DVCS on deuteron

kinematics and diagrams

Kong Tu
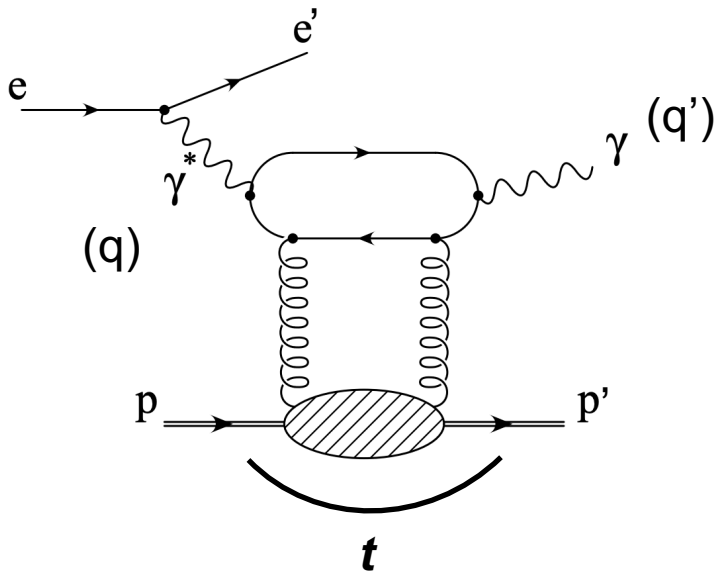
BNL

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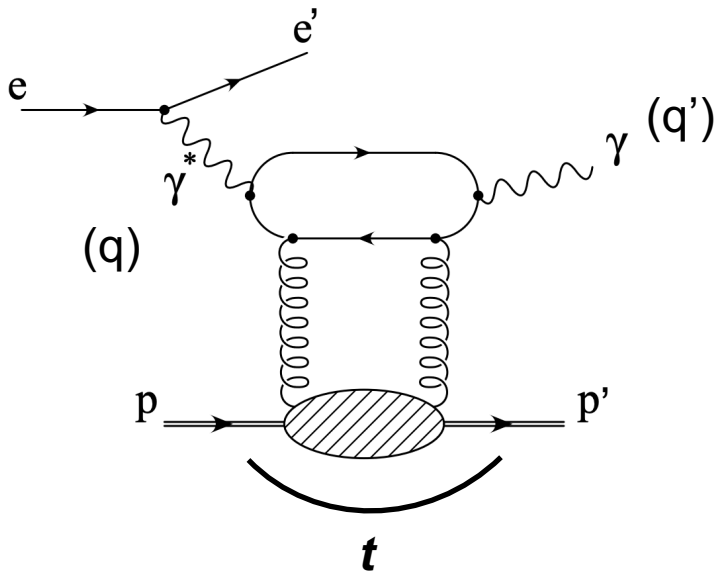# DVCS on proton

Two ways of reconstructing t
1) $t = (p' - p)^2$
2) $t = (e - e' + q')^2$

e

e'

γ^*

(q)

γ (q')

p

p'

t

DVCS on proton

(q)

Many studies and measurements have been done in the past, serves as a baseline.

Two ways of reconstructing t
1) $t = (p' - p)^2$
2) $t = (e - e' + q')^2$

Experimental effects:

1) $t = (p' - p)^2$
   I. momentum reso. on p'
   II. (initial momentum spread + angular divergence) on p

2) $t = (e - e' + q')^2$
   I. momentum reso. on e'
   II. (initial momentum spread + angular divergence) on e
   III. energy/momentum reso. for q'

- $\delta t_{1)}/t_{1)}$? > $\delta t_{2)}/t_{2)}$ - p_T balance method can be an approx.~ to 2).

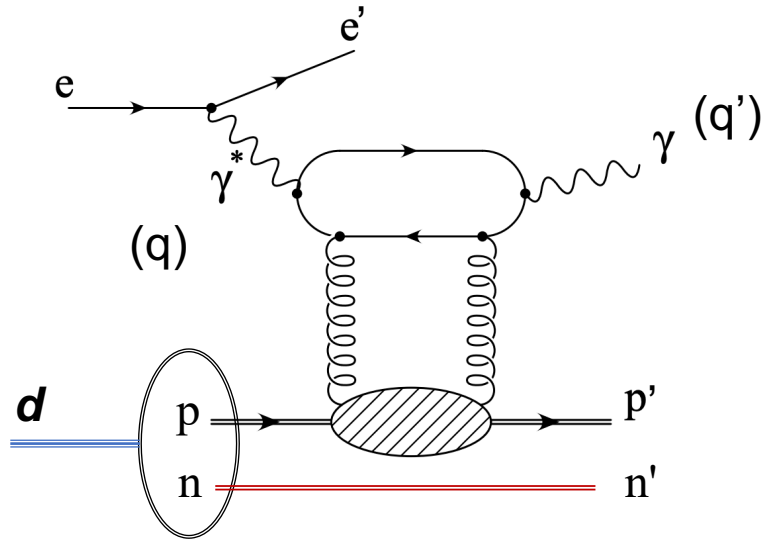## DVCS on deuteron
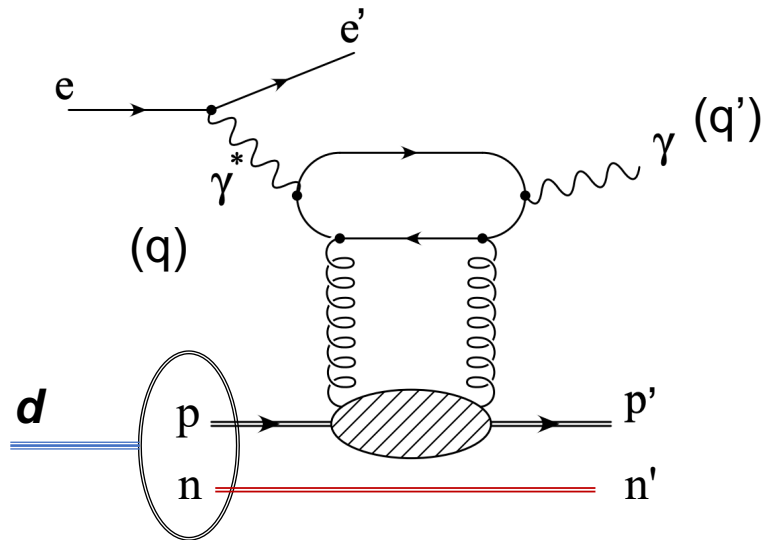
Two ways of reconstructing **t**
1) **t** = (p' – p)^2
2) **t** = (e - e' + q')^2

Initial momentum of proton
(active nucleon) is unknown!

Fermi momentum - SRC

DVCS on deuteron

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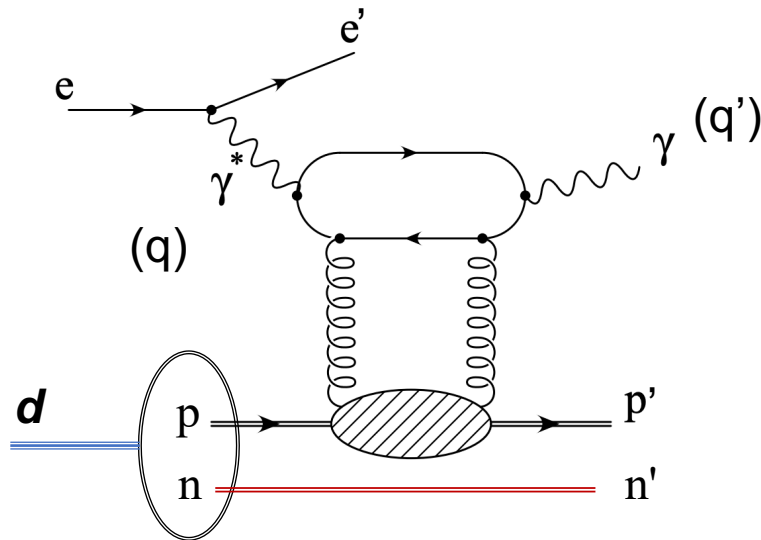(active nucleon) is unknown!

Fermi momentum - SRC

Need to tag n' as well

$$t = (p' - p)^2 = (p' - [-n''])^2$$

n'' != n' due to the *light front kinematics*,
but n'' can be calculated/measured from n'

DVCS on deuteron

Experimental effects:

$t = (p' - [-n''])^2$

   I.   Momentum reso. p'
   II. Momentum/energy reso. n'
   III. final-state interactions (FSI)
   IV. Acceptance of tagging both (rate)
   * physics? GPD of off-shell nucleon?

Two ways of reconstructing t
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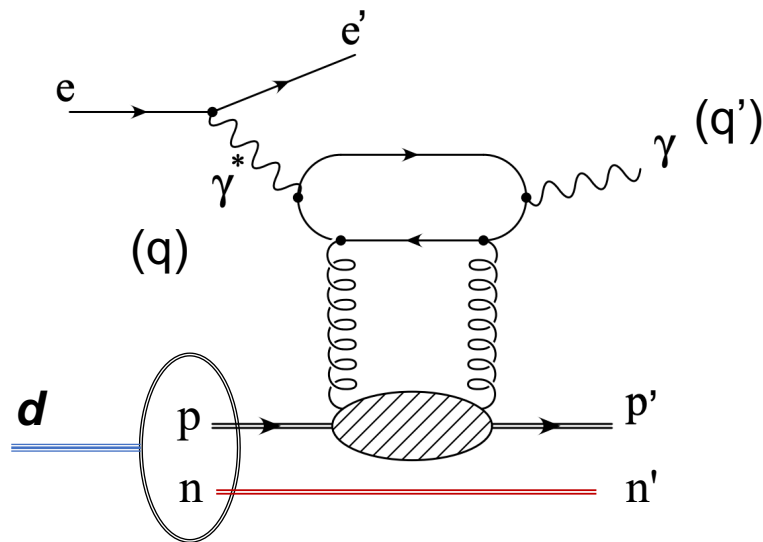Need to study in order to
compare with method 2)

Insensitive to **d** beam uncertainty?

DVCS on deuteron

What we have in BeAGLE

a. No DVCS process simulated, no real final-state photon.

a. e+d → e'+J/psi+p'+n' is well established. Can pretend the J/psi to be a real photon.

b. Active nucleon can be either proton or neutron.

c. Realistic deuteron wavefunction + correct light front kinematics!

d. Detector/Machine simulations are in place and initial results are obtained – *Alex Jentsch et al*.

If you don't know what BeAGLE is, check this out https://wiki.bnl.gov/eic/index.php/BeAGLE
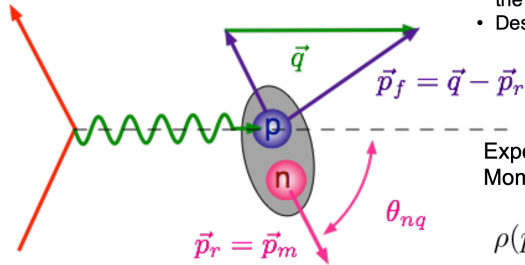
One semi-related example

BeAGLE

Introduction: D(e,e'p) in PWIA

$$\frac{d^5\sigma}{d\omega d\Omega_e d\Omega_p} = k\sigma_{ep}\rho(p_r)$$

Plane Wave IA:
- Hit nucleon does not interact with the recoiling system
- Described by a plane wave

$$\vec{q}$$

$$\vec{p}_f = \vec{q} - \vec{p}_r$$

Experimental Momentum distributions:

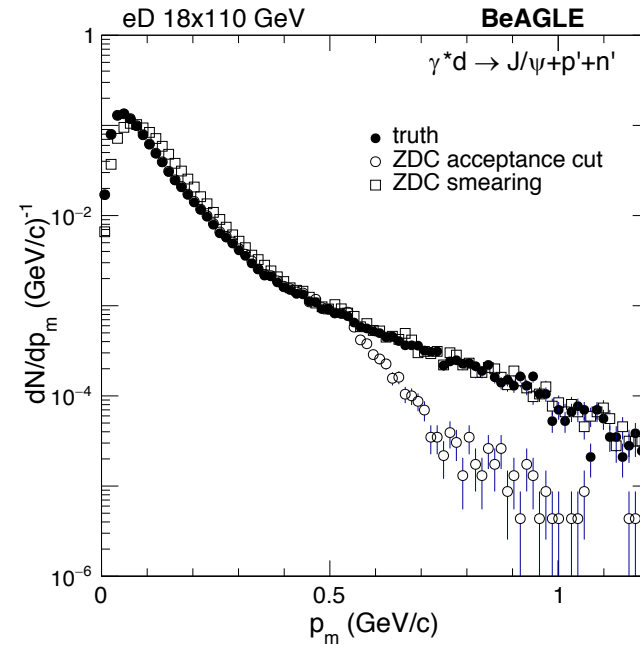$$\vec{p}_r = \vec{p}_m \qquad \theta_{nq}$$

$$\rho(p_r)_{exp} = \sigma_{red} = \frac{\sigma_{exp}}{k\sigma_{ep}}$$

also called reduced cross sections

1/21/20   Exploring QCD with light nuclei at EIC   5

eD 18x110 GeV   **BeAGLE**

$\gamma^* d \to J/\psi + p' + n'$

- truth
- ZDC acceptance cut
- ZDC smearing

Hit proton with neutron spectator

My point is:

For DVCS, it would be just identical when reconstructing spectator neutron

Zero Degree Calorimeter:
- ZDC is +/-5 < mrad in acceptance in my toy model
- Energy resolution is ~ 50%/sqrt(E) + 5%
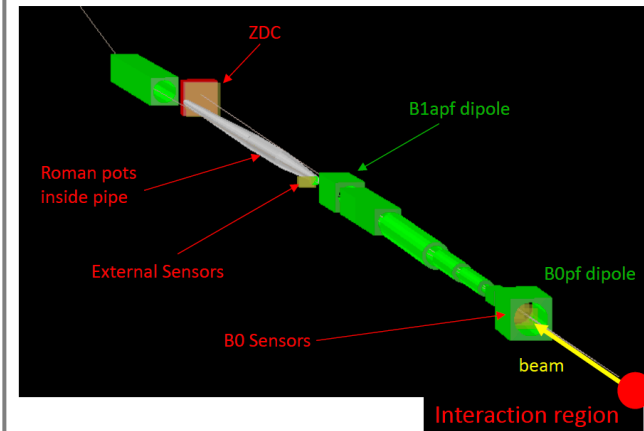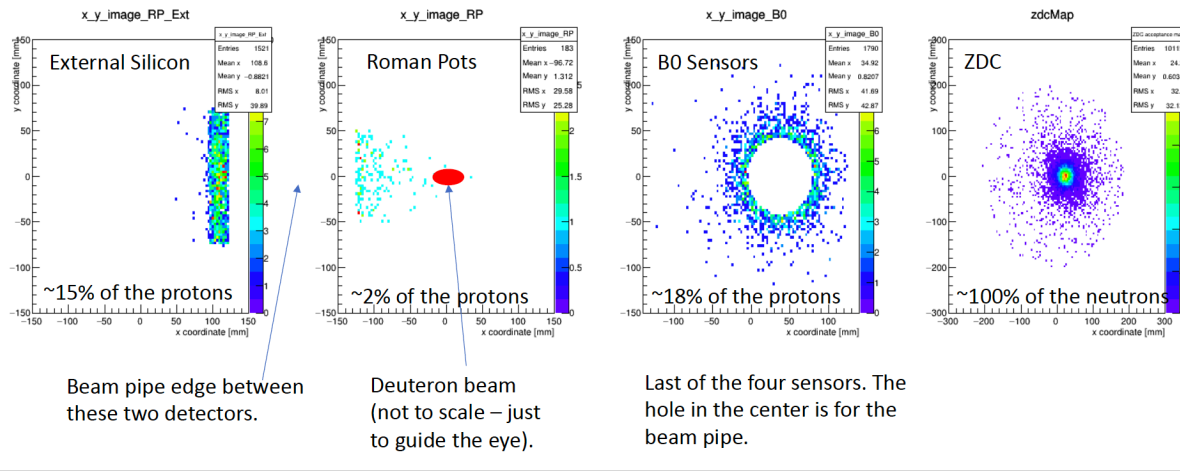- Angular resolution is ~ 0.3 mrad, according to Yuji's EIC R&D Letter of Intent.
  https://wiki.bnl.gov/conferences/images/3/32/Goto_EIC_ZDC_LoI.pdf

One quick look from detector simulation

Caveat: very preliminary and will be iterated many times even before Temple meeting

Taken from Alex Jentsch's slide, great works!

Summary

- For tagging deuteron breakups, some progresses have been made. No duplicate work should be done.

- Some dedicated studies might be needed for the real photon, for different method of reconstructions, and scenarios of different physics…

- Identify manpower, objectives, and goals for the yellow report for DVCS on deuteron.

- Other ideas? Suggestions?