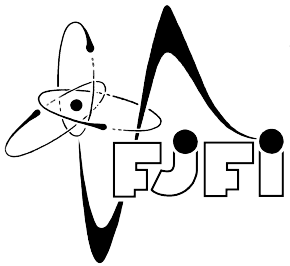
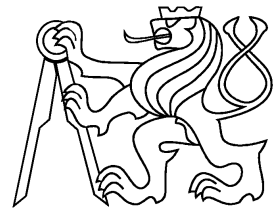




FNSPE CTU in Prague

Ultra-peripheral collisions at ALICE

Heraeus Physics School

Roman Lavička

Sep 25, 2017, Bad Honnef

Supervisor: Guillermo Contreras

Content

1 Introduction

2 Overview

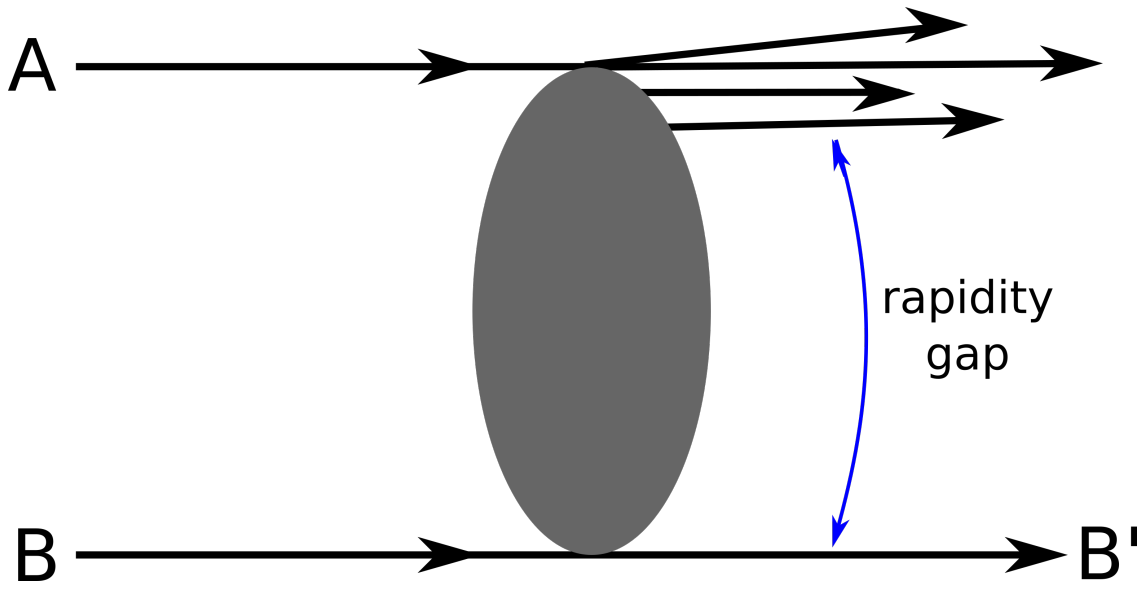
3 Ultra-peripheral collisions at ALICE

4 Measurement

5 Summary

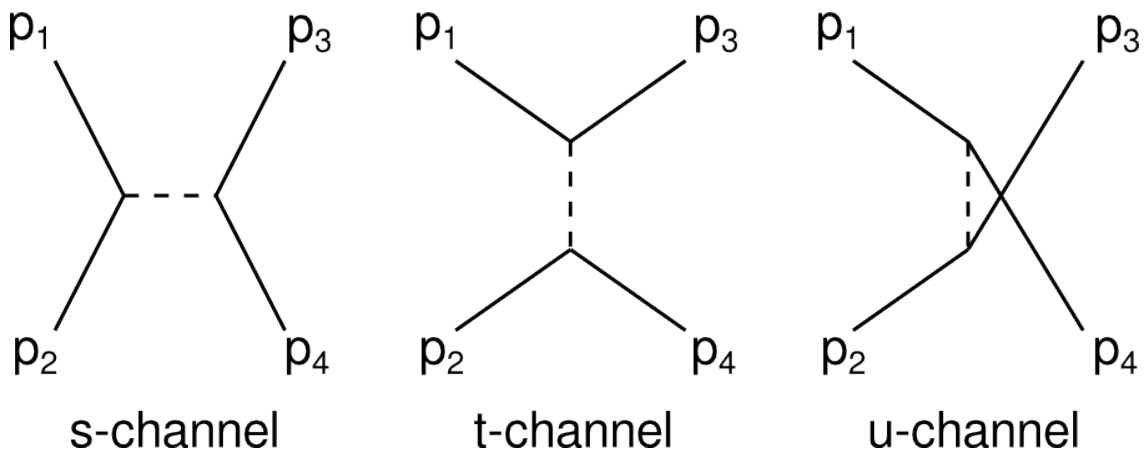
Introduction

Diffractive physics - definition



- No quantum number exchange.
- High energy.
- Rapidity gap.

Diffractive physics - kinematics



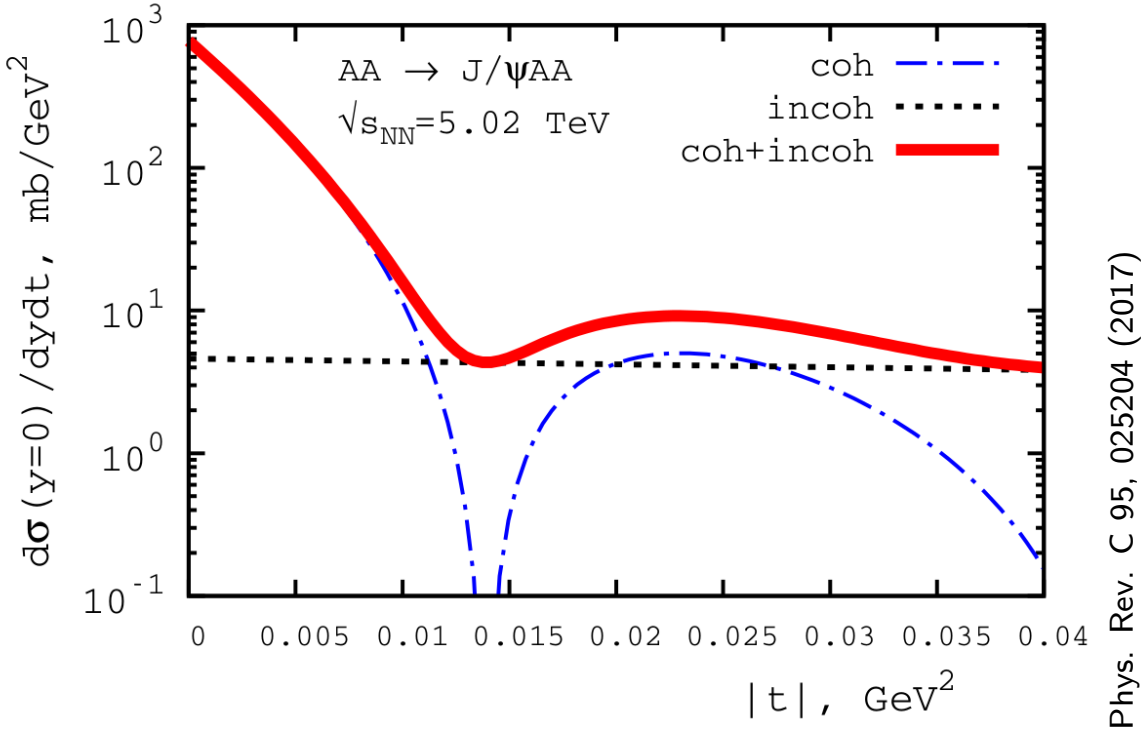
- t - transferred momentum (Mandentelstam variable).

$$t = (p_1 - p_3)^2 = (p_2 - p_4)^2$$

- y - rapidity.

$$y = \frac{1}{2} \ln \frac{E + p_z}{E - p_z}$$

Diffractive physics - what can be studied



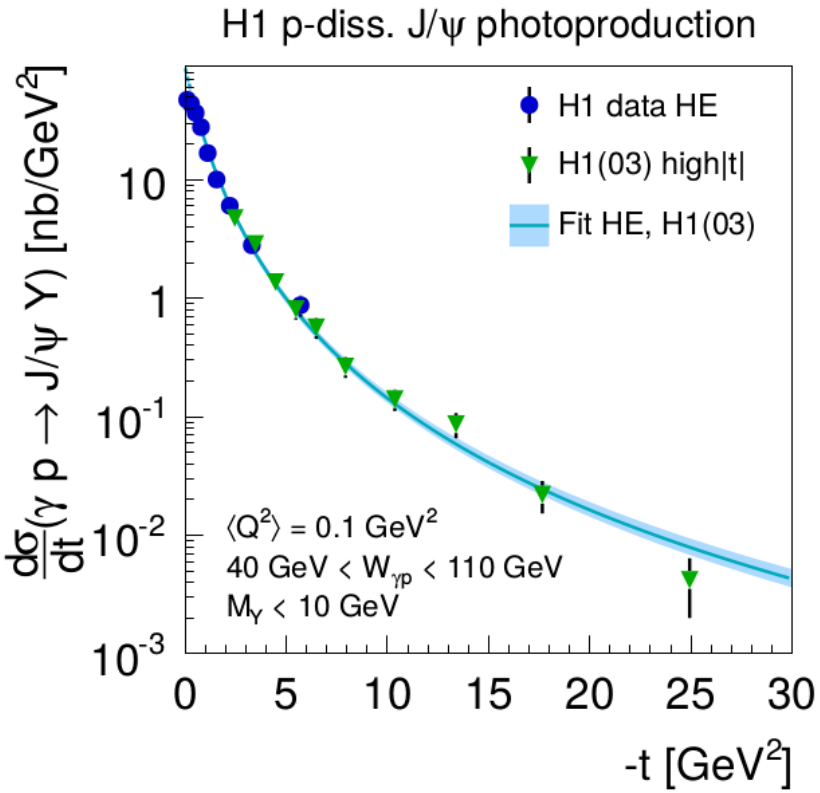
Phys. Rev. C 95, 025204 (2017)

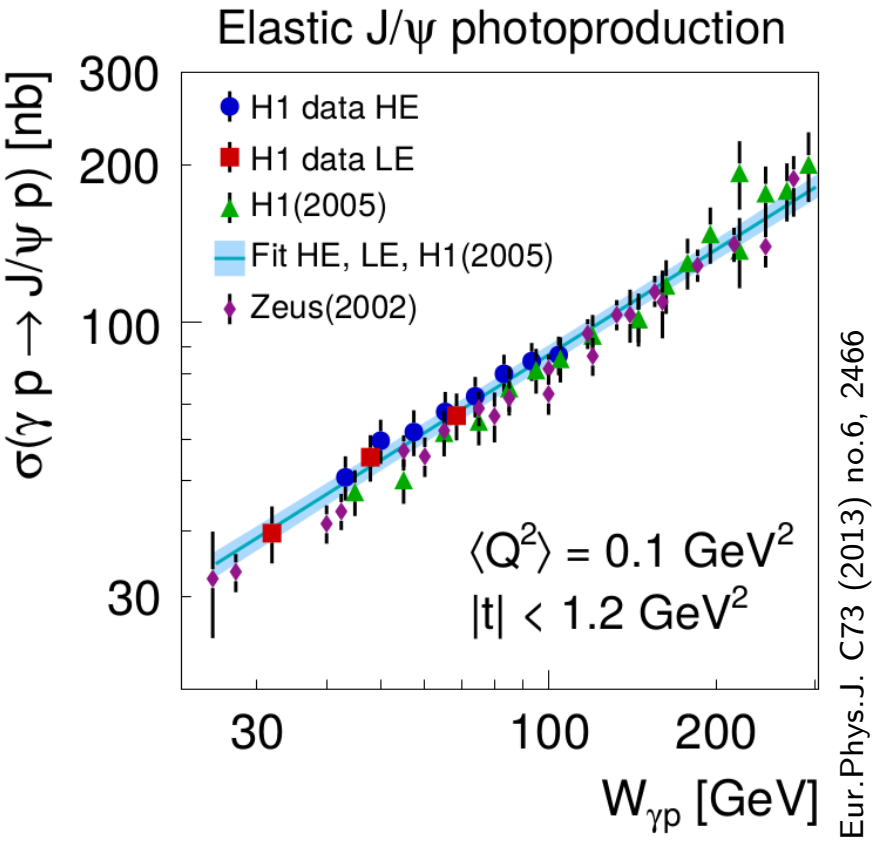
- Nuclear shadowing effects, gluon saturation, distribution functions...
- Cross section t-dependence.

$$\frac{\mathrm{d}\sigma}{\mathrm{d}t} = \left.\frac{\mathrm{d}\sigma}{\mathrm{d}t}\right|_{t=0} |F(t)|^2$$

Results overview

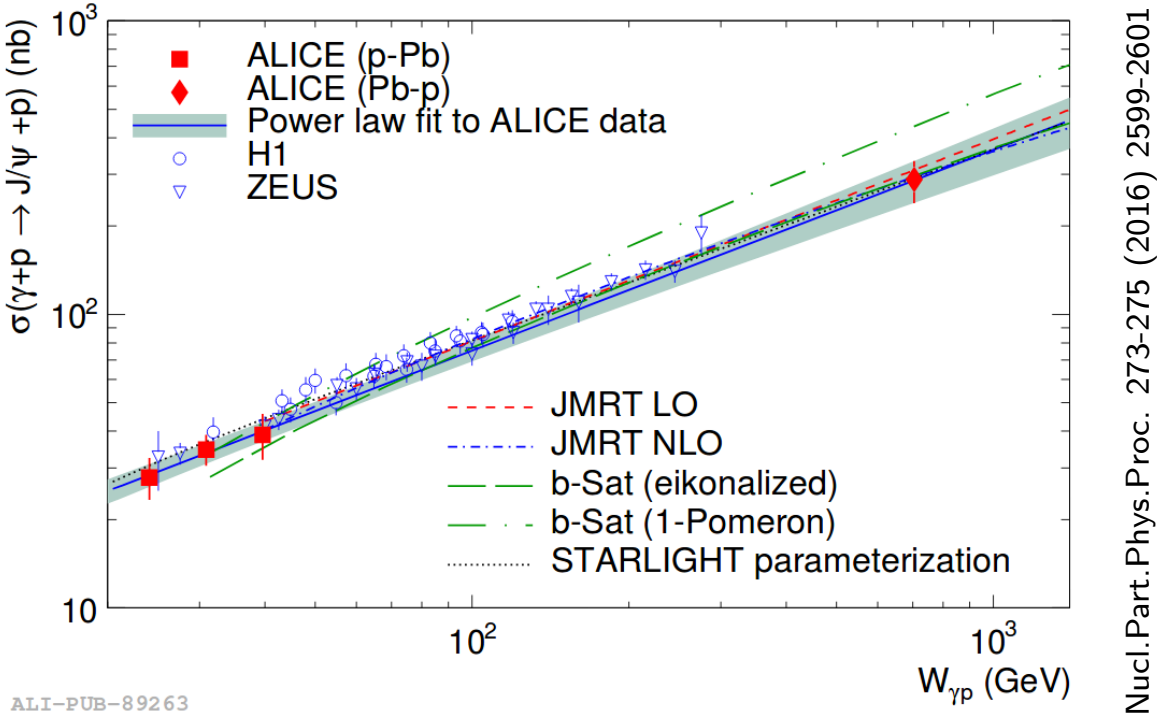
Published results - ep collisions at HERA





- High precision data covering a large part of the phase space is available from HERA.

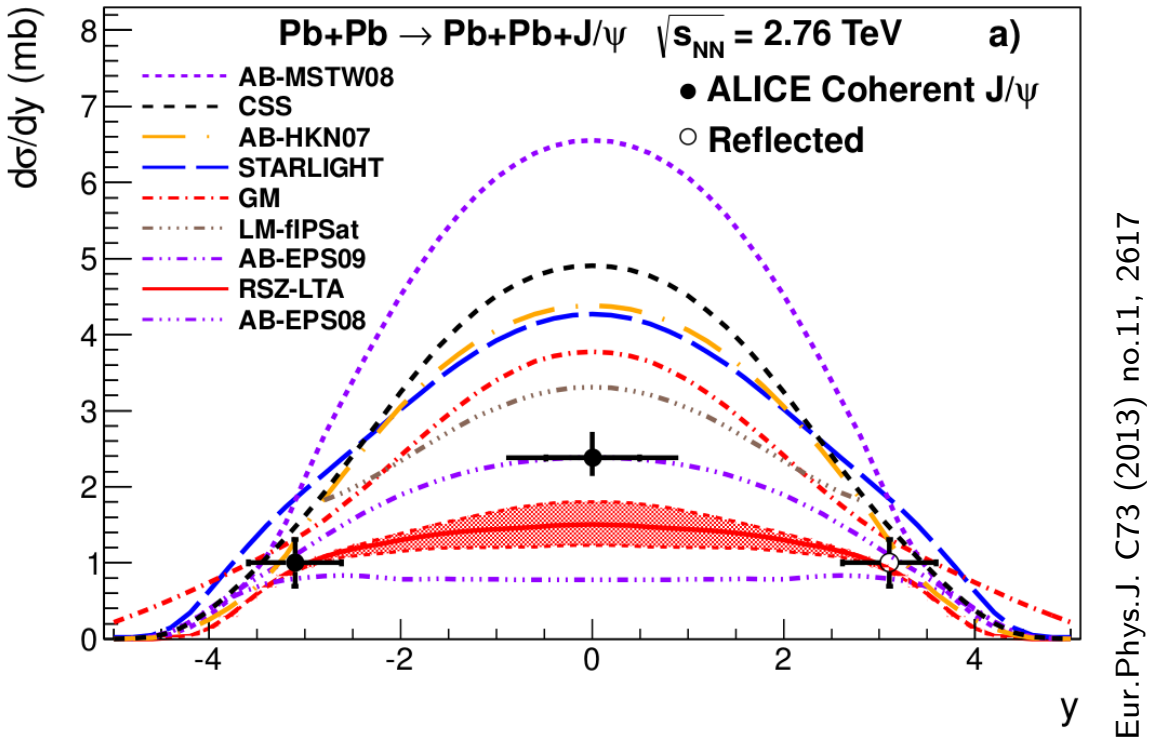
Published results - p-Pb/Pb-p collisions at ALICE



Nucl.Part.Phys.Proc. 273-275 (2016) 2599-2601

- Consistency with HERA results and its extention by factor of 2.
- Recent collisions at higher energies will allow to reach over 1 TeV.

Published results - Pb-Pb collisions at ALICE

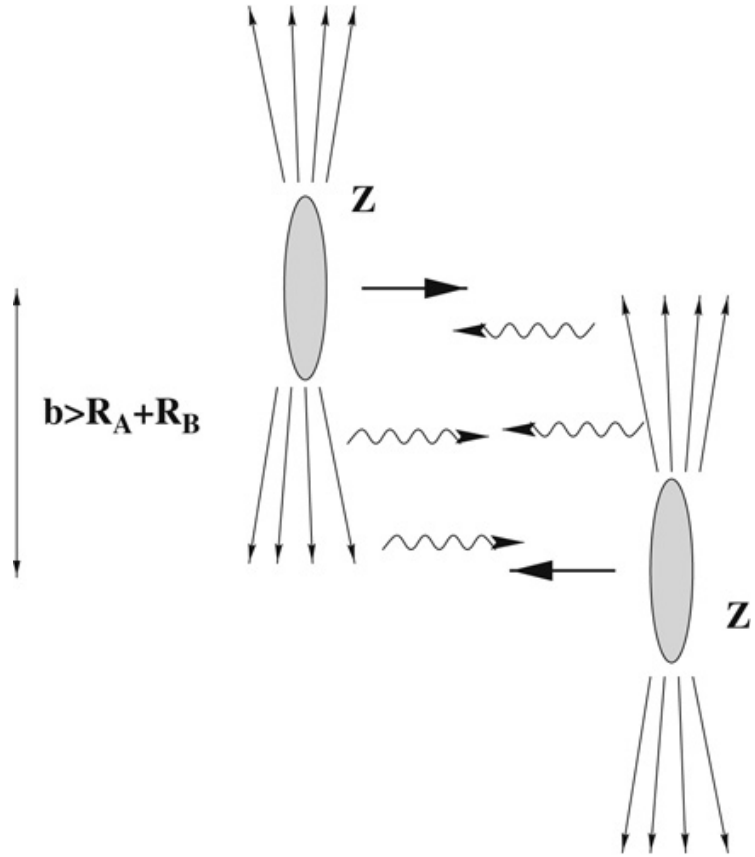


- Forward and central rapidity region.
- Large difference between of measurement and no nuclear shadowing models.

Ultra-peripheral collisions at ALICE

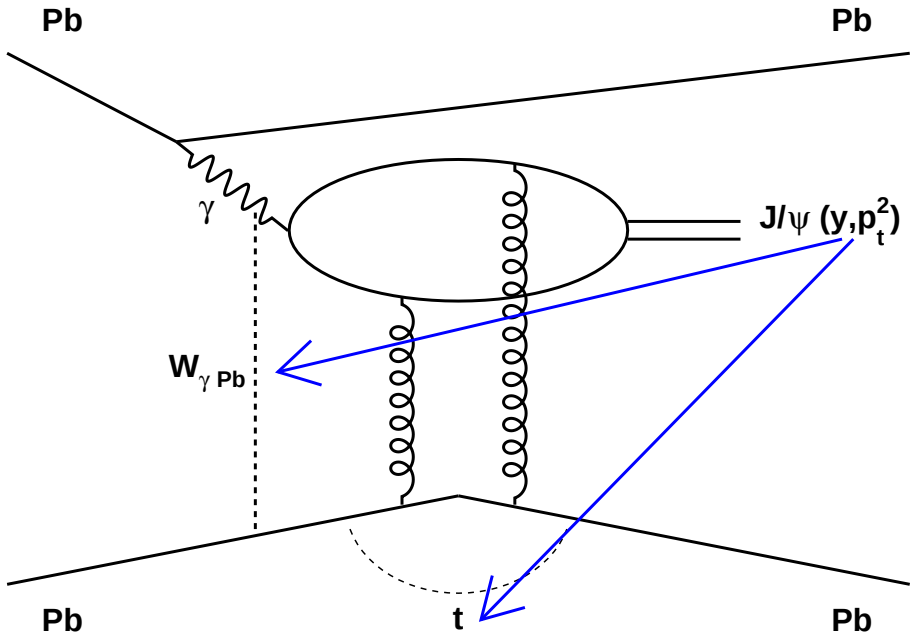
Ultra-peripheral collisions

- Collisions with impact parameter $b > R_A + R_B$.
  - Strong interaction suppressed.
  - EM interaction remains.
- EM field of ultra-relativistic electrically charged particle $\sim$ flux of photons.
  - Interaction intensity increasing with Z^2.



Phys.Rept. 458 (2008) 1-171

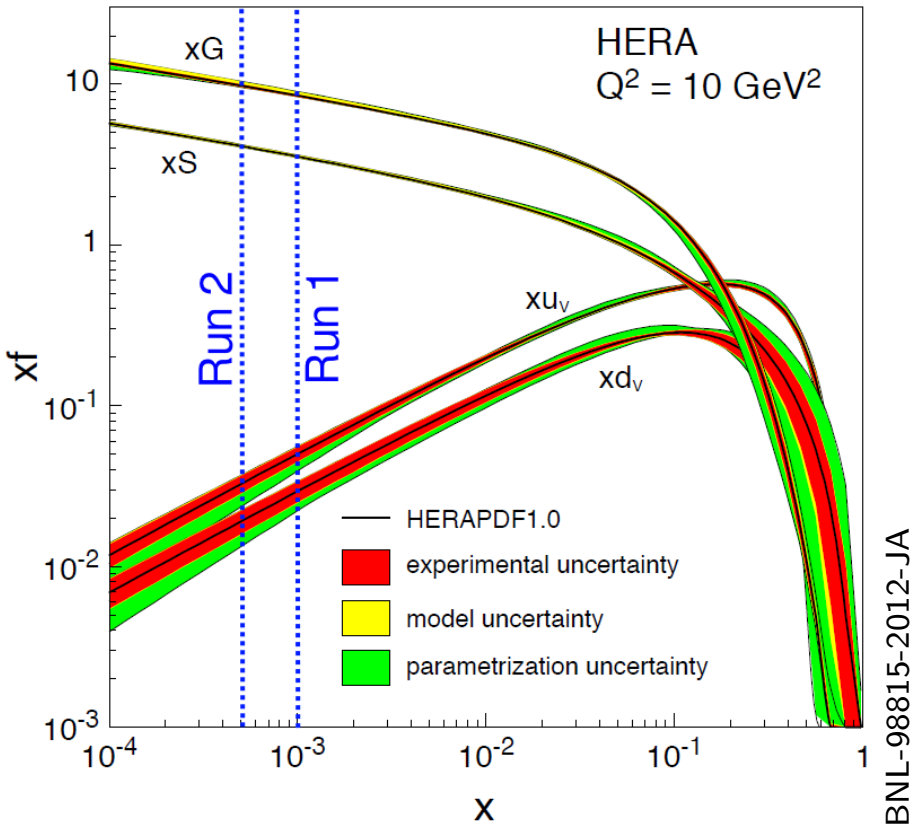
Tool to use light to study gluons

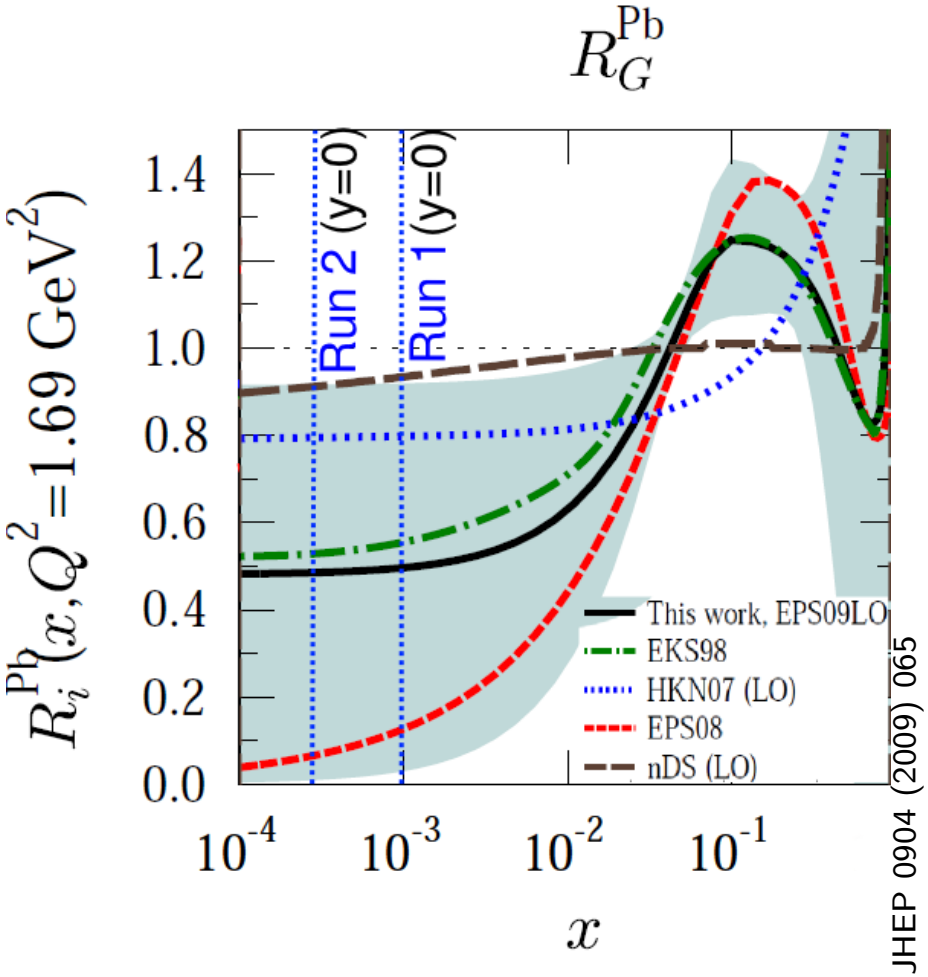


- Coherent photoproduction of J/ψ.
- Probe to QCD.

Where is QCD now

- Proton is mainly gluons at Bjorken $x \sim 10^{-3}$ (HERA).
- LHC provides possibility to study lead nuclei at small Bjorken x.



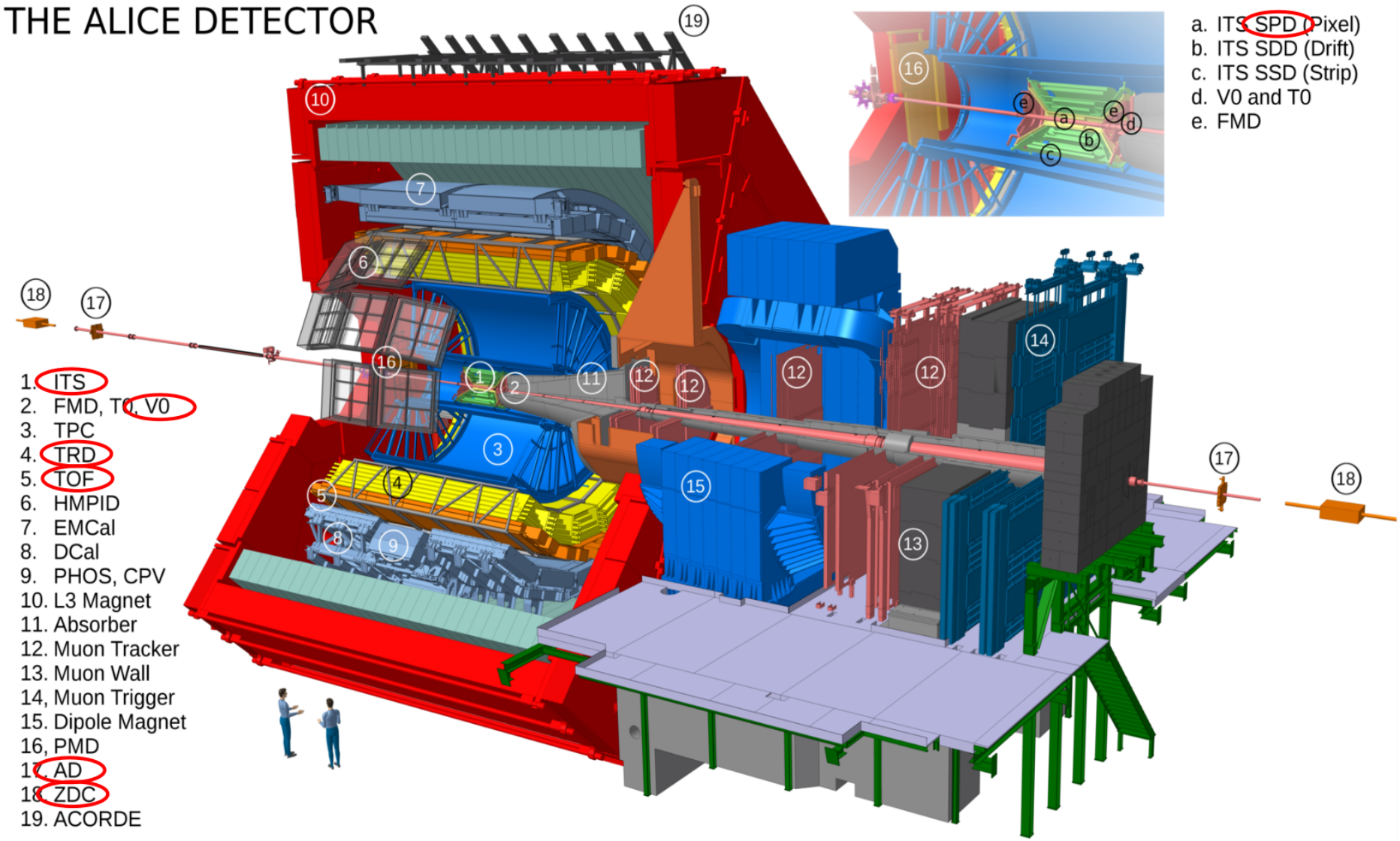


What we are going to study

- Coherent production of J/ψ in Pb-Pb UPC at mid rapidity at ALICE.
  - Run 1: $x \sim 10^{-3}$; Run 2: $x \sim 0.5 \cdot 10^{-3}$.
- t-Dependence of the cross section.
- Sensitive to the gluon distribution of the target in the impact parameter plane.

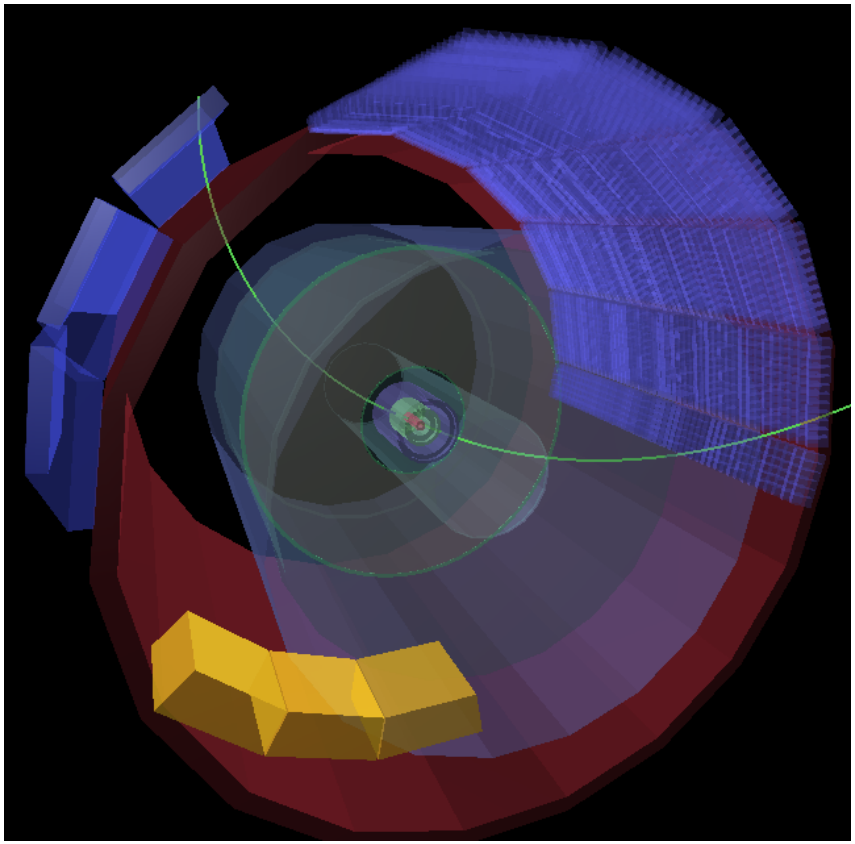
Measurement
Experiment

ALICE detector



What we look for in a collision

- Events with exactly two reconstructed tracks:
  - these are leptons,
  - these are back-to-back (TOF/ITS).
- VETO:
  - nothing in forward regions (V0, AD),
  - no more than 6 hits in SPD (inner layers of ITS).



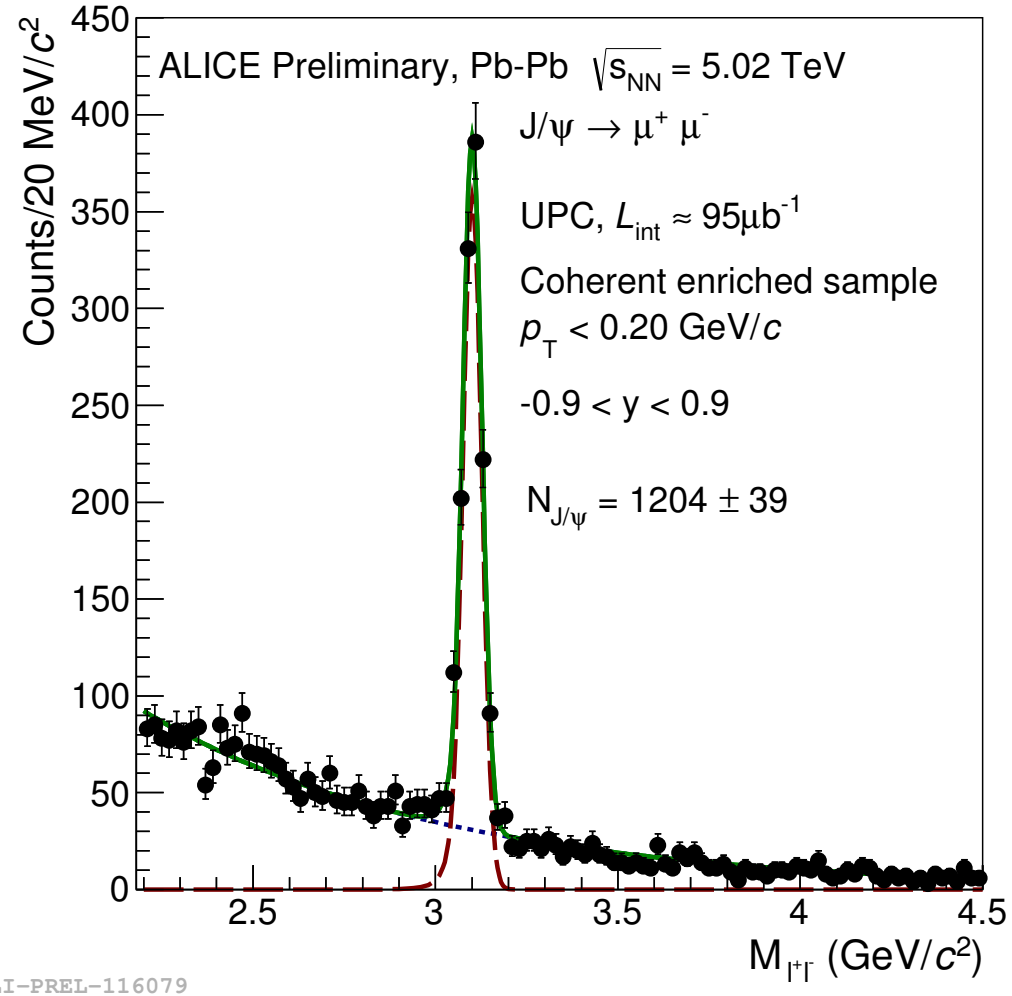
Measurement
Analysis

Measurement - theory

$$\frac{\partial^2 \sigma^{\text{coh}}_{J/\psi}}{\partial y \partial t} = \frac{N^{\text{coh}}_{J/\psi}}{(\text{Acc} \times \epsilon)^{\text{coh}}_{J/\psi} \cdot BR(J/\psi \to l^+ l^-) \cdot \mathscr{L}_{int} \cdot \Delta t \cdot \Delta y},$$

- $N^{\text{coh}}_{J/\psi}$ - number of coherently produced J/ψ
- $(\text{Acc} \times \epsilon)^{\text{coh}}_{J/\psi}$ - correction on detector effects
- $BR(J/\psi \to l^+ l^-)$ - branching ratio
- $\mathscr{L}_{int}$ - integrated luminosity of UPC triggers
- Δt - bin size
- Δy - rapidity region

Yield of coherently produced J/ψ



- Crystal Ball function fit.
- Additional corrections on other processes generating J/ψ.

Work in progress

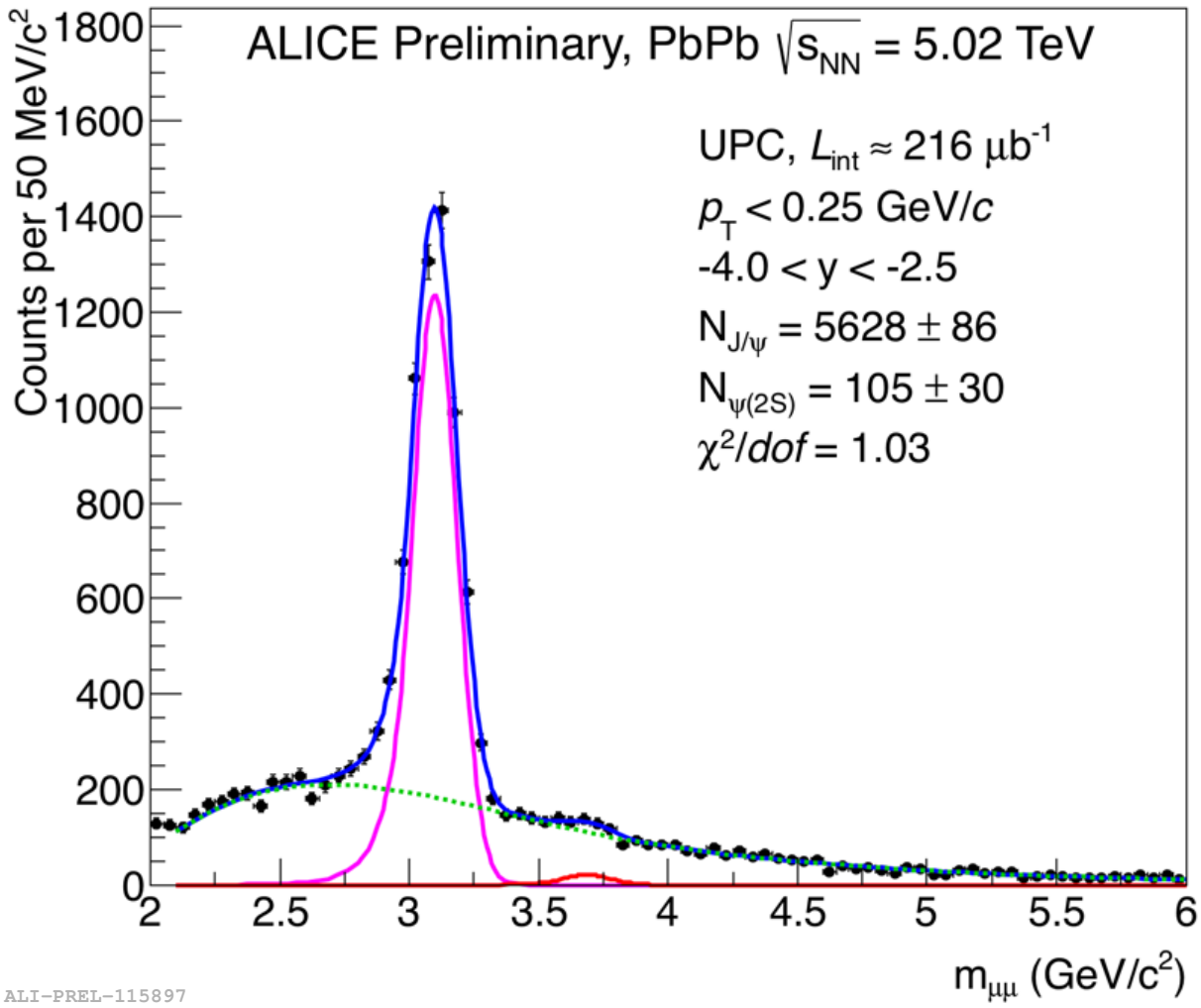
- Evaluating unfolding of the t-spectrum using different methods.
  - Regularization method (TUnfold).
  - Bayes method (D'Agostiny).
  - Singular Value Decomposition (RooUnfold).
- Evaluating with data the trigger efficiencies.
- Evaluation systematic uncertanities.

Summary

- ALICE can study the QCD evolution in x-Bjorken of the gluon distribution in Pb for scales of the order of the charm mass using J/ψ coherent photonuclear production.
- Studying the t-dependence of this process, we can study the transverse distribution of gluons in Pb at small x.
- This is work in progress and we are planning to have final results in a few months.

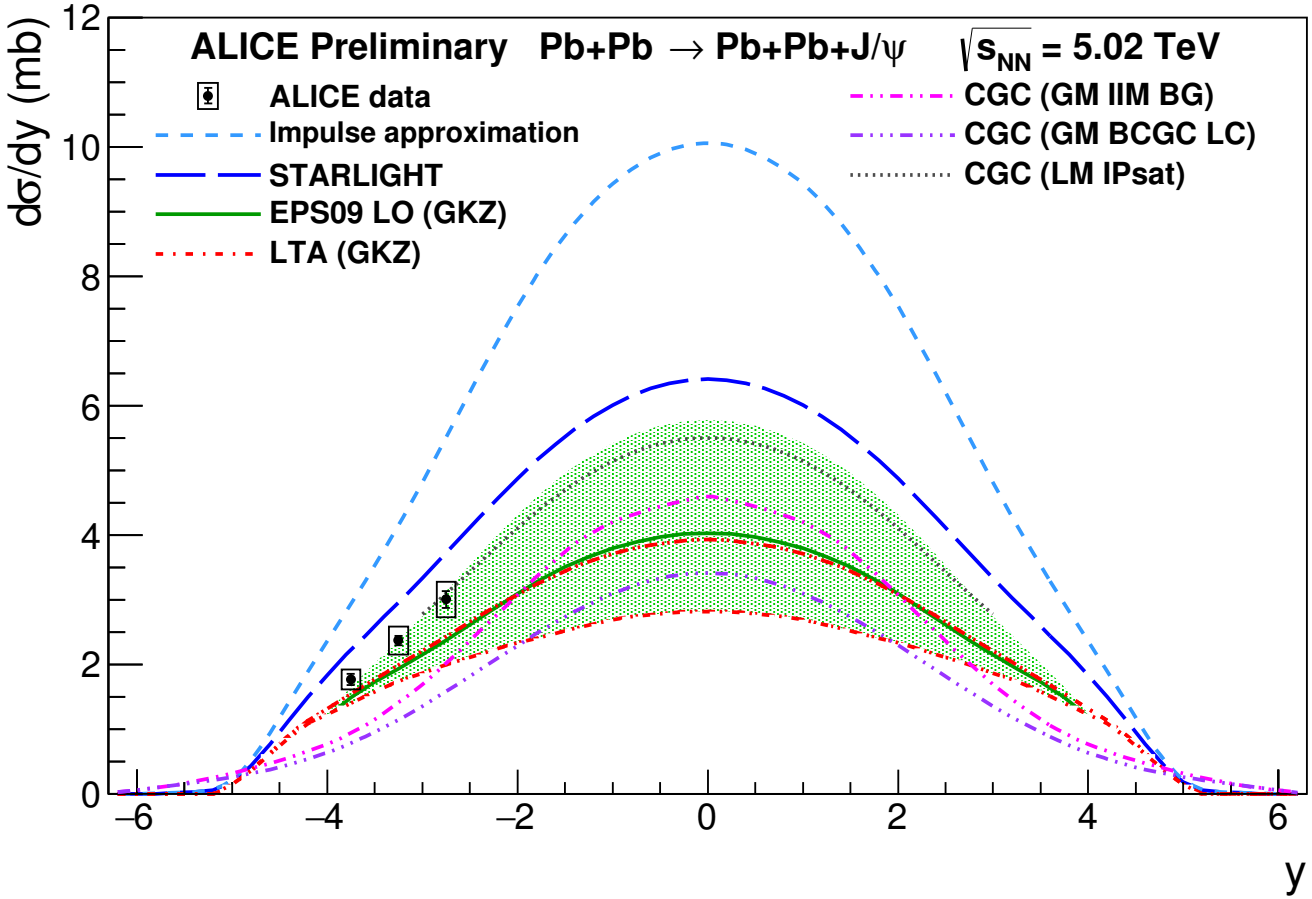
BACK UP

Preliminary invariant mass of Run 2



- Muons and electrons combined.

Preliminary results - Pb-Pb collisions at ALICE of Run 2



- Forward region.

Template title

- Template item.