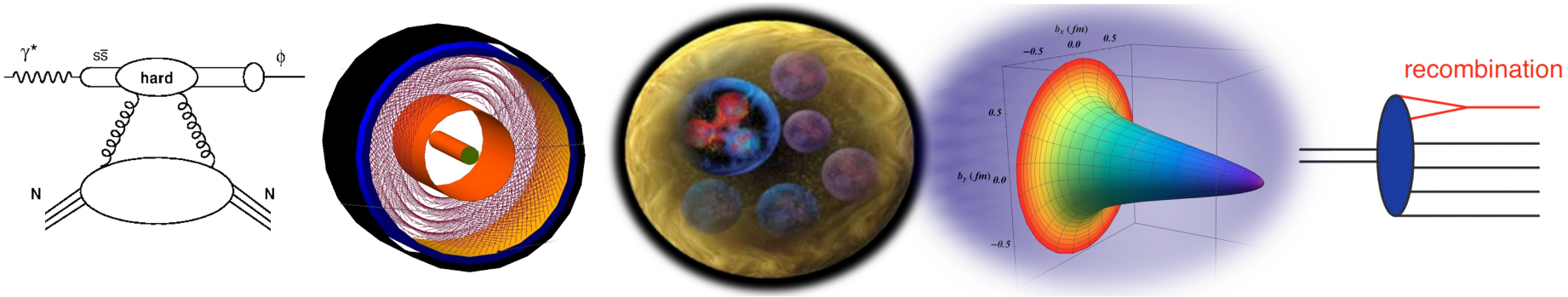
From mean-field to short range correlated pairs



How to transition from one to the other ?

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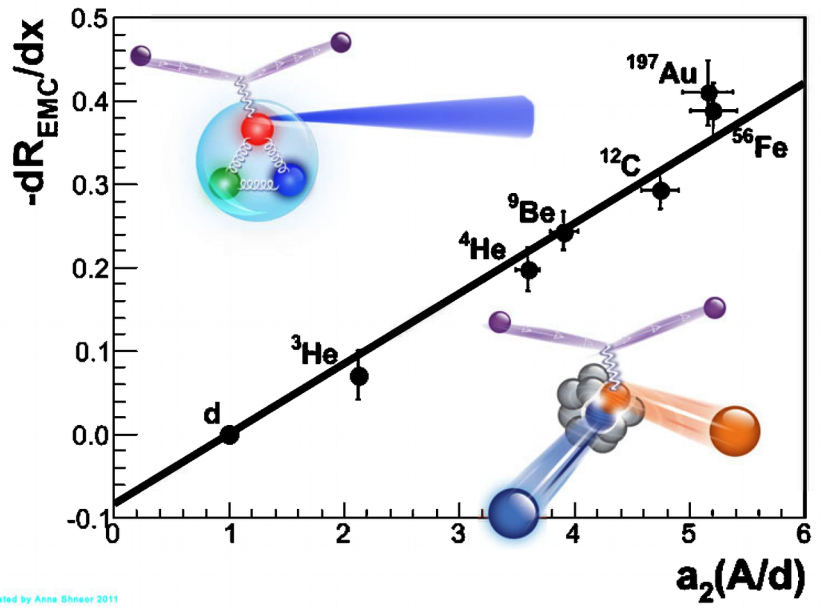
Short range correlated nucleons

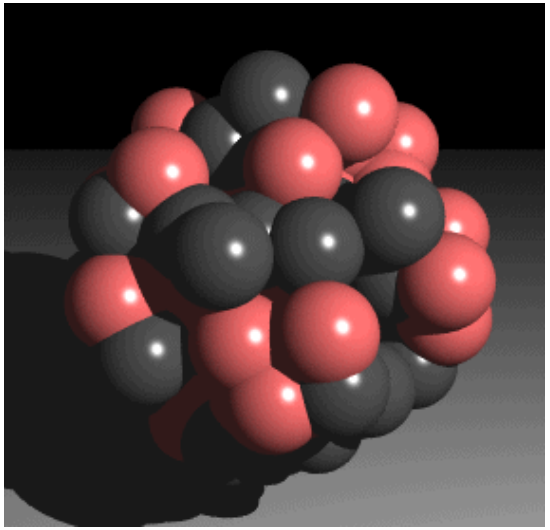
We understand a lot now

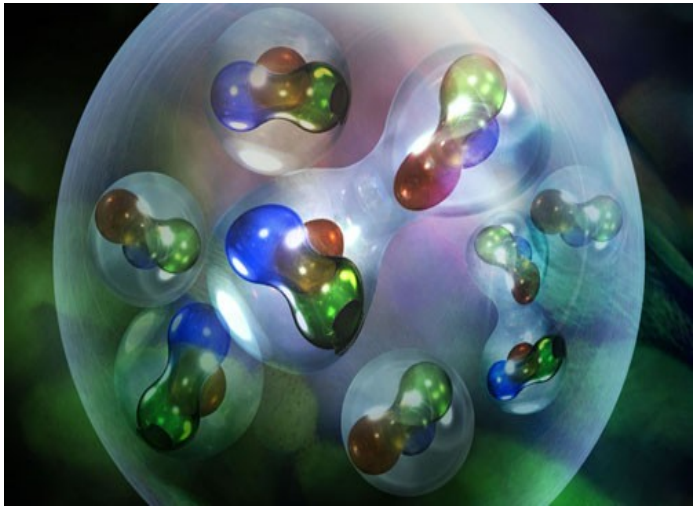
- We can link the SRC and EMC behavior
- The pn dominance observed fits with EMC measurements rather well
- Linked to the tensor force in the nuclear structure

Remains a question:

- How does it affects the quark and gluon structure?







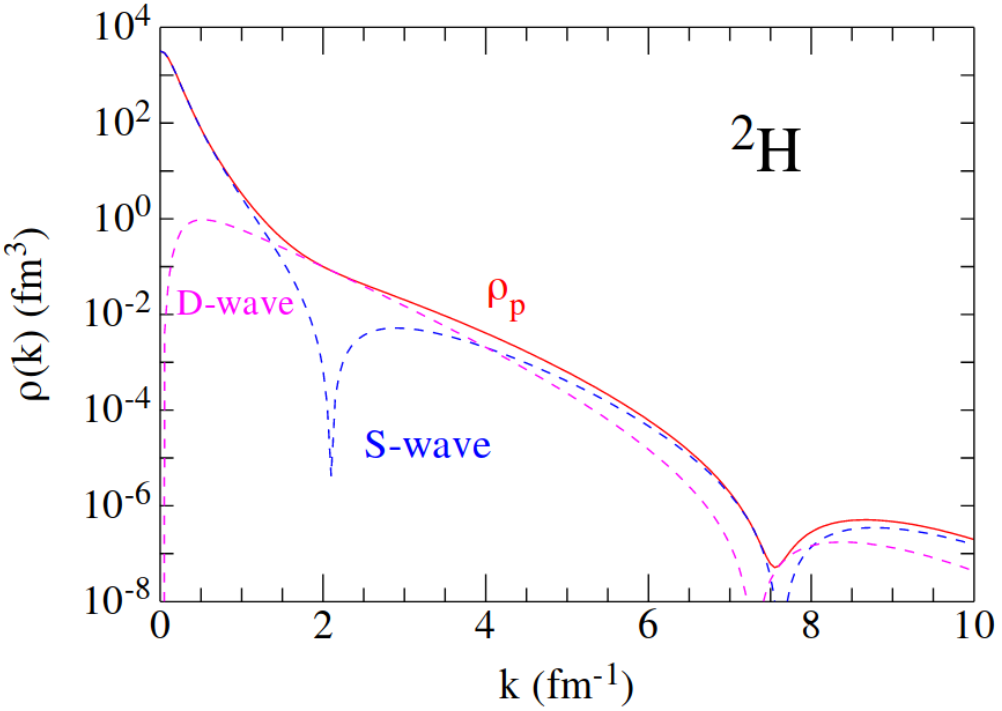
Mean field nucleon vs SRC nucleons

How to set a limit?

- Different arguments can be made
- It will be nuclei dependent

How relevant is this limit?

- Does only momentum or virtuality matters?
- Or the nucleon correlation matters as well?
  - *If yes in what direction?*



How can we resolve these questions?

- Tagged processes (A-1 tagging mainly here)
- Generalized parton distributions

Tagging Nuclear Reactions

Tagged processes

- **When we detect nuclear fragments in coincidence**
- **Mix classic nuclear physics with quark level observables**

Why tagging?

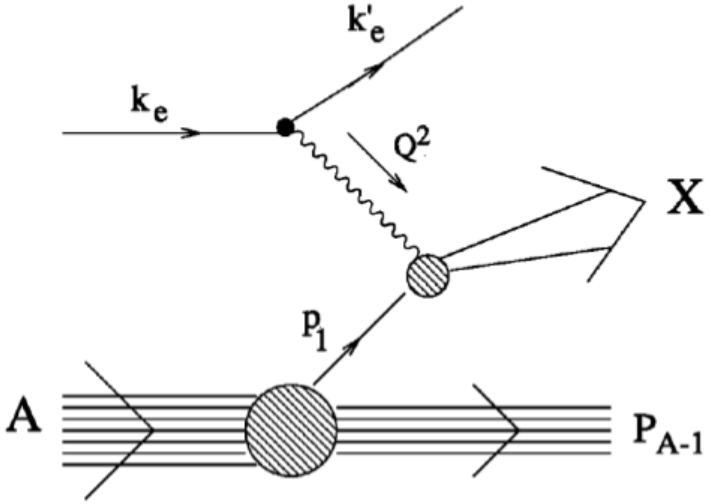
- **To control final state interaction**
- **To control the initial state**
  - *Access to the nucleon's virtuality*

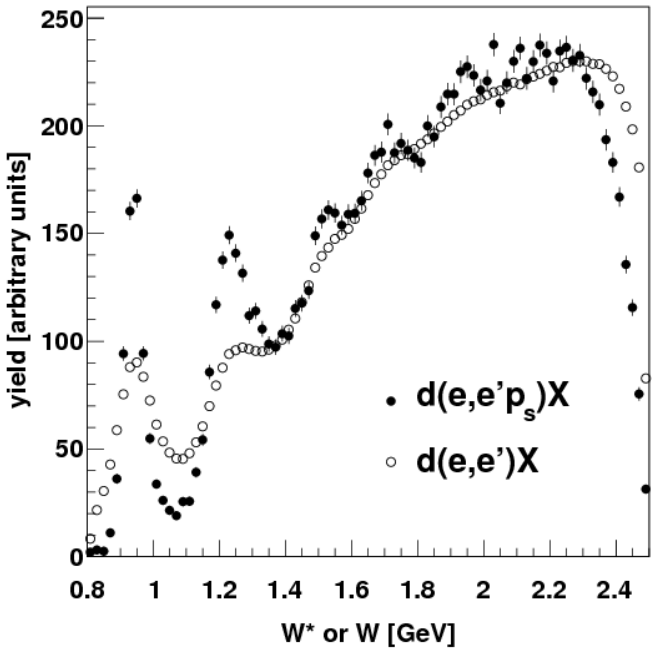
Can we do tagging?

- **Done only for deuterium**
  - *Bonus measurement from CLAS*
- **Need a recoil detector (fixed target)**

  → ALERT
- **Or a forward detector (collider)**

  → EIC (?)





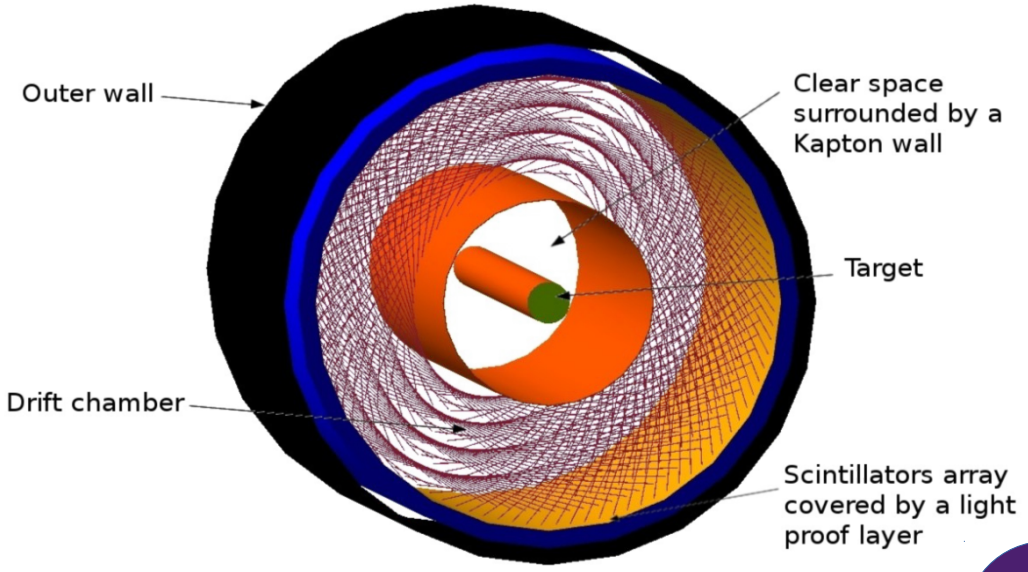
Tagging at JLab with ALERT

A Low Energy Recoil Tracker

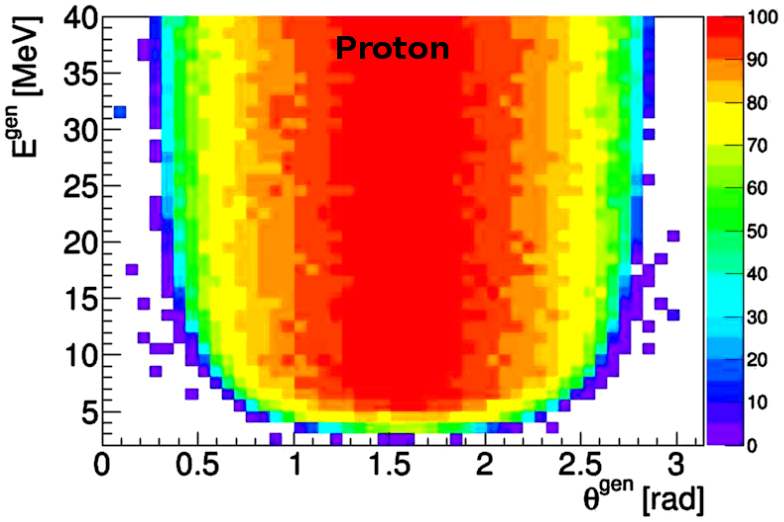
- **Optimized for low momentum measurement**
- **Placed in the center of CLAS12 (Hall-B)**
- **Around a thin gaseous target**

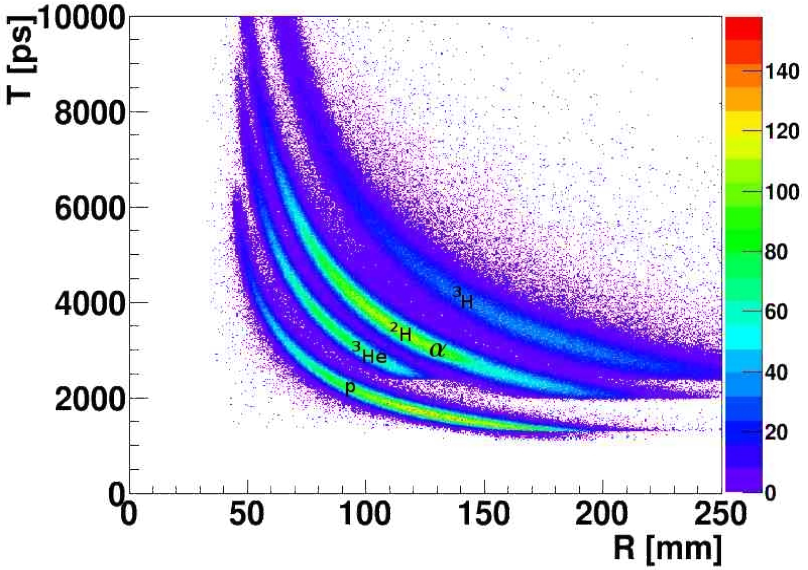
Composed of

- **An hyperbolic drift chamber**
  - *Stereo angles give the z-axis resolution*
- **Scintillators**
  - *For Time-of-Flight measurement*
  - *Energy measurement for good PID*



ALERT specifications





Capabilities for very low momentum detection

- As low as 70 MeV/c for protons and 240 MeV/c for 4He
- Detection at large angles in forward and backward directions (25° from the beam)

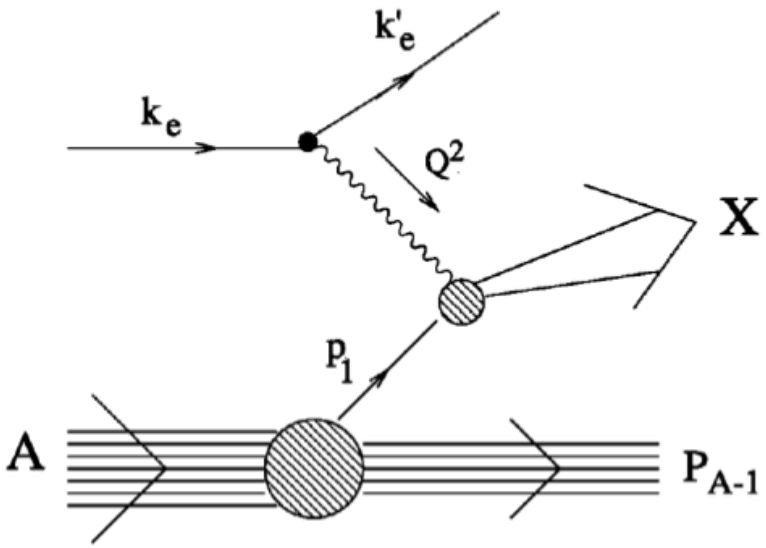
Capabilities to handle high rates

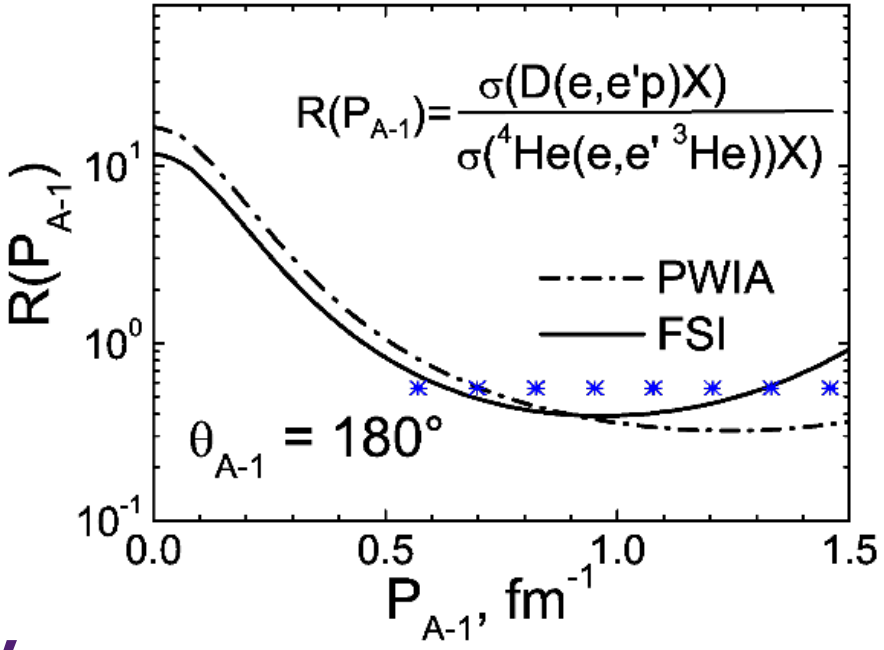
- Luminosity up to 10^{35} $cm^{-2}s^{-1}$

Excellent PID and resolution

- Can identify isotopes of light nuclei precisely

Testing tagging models





Not sexy, but necessary

- First, test that the theory is under control
- CLAS12 + ALERT give a large momentum and angle range to test

First test of the process for A>2

- It is key to generalize the method beyond deuterium
- Allows to access higher Fermi momentum and to generalize any finding

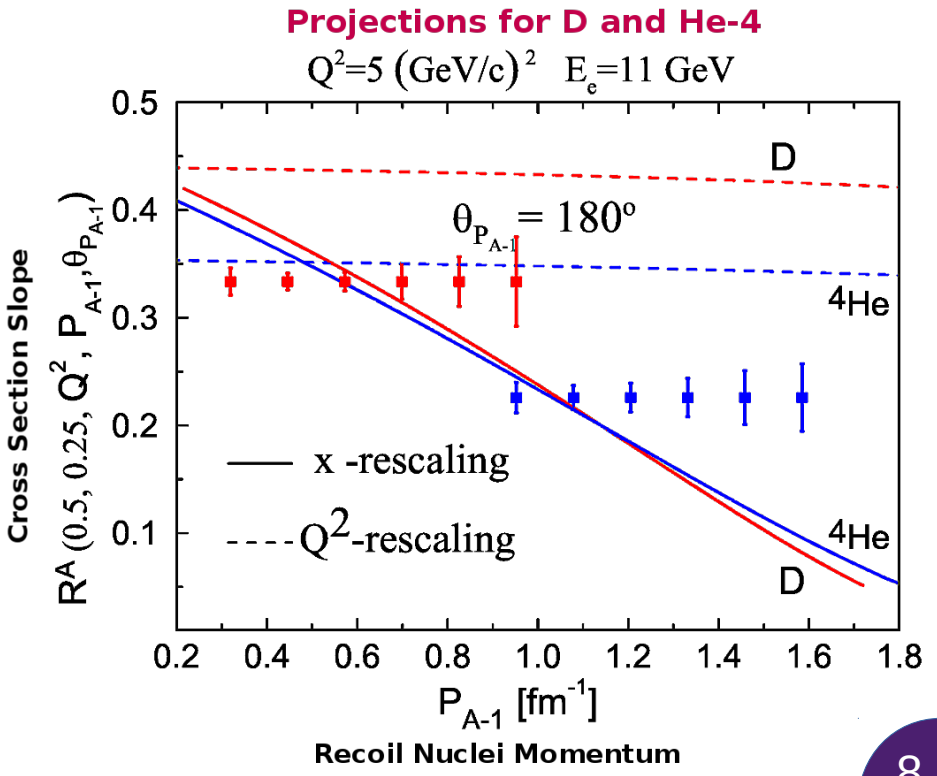
Link EMC effect to nucleon momentum

Tagging links EMC to nucleon kinematics

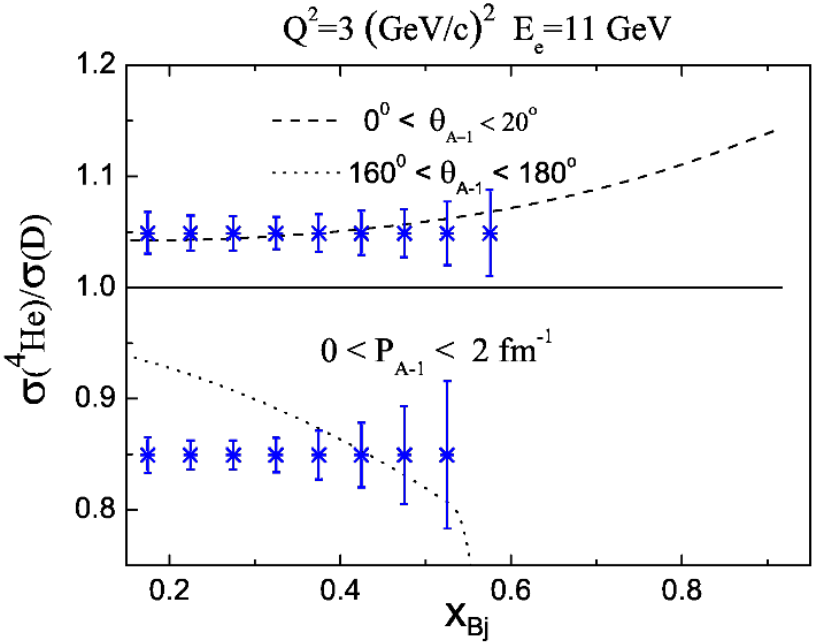
- Linked to virtuality
- Differentiate mean field from SRC

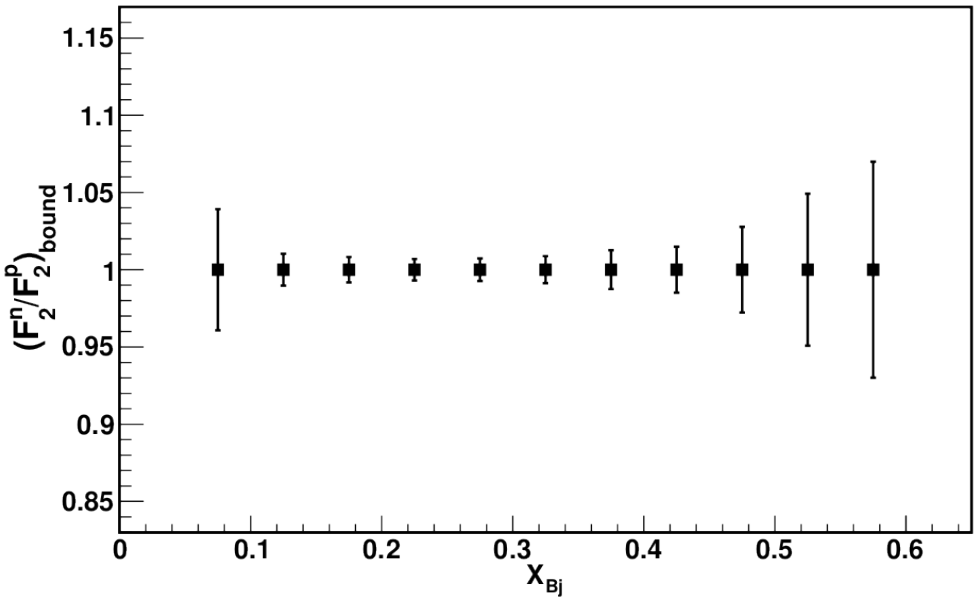
Test models and more

- Comparison between deuterium and helium is key
- It unequivocally resolve the link between EMC and nucleon momentum



Other opportunities with tagging





Tagged DIS gives many other opportunities to test specific EMC models

- In some binding models, the EMC effect is due to the cancellation of much larger effects
- These can be tested with spectator detection

Tagged DIS can also be used for flavor selection

- We can test how the d/u ratio changes in the nuclear medium

GPDs & Nuclei

Generalizing the parton distributions

- Three dimensions: x, ξ and t
- Spin-0 → 1 GPD // Spin-1/2 → 4 GPDs

Deep virtual Compton scattering

- The simplest access to GPDs
- Allows the tomography of the target

In the nucleus

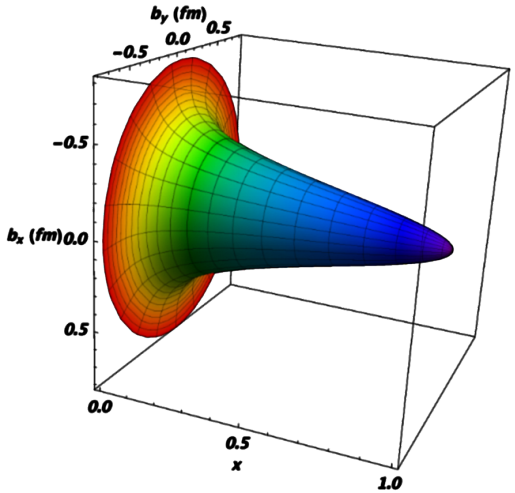
- Coherent and incoherent channels
  - *Similar to elastic and quasi-elastic*

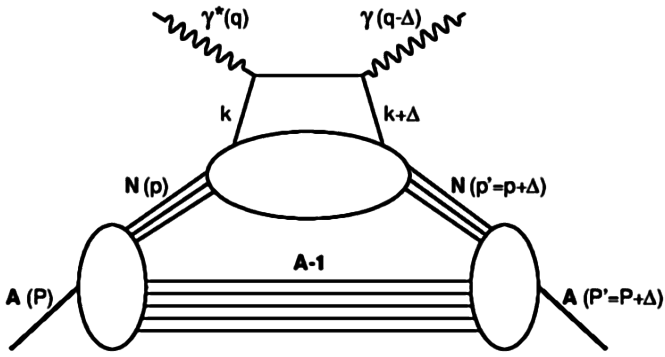
Perfect probe into the EMC effect

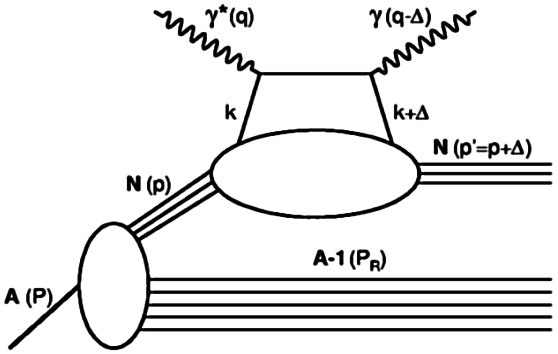
- Offer localization with the t dependence

Goes much beyond

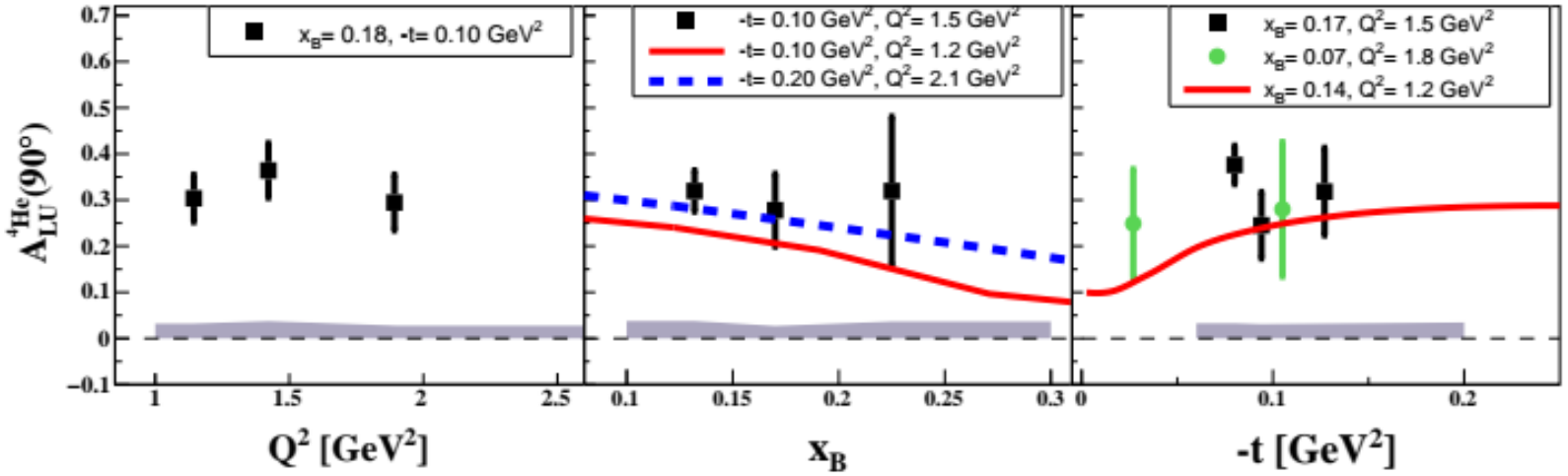
- Can look at the nuclei without the nucleons

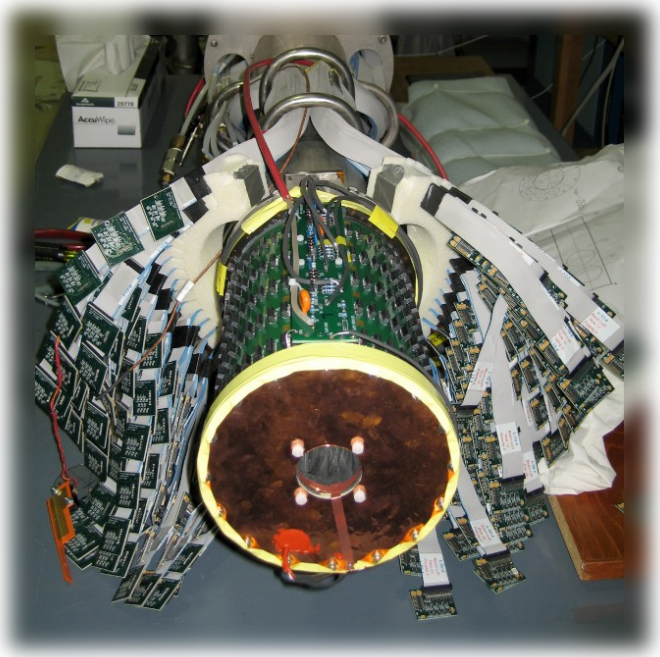






CLAS Coherent DVCS





Coherent DVCS on helium

- **Measured at CLAS**
  - *Use recoil detector to ensure exclusivity*
- **Shows very strong beam spin asymmetry**

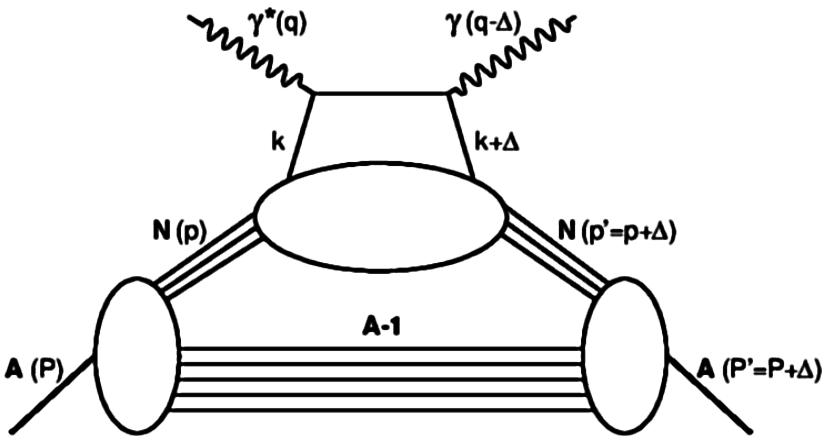
Interpretation

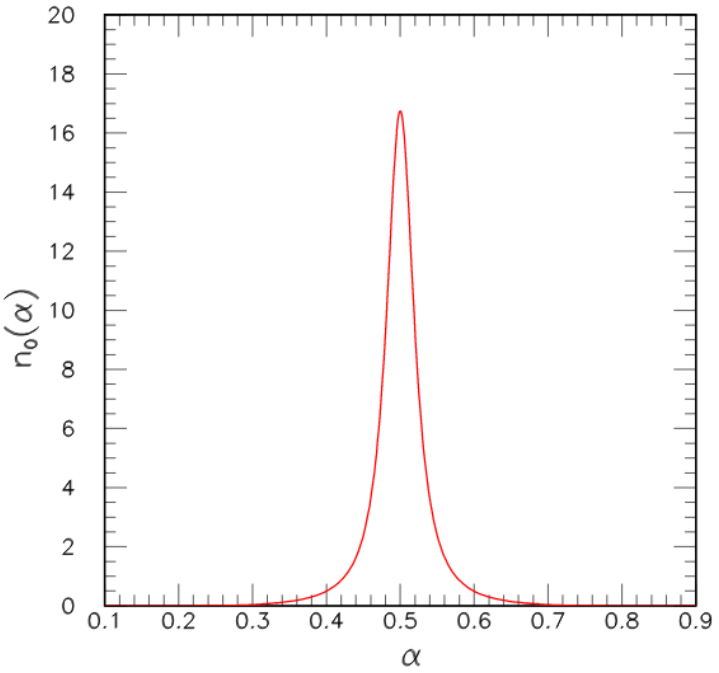
- **Very strong signal proves that we have the nuclei as a whole**

Easy direct GPD extraction

- **Helium has a single GPD**

Probe SRC with DVCS





Coherent DVCS gives access to different components of nuclei

- Most present model are in impulse approximation
- Include only nucleons
- Create large forbidden kinematic regions

Can be probed in a similar fashion as x>1

- Needs high statistics
- Would provide position information on SRC pairs

CLAS Incoherent DVCS

Measurement of CLAS

- **Proton bound in helium target**

Gives a generalized EMC

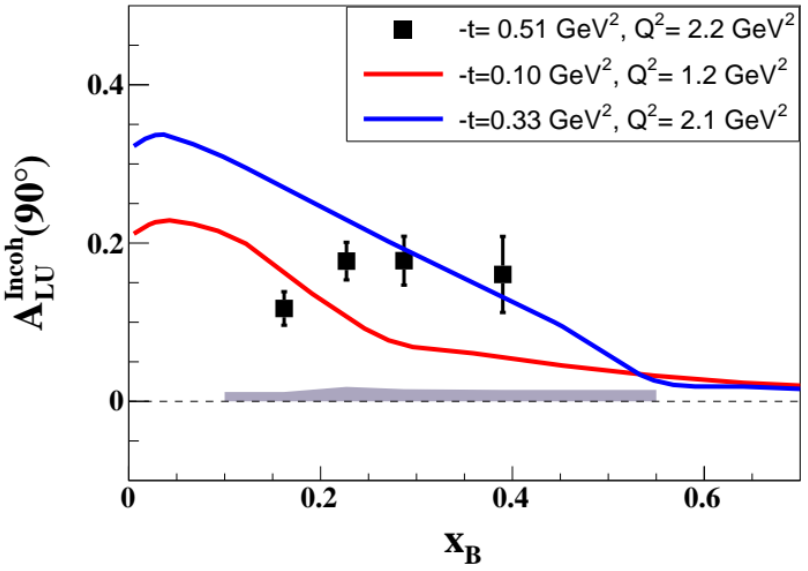
- **Strongly suppressed in particular in the anti-shadowing region**
- **Strange behavior compared to the models**

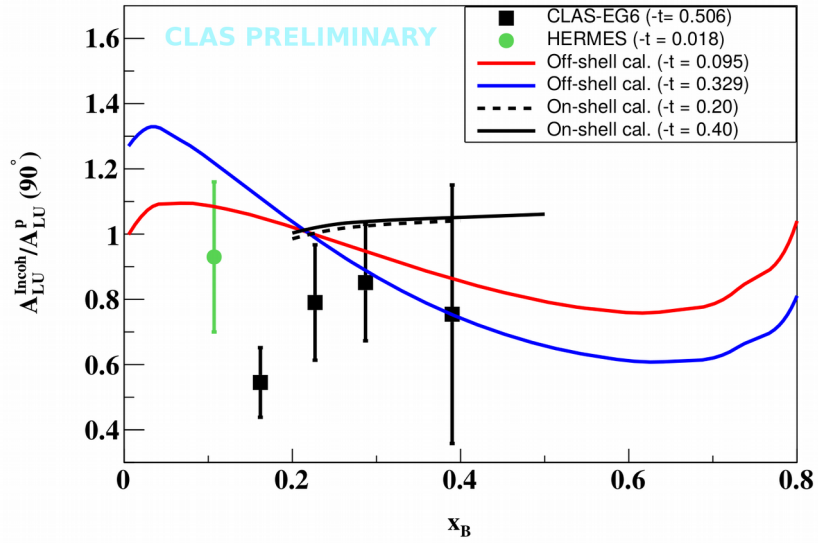
A New kind of EMC effect?

- **It could be a nuclear effect**
- **Or it could be due to final state interactions**
  - *Can be very complicated in DVCS*

Can we resolve this with tagging?

- **We will try using ALERT**





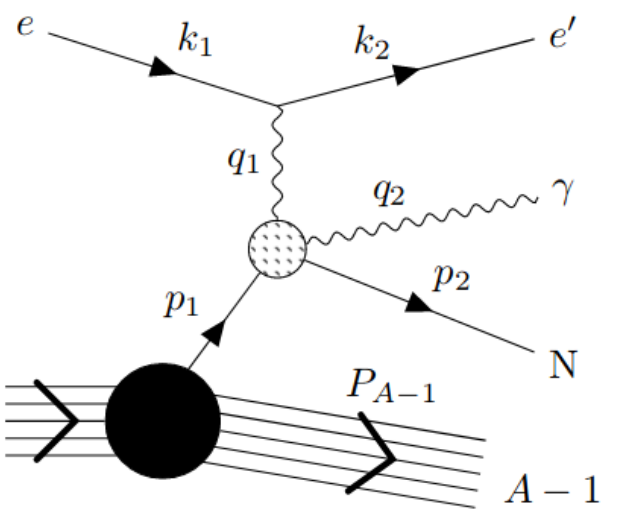
Tagged DVCS

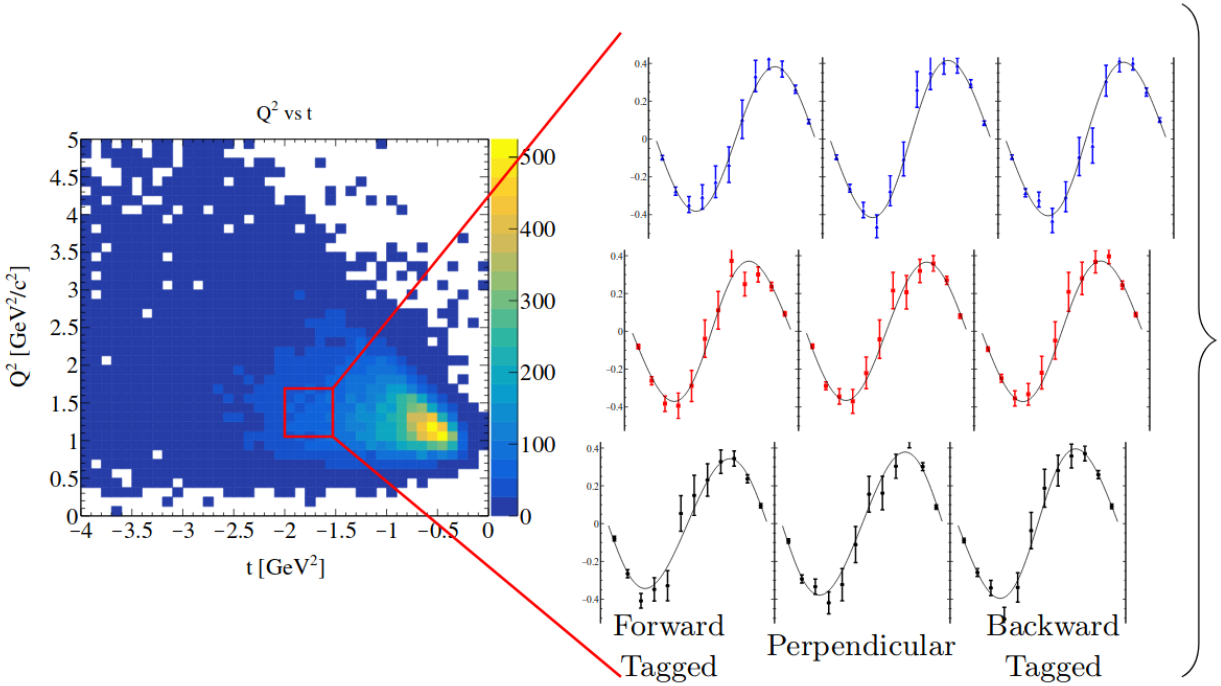
Tagging DVCS

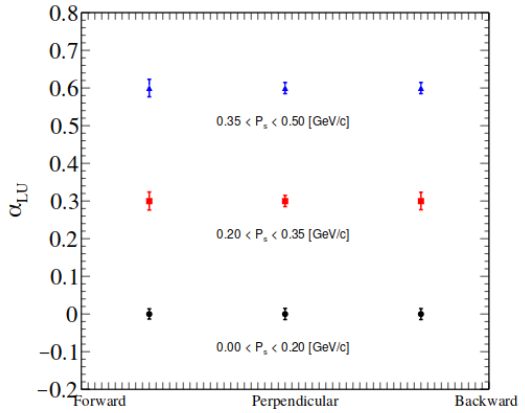
- To better control the reaction
- Both initial and final state are better undercontrol

Proposed for JLab 12 GeV

- Similar method can be used for all sort of processes, quasi-elastic etc.







Tagging at the EIC

Kinematics of colliders makes it much simpler

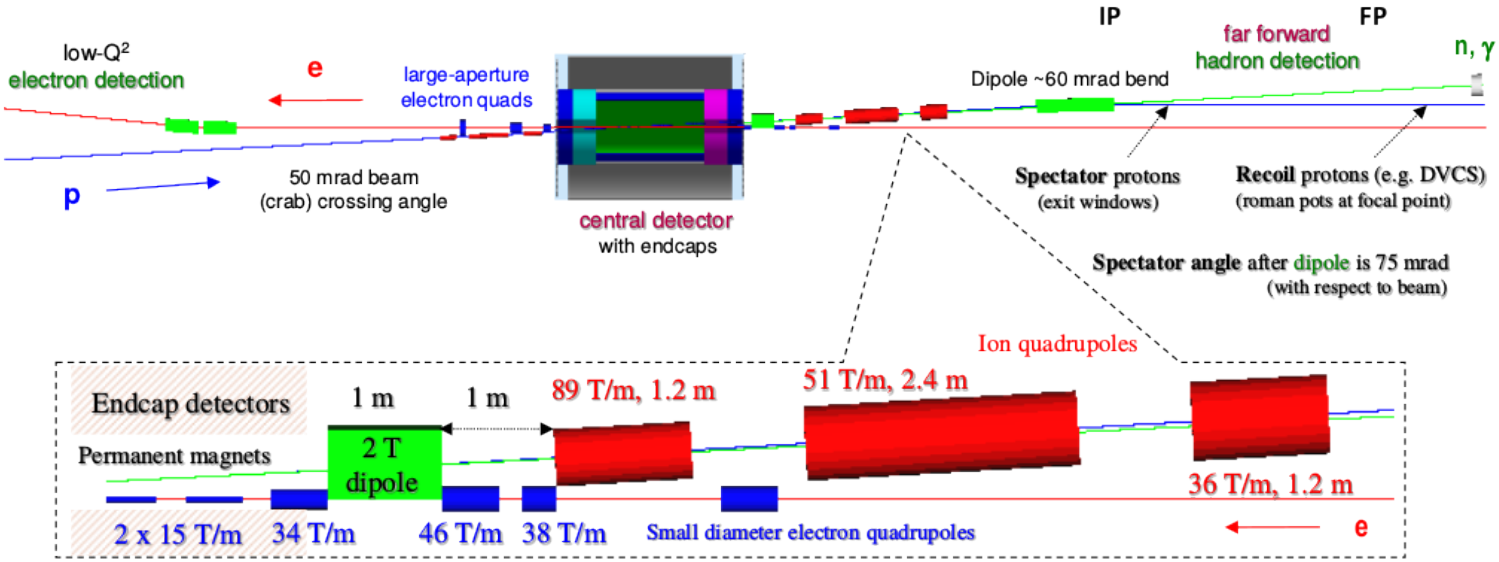
- **Allows detection of both proton and neutrons**
- **As any nucleus with a magnetic rigidity different from the beam**
  - *Raises questions for A-2 tagging in view of the pn dominance in SRC pairs*

Allows tagging and polarized target at the same time

- **Access to effective target of polarized neutrons**

Gives access to many body tagging

- **For large nuclei, the A-1 contribution becomes small**
- **Other information can be gathered**



Tagging in Many Body Systems

Centrality measurements are now standard in A-A

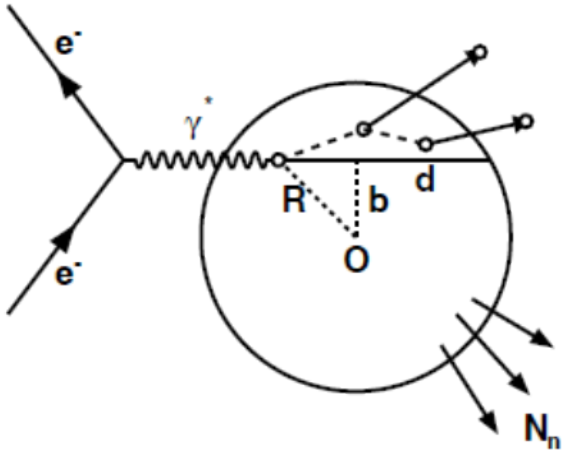
- They get more and more evolved
- Also applied in p-A
  - *With some caveats*

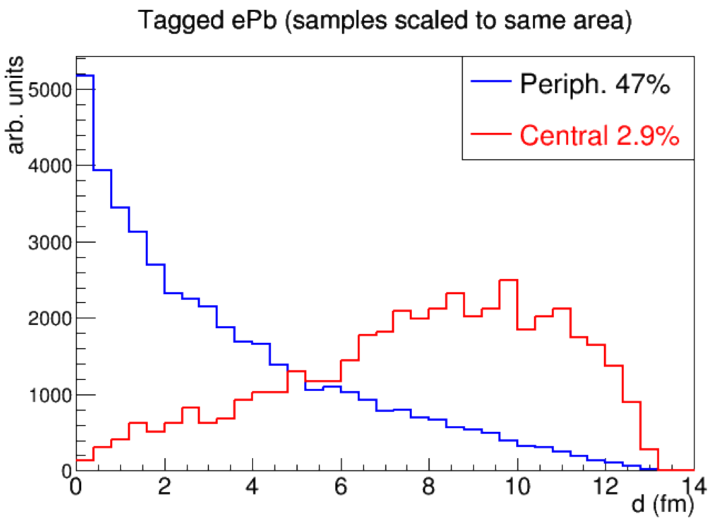
We will need similar measurements at EIC

- Else we are dominated by surface events
- Effort to create proper Monte-Carlo tools with Beagle
- Plans to use E665 data from Fermi Lab to calibrate

Impacts the beam line design

- This is a good time to worry about this





Summary

We do not understand the link between the nucleon and quark structure of nuclei

- We need new observables to resolve this issue

Tagged process offer clean new observables

- To help understand the EMC effect
- And many other features of the nucleus

We have now also access to nuclear GPDs

- Through recent measurement of nuclear DVCS
- These first measurements open the way for more precision at 12 GeV

EIC will extend these studies much more

- Simplify tagging with proper instrumentation
- These kind of studies are highly luminosity dependent