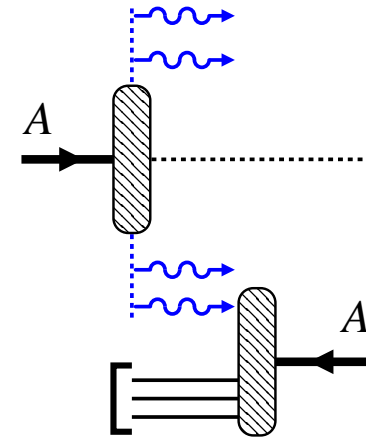


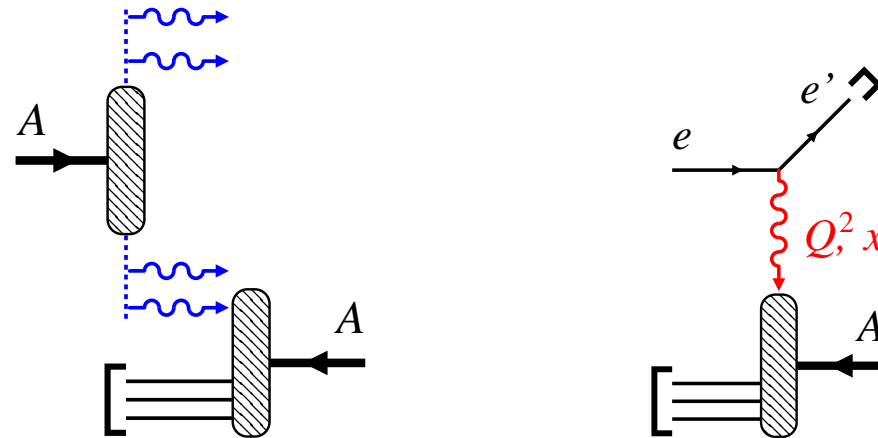
# High-energy EM processes in ultraperipheral collisions at LHC/RHIC and the EIC

Informal meeting, JLab + remote participants, 24 April 2017

- Ultraperipheral  $AA/pA$  collisions
  - Use Weizsäcker–Williams photon field
  - High-energy photoproduction
  - Distinctive event characteristics
  - Results coming ALICE, CMS, ATLAS, LHCb, STAR
- Physics topics
  - Gluons/quarks in nuclei, nuclear shadowing
  - QCD at small  $x$ , non-linear phenomena, saturation
  - Diffraction and initial-state fluctuations
  - Final states in nuclei, heavy quarks, jets
- Complementarity and synergies with EIC
  - [Workshop INT-17-65W, INT Seattle, 13-17 Feb 2017 \[webpage\]](#)



# UPC and EIC: Comparison



$\gamma N$  CM energy  $W$

$\sim 500 - 1800$  GeV

$\sim 20 - 70$  GeV

Hard processes  
kinematics

final state  
 $p_T^2, M^2$

initial and/or final state  
 $x, Q^2$  and/or  $p_T^2, M^2$

Photon flux  $k dN/dk$

comparable

comparable

- UPC: Highest energies, limited control of hard process kinematics  
Review: [Baltz et al. arXiv:0706:3356 \[INSPIRE\]](https://arxiv.org/abs/0706.3356)
- EIC: Limited energy, hard process kinematics controlled by electron:  
Inclusive/semi-inclusive measurements;  $Q^2$  evolution at fixed  $x, p_T, \dots$

# UPC and EIC: This meeting

3

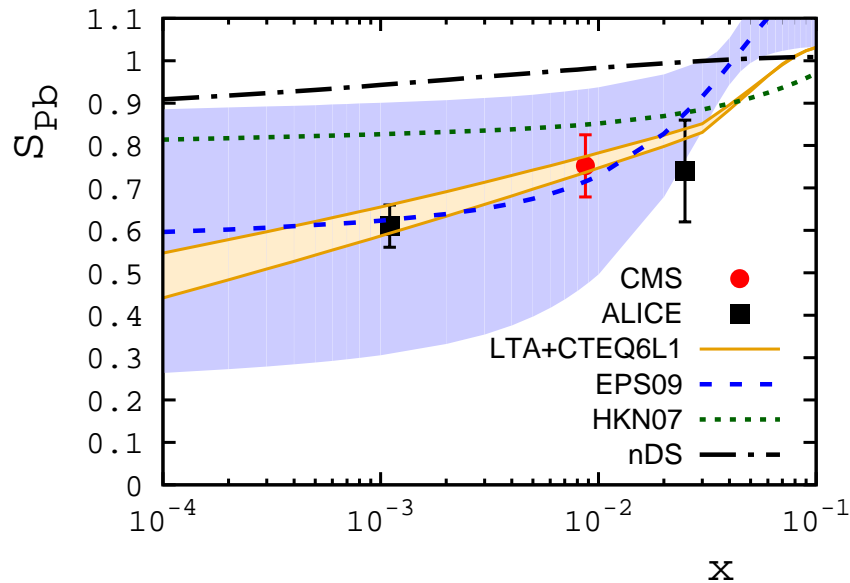
- Learn about recent UPC results, theoretical interpretations, future prospects
- Discuss impact on EIC physics program, complementarity and synergies

## Agenda

1300-1310	C. Weiss	Introduction and plan of meeting
1310-1340	V. Guzey	Nuclear shadowing of gluons with UPCs and EIC
1340-1400	Discussion	
1400-1430	T. Lappi	Non-linear effects and saturation with UPCs and EIC
1430-1500	Discussion	
1500-1530	S. Brodsky	Ridge-like correlations in high-multiplicity collisions

- Educational — review results, explain concepts
- Informal — ask questions, make contributions

Supplementary material



- UPC  $J/\psi$  photoproduction confirms large gluon shadowing at  $x < 10^{-2}$   
Frankfurt, Strikman, Guzey 12
- New questions: Gluons at large  $x$ ?  
Approach to saturation?

- EIC  $eA$  program

Mechanism of shadowing in deuteron, connection with diffraction?

→ LDRD spectator tagging

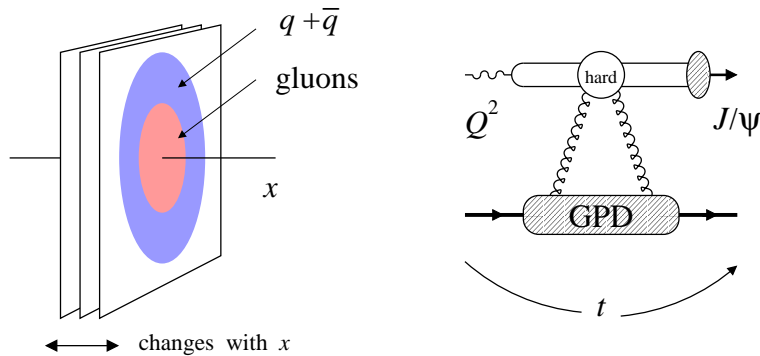
Nuclear gluons at large  $x$ : Antishadowing, EMC effect?

→ LDRD charm

Nuclear quarks: Shadowing, antishadowing, charge/flavor separation?  
Connection with  $NN$  interaction?

Polarized quark/gluons in nuclei?

# UPC and EIC: Nucleon transverse structure

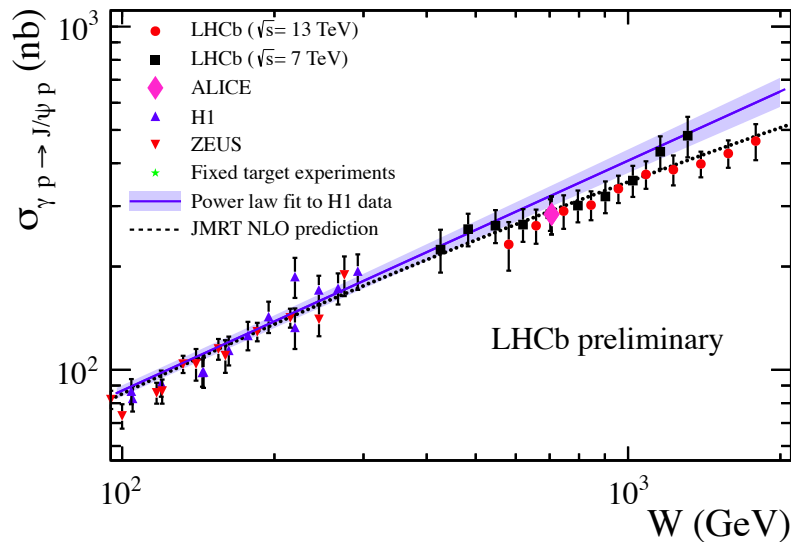


- Exclusive  $J/\psi$  production measures transverse distribution of gluons  
Dynamics, input for saturation, MPI in  $pp@LHC$

- UPC exclusive  $J/\psi$  data coming!

$W^2$  up to  $10 \times$  HERA,  $x \sim 10^{-5}$

No dramatic changes in mechanism  
Nonlinear effects, saturation?



- EIC  $ep$  imaging program

Valence-like gluons at large  $x$ ?

Imaging of quarks, spin, flavor?  
DVCS, meson production

Electroproduction: Leading vs. higher twist mechanism,  $Q^2$  evolution, precision