

Incoherent diffractive J/ψ productions off *deuteron* at the EIC

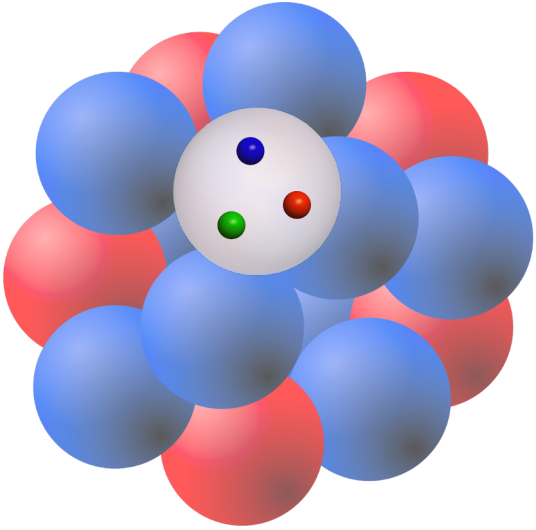
Zhoudunming Tu (*Kong*)

BNL

04.13.2021

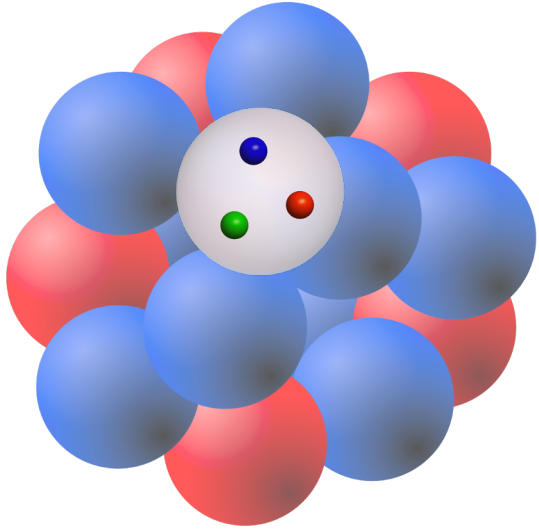
Collaboration with A. Jentsch , M. Baker , L. Zheng,
JH. Lee , R. Venugopalan , O. Hen , D. Higinbotham
, E. Aschenauer , T.Ullrich
(*Phys.Lett.B* 811 (2020) 135877)

Nucleon structure in nucleus

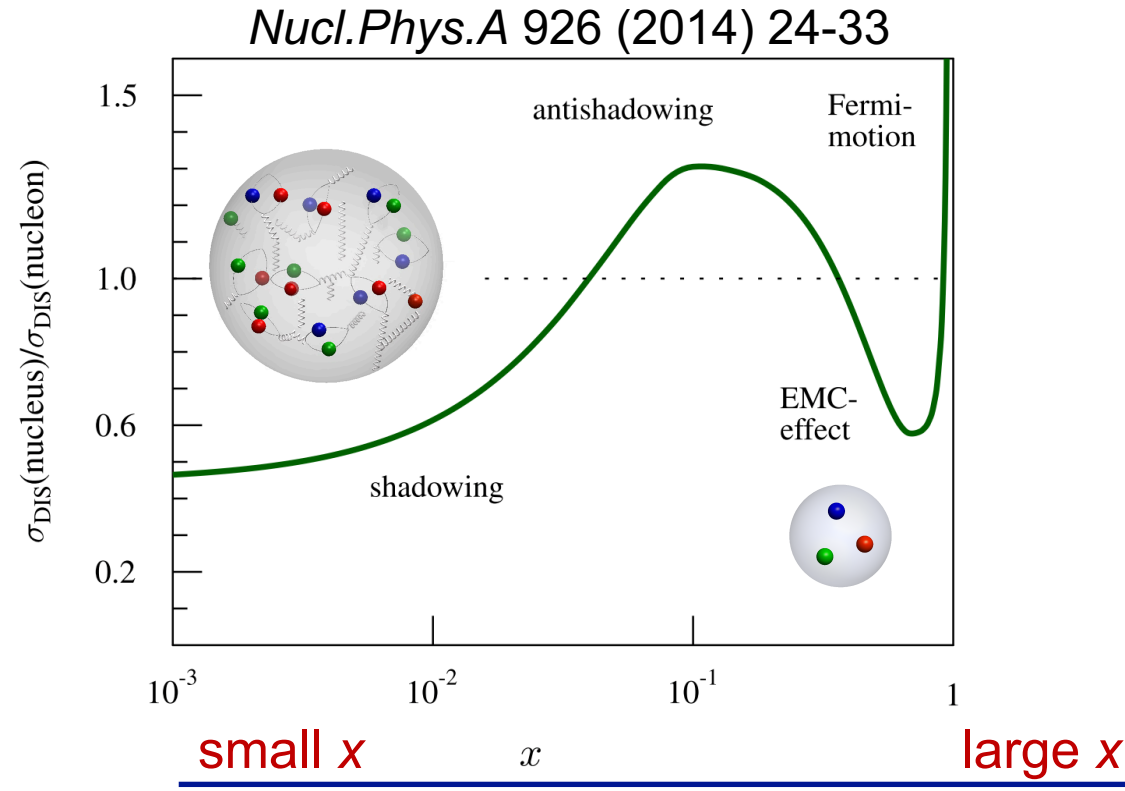


Nucleus
Protons + Neutrons

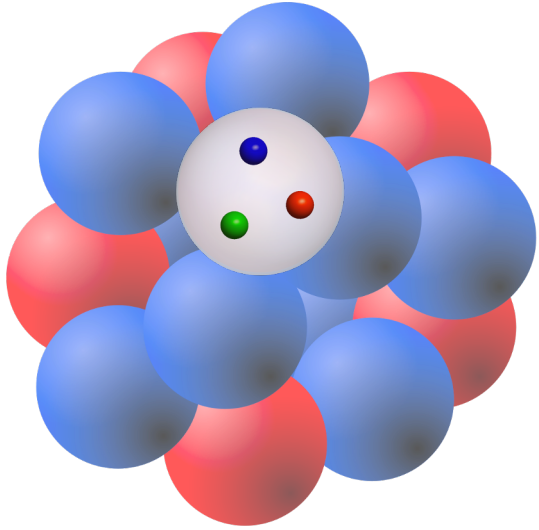
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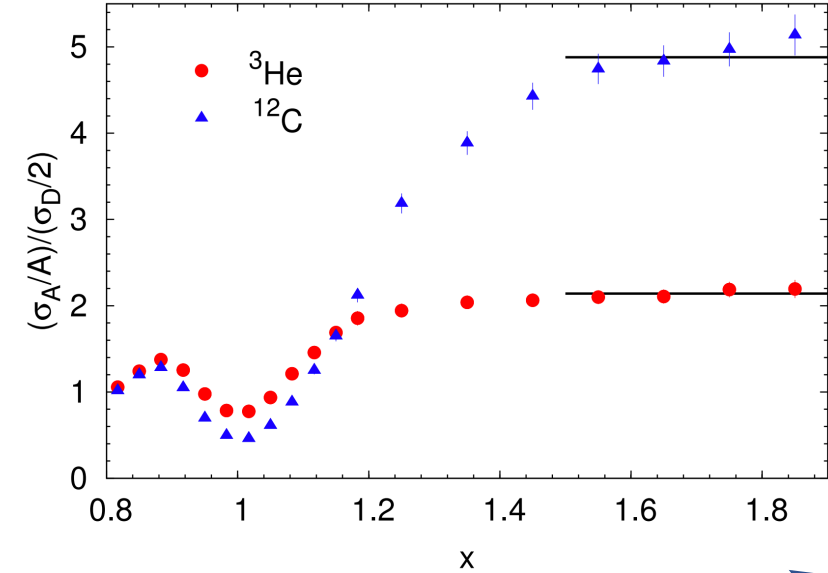
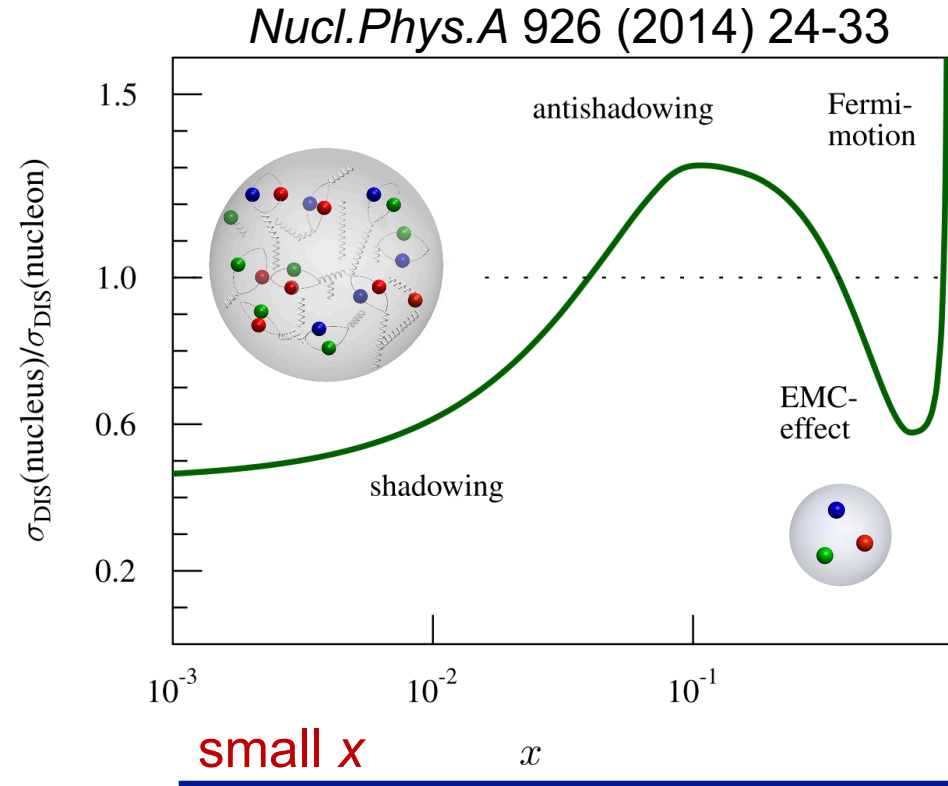
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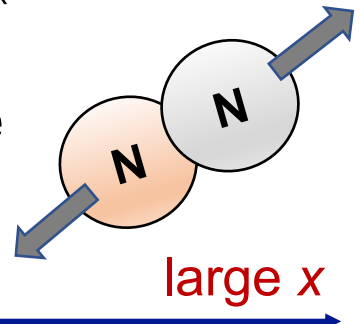
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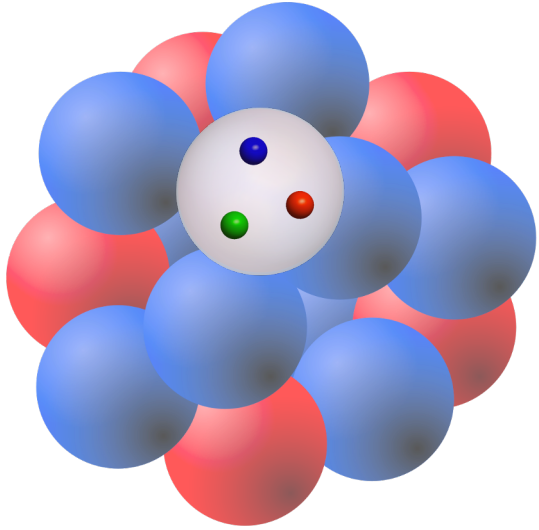
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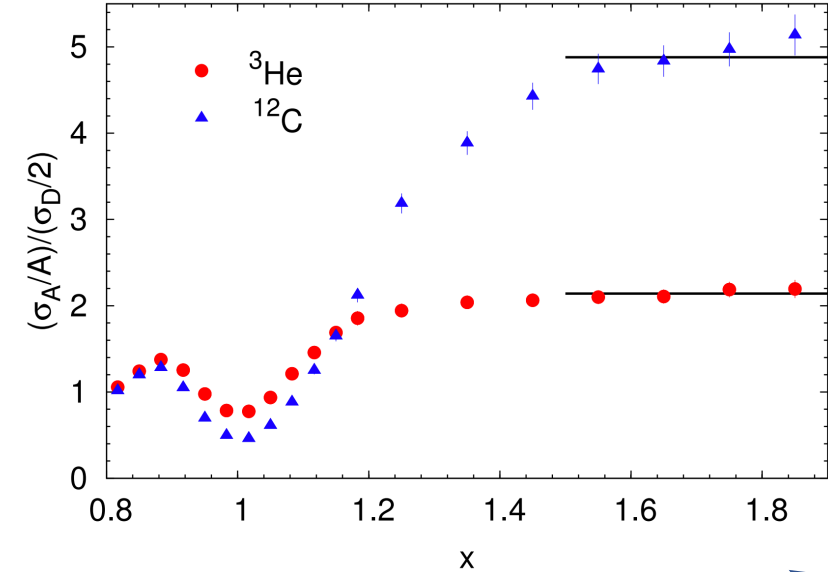
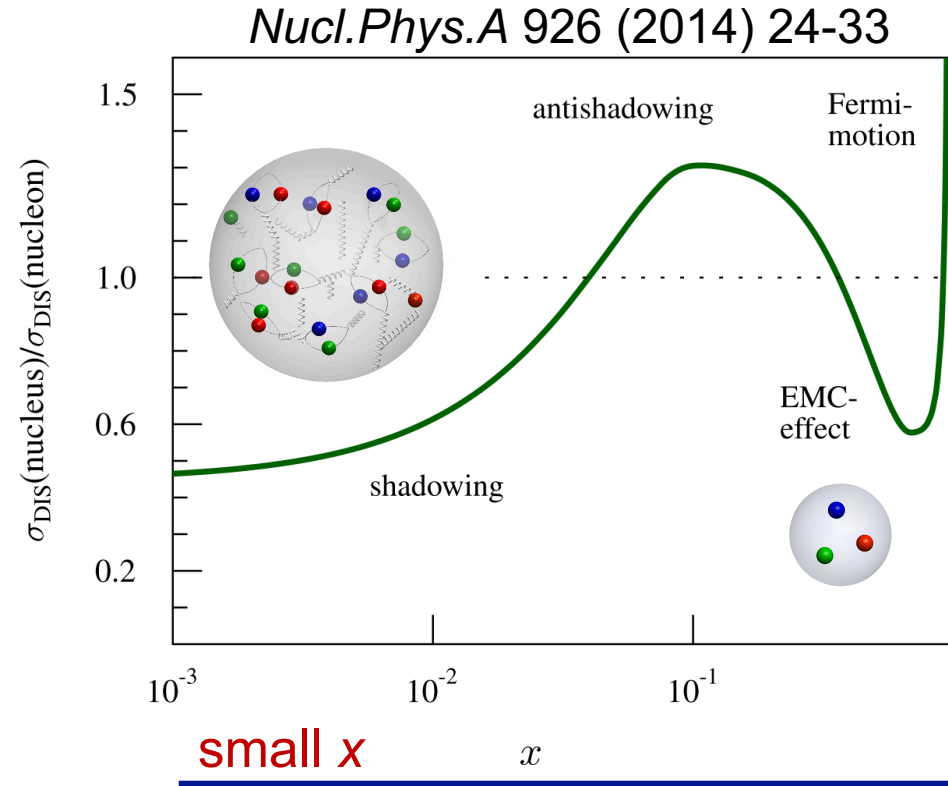
SRC:
Short-Range
Correlations



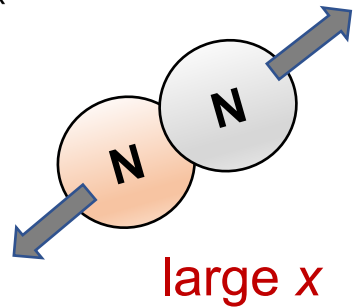
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Nucleus
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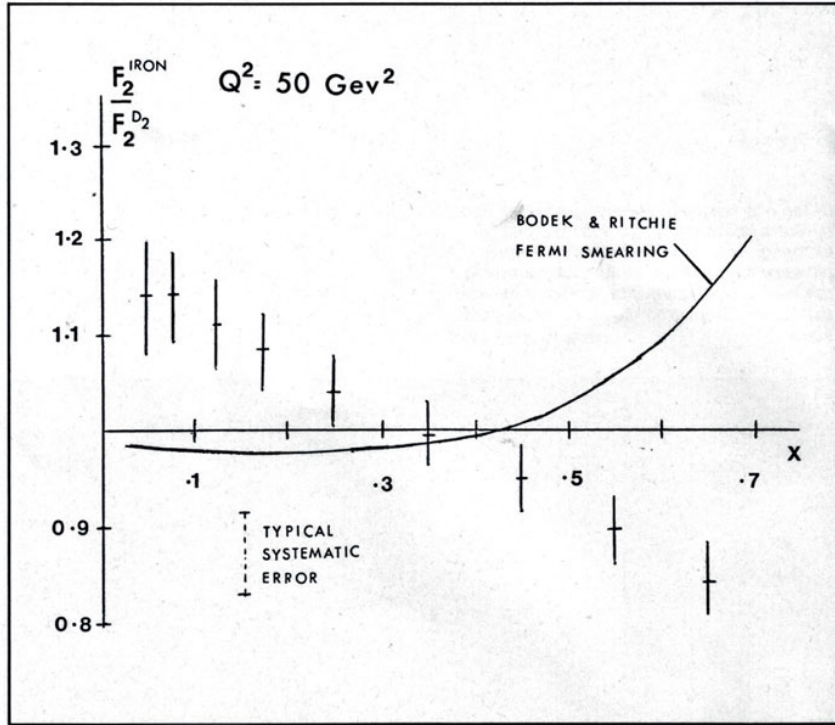
SRC:
Short-Range
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Why is nucleus not a collection of free nucleons?

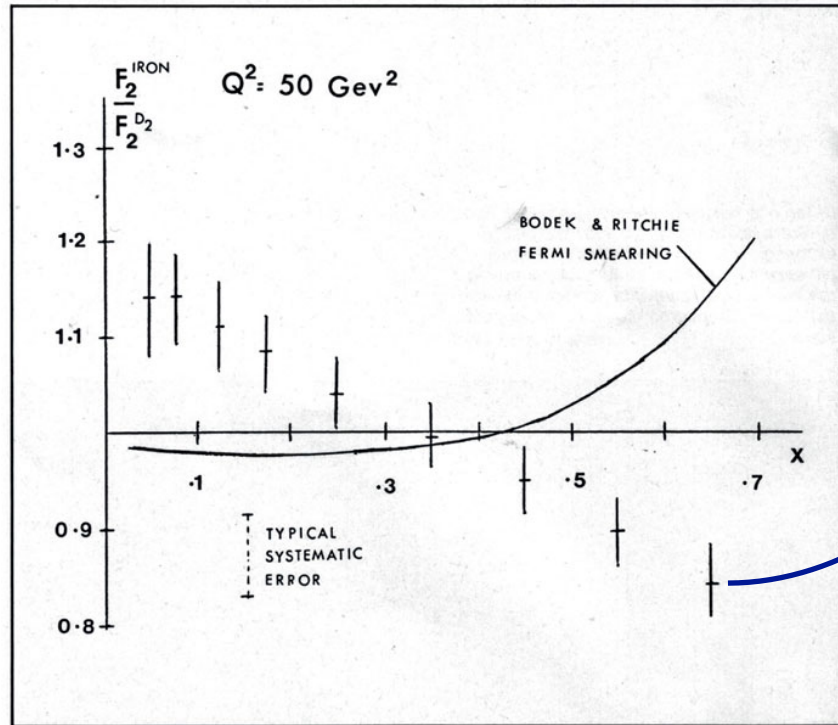
EMC-SRC correlation

EMC puzzle (Aubert *et al.* 1983)



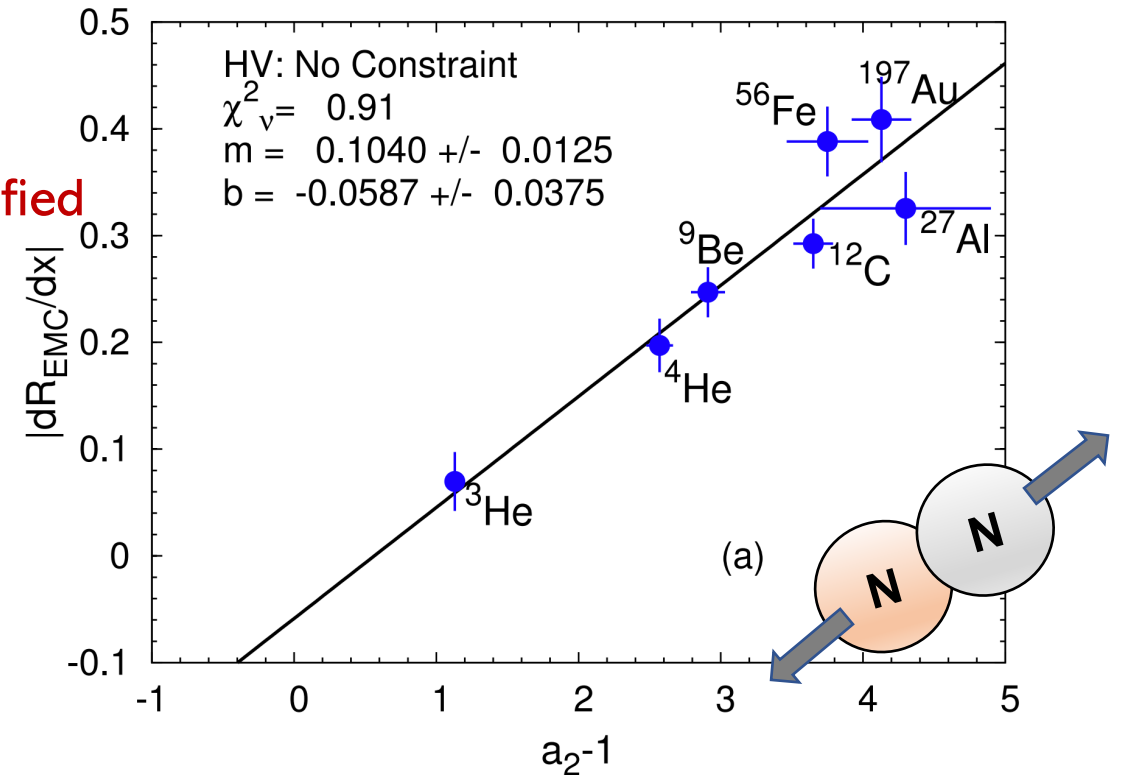
EMC-SRC correlation

EMC puzzle (Aubert *et al.* 1983)



How much nucleon structure gets modified

EMC-SRC are correlated

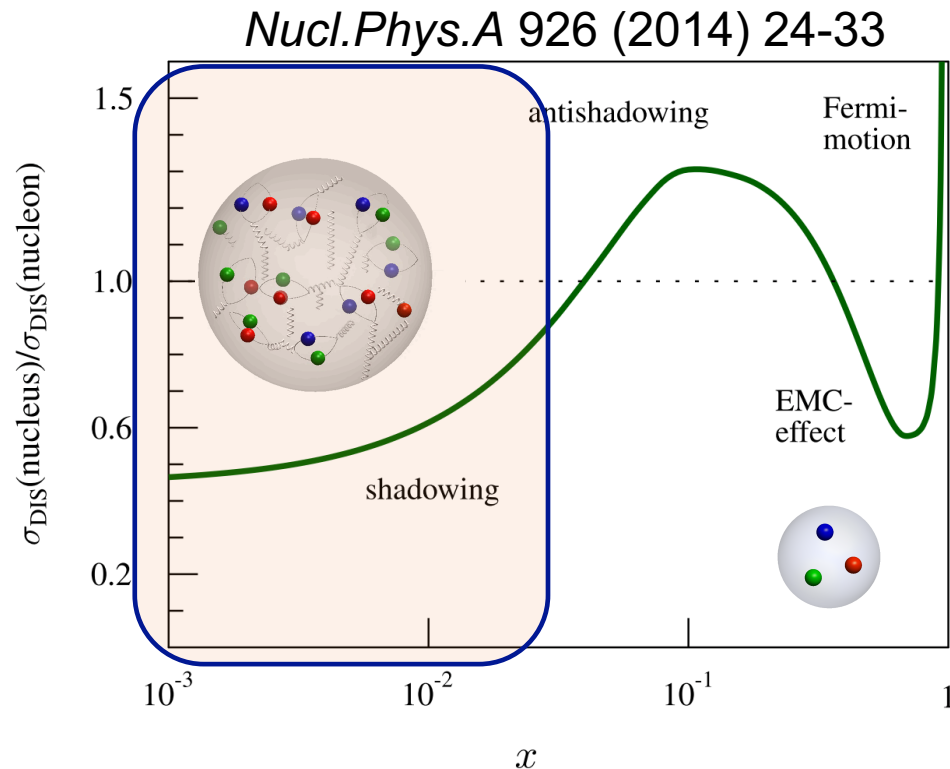


How strong the SRCs are

Recent data indicated the SRC might be the cause of EMC

What about gluon?

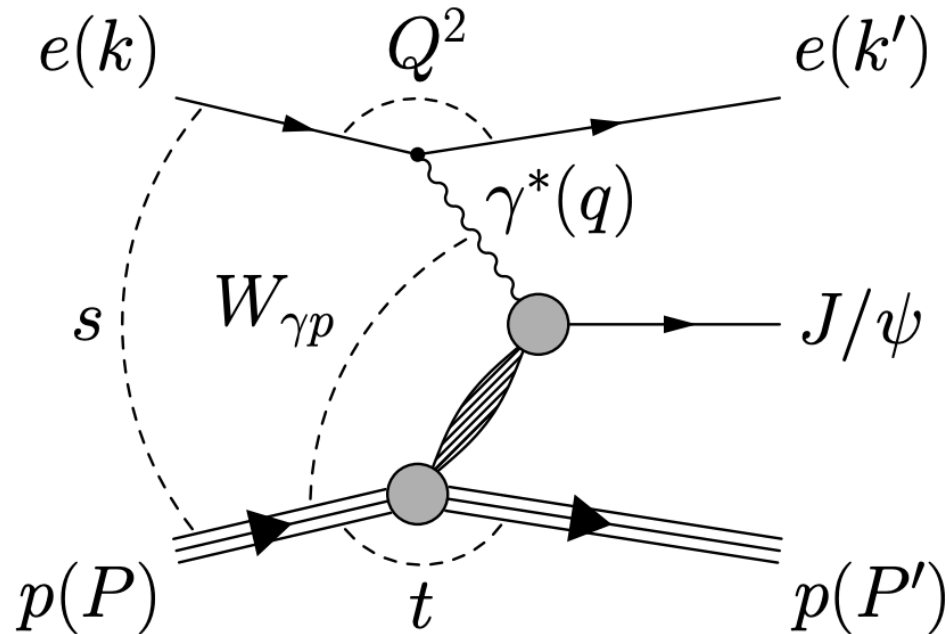
- A natural question to ask is whether SRC pairs would modify the gluonic structure of nucleons at low x .



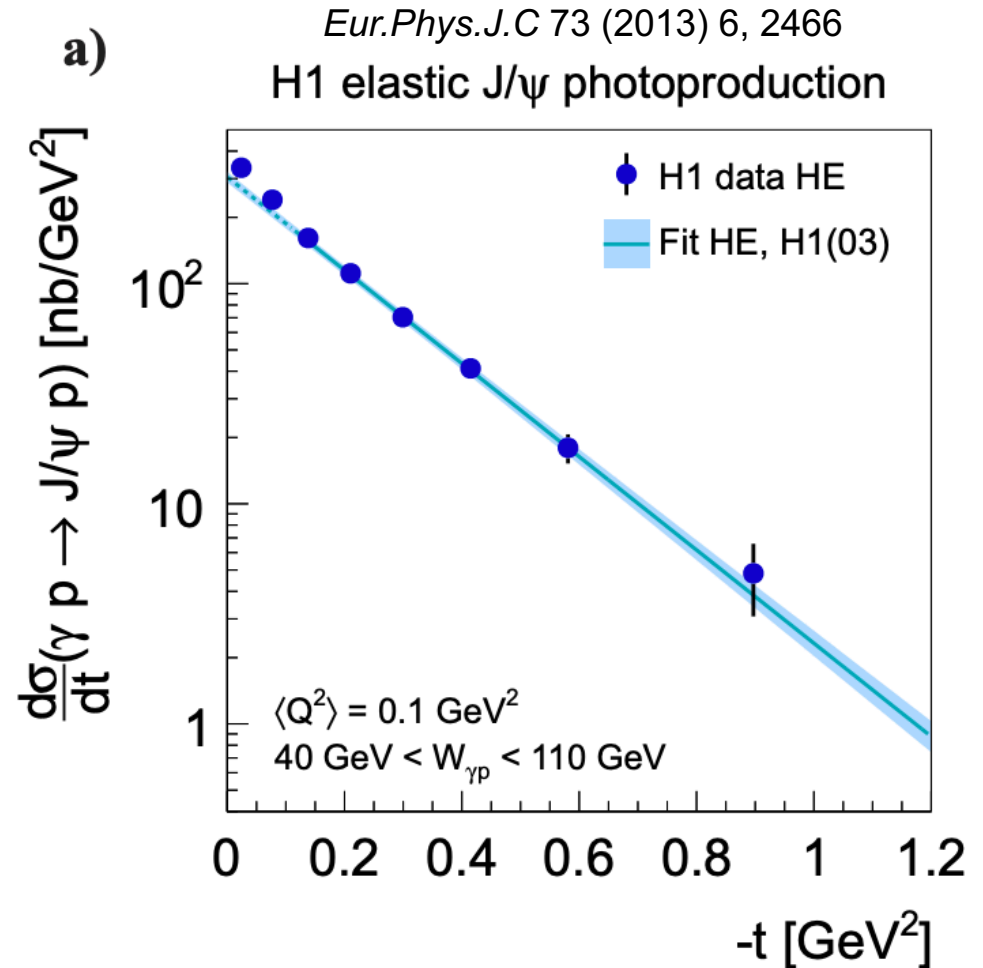
More specifically we ask:

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

Diffractive J/Ψ production

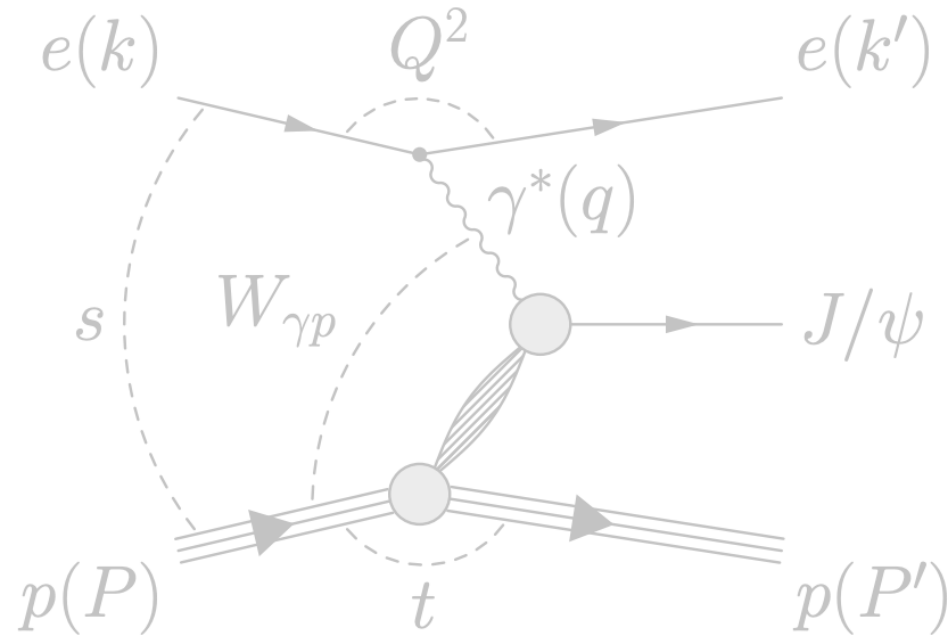


Diffractive J/Ψ in ep



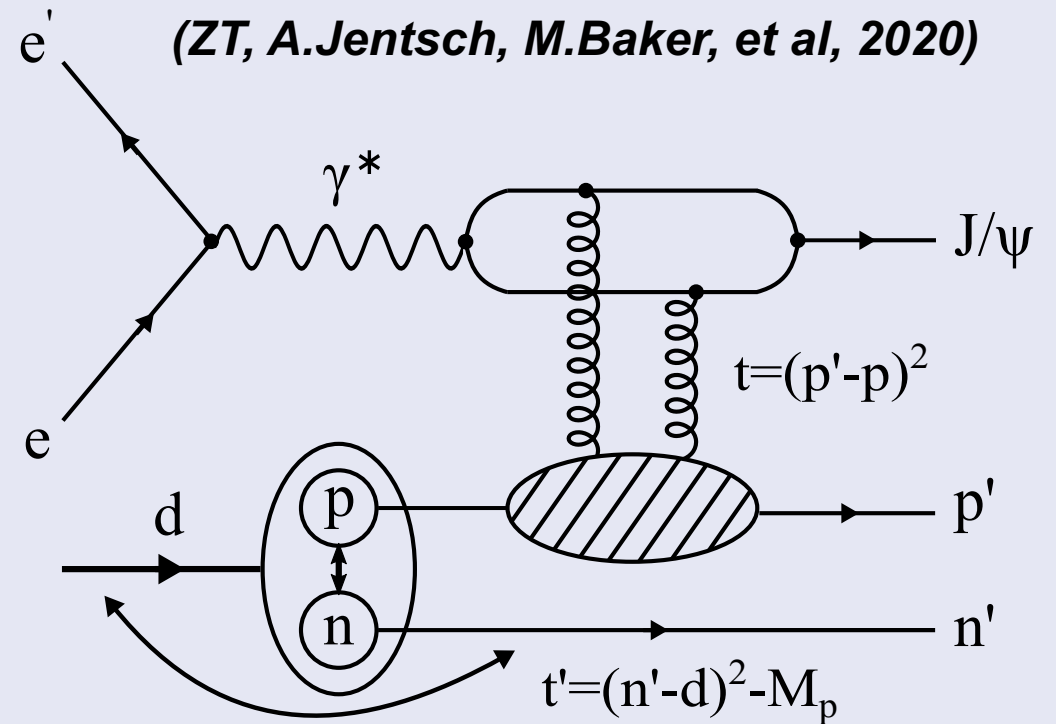
Momentum transfer $-t$ distributions $\rightarrow$ source distribution (gluons)

Diffractive J/Ψ production in *deuteron*



Diffractive J/Ψ in ep

New

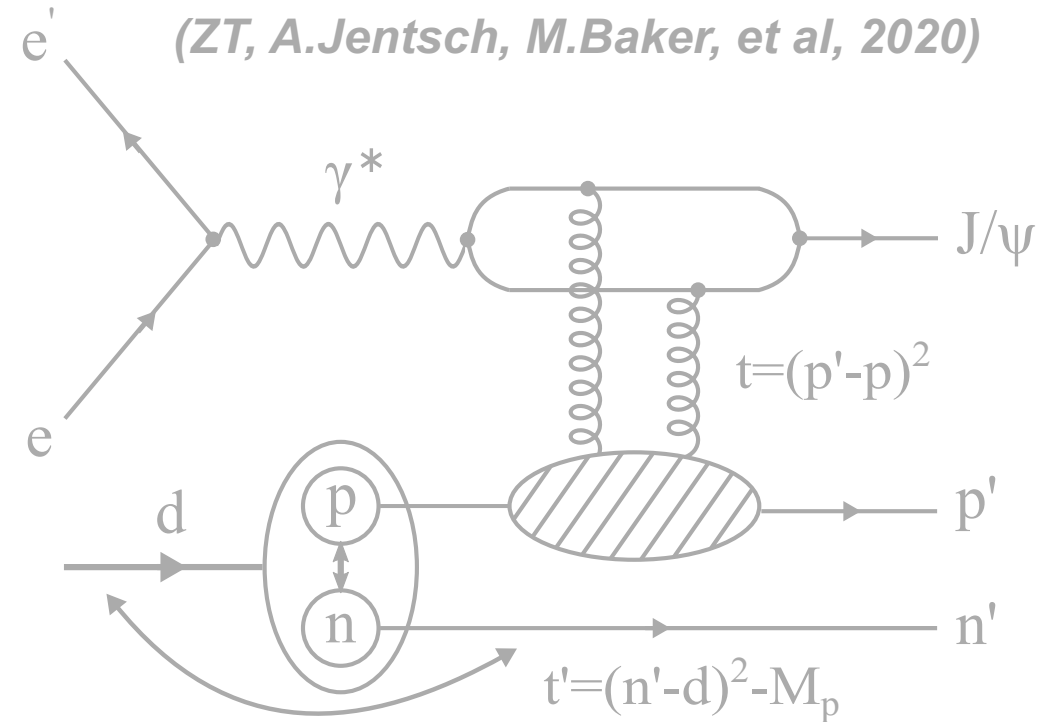


Probing the gluonic structure with an experimental **control - spectator**

Diffractive J/Ψ production in *deuteron*

Advantages of this new measurement:

- Incoherent J/Ψ production directly probes bounded nucleons;

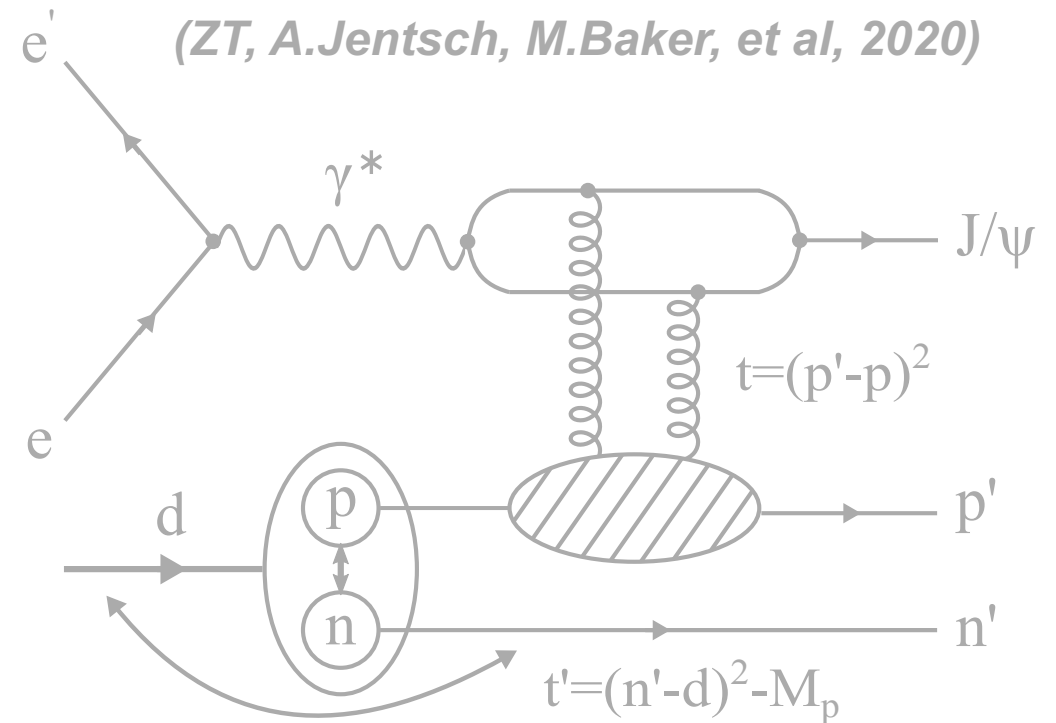


Probing the gluonic structure with an experimental *control - spectator*

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- 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**

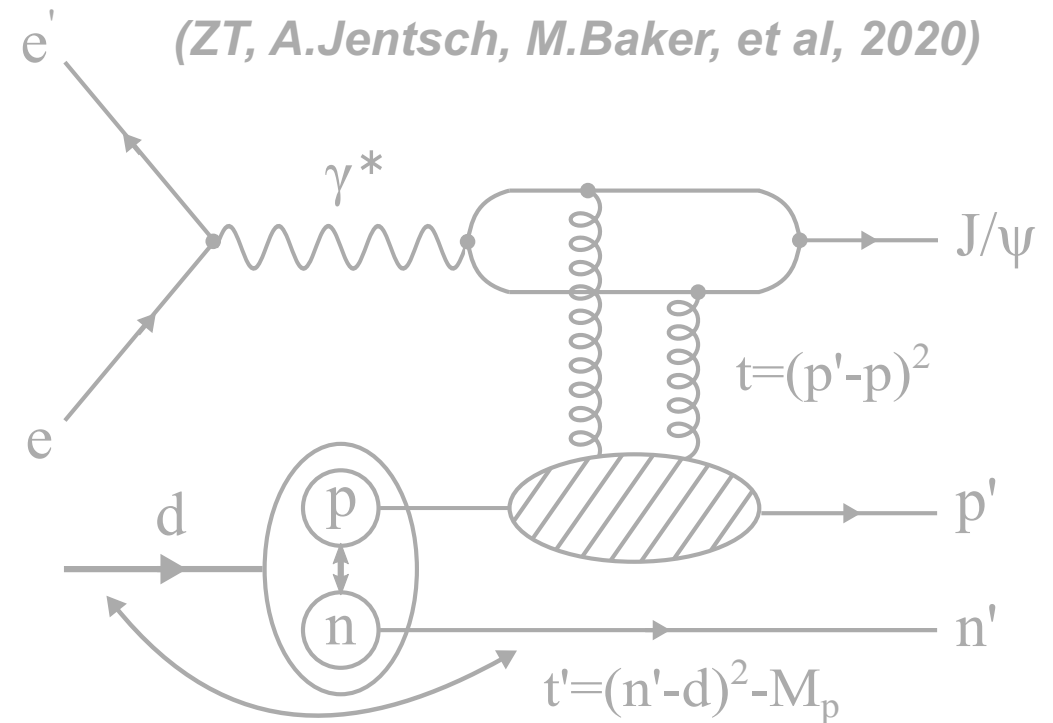
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Similar technique is being used for free nucleon structure measurement.

See talk by **A. Jentsch**, 15 Apr 2021, 08:00am



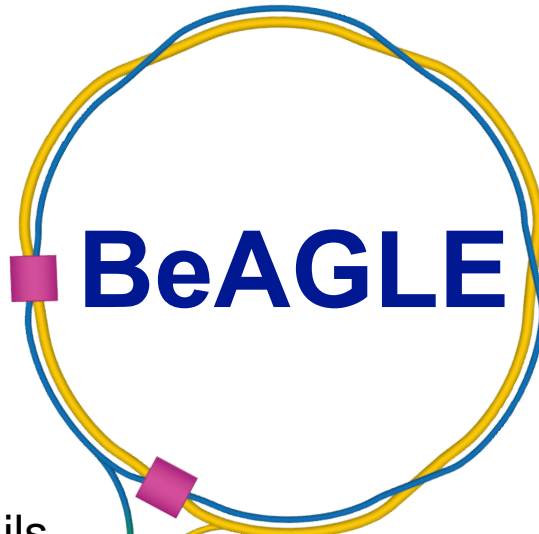
Probing the gluonic structure with an experimental ***control - spectator***

Diffractive J/ψ production in *deuteron*

How can we study this process now?

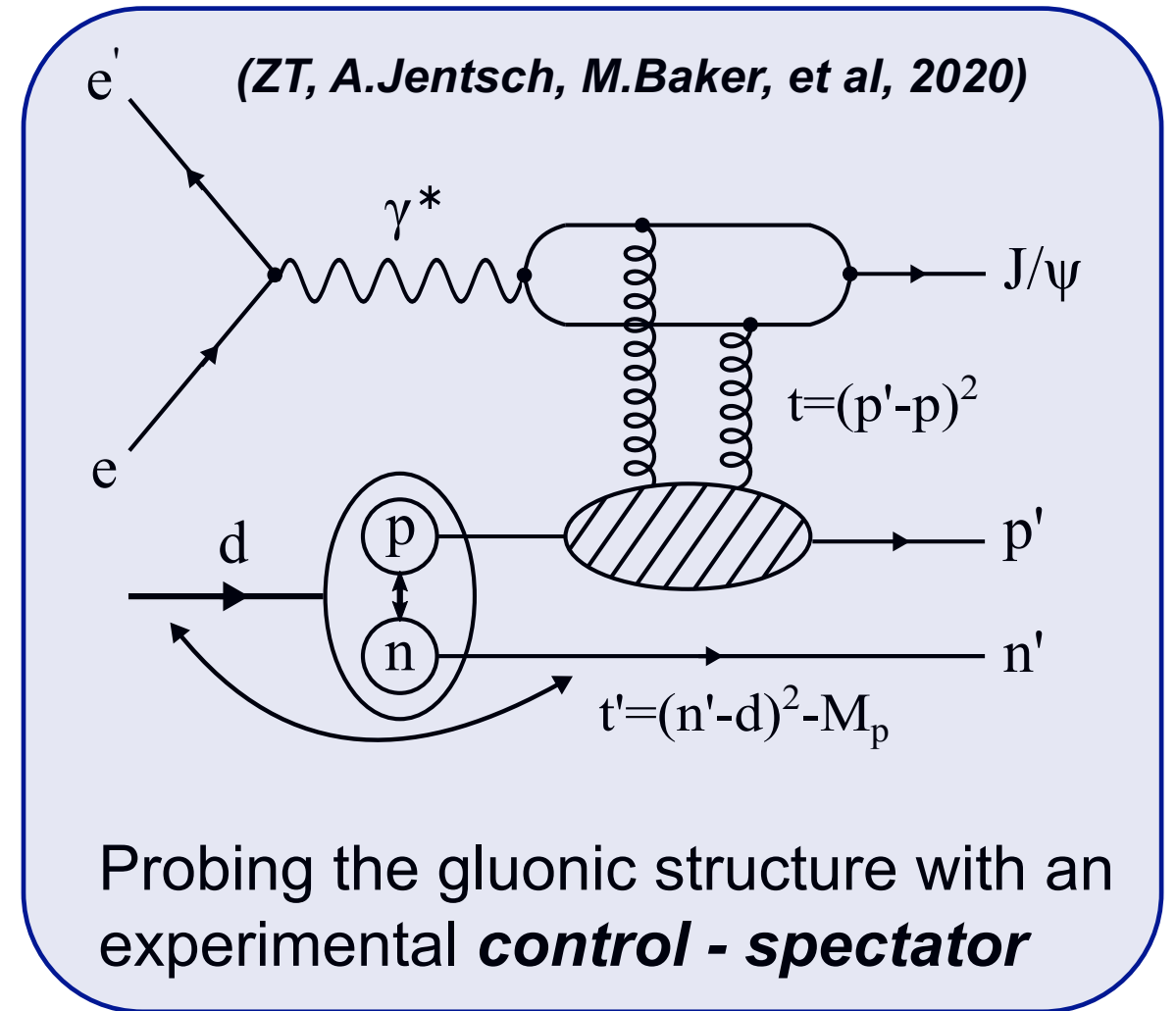


Click [here](#) for details



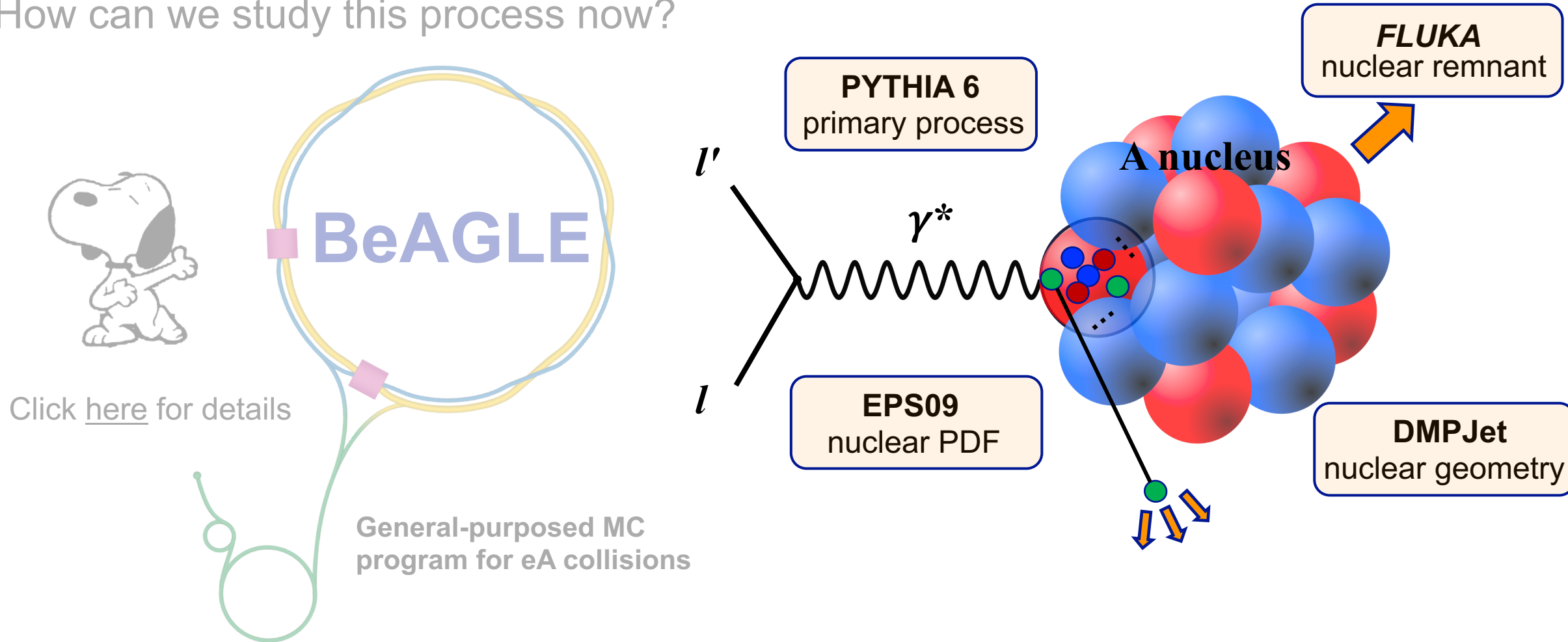
General-purposed MC
program for eA collisions

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



Diffractive J/ Ψ production in *deuteron*

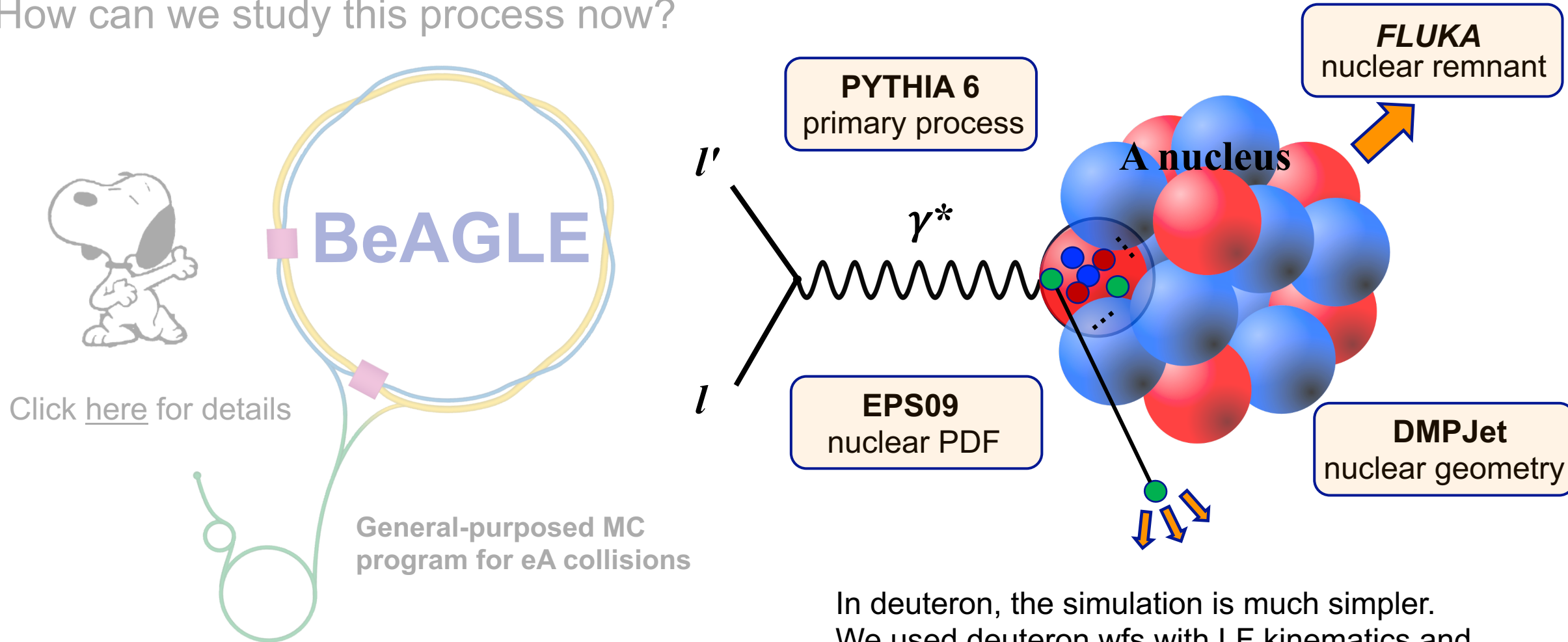
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(E. Aschenauer, M. Baker, J. Lee, ZT, and L. Zheng)

Diffractive J/ Ψ production in *deuteron*

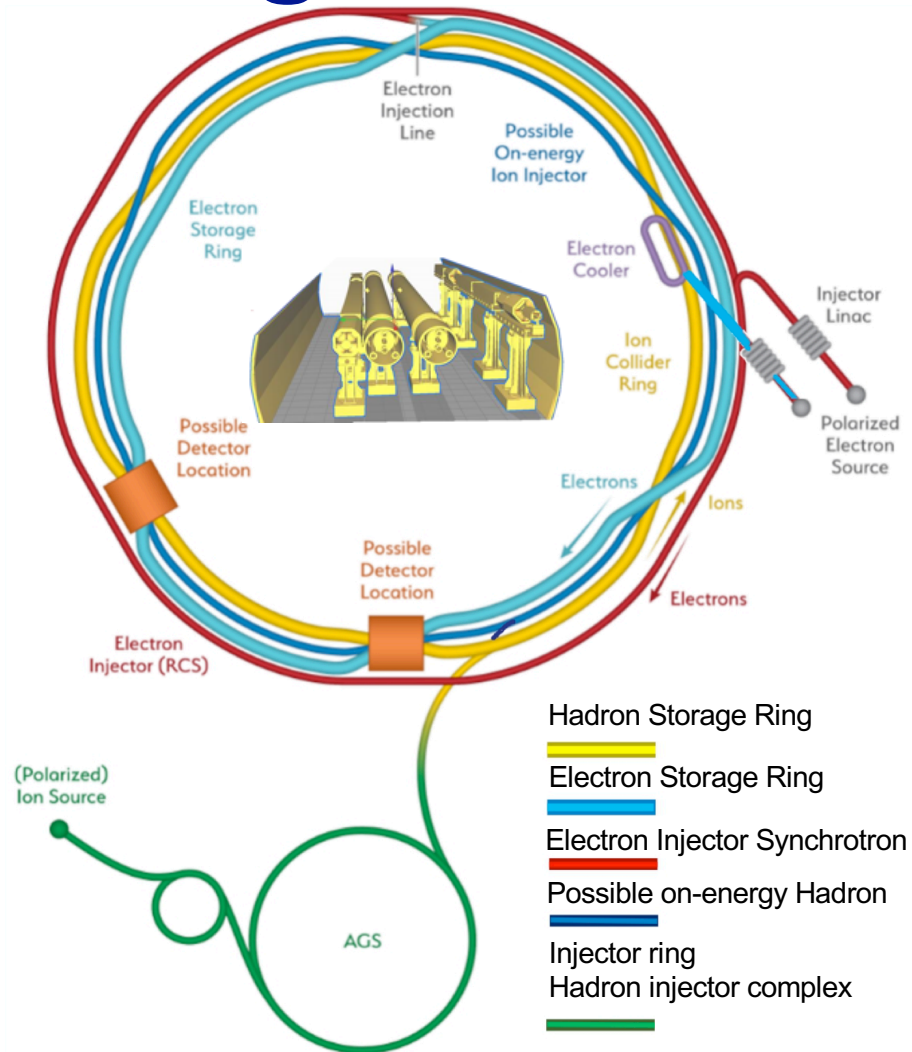
How can we study this process now?



(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



Sited at Brookhaven National Laboratory
Electron-Ion Collider

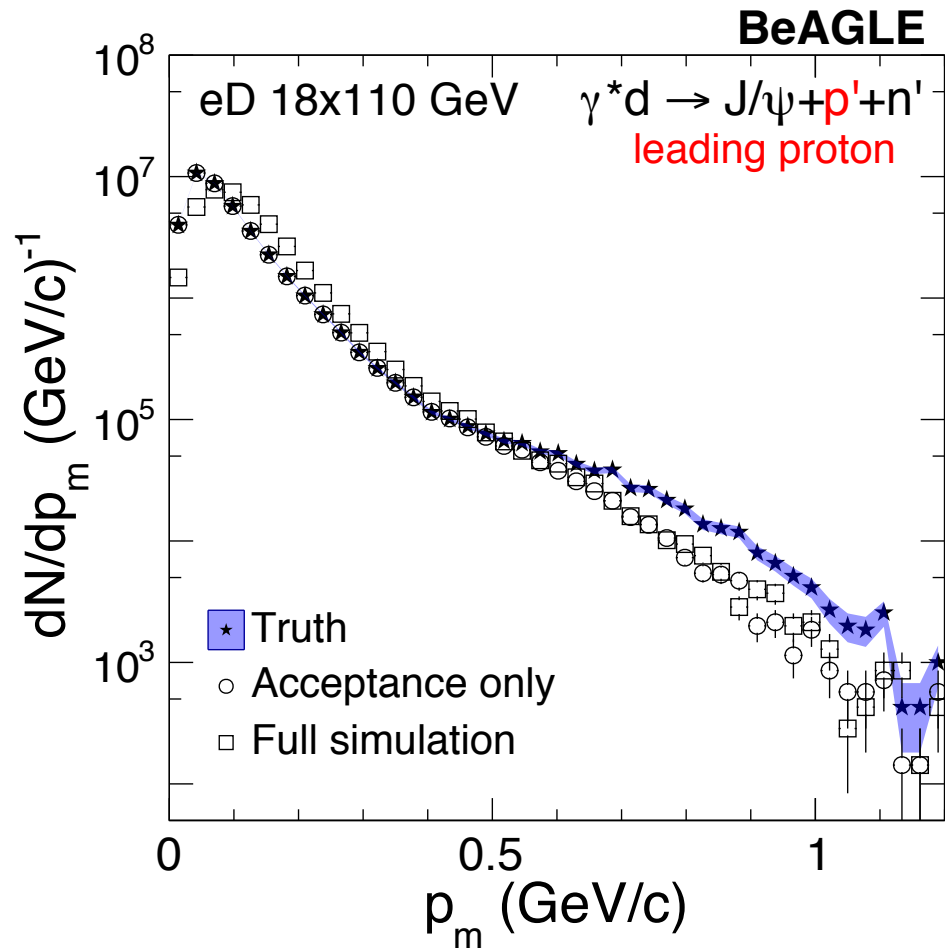
High energy & luminosity accelerator machine with beam polarization.

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

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

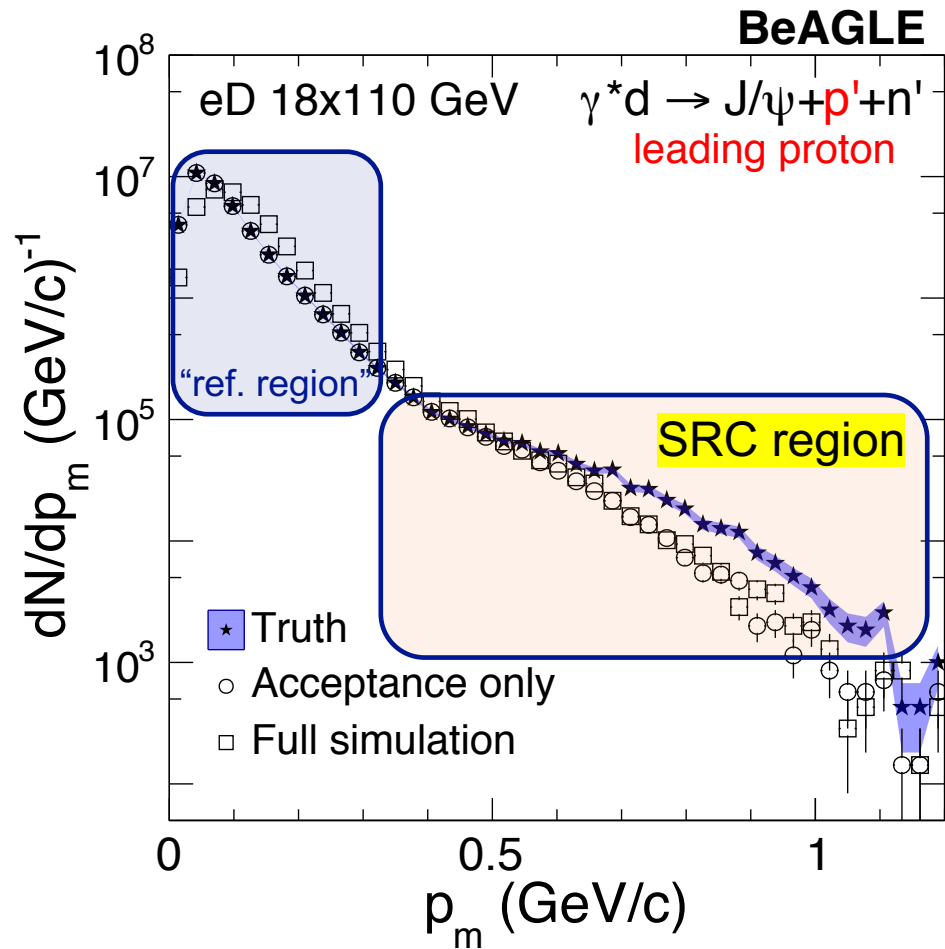
Diffractive & Exclusive reactions are one of the major physics at EIC

Results



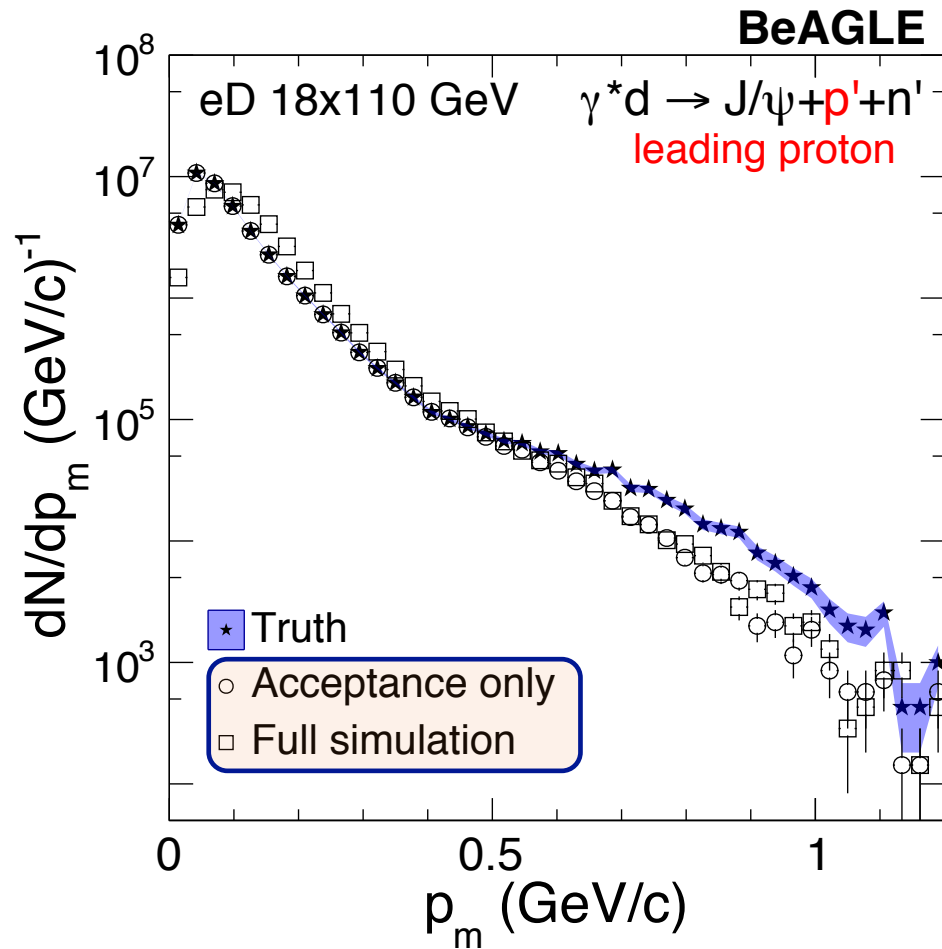
P_m - total three-momentum of the spectator

Results



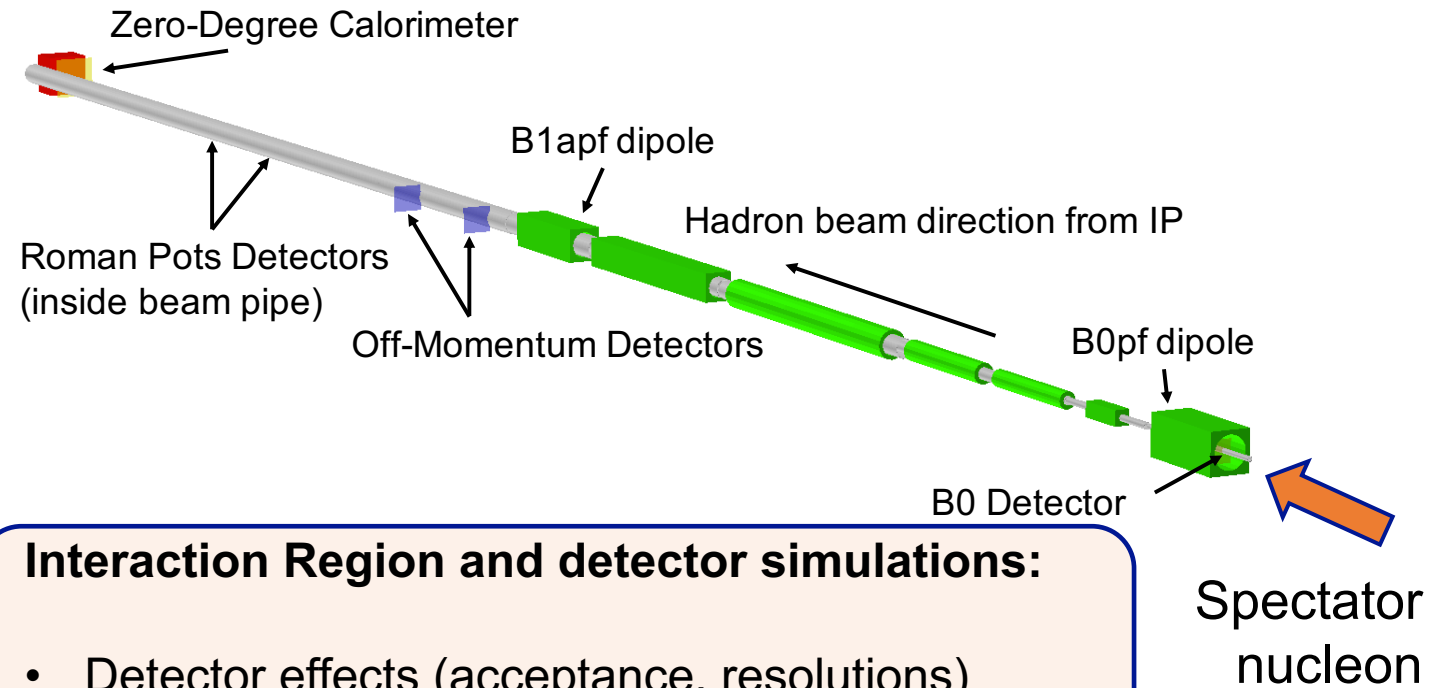
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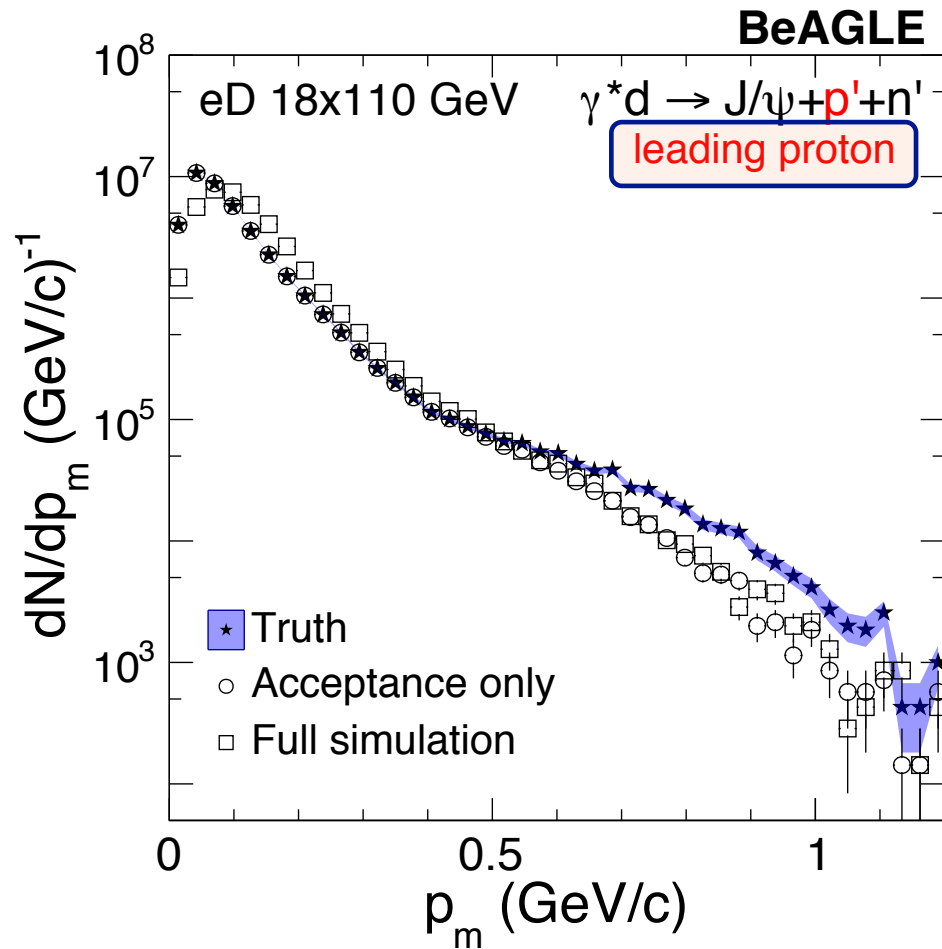
EIC IR concept



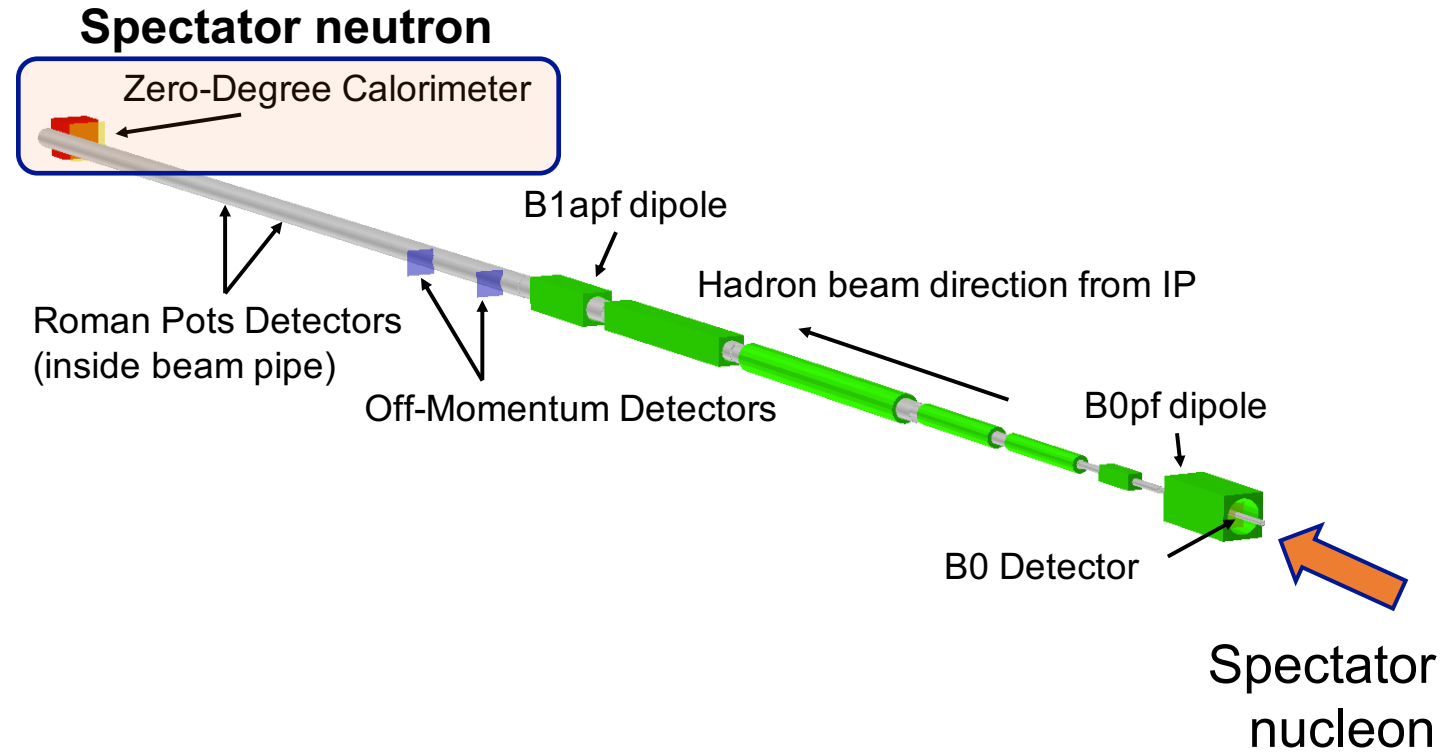
Interaction Region and detector simulations:

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

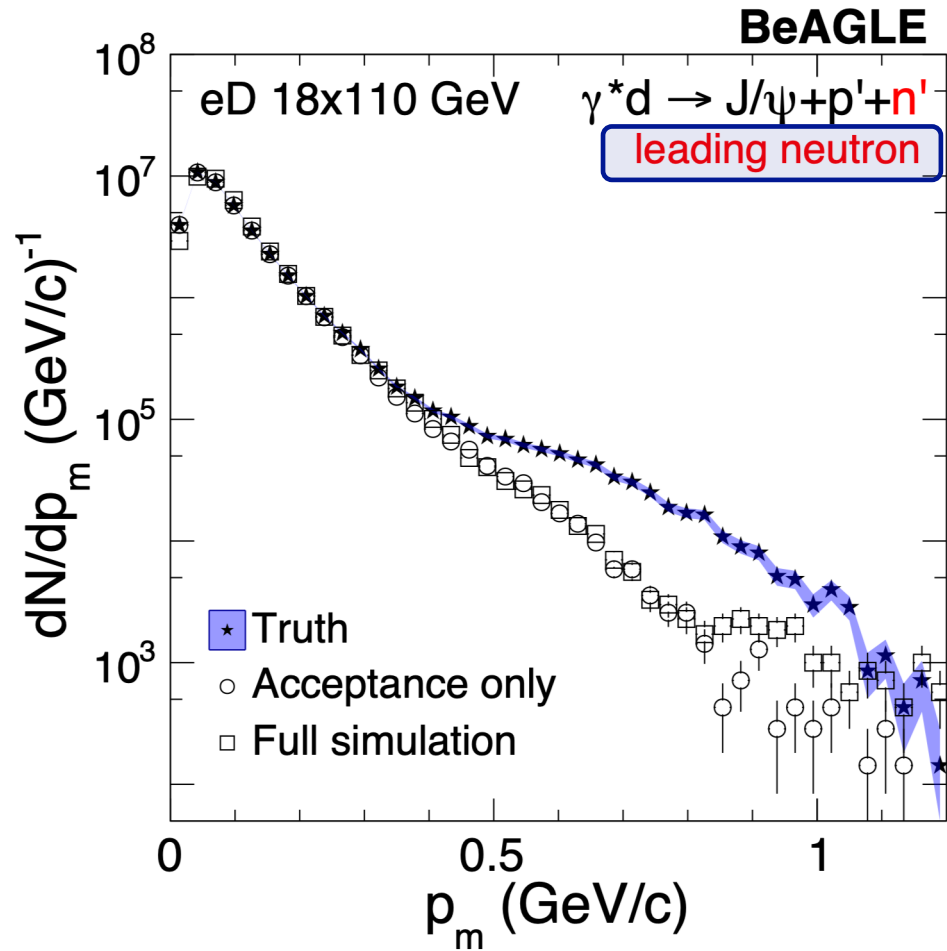
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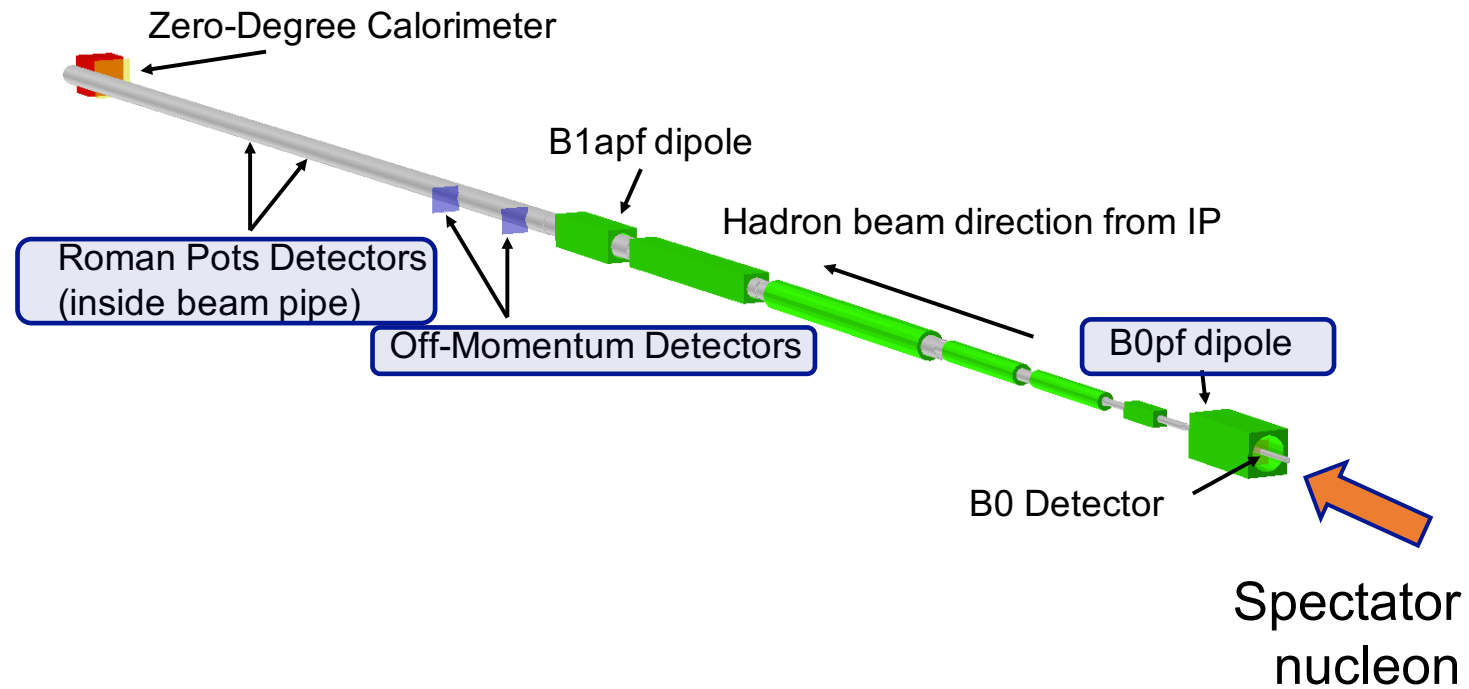
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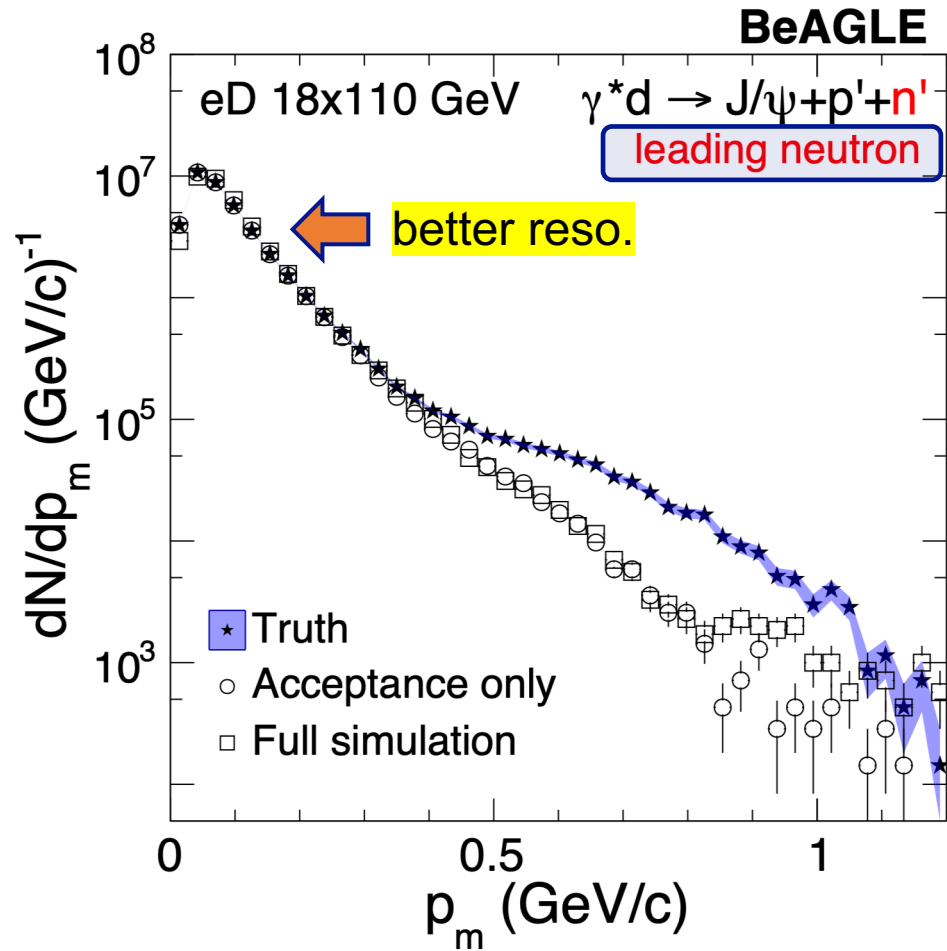
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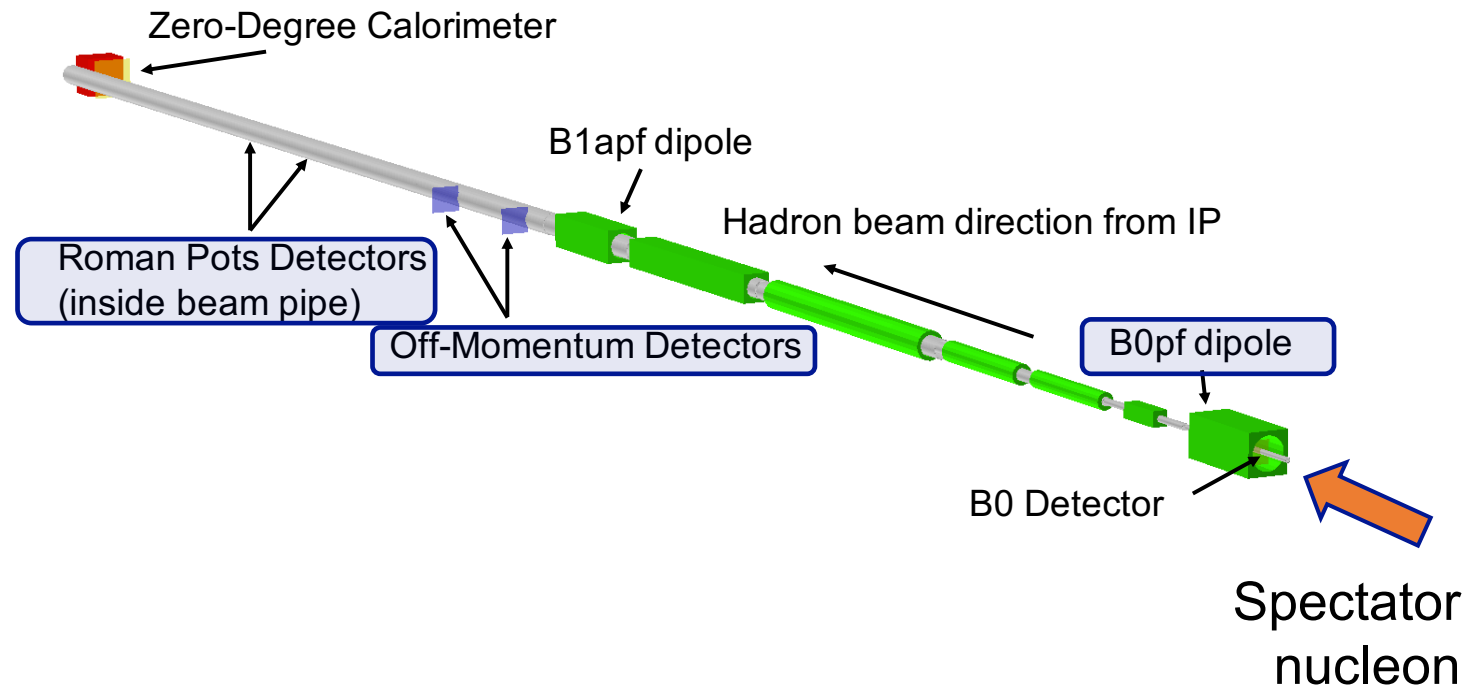
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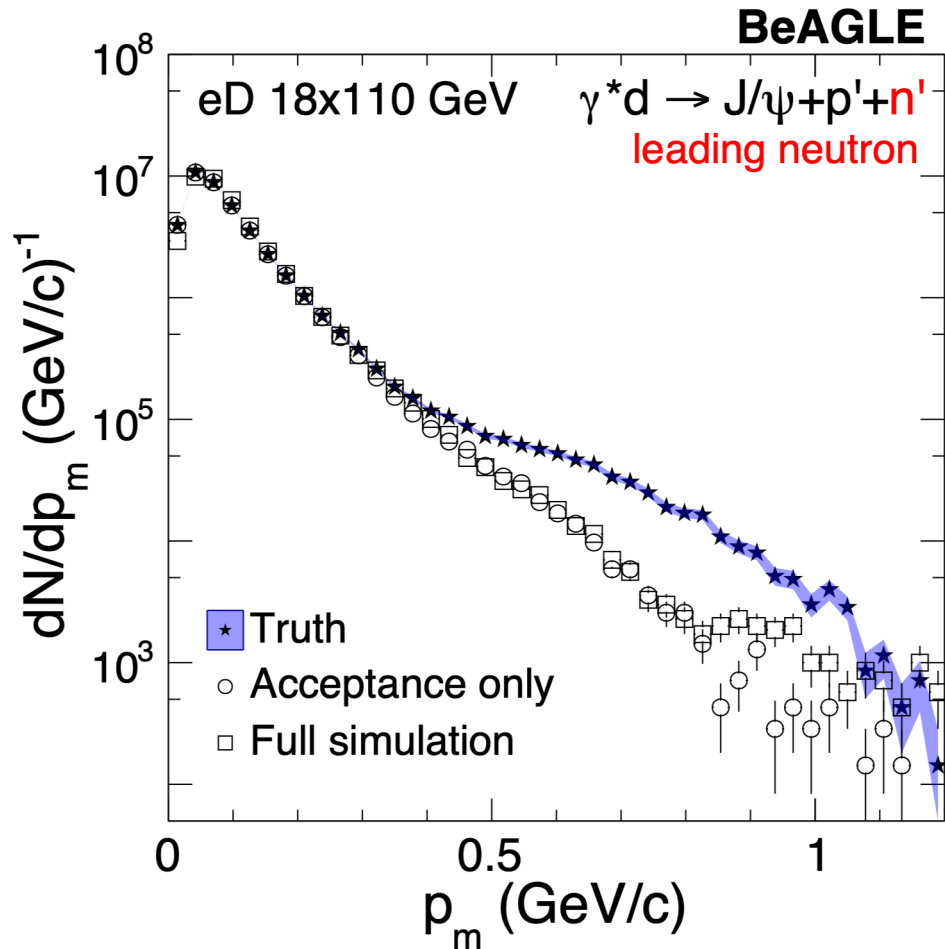
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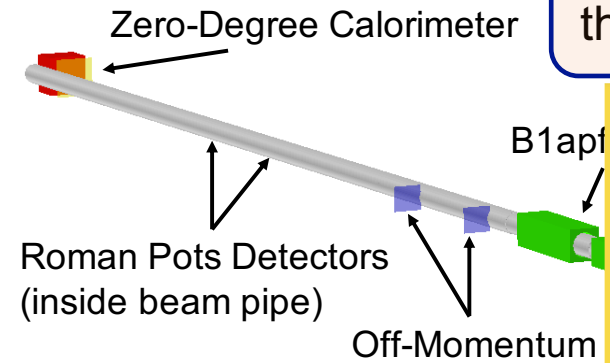
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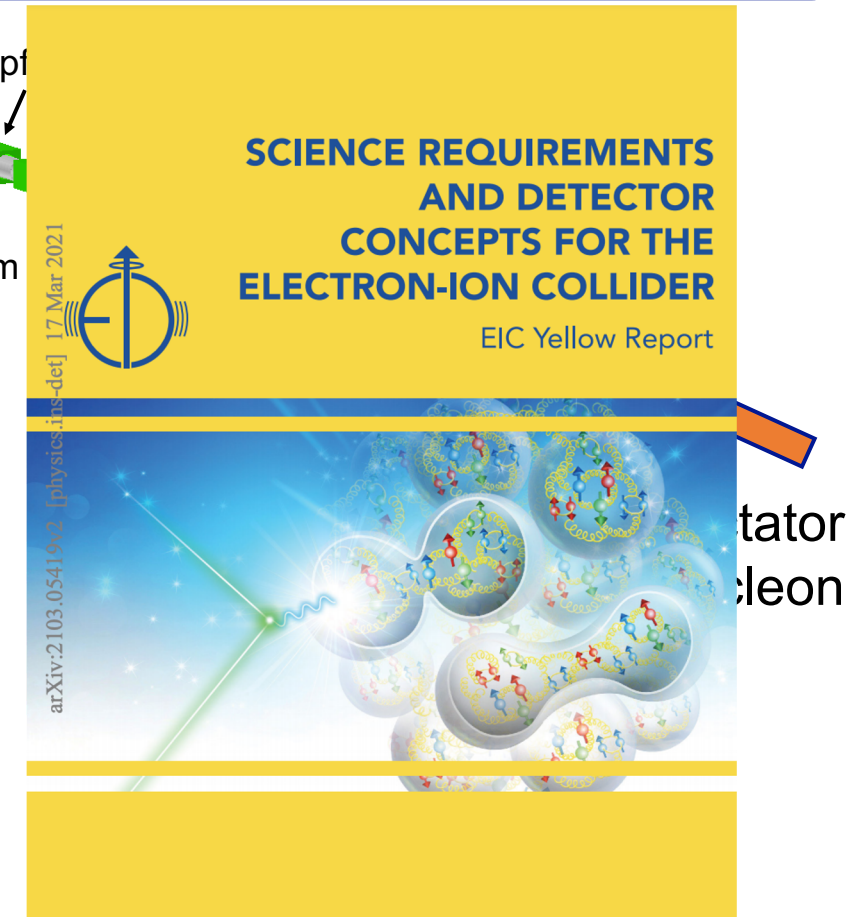


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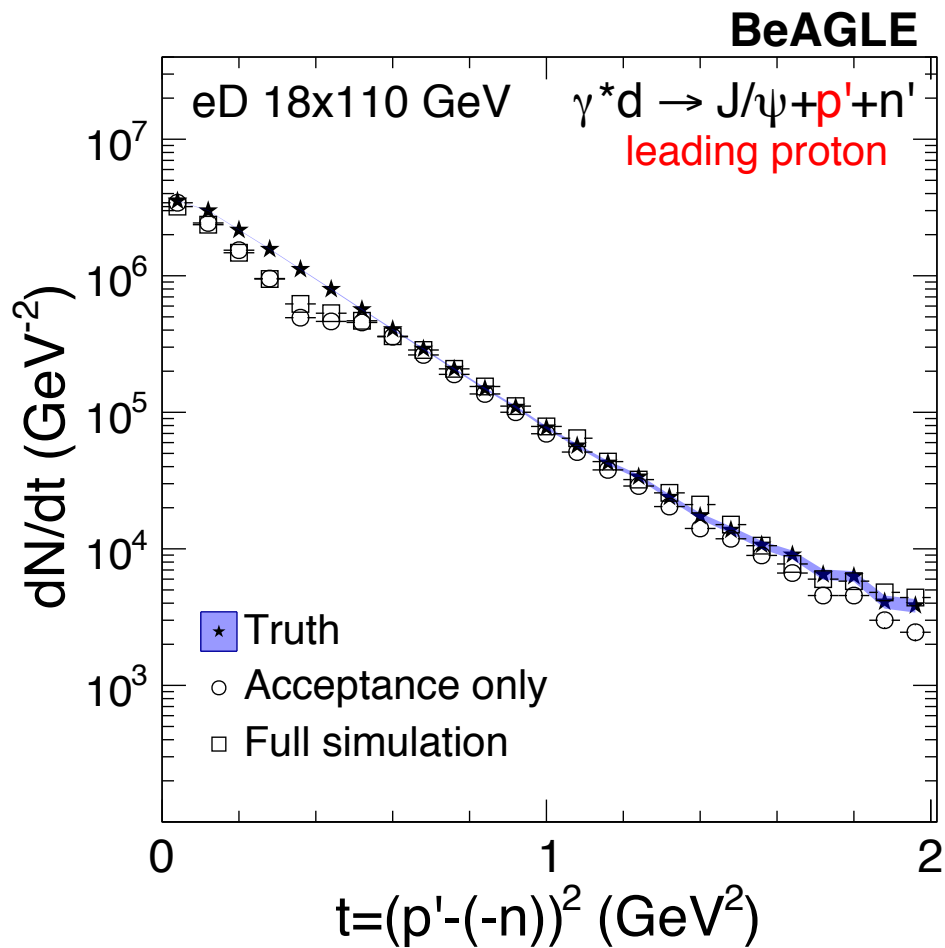


Far forward region was found to be extremely important to the EIC

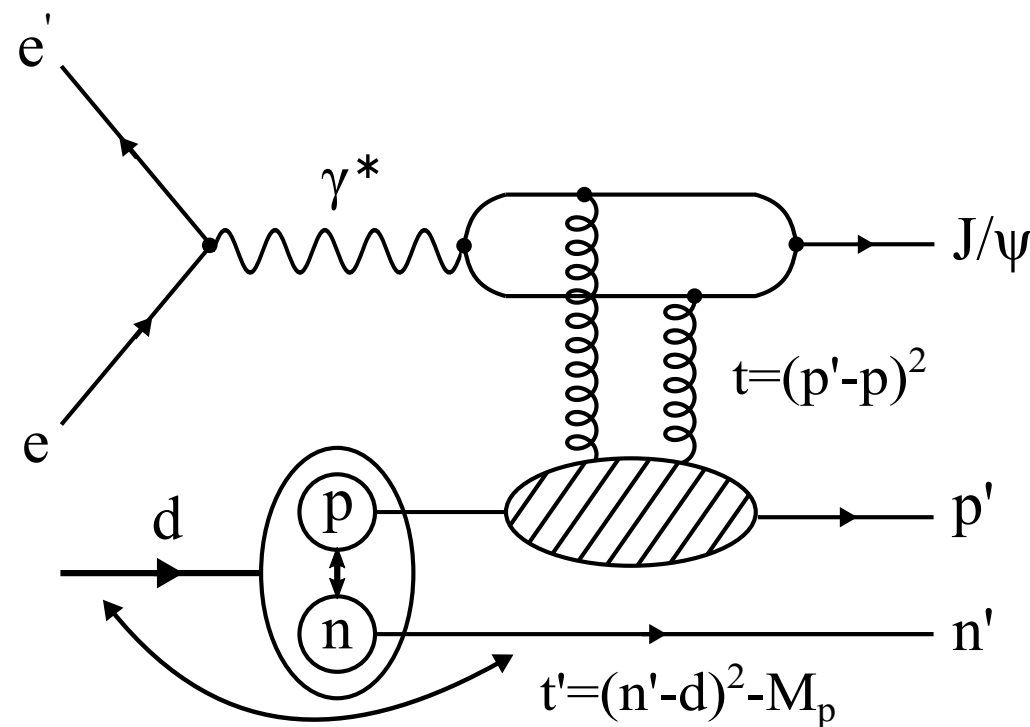
Details published in the Yellow Report, [arXiv:2103.05419](https://arxiv.org/abs/2103.05419)



-t distribution



New method of reconstructing $|t|$
 - complementary

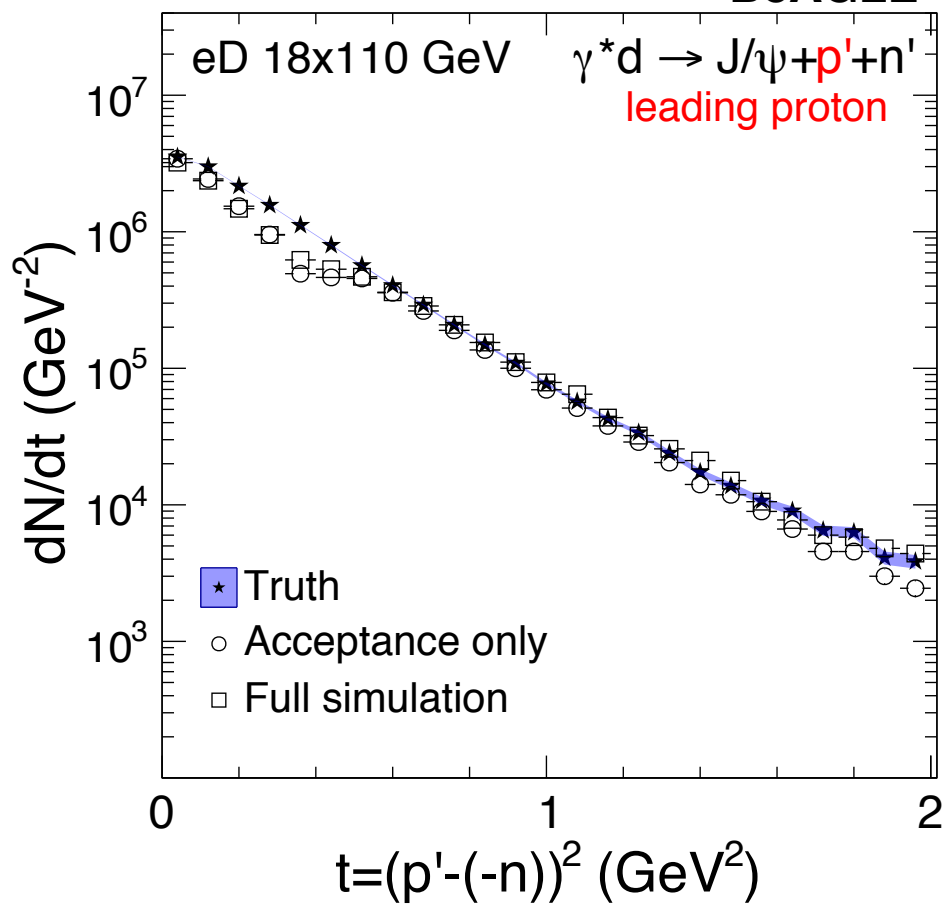


Initial leading nucleon momentum is
 unknown unless we tag a spectator

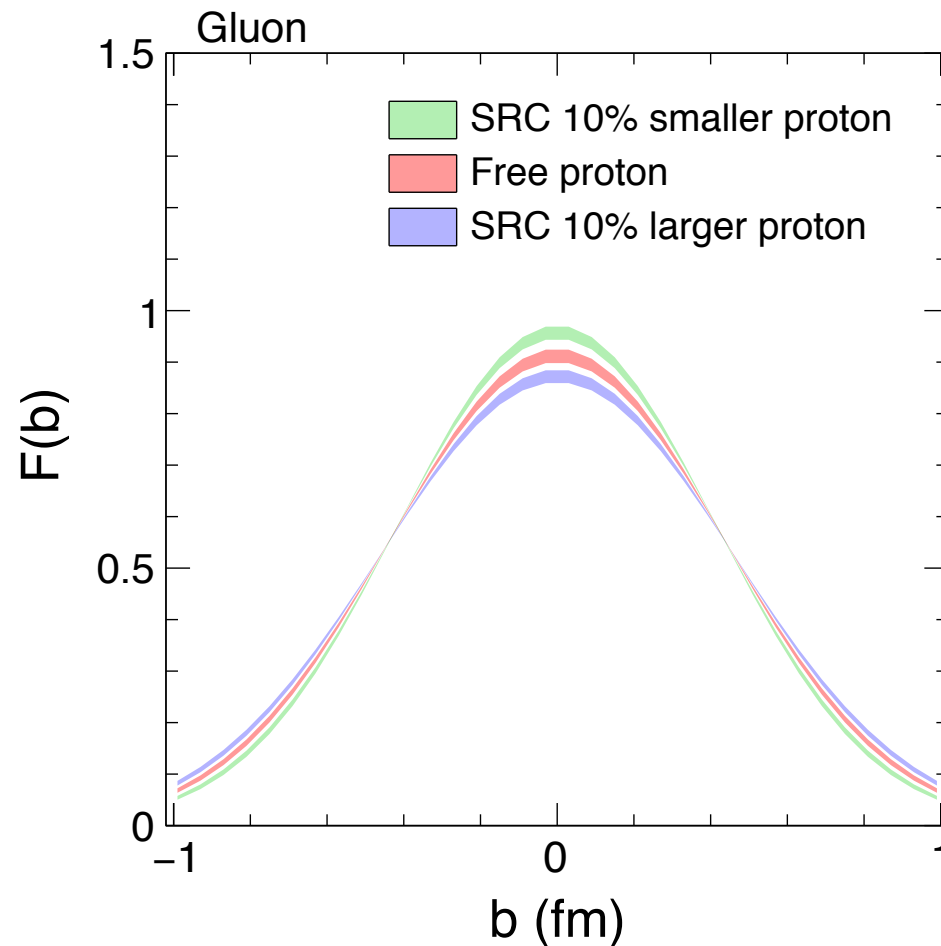
$-t$ distribution

Integrated luminosity $\sim 10\text{-}30 \text{ fb}^{-1}$

BeAGLE



New method of reconstructing $|t|$
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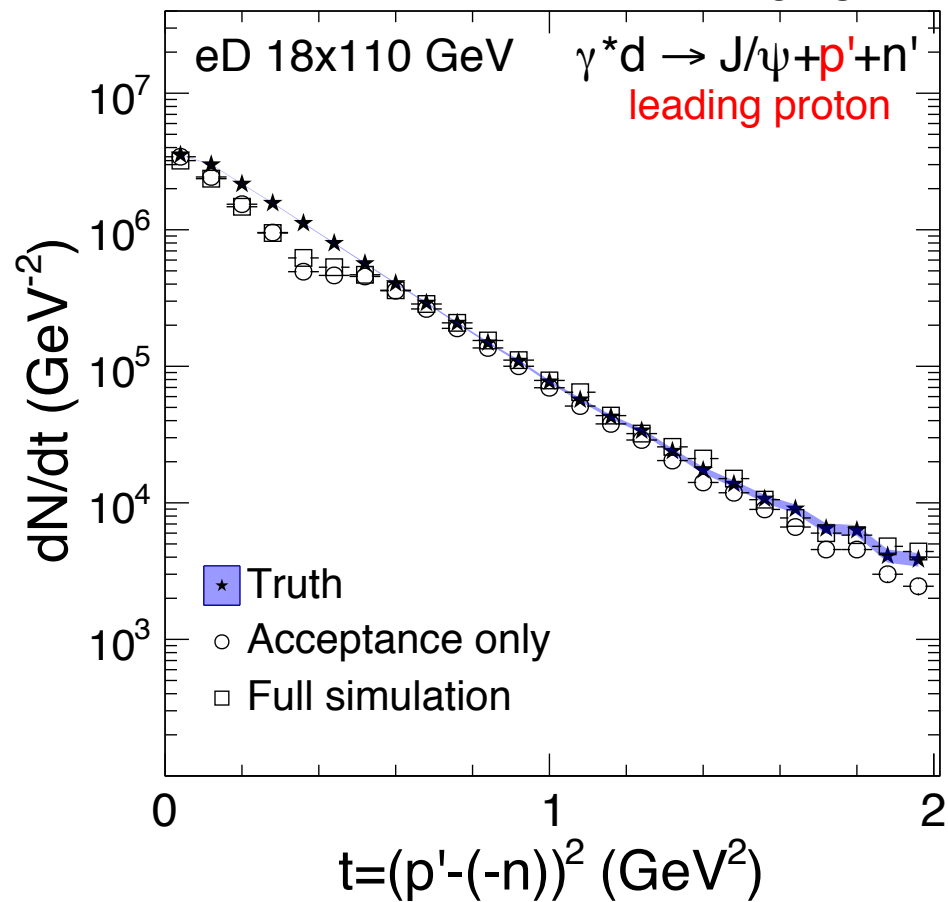


Comparison between SRC nucleon with free nucleon

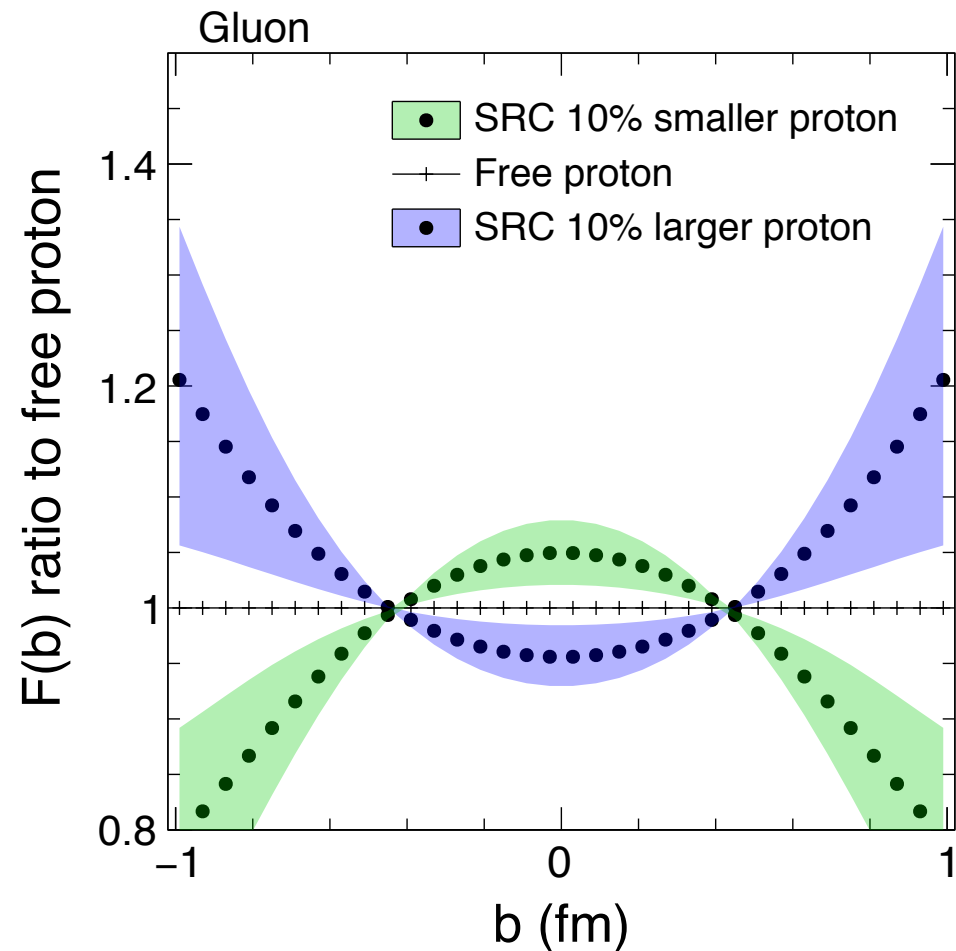
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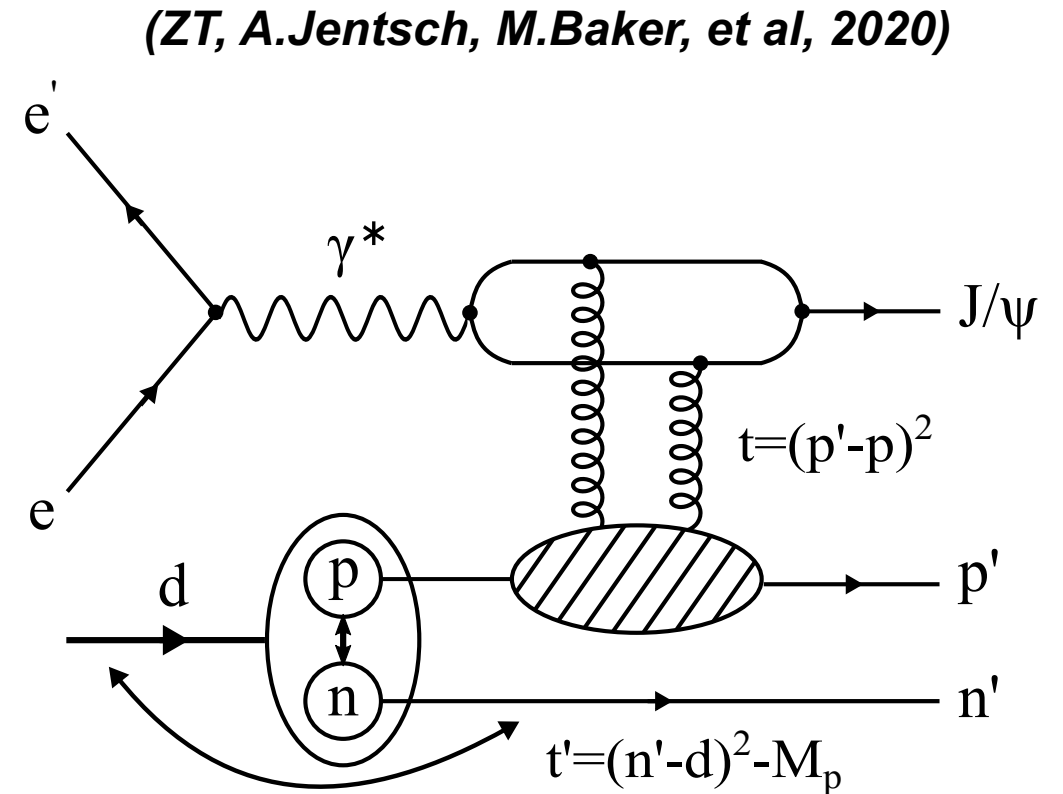


Comparison between SRC nucleon with free nucleon

Summary

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

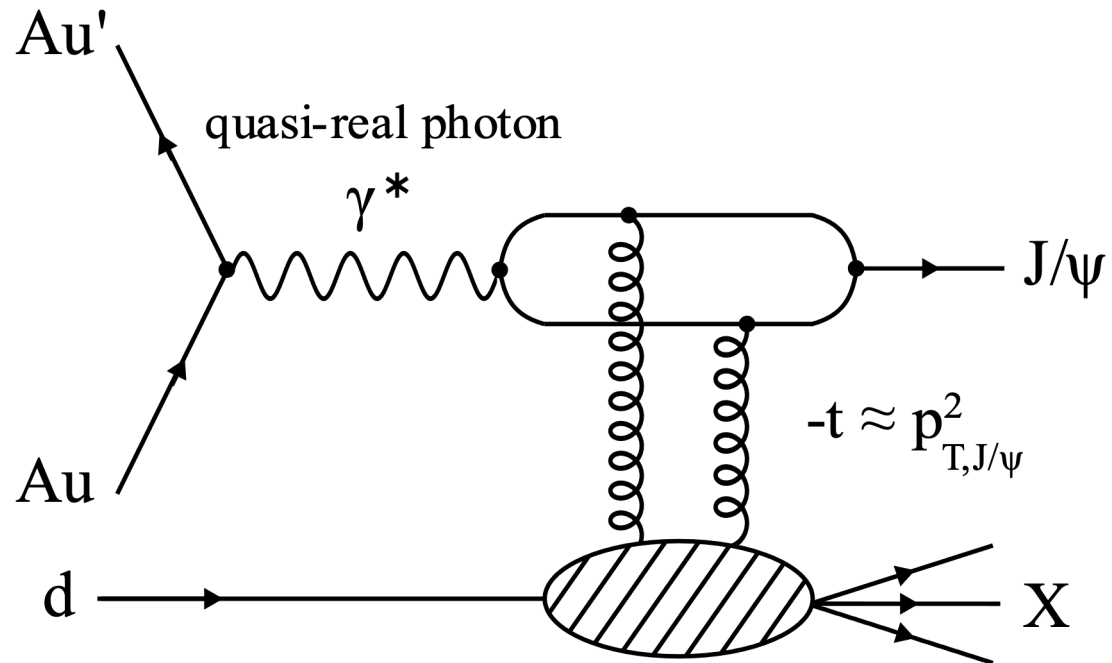
- Physics:
 - gluonic structure and nuclear modifications
- Advantages:
 - Directly probe bounded nucleons;
 - Short-range correlations might provide a “nuclear-like” environment.
- Electron-Ion Collider:
 - Complex IR and great forward detectors;
 - Great acceptances and resolution to tag a spectator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



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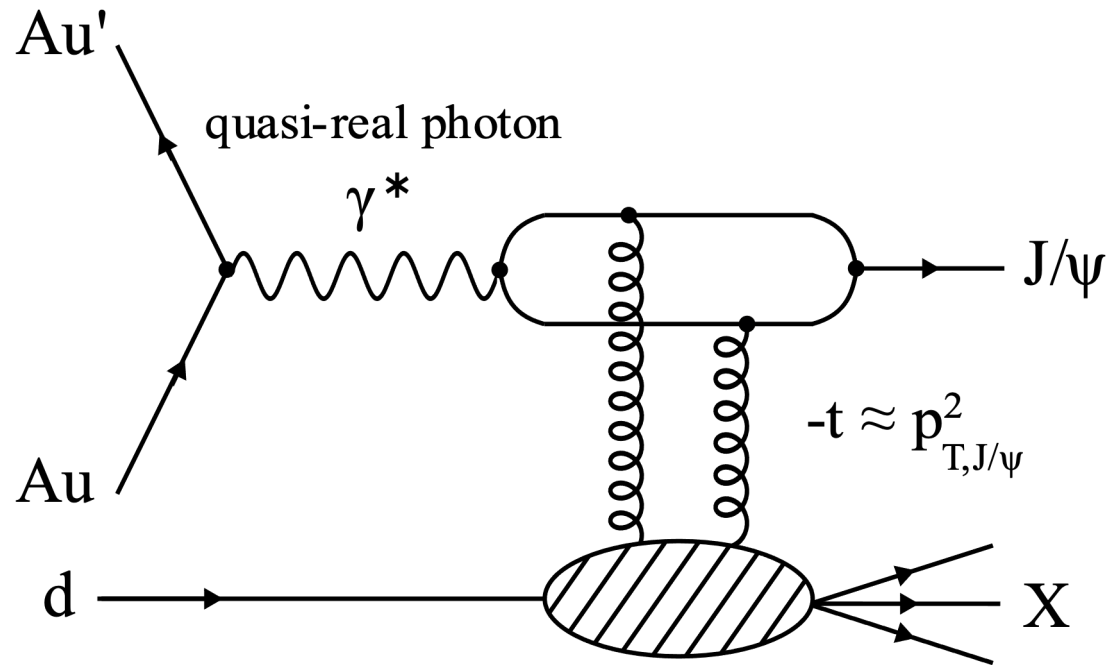
Backup

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)

