Recent ALICE results on photoproduction in ultra-peripheral collisions at the LHC

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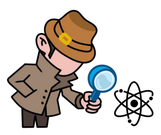
Proton and Nucleus structure

- Gluon **saturation** predicted at **low *x***!



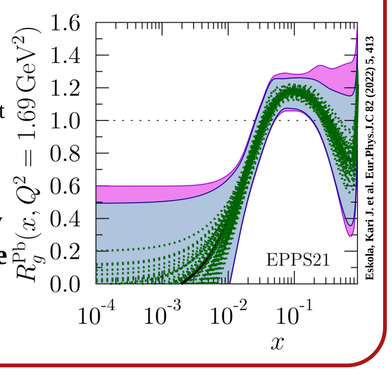
- New measurements are needed

- **Shadowing at low *x*** → **large uncertainty** on the scale

$$R_g^{Pb}(x,Q^2) = \frac{g_{Pb}(x,Q^2)}{A g_p(x,Q^2)} < 1$$

- **Saturation** is expected to appear at **larger *x* in Pb** than in protons

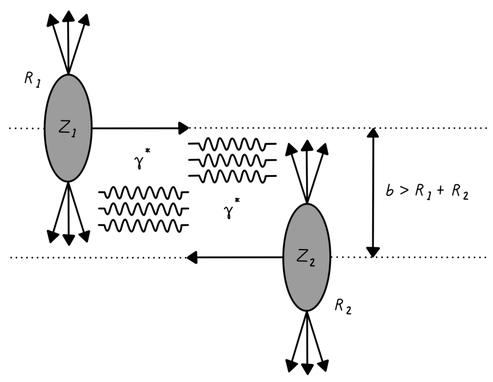
Are the *x* values probed by ALICE sufficiently low to be described by the saturation approach?



Ultra-Peripheral Collisions

- Hadronic interactions are suppressed

→ **Photon-induced reactions can be measured at the LHC!**



- Abundant diffractive photoproduction of **vector mesons**
- Decay into two charged particles → **clean experimental signature**

Photoproduction

- LHC is a **Light-Hadron Collider** at the highest available energies
- **Bjorken-*x*** evolution of the parton distribution

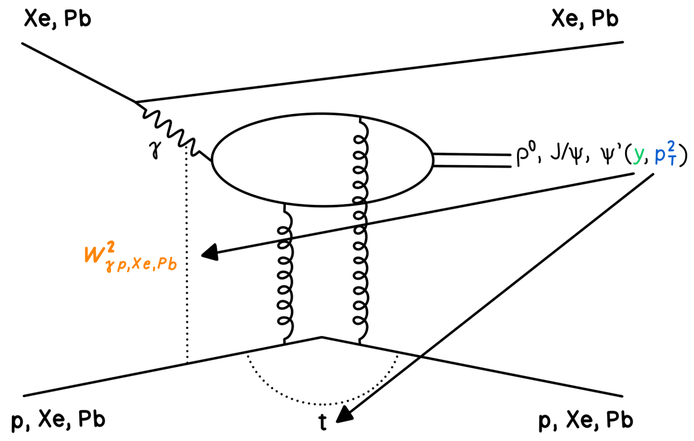
→ $x = \frac{M_{VM}}{\sqrt{s_{NN}}} e^{\pm y}$

- Centre-of-mass **energy** of the photon–target system

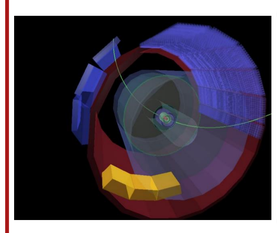
→ $W^2_{\gamma p,Xe,Pb} = 2E_{p,Xe,Pb} M_{VM} e^{\mp y}$

- **Transverse**-plane distribution of the partons

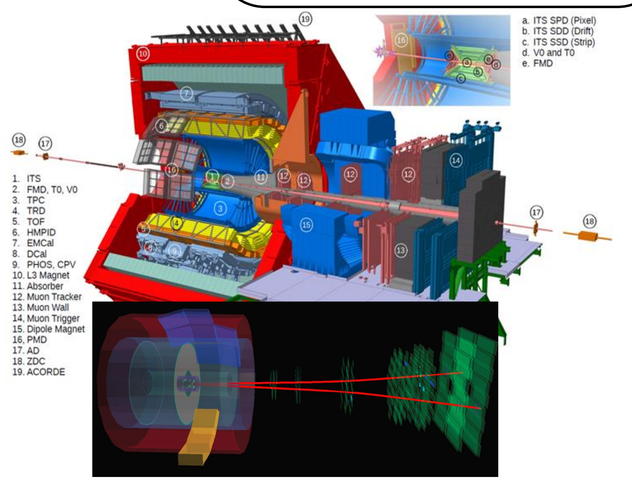
→ **2D Fourier** transform to the $|t|$ ($\sim p_T^2$) **dependence**



ALICE detector in Run 2



- **Inner Tracking System (ITS)**
  - Silicon detector
  - Triggering and tracking
- **Time Projection Chamber (TPC)**
  - Drift volume with multiwire proportional chambers end caps
  - Tracking and particle identification
- **Time-of-Flight (TOF)**
  - Multigap resistive plate chambers
  - Triggering and particle identification



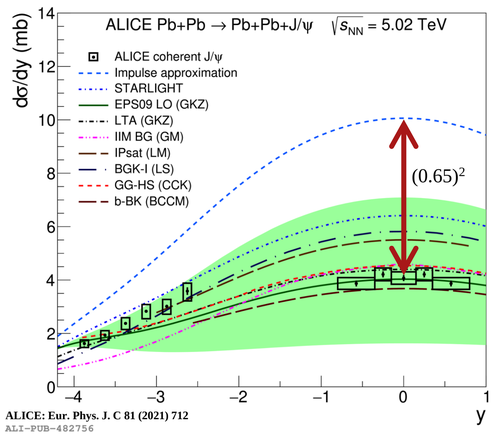
- **V0, AD**
  - Scintillator counter
  - Veto activity
  - Time resolution well below 1 ns
  - Large rapidity coverage close to the beam
- **Muon Tracker**
  - Cathode pad chambers
  - Tracking
- **Muon Trigger**
  - Resistive plate chambers
  - Triggering

Coherent J/ψ: y - dependence

- **Nuclear suppression factor:** for $x \in (0.3,1.4)\cdot 10^{-3}$

$$S_{Pb} = \sqrt{\left(\frac{d\sigma}{dy}\right)_{data} \Big/ \left(\frac{d\sigma}{dy}\right)_{IA}} = 0.65 \pm 0.03$$

- Models with **shadowing** (EPS09, LTA) and **saturation** (GG-HS):
  - Describe central and forward data
  - Underestimate semi-forward data
- Other models describe either the central or the forward rapidity region



Coherent J/ψ: $|t|$ - dependence

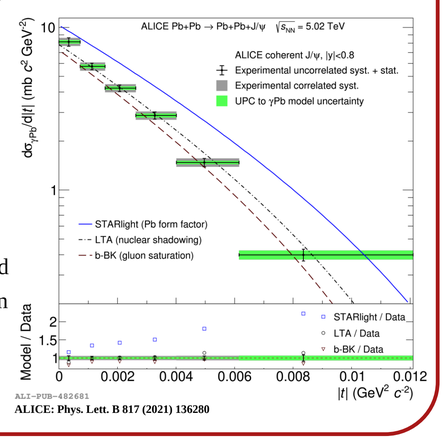
- Measurement down to **very low $|t|$** approaching **HERA-like precision!**
- Models including **shadowing** or gluon **saturation**

→ **Agree with data!**

- Model **without dynamical pQCD** effects

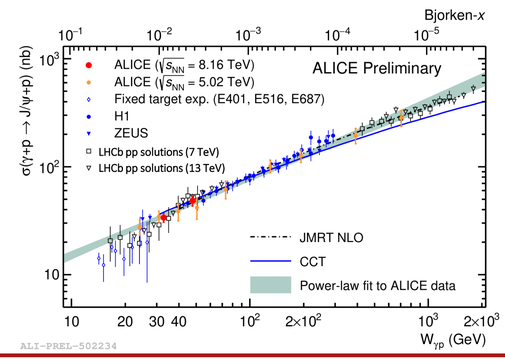
→ **Does not agree!**

- Future measurements should allow to distinguish between the predictions



Exclusive J/ψ cross section

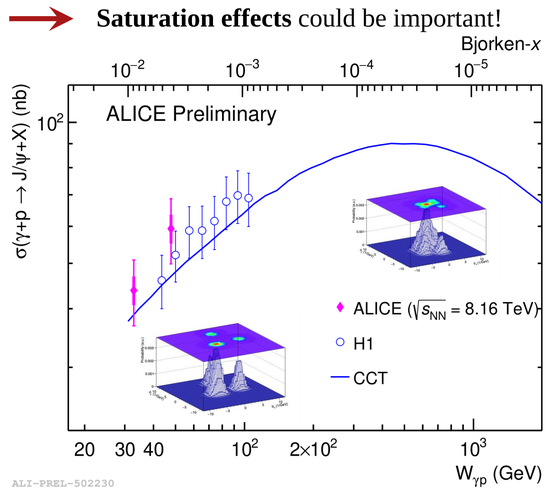
- Process **sensitive** to the square of the **gluon distribution**
- **ALICE** data covers **three orders of magnitude in *x***
- Data from **LHC** and **HERA** show the **same behaviour**
  - Models with or without saturation describe data



Dissociative J/ψ cross section

- **First measurement of the dissociative cross section at the LHC!**
- Agreement with H1 results
- Future LHC data → measurement up to the **1 TeV**

→ **Saturation effects** could be important!



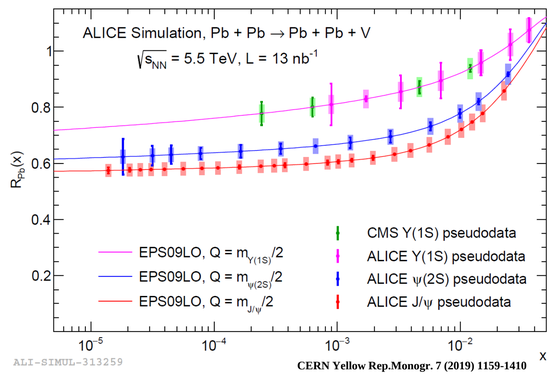
Outlook

- **$\mathcal{L}$ increase** - 1 nb^{-1} (Run 2) → 13 nb^{-1} (Runs 3+4)
- **Continuous readout** → higher data collection efficiency
- Significant **detector upgrades**
- Proposed **O-O run** → new system size

→ **Many more collisions to be recorded by ALICE!**

	PbPb					
Meson	σ	All Total	Central 1 Total	Central 2 Total	Forward 1 Total 1	Forward 2 Total
$\rho \to \pi^+\pi^-$	5.2b	68 B	5.5 B	21B	4.9 B	13 B
$\rho' \to \pi^+\pi^-\pi^+\pi^-$	730 mb	9.5 B	210 M	2.5 B	190 M	1.2 B
$\phi \to K^+K^-$	0.22b	2.9 B	82 M	490 M	15 M	330 M
J/$\psi \to \mu^+\mu^-$	1.0 mb	14 M	1.1 M	5.7 M	600 K	1.6 M
$\psi(2S) \to \mu^+\mu^-$	30μb	400 K	35 K	180 K	19 K	47 K
$\Upsilon(1S) \to \mu^+\mu^-$	2.0 μb	26 K	2.8 K	14 K	880	2.0 K

- **More differential** measurements:
  - $\frac{d^2\sigma}{dy\,d|t|}$, Angular dependences between l^+l^-, Coherent ρ^0 evolution with A in O-O …
- **New** measurements:
  - $\Upsilon(1S)$ - Q^2 factor 10 larger than J/ψ, Interference effects, Incoherent ρ^0 production …



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