

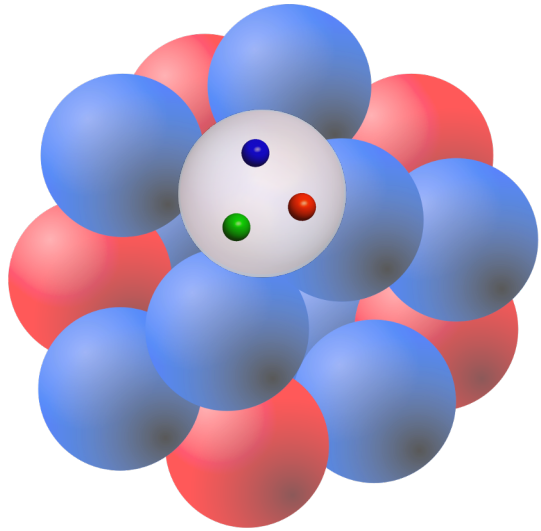
Probing short-range correlations using diffractive J/Ψ production in *deuteron*

Zhoudunming Tu (*Kong*)

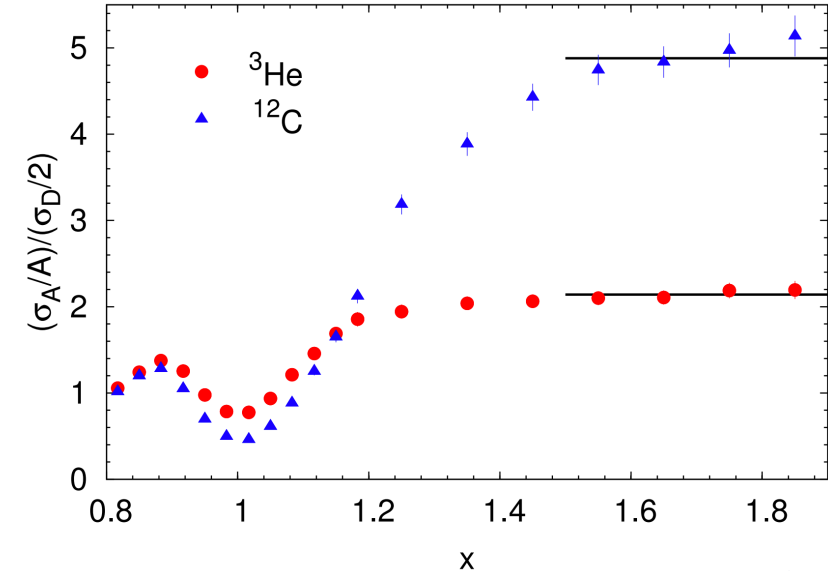
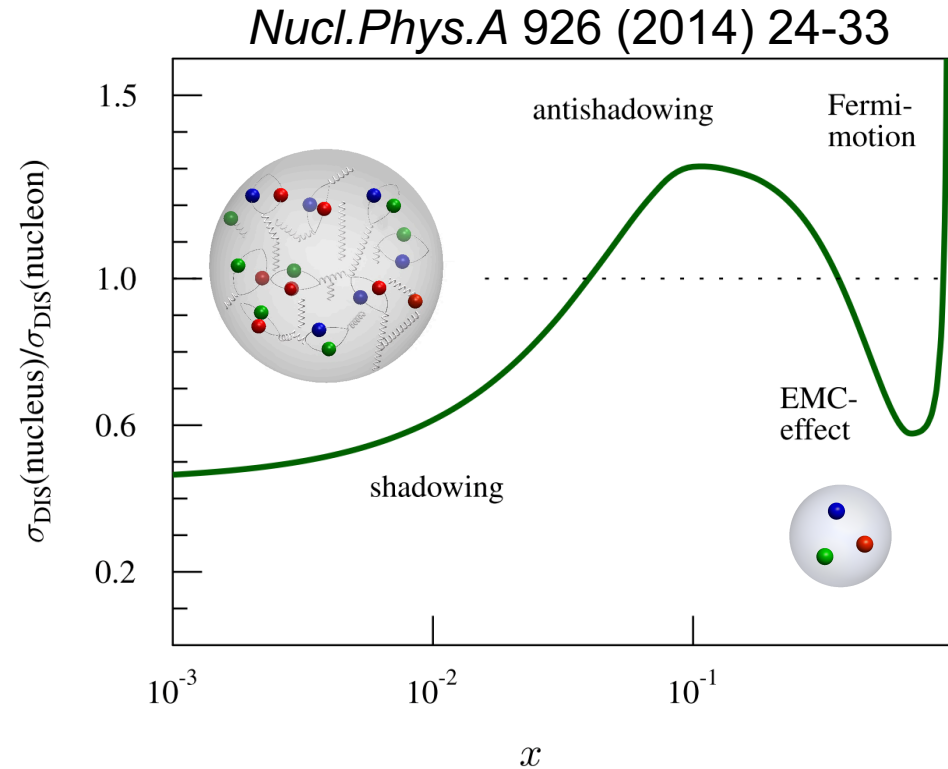
BNL

03.19.2021

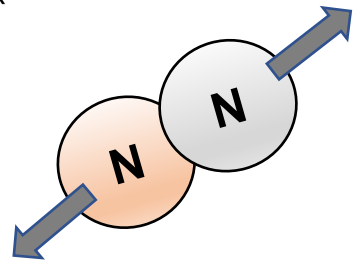
Nucleon structure in nucleus



Nucleus
Protons + Neutrons



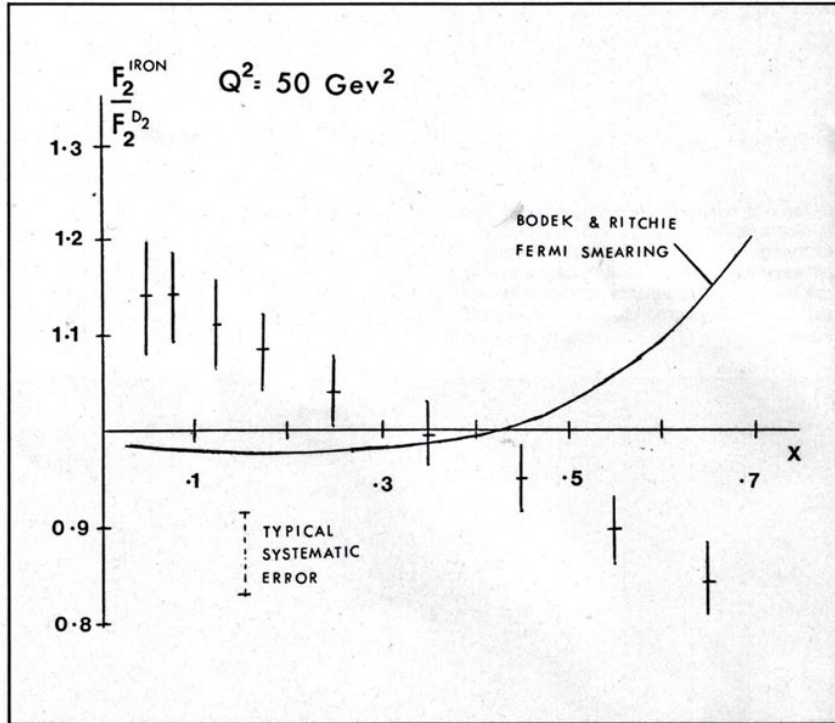
SRC:
Short-Range
Correlations



Why is nucleus not a collection of free nucleons?

EMC-SRC correlation

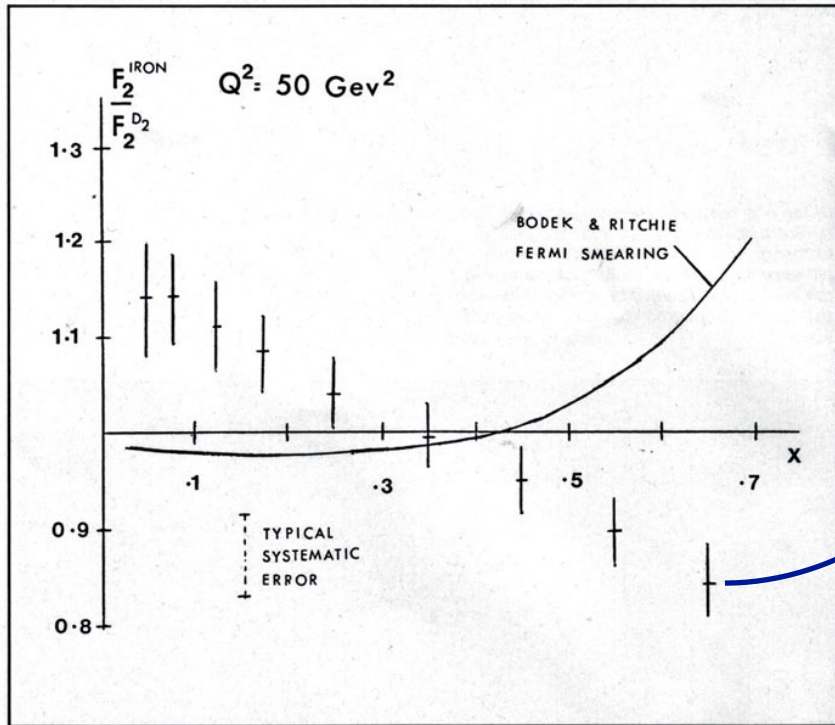
EMC puzzle (Aubert *et al.* 1983)



EMC-SRC correlation

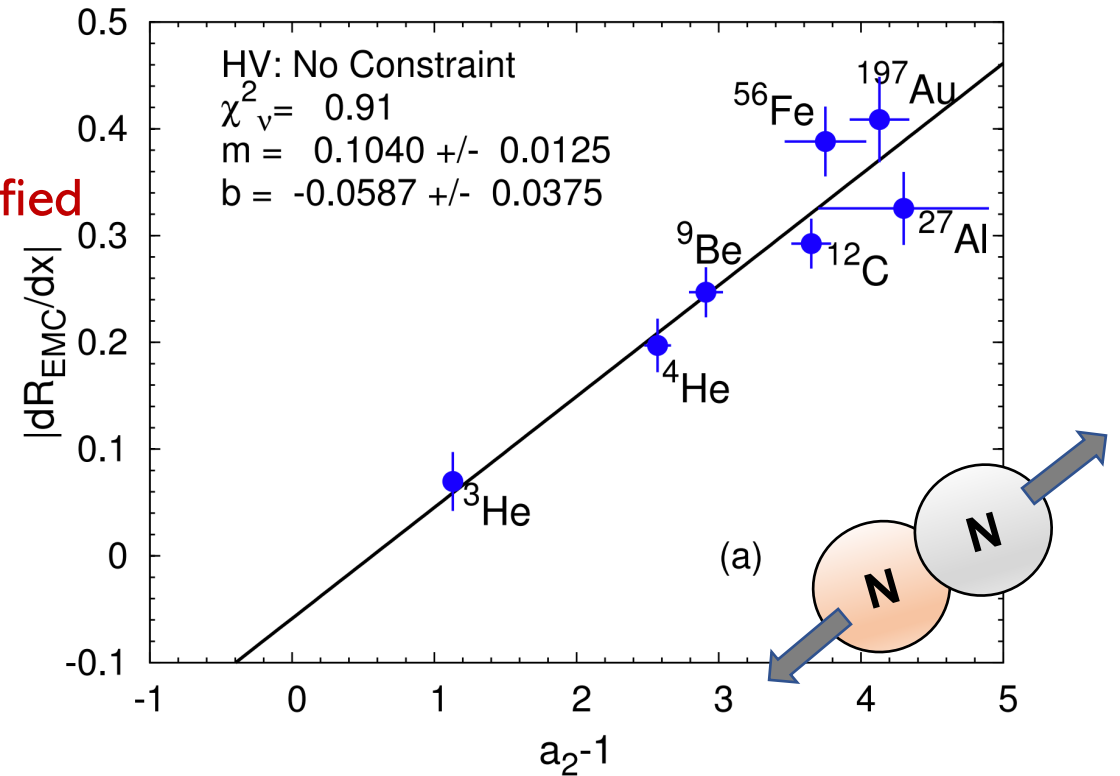
EMC-SRC workshop next week - <https://indico.jlab.org/event/428/overview>

EMC puzzle (Aubert *et al.* 1983)



How much nucleon structure gets modified

EMC-SRC are correlated

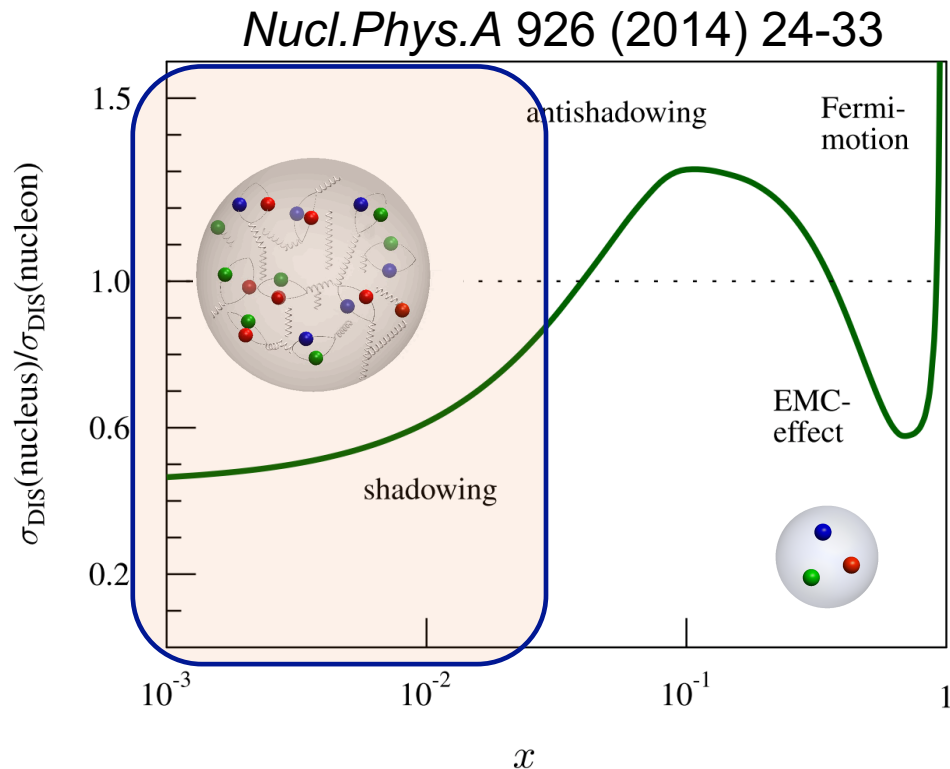


How strong the SRCs are

Recent data indicated the SRC might be the cause of EMC

What about gluon?

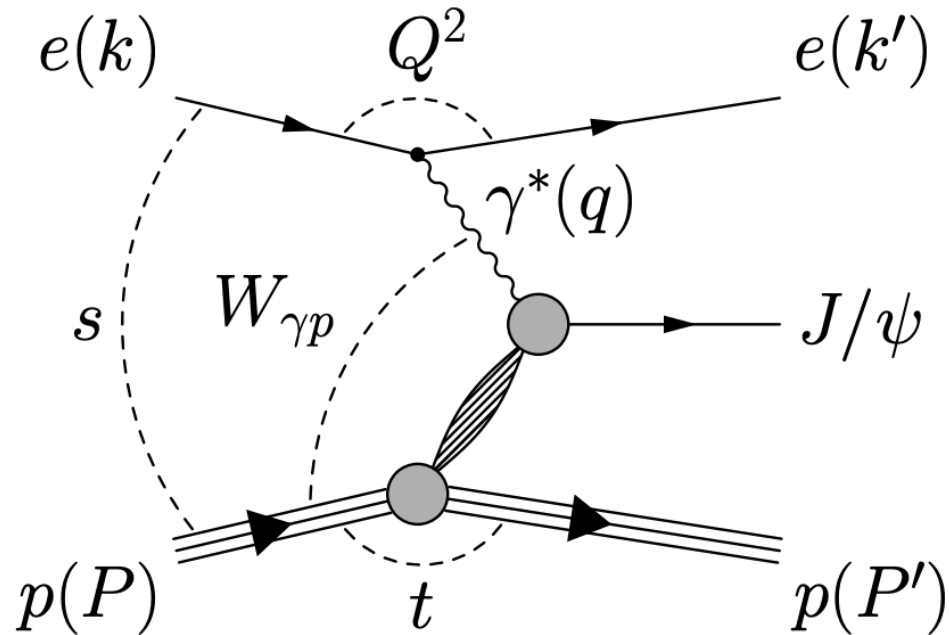
- A natural question to ask is whether SRC pairs would modify the gluonic structure of nucleons at low x .



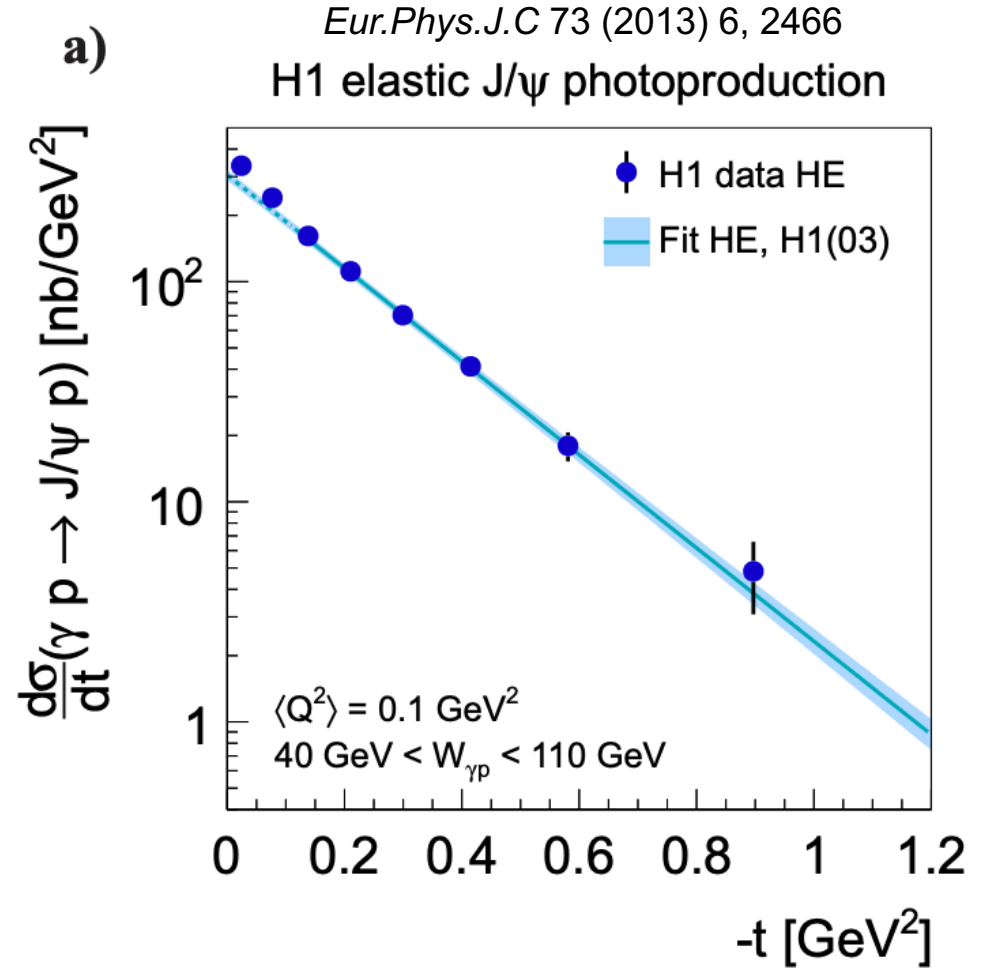
More specifically we ask:

1. What is the nucleon gluon density w. and without a SRC pair?
2. What is the gluon spatial distribution? How to measure them?

Diffractive J/ψ production

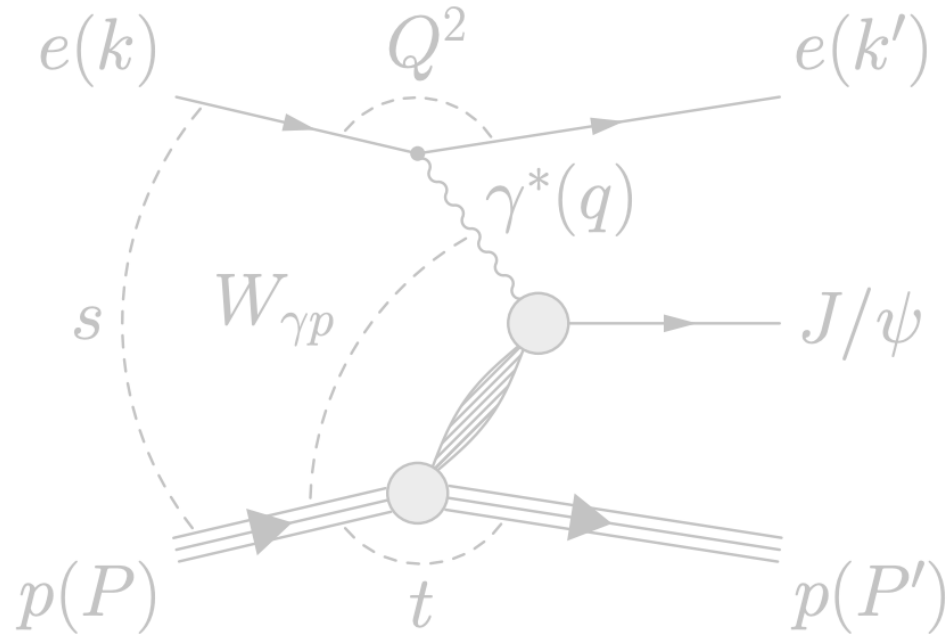


Diffractive J/ψ in ep



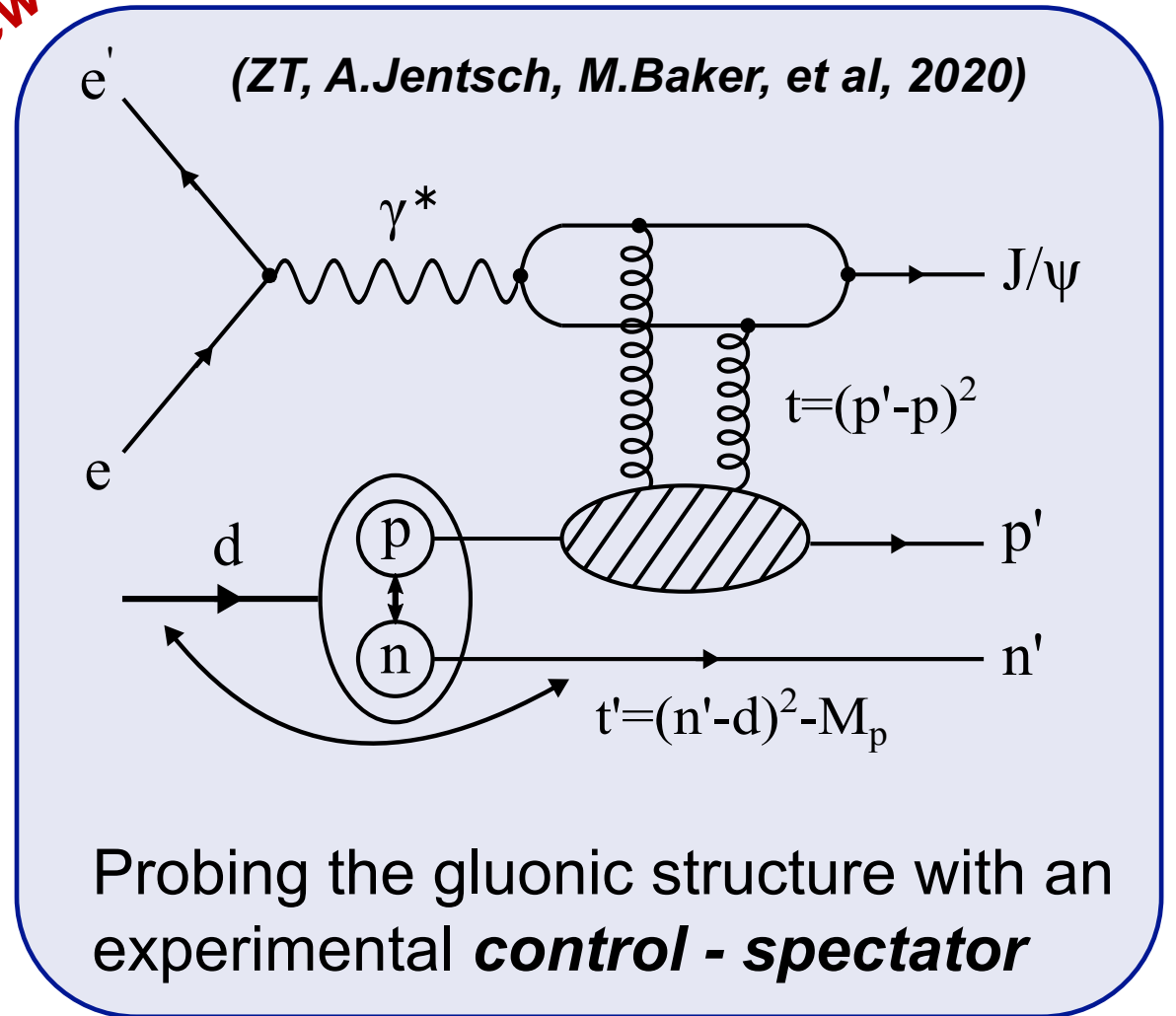
Momentum transfer $-t$ distributions \rightarrow source distribution (gluons)

Diffractive J/ψ production in *deuteron*



Diffractive J/ψ in ep

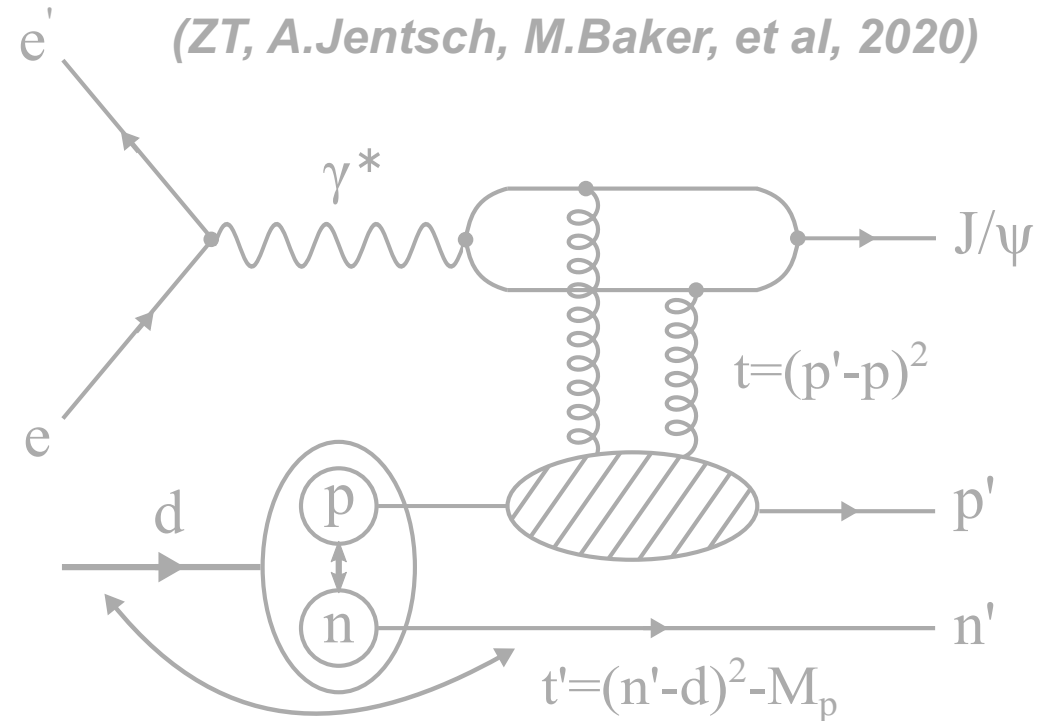
New



Diffractive J/ψ production in *deuteron*

Advantages of this new measurement:

- Incoherent J/ψ production directly probes bounded nucleons;

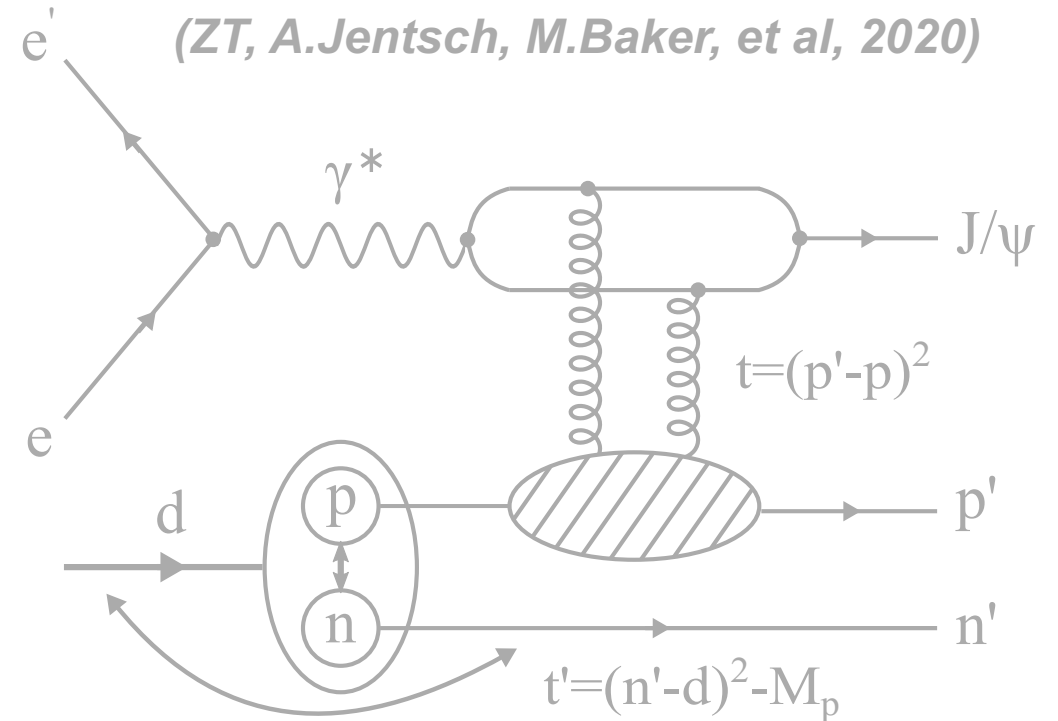


Probing the gluonic structure with an experimental *control - spectator*

Diffractive J/ψ production in *deuteron*

Advantages of this new measurement:

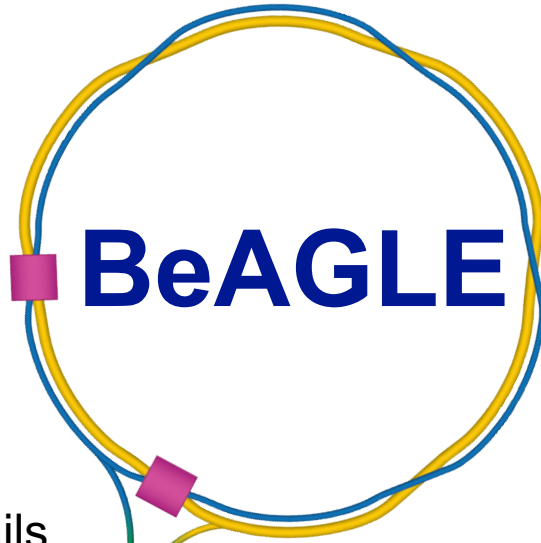
- Incoherent J/ψ production directly probes bounded nucleons;
- Tagging a spectator – *deuteron* configuration can be either:
 - NO nuclear effect – **free nucleons**
 - Nuclear effect – **deeply bound nucleons**



Probing the gluonic structure with an experimental **control - spectator**

Diffractive J/ψ production in *deuteron*

How can we study this process now?

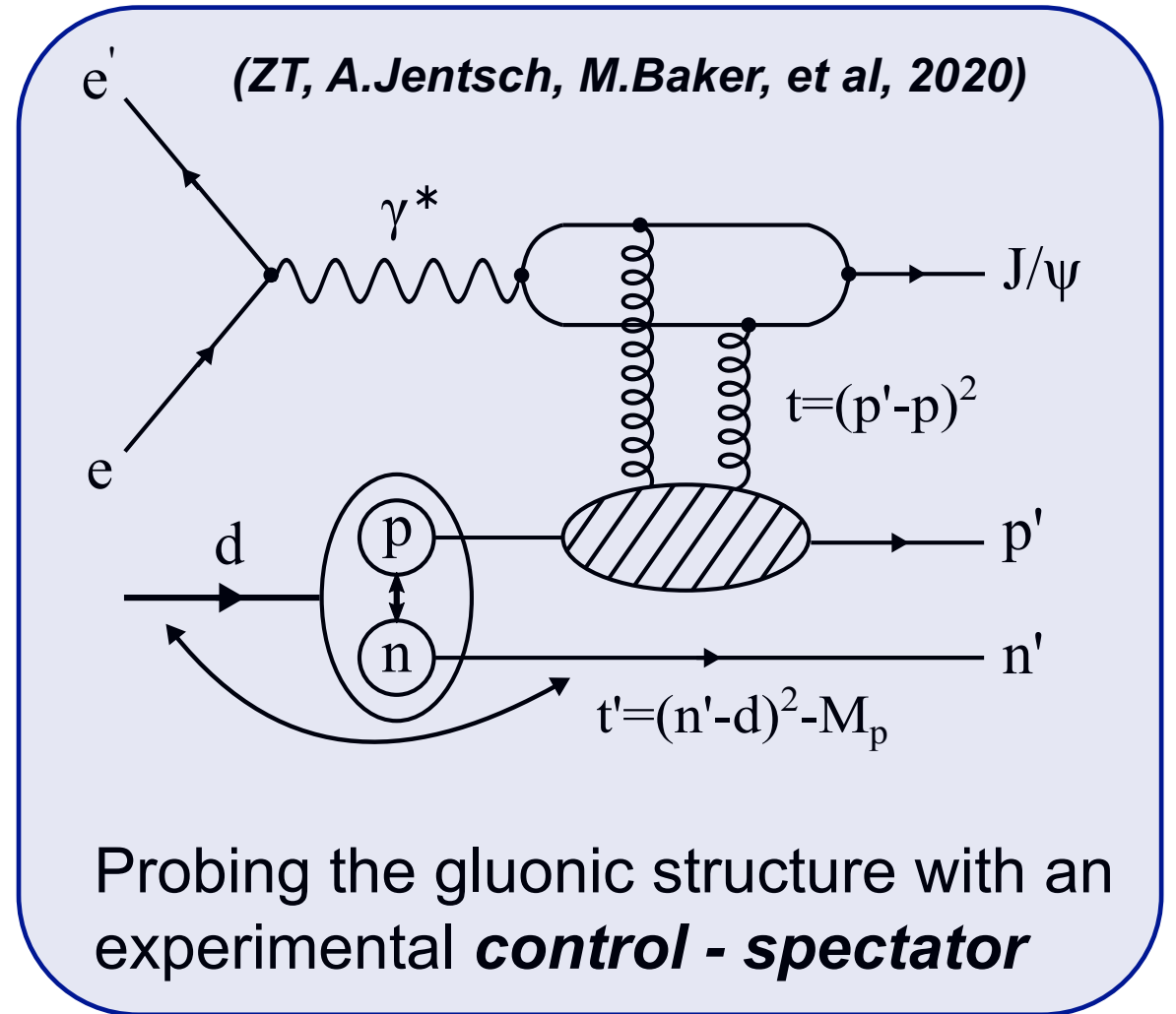


Click [here](#) for details



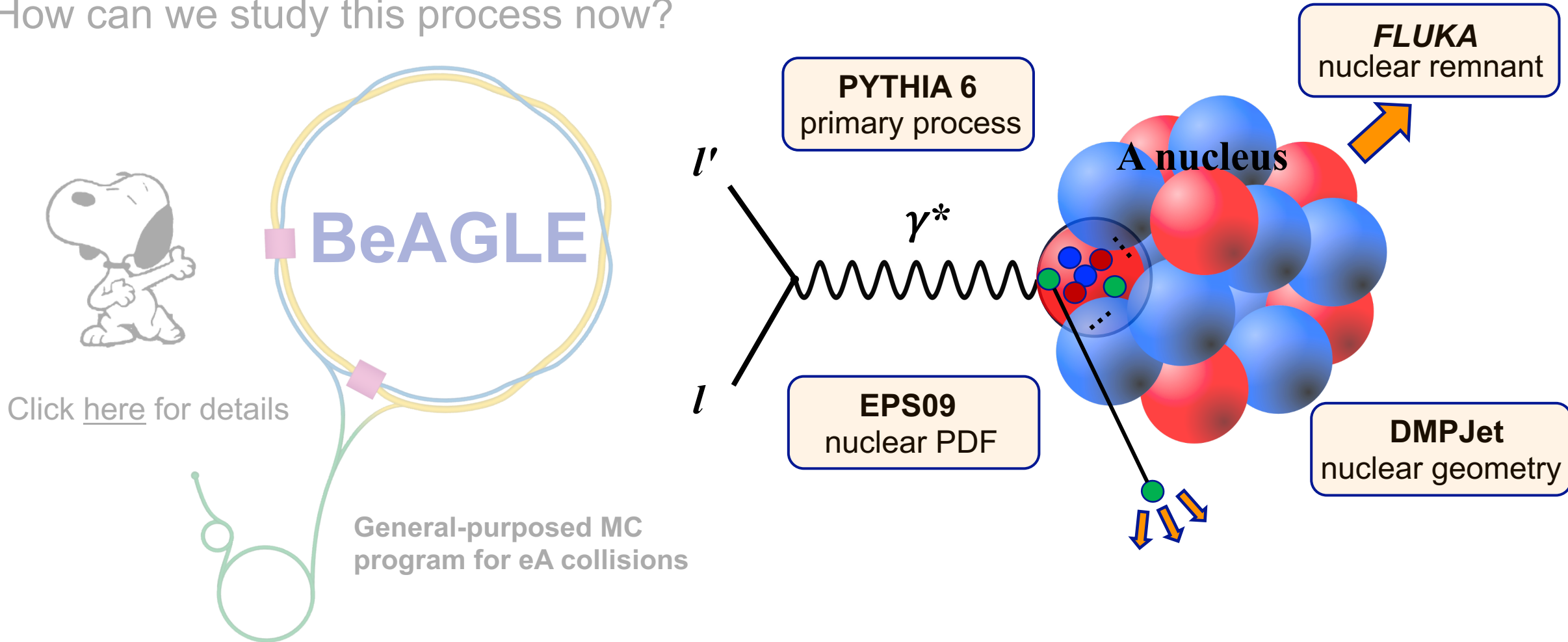
General-purposed MC program for eA collisions

(E. Aschenauer, M. Baker, J. Lee, ZT, and L. Zheng)



Diffractional J/ψ production in *deuteron*

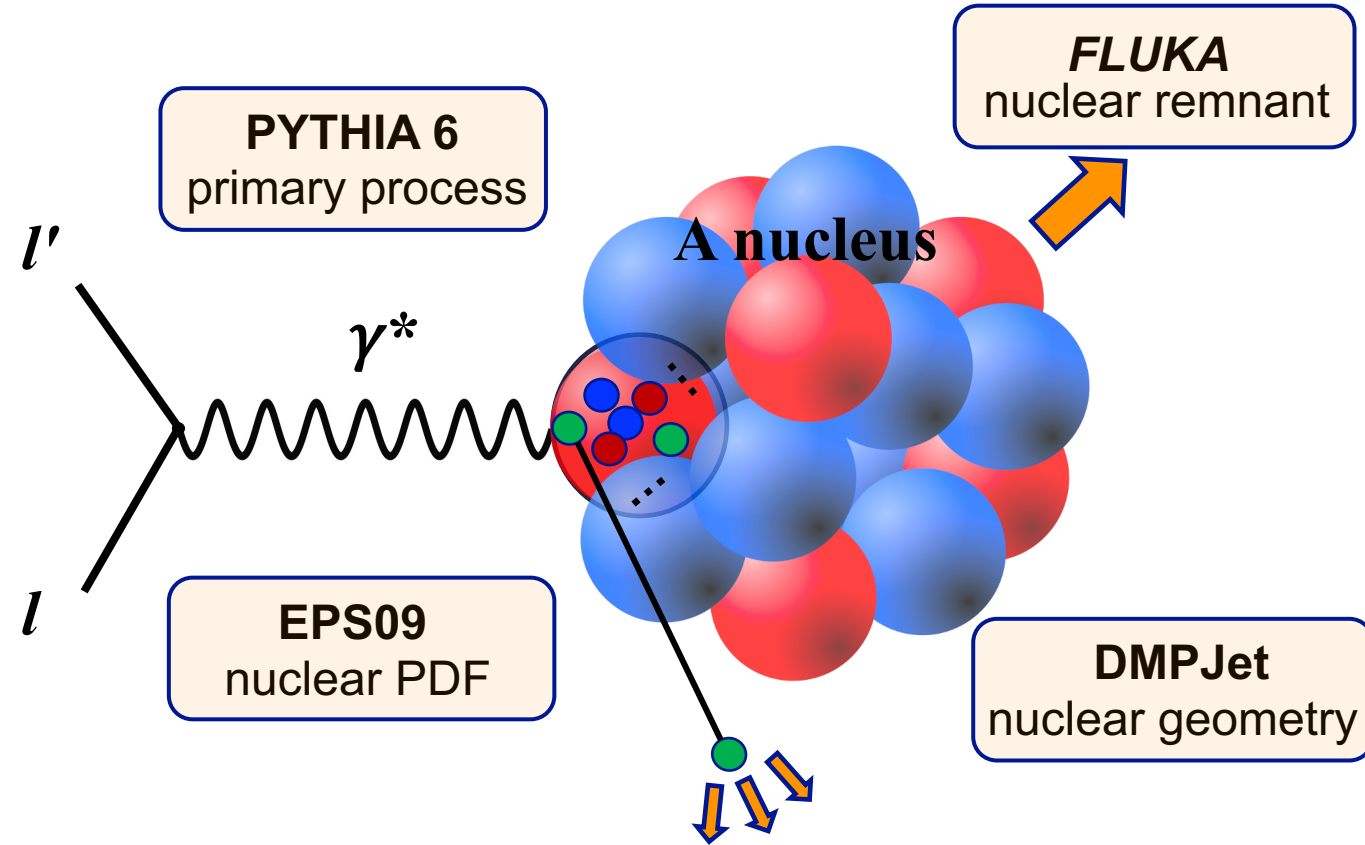
How can we study this process now?



(E. Aschenauer, M. Baker, J. Lee, ZT, and L. Zheng)

Diffractional J/ψ production in *deuteron*

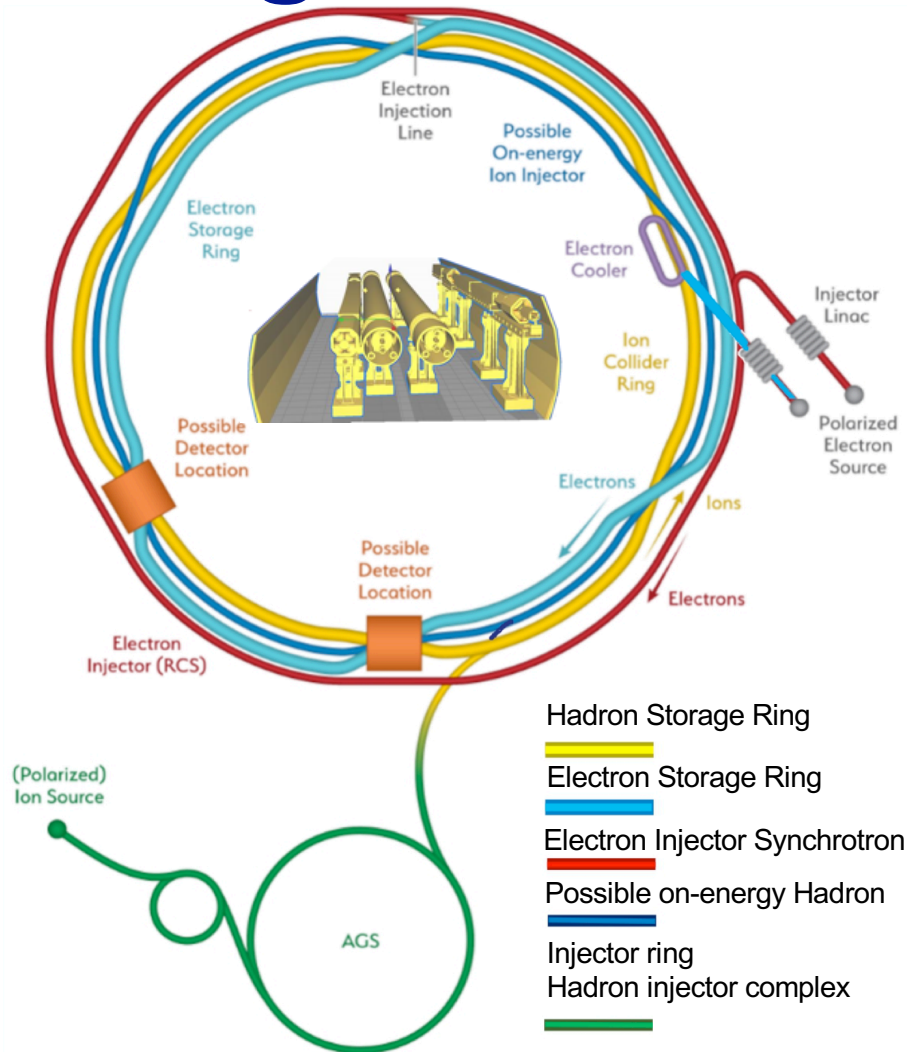
How can we study this process now?



(E. Aschenauer, M. Baker, J. Lee, ZT, and L. Zheng)

In deuteron, the simulation is much simpler. We used deuteron wfs with LF kinematics and assumes *Plane Wave Impulse Approximation*

Next generation QCD machine - EIC



High energy & luminosity accelerator machine with beam polarization.

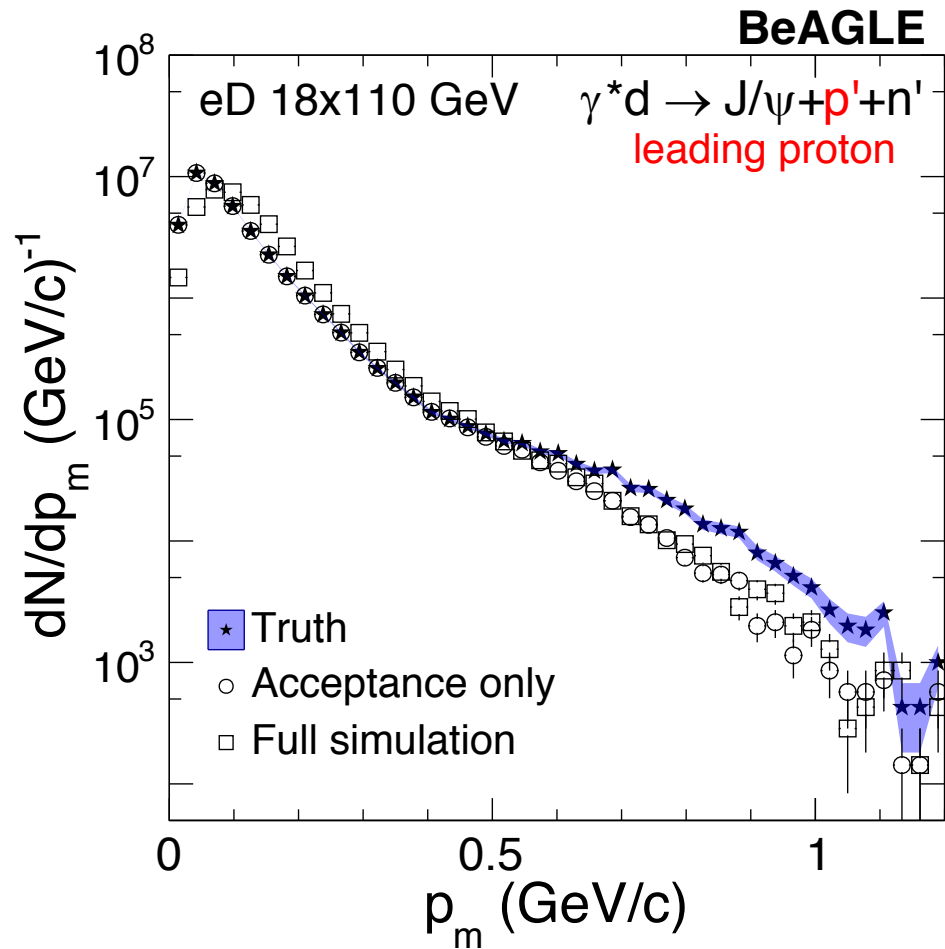
- $\sqrt{s} \Rightarrow 20 - 141 \text{ GeV}$
- $\mathcal{L}_{max} \Rightarrow 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$

Polarization (e & p) $\Rightarrow 80\%$
 A \Rightarrow proton to Uranium

Diffractive & Exclusive reactions are one of the major physics at EIC

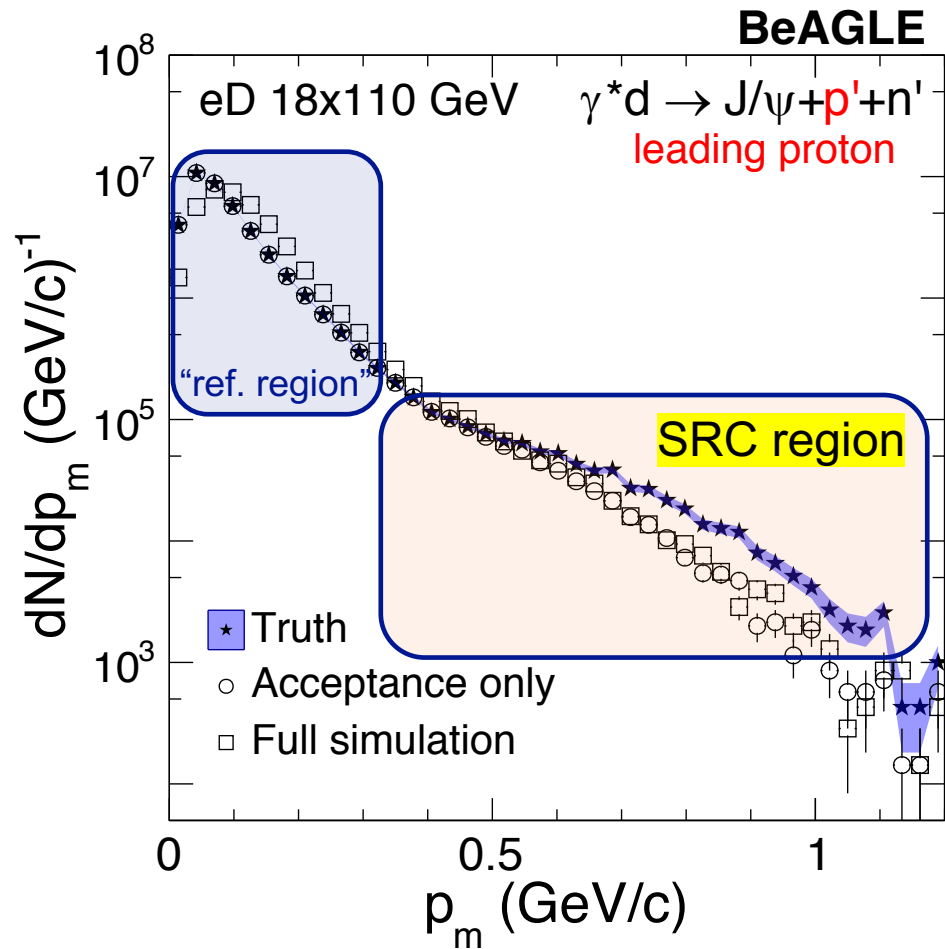
Sited at Brookhaven National Laboratory
Electron-Ion Collider

Results



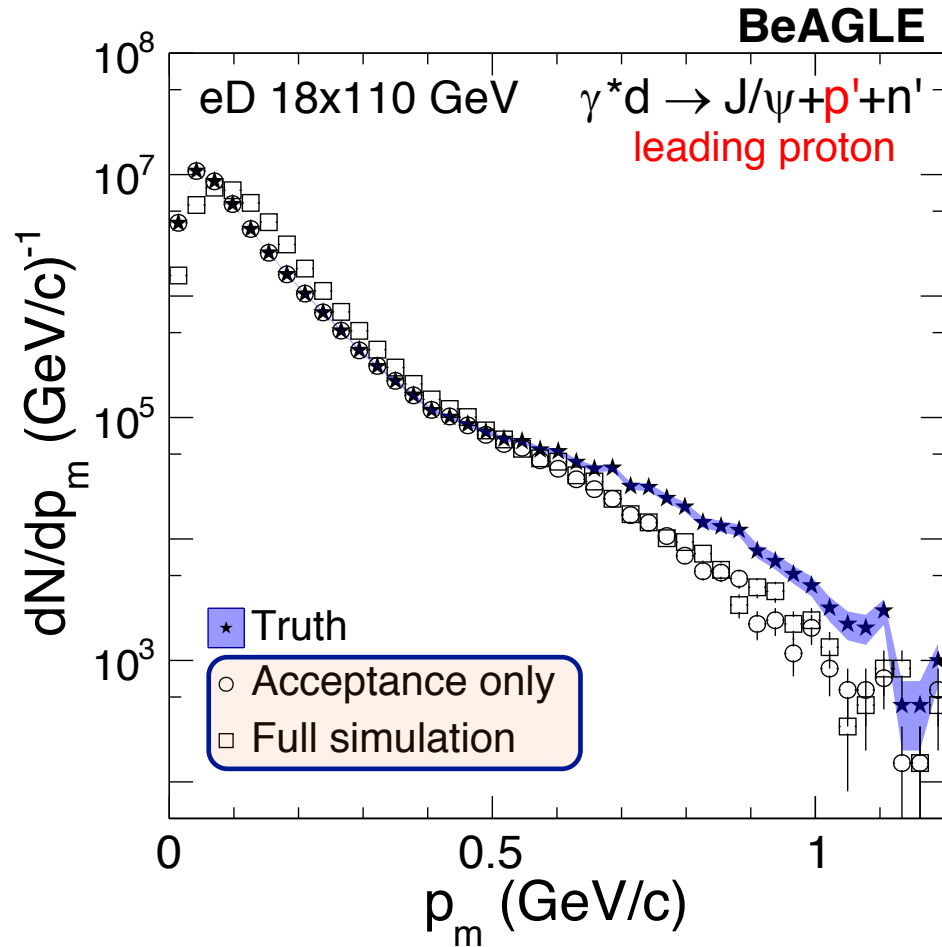
P_m - total three-momentum of the spectator

Results



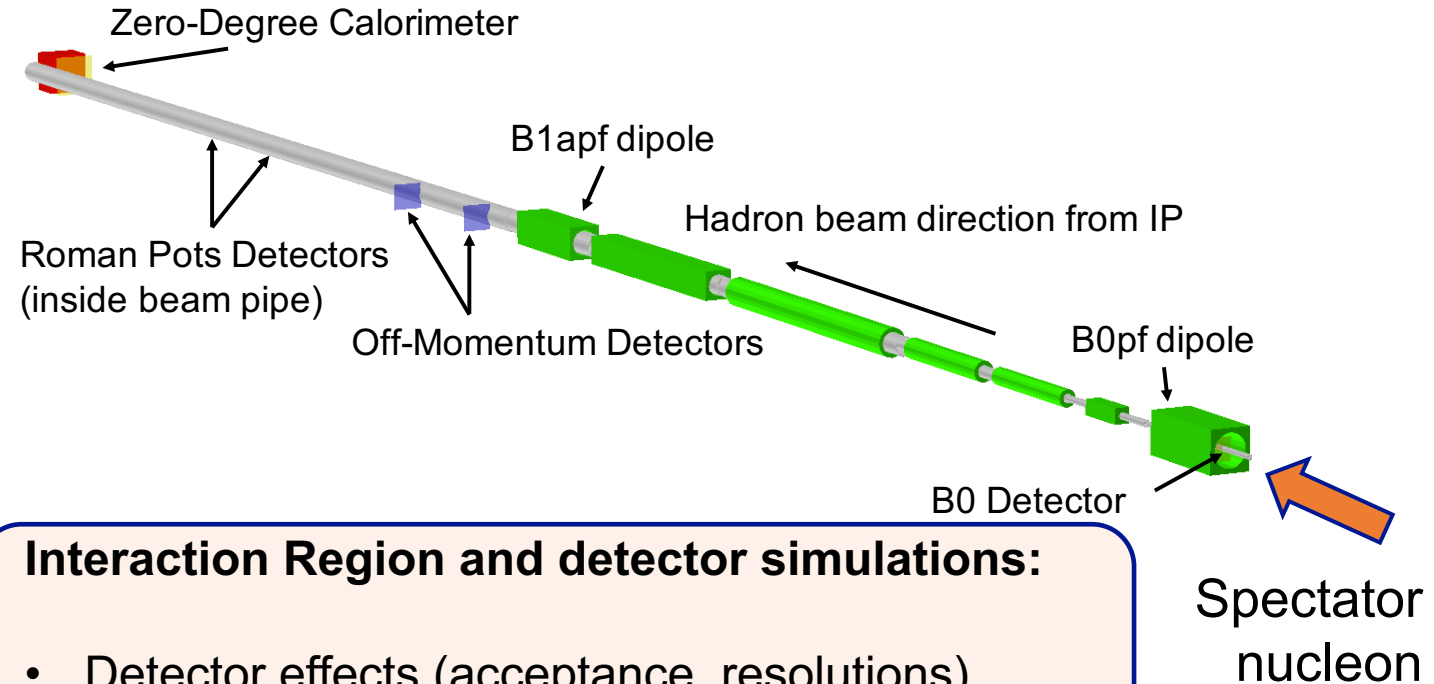
P_m - total three-momentum of the spectator

Results



P_m - total three-momentum of the spectator

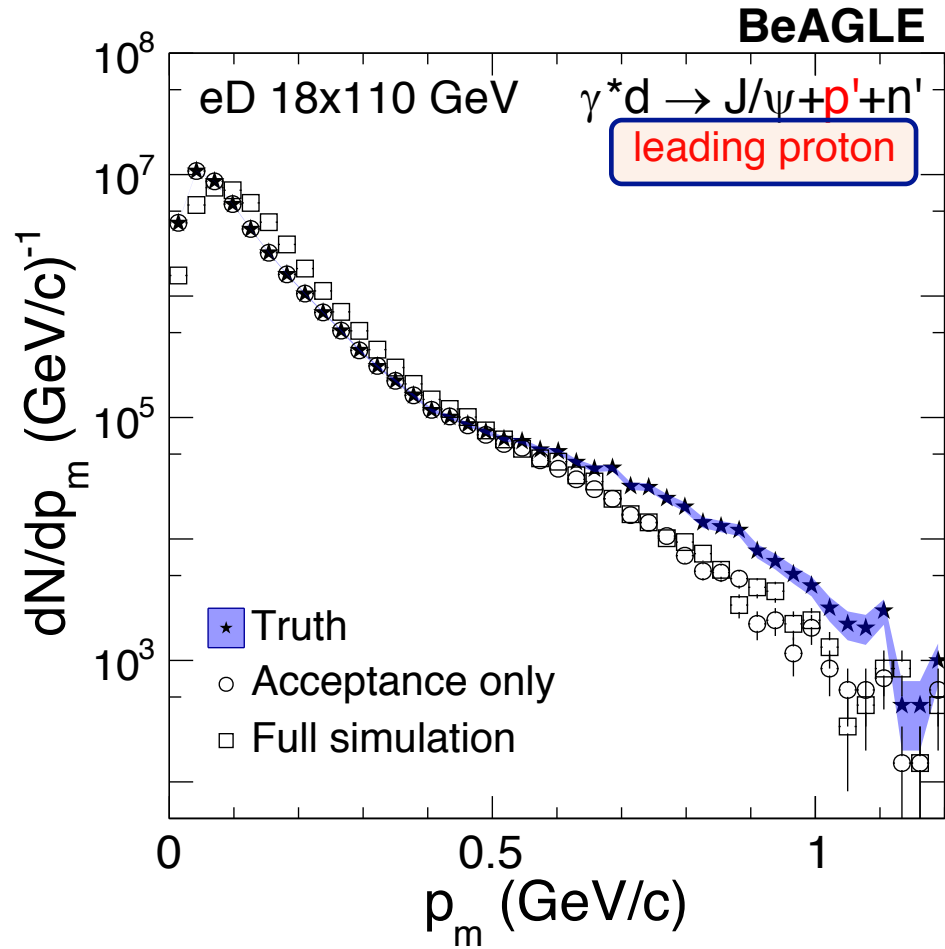
EIC IR concept



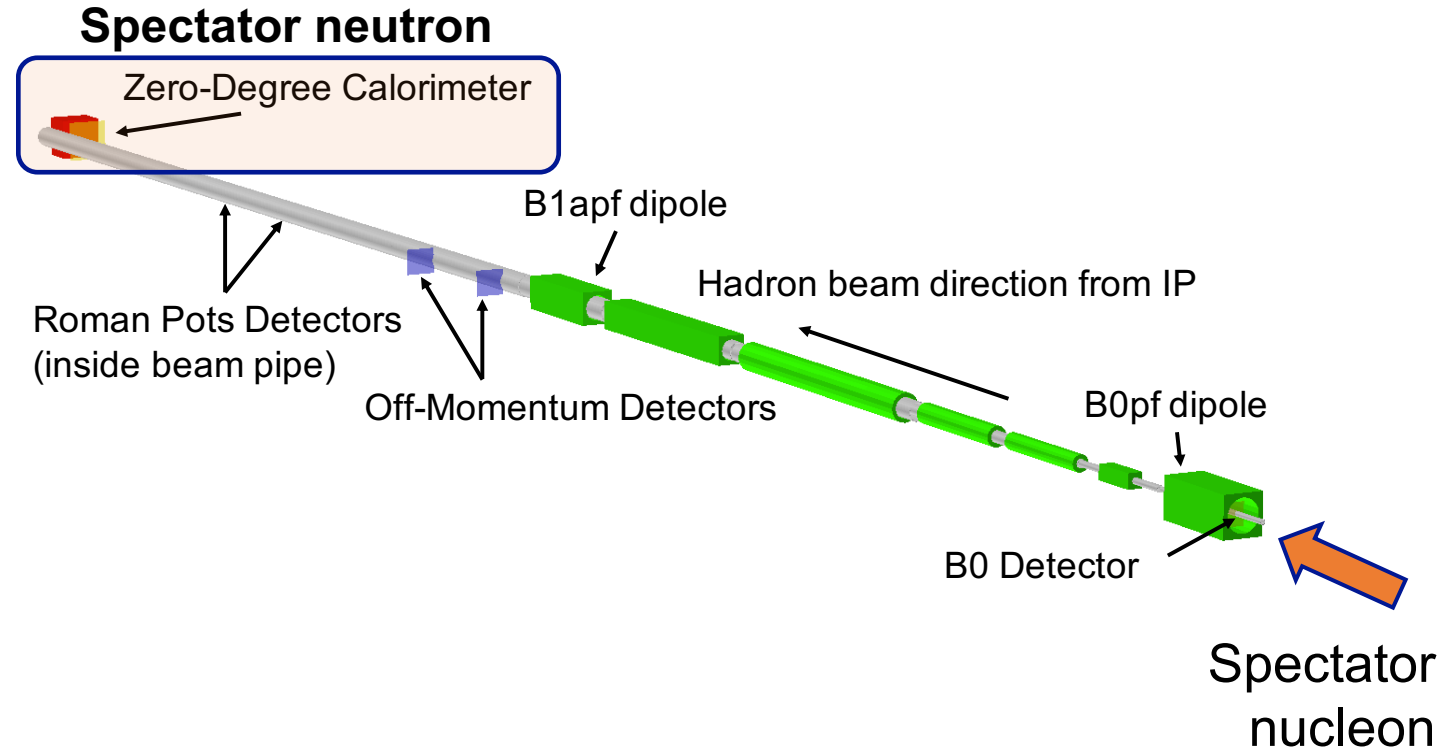
Interaction Region and detector simulations:

- Detector effects (acceptance, resolutions)
- Beam-related effects (e.g., angular divergence)

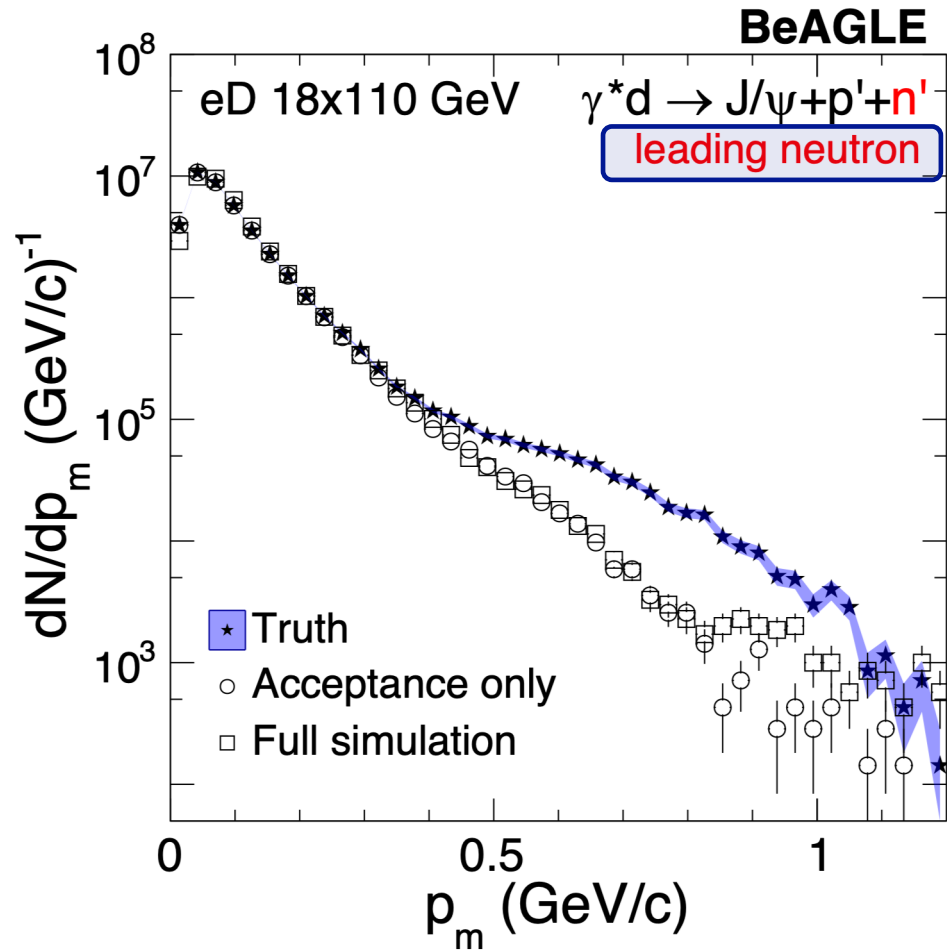
Results



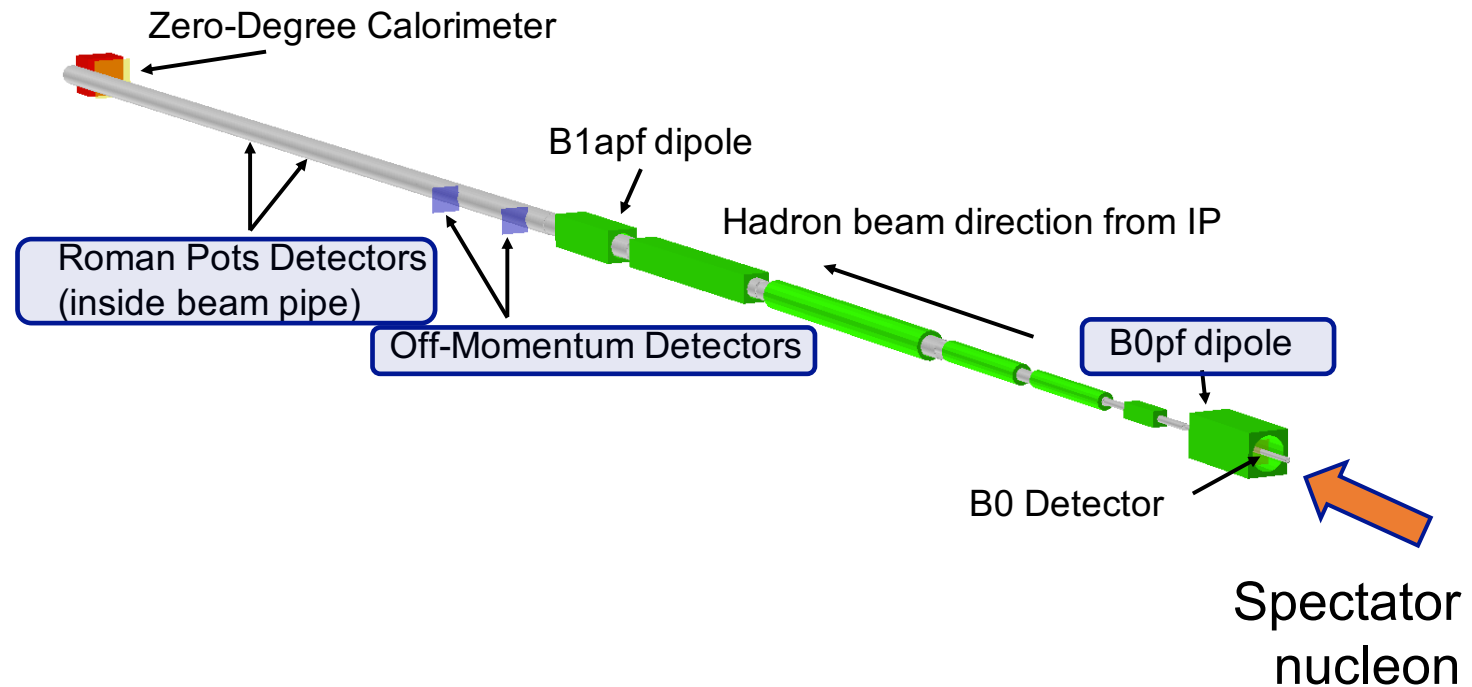
P_m - total three-momentum of the spectator



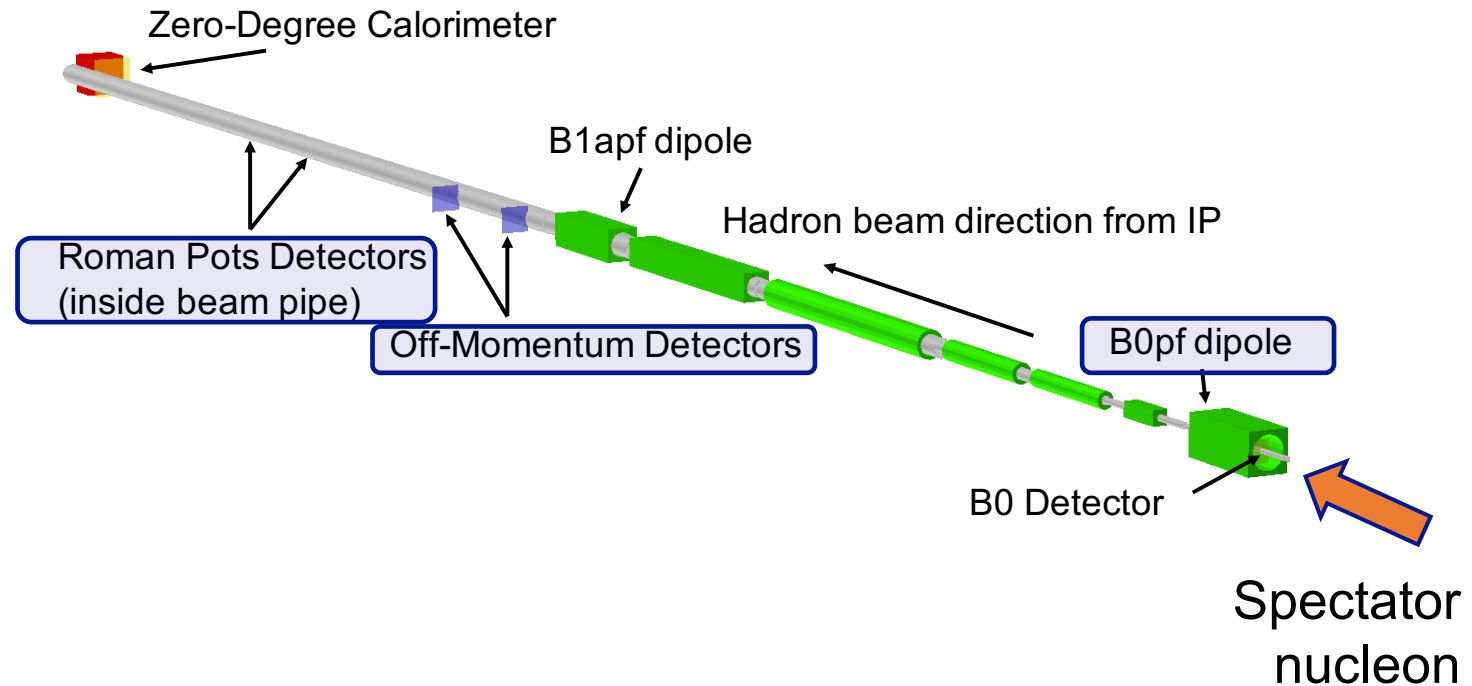
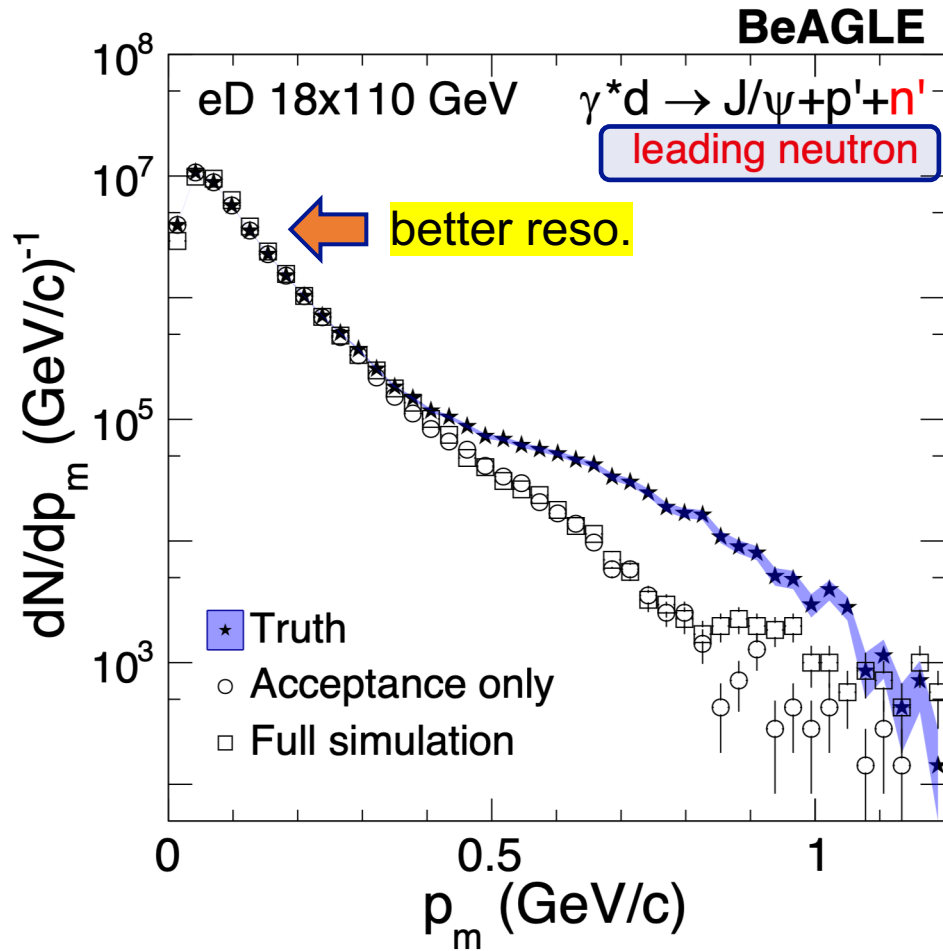
Results



P_m - total three-momentum of the spectator

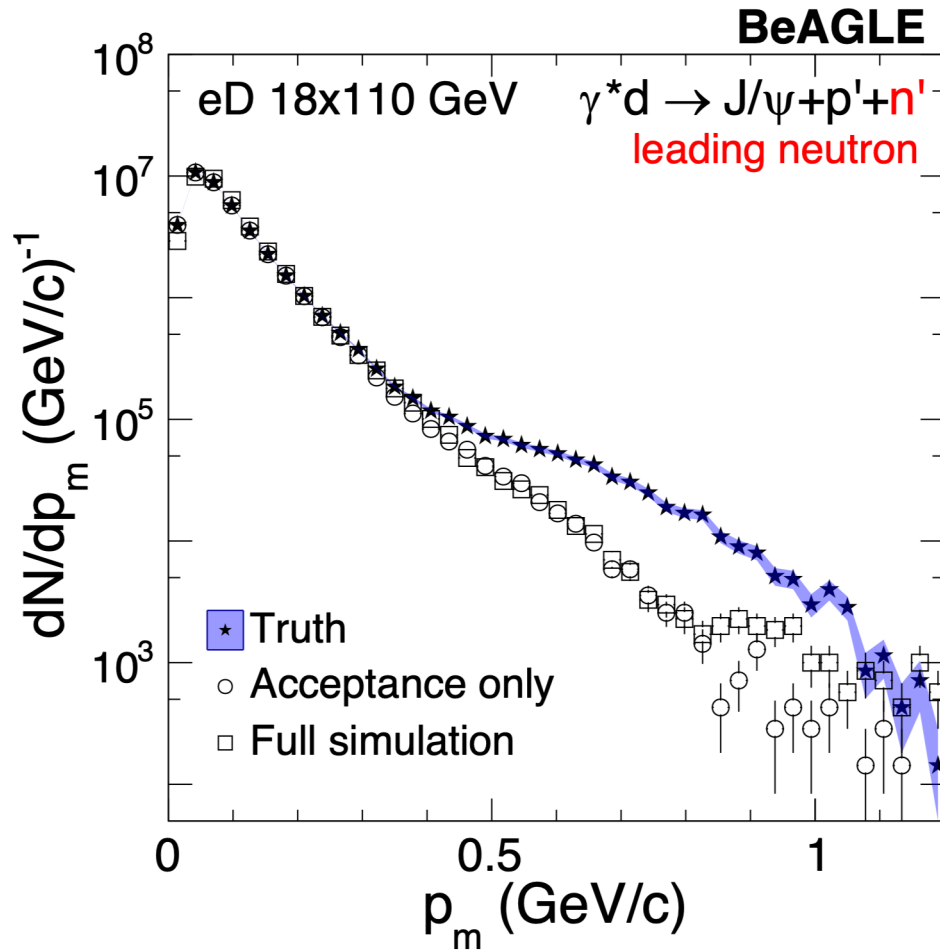


Results

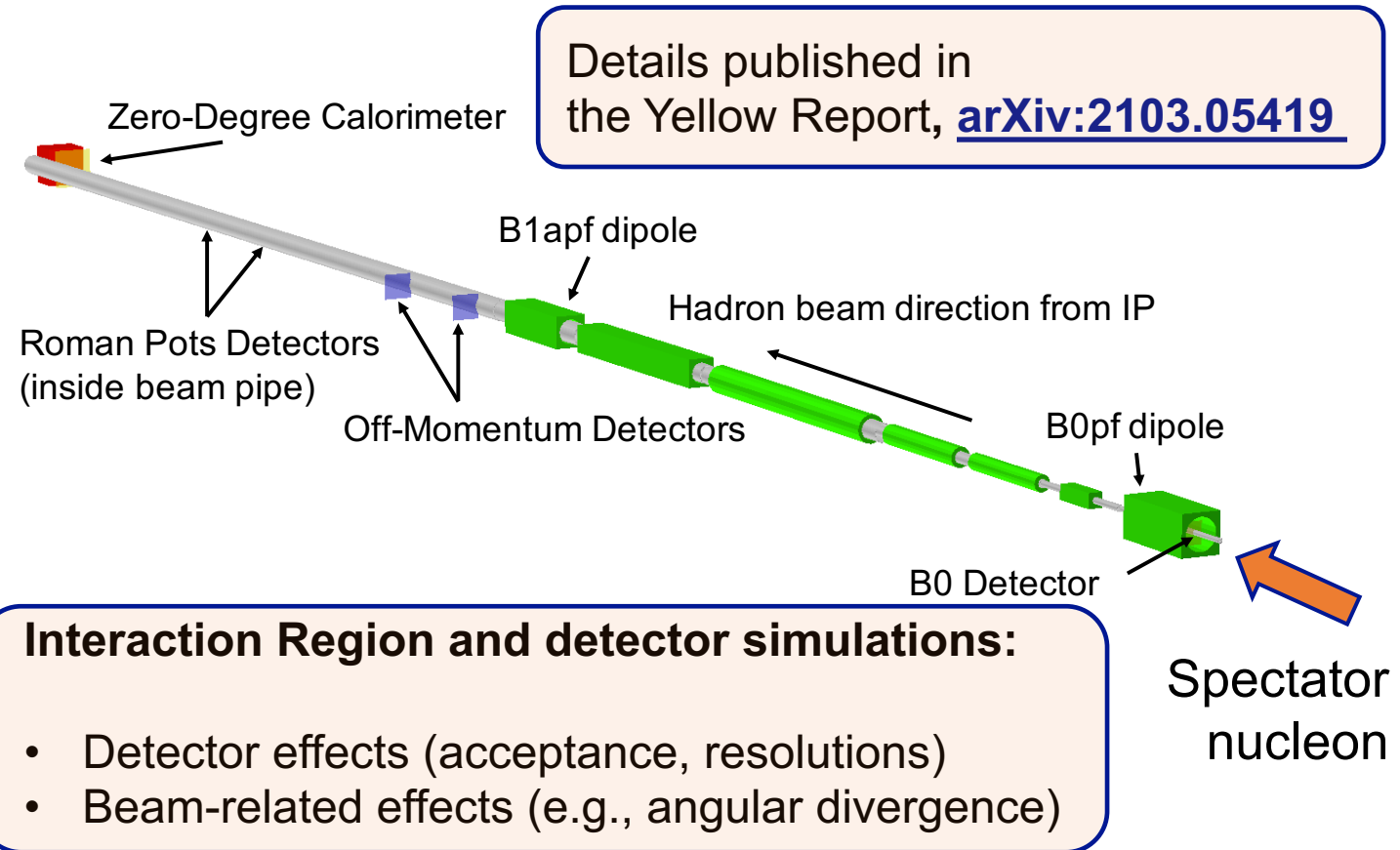


P_m - total three-momentum of the spectator

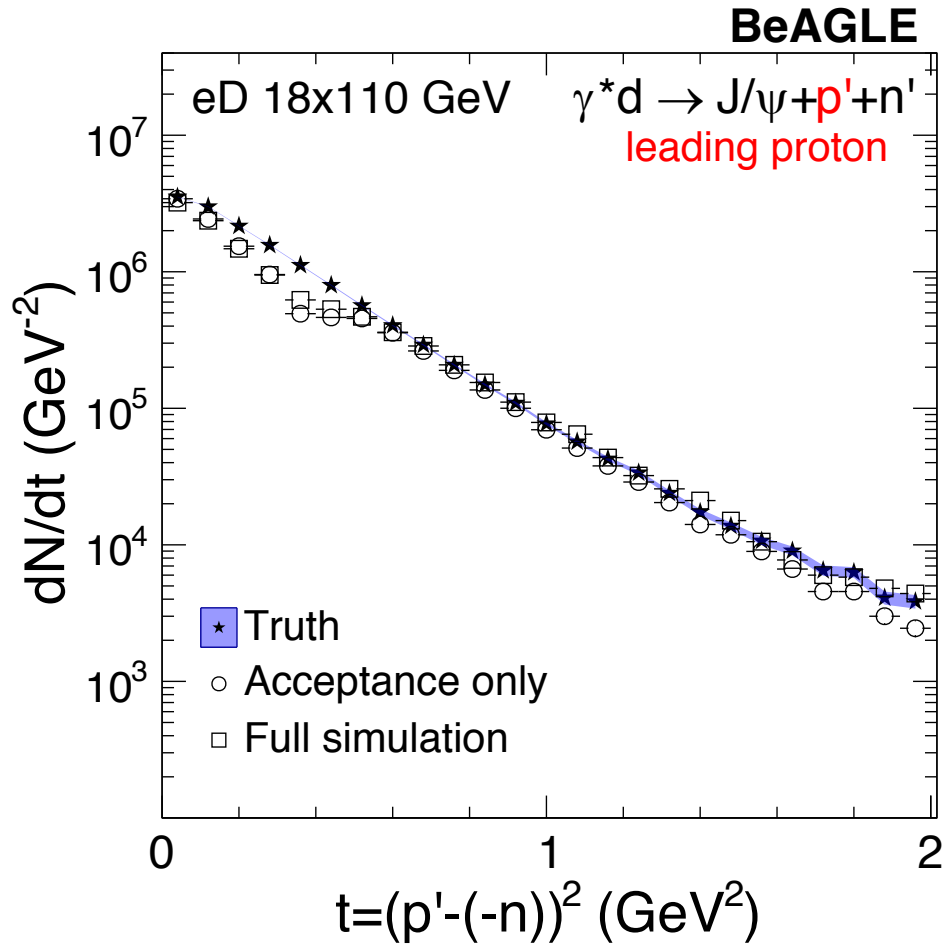
Results



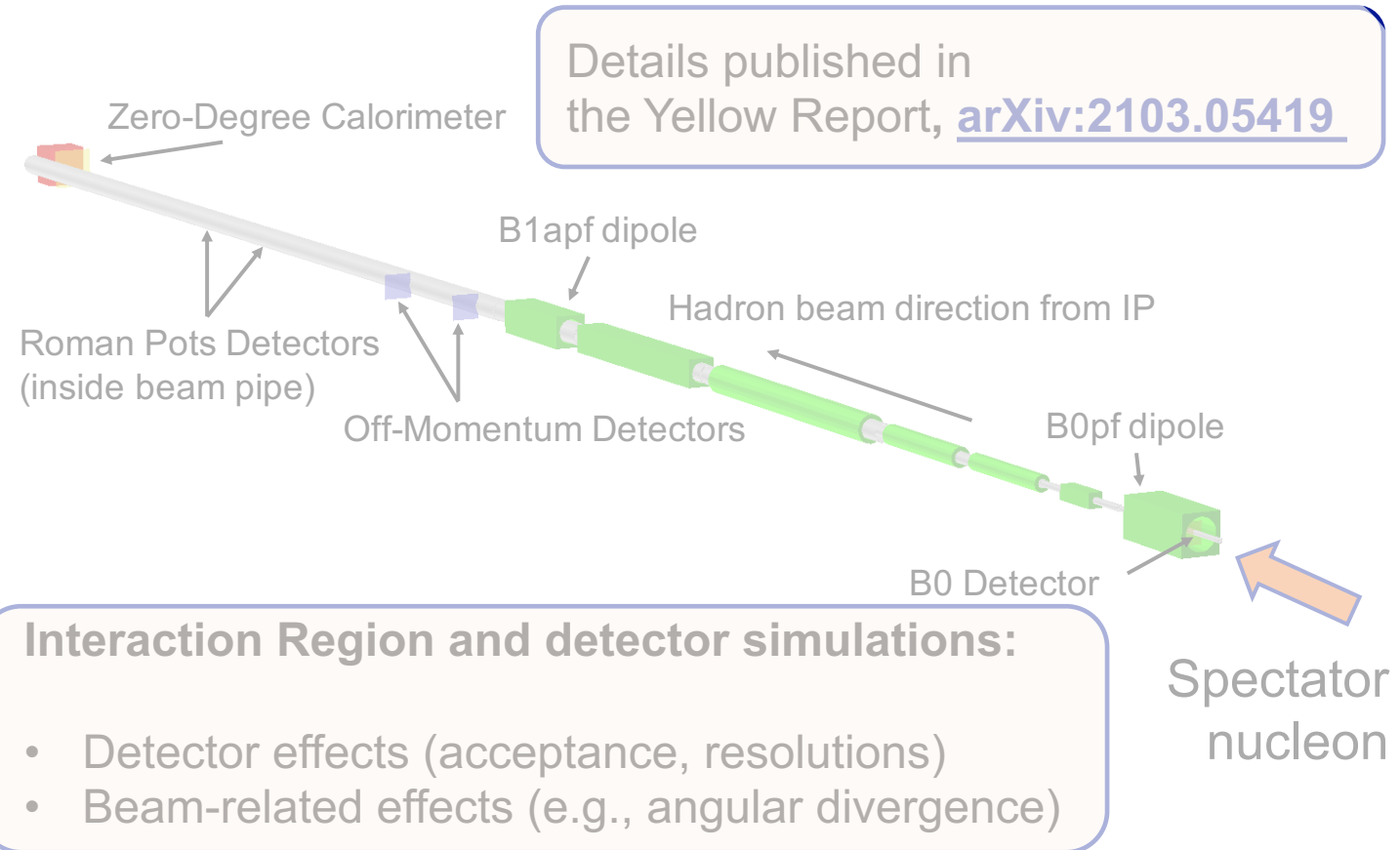
P_m - total three-momentum of the spectator



Results

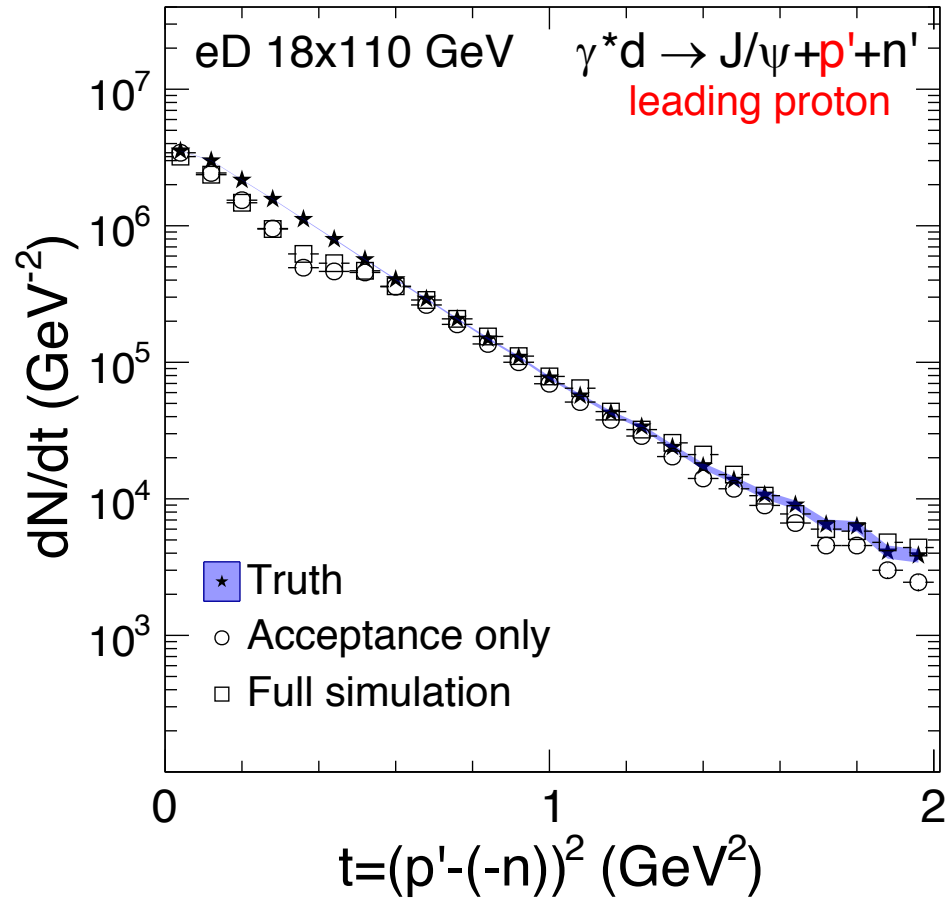


Momentum transfer $|t|$ distribution

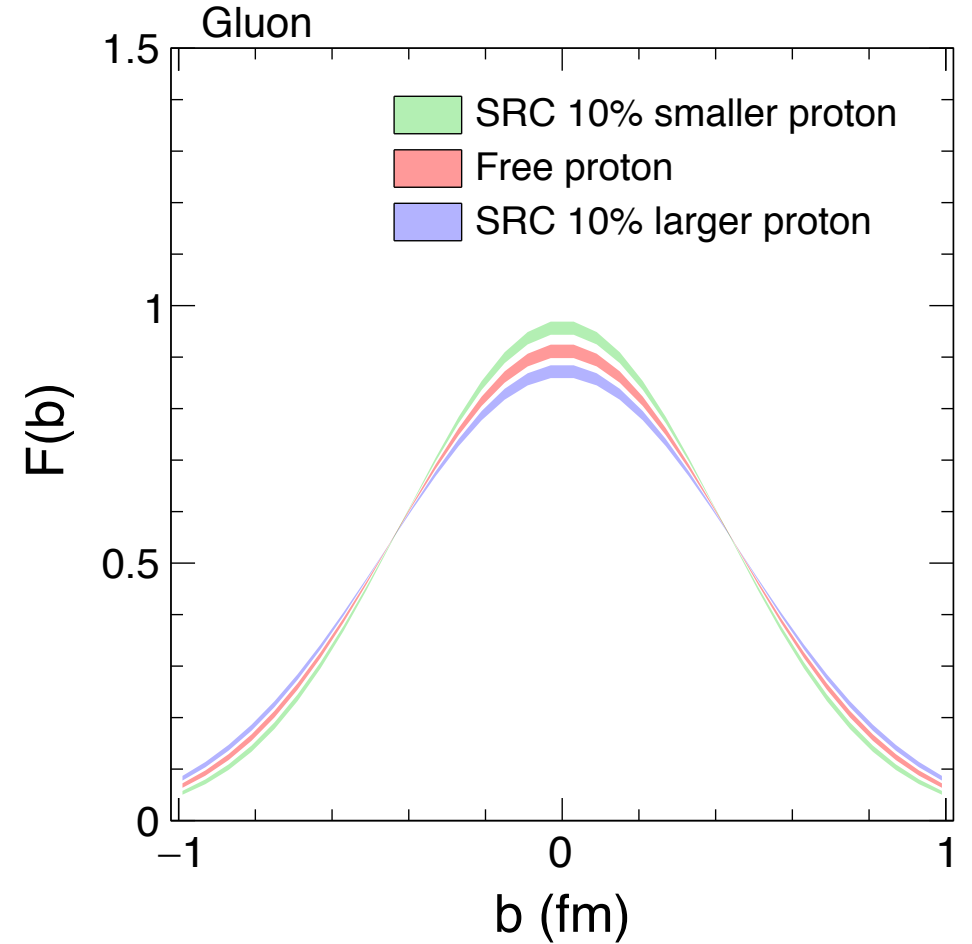


Results

BeAGLE



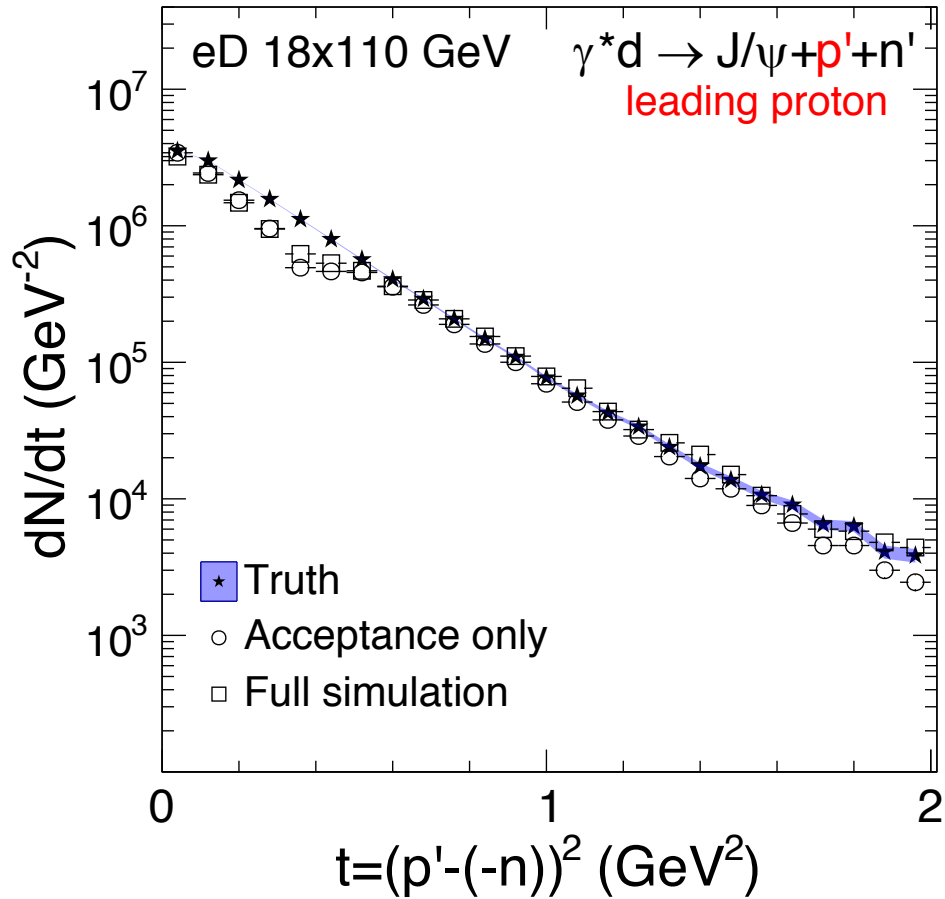
Momentum transfer $|t|$ distribution



Comparison between SRC nucleon with free nucleon

Results

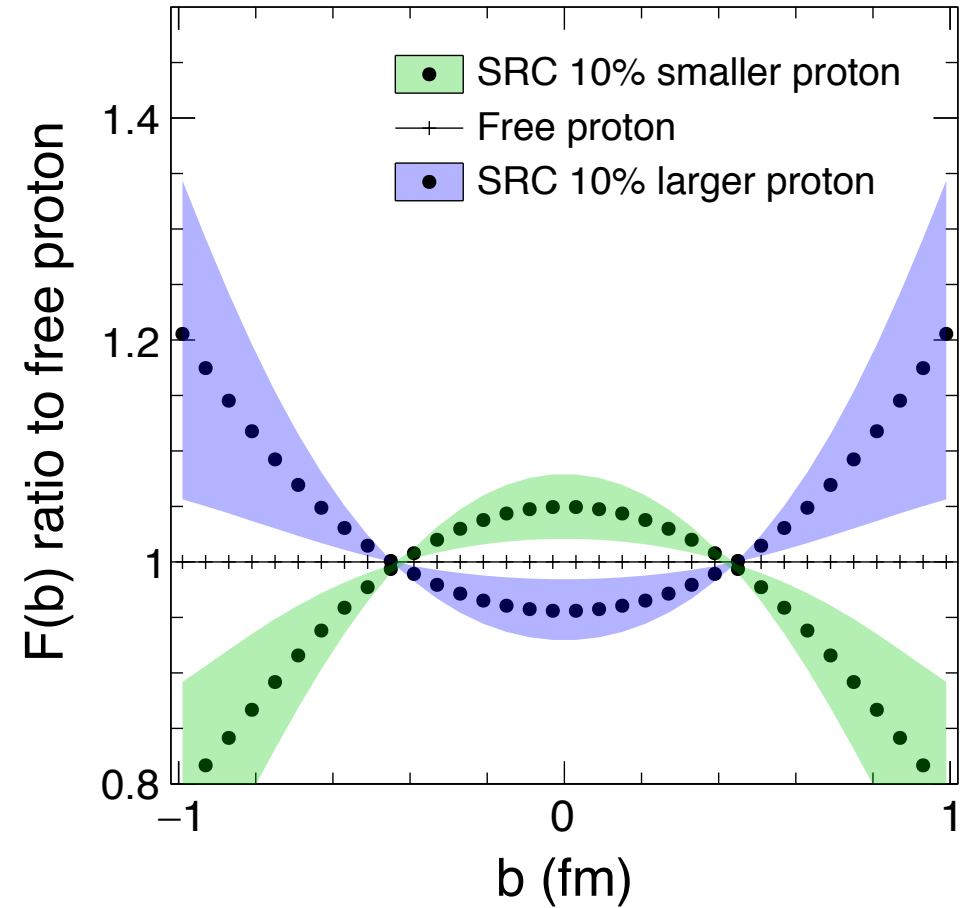
BeAGLE



Momentum transfer $|t|$ distribution



Gluon

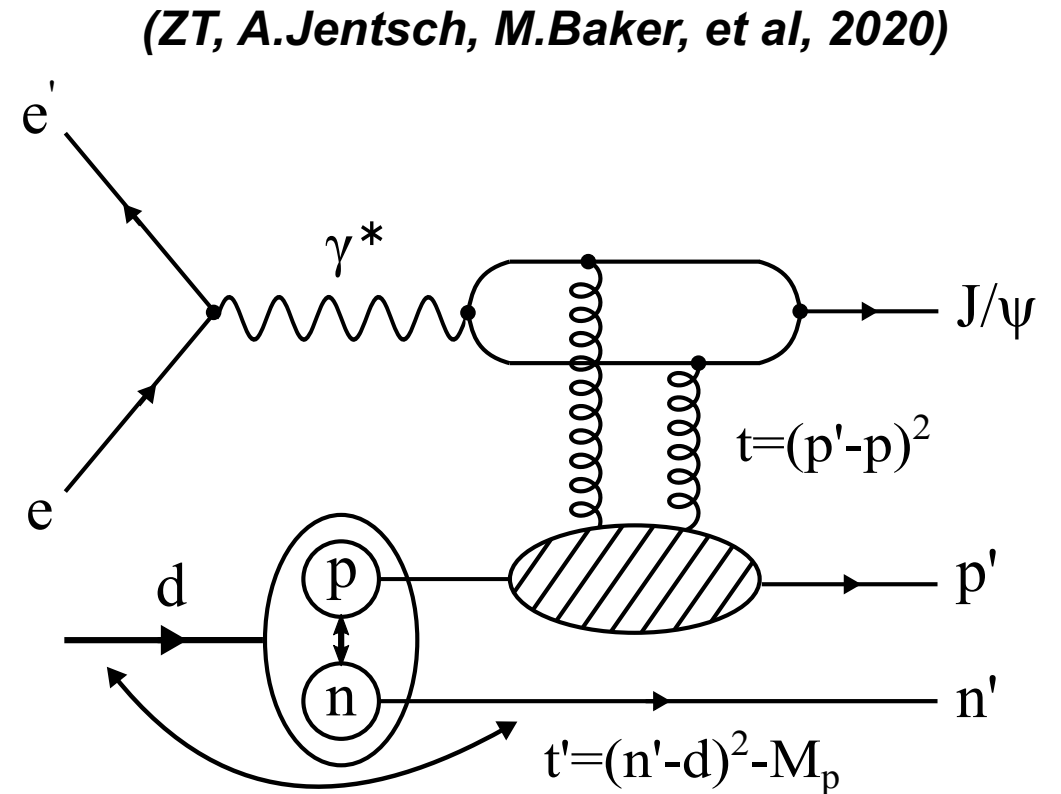


Comparison between SRC nucleon with free nucleon

Summary

Incoherent diffractive J/Ψ production in electron-deuteron scattering:

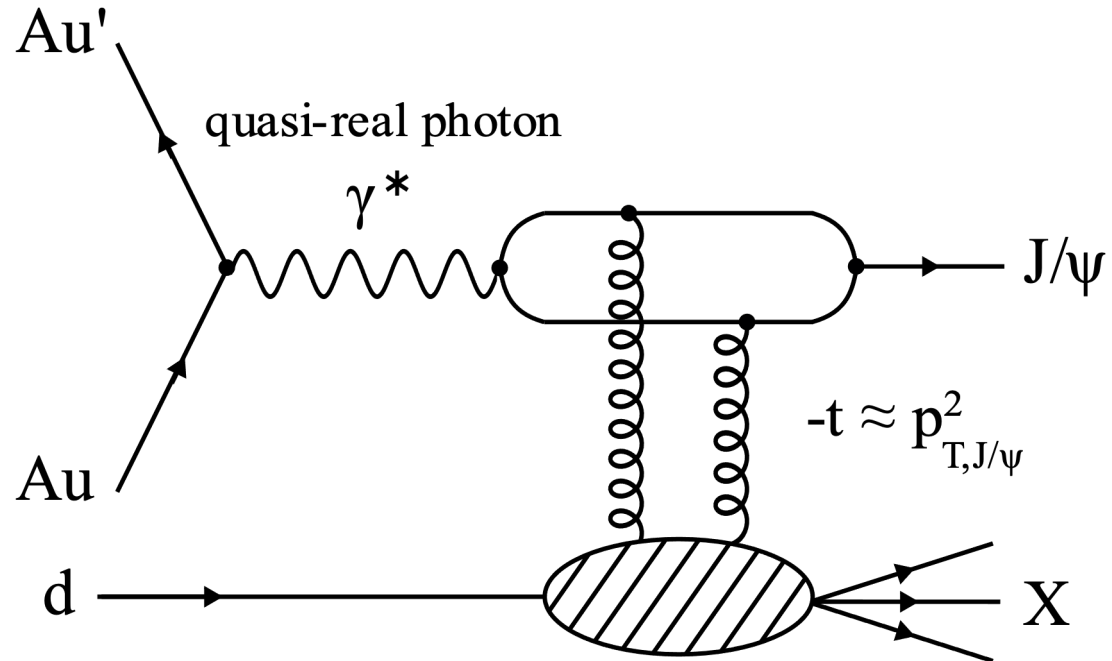
- Physics:
 - gluonic structure and nuclear modifications
- Advantages:
 - Directly probe bounded nucleons;
 - Short-range correlations might provide a “nuclear-like” environment.
- Electron-Ion Collider:
 - Complex IR and great forward detectors;
 - Great acceptances and resolution to tag a spectator and the J/Ψ



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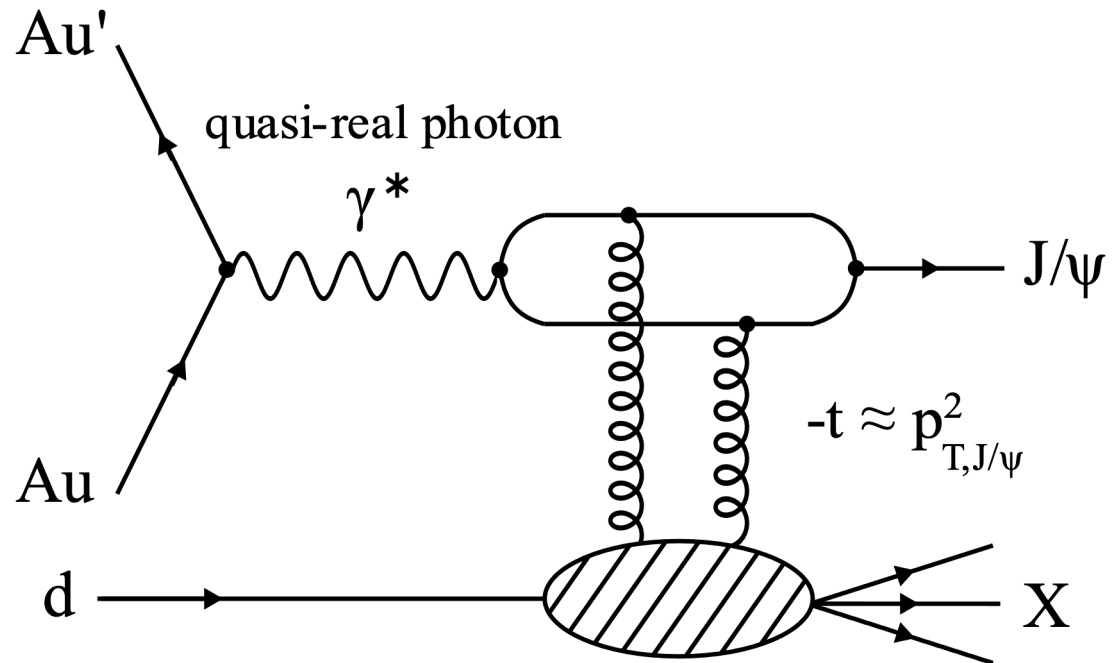
Backup

Ultra-peripheral collisions in d+Au



UPC data provides a promising result related to this study – photoproduction of J/ψ

Ultra-peripheral collisions in d+Au



UPC data provides a promising result related to this study – photoproduction of J/ψ

- Total = Coherent + incoherent (incoherent = elastic and dissociative)

