, 2617
Phys.Lett. B718 (2013) 1273

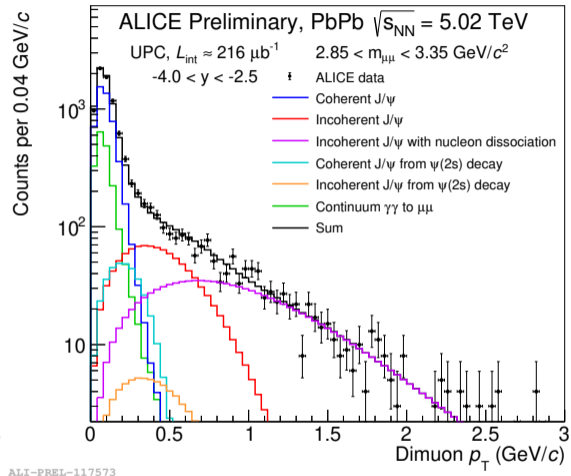
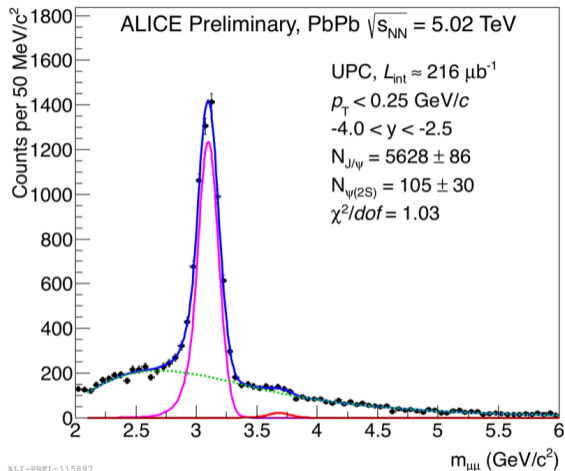
- Coherent J/ ψ cross sections were measured in the forward and the central rapidity region.
- Large spread of predictions before the measurement.
- Disfavour no and strong nuclear shadowing models.



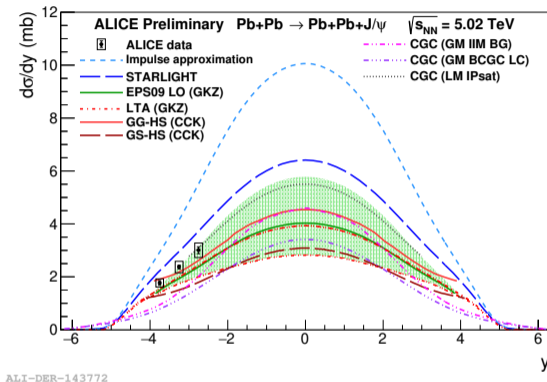
$$S_{Pb}(W_{\gamma p}) = \left[\frac{\sigma_{\gamma Pb \rightarrow J/\psi Pb}^{\text{exp}}(W_{\gamma p})}{\sigma_{\gamma p \rightarrow J/\psi p}^{\text{IA}}(W_{\gamma p})} \right]^{1/2}$$

$$x = \frac{M_{J/\psi}^2}{W_{\gamma p}^2}$$

- Based on experimental inputs.
- Pb-Pb UPC experimental cross section.
- Impulse approximation (γ -p data).
- Good agreement with EPS09 and LTA.



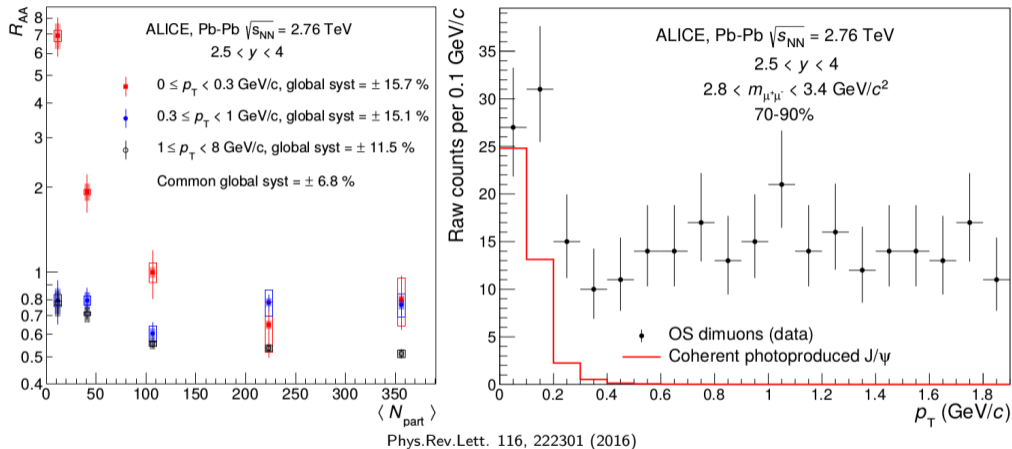
■ Clear J/ψ signal, p_T spectrum is well understood.



- New measurements at higher energies with higher luminosity are underway.
- These will tell us more about the gluon content of nuclei and its Bjorken- x evolution.

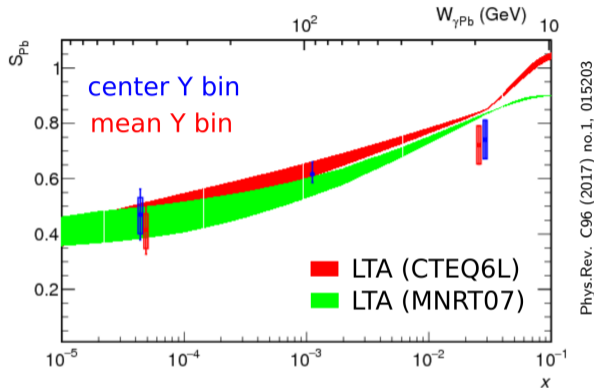
Surprise

Excess in peripheral events

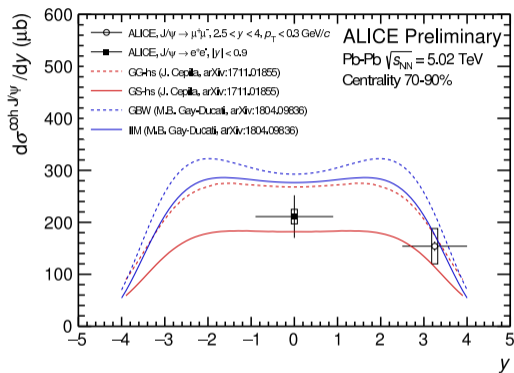


- J/ ψ excess at low- p_T in peripheral collisions, first visible in Run 1.
- Interpreted as coherent J/ ψ photoproduction.

What we have learnt - Nuclear gluon shadowing in Lead



- Two contributions at forward rapidity: low and high- x .
- This measurement and the UPC one allow us to study $g_A(x, Q^2)$ in lead down to $\sim 5x^{-5}$.



ALI-PREL-309948

- New data at higher energies.
- Preliminary cross sections at mid and forward rapidities.
- Run 2 UPC and peripheral data will allow us to put constraints on pQCD models.

- 2015 Pb-Pb collisions:
 - Working to finalise the UPC and peripheral analyses.
- November 2018 new Pb-Pb collisions:
 - Higher interaction rate → even more statistics.
 - Better triggers.
- LHC Run 3 and Run 4:
 - Higher luminosity (up to 13 nb^{-1} in comparison to that expected in Run 2 $\sim 1 \text{ nb}^{-1}$).
 - ALICE will read out data continuously.
 - No triggering → better efficiency.

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More interesting data are coming - stay tuned!

BACK UP

Preliminary invariant mass of Run 2 - central

