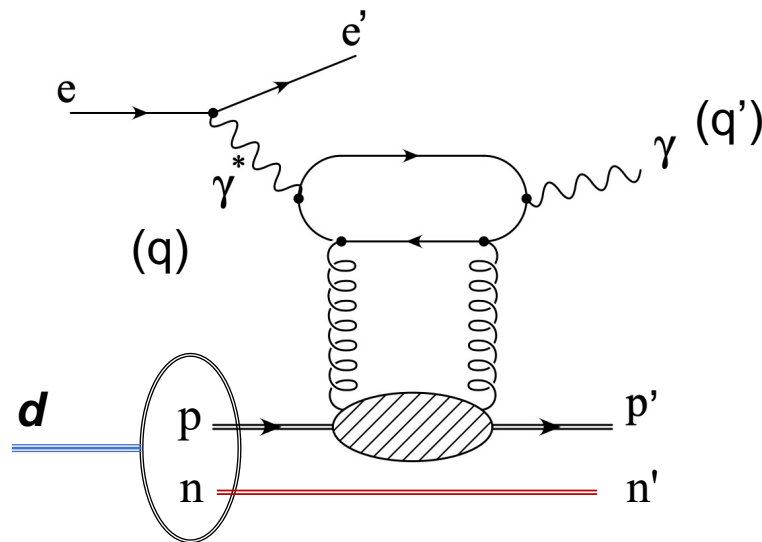# DVCS in *ed* at ATHENA – spectator tagging

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Idea - DVCS in deuteron with tagging

[YR meeting. 02.28.2020.]

- **Setup:** Process can be reversed, on neutron with proton spectator. Both are accessible at the EIC.

- **Benefit:** Access to the neutron target, and with precise control of the initial deuteron configuration. For example, see our recent paper [A. Jentsch, **ZT**, C. Weiss (2021) (arXiv:2108.08314)]

- **How:** a hybrid method*
  1. Use deuteron light cone wavefunction
  2. + DVCS on *ep* [EpIC]
  3. Model the breakup as in BeAGLE.
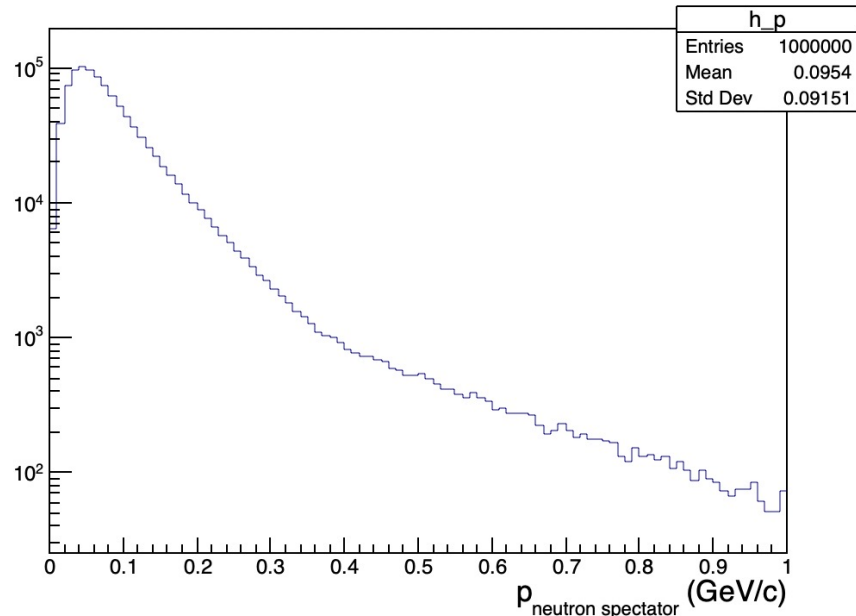 4. Output* with **gamma, proton, neutron, e'**

*1. Call it "EpiC-D"?...
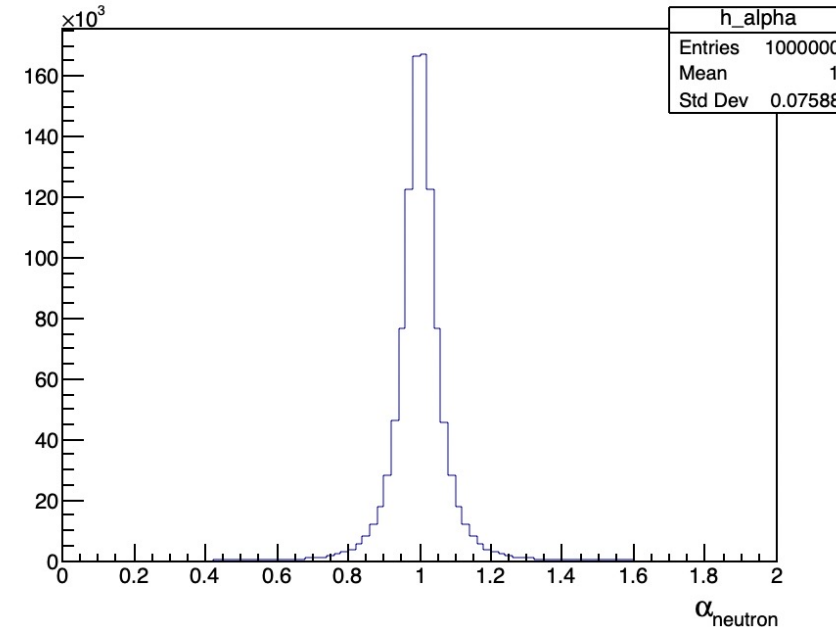*2. Read in hepmc3 from EpIC and then output to hepmc3 (need some coding)

Spectator kinematics.

Spectator neutron momentum in d rest frame

Light-cone momentum fraction

This is the same as what BeAGLE has been using for deuteron wavefunction.

Method to combine deuteron wfs and EpIC

- EpIC: e+p=e'+γ+p'
  1. Sample nucleon momentum distribution in deuteron rest frame, according to the light-cone kinematics, see - arXiv:2005.14706. Let's denote the proton 4vector – p_inD, and neutron's – n_inD. Boost them in the lab frame using p.
  2. Boost p' and γ to p rest frame, and then reverse boost using p_inD. (it's similar like we study the beam effects)
  3. Now we have e+D=e'+ γ +p'+n_inD; However, this does not conserve momentum and energy, because D != p+n. (we treat the incoming proton on mass shell, which is wrong…)
  4. Ad-hoc correction to γ and p' in order to conserve energy and momentum, and keep them on mass shell, leaving e' and n_inD untouched.
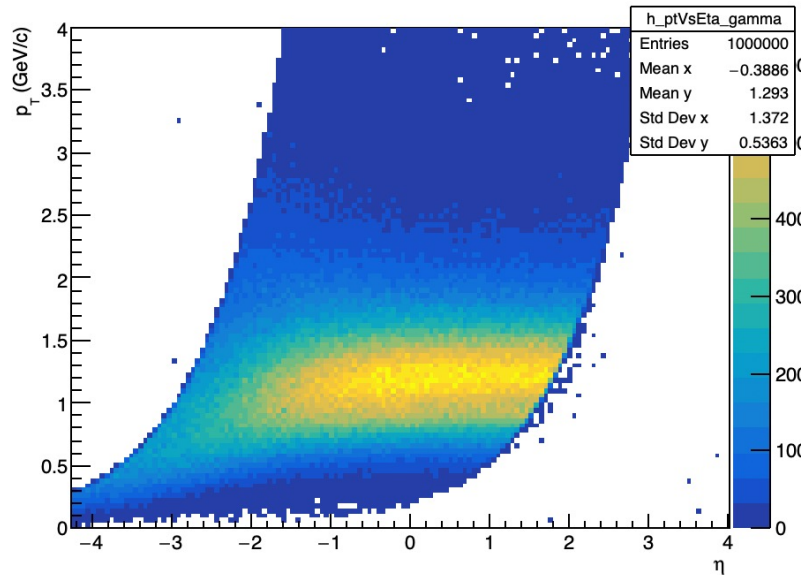
[This is similar to what BeAGLE has done to the J/psi in ed, the key is to leave the spectator untouched!]

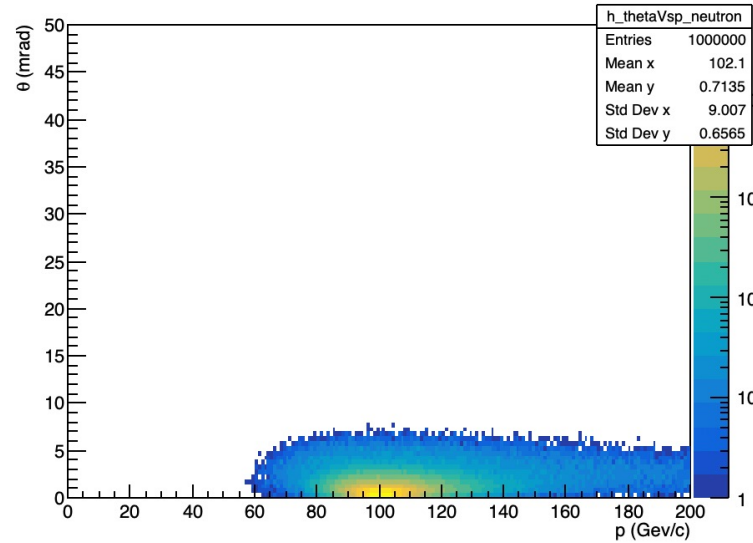# EpIC samples

- Provided by Salvatore:
    1. DVCS_10x100_2M
    2. DVCS_18x275_2M
    3. DVCS_5x100_2M
    4. DVCS_5x41_1M

- This study, 1. is used.
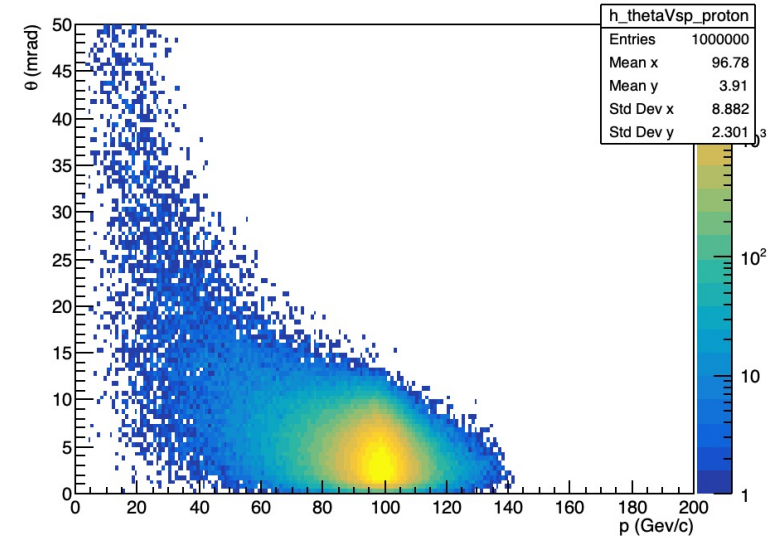
DVCS on deuteron (neutron tagged)!
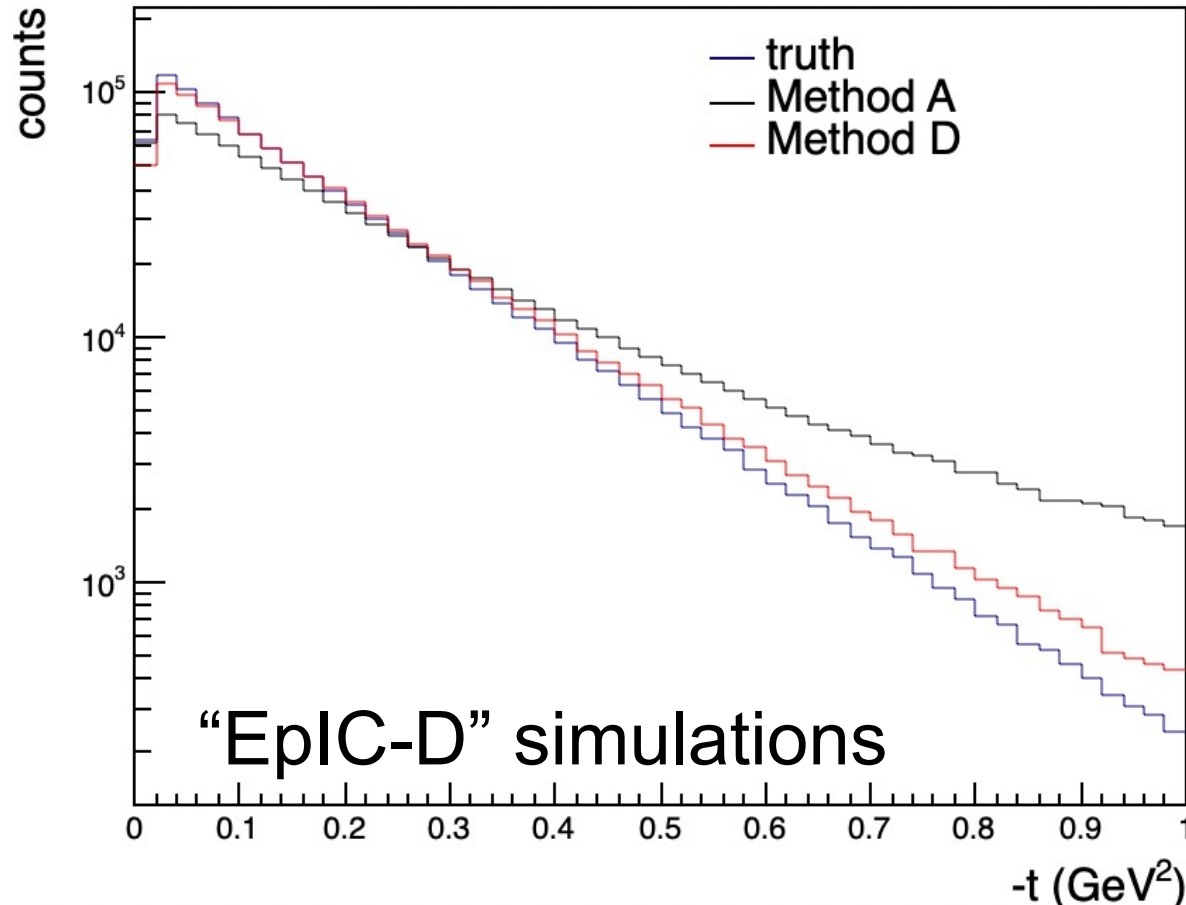# 2D kinematics

photon

neutron

proton

These kinematic distributions look ok.

t distributions

"EpIC-D" simulations

- Method A is $(p_{T,e'} +_{vector\_sum} p_{T,V})^2$

- Method D is: $(p'-(-n'))^2$ double tagging

- Method A is not accurate because of finite Q2? Need a closer look

Note, this hybrid method is *conceptually wrong* because we do not have a threshold effect. Incoherent at t=0 should be 0

Summary

- The first version is working – EpIC-D
- Need to write the output in HepMC3
- For DVCS on neutron with proton tagging, we only need to swap the kinematic distributions for detector simulations.

- Preliminary code lives, /gpfs02/eic/ztu/ATHENA/exclusiveGroup_ATHENA/analysis/EpIC

Backup

EpIC ep distribution of photon