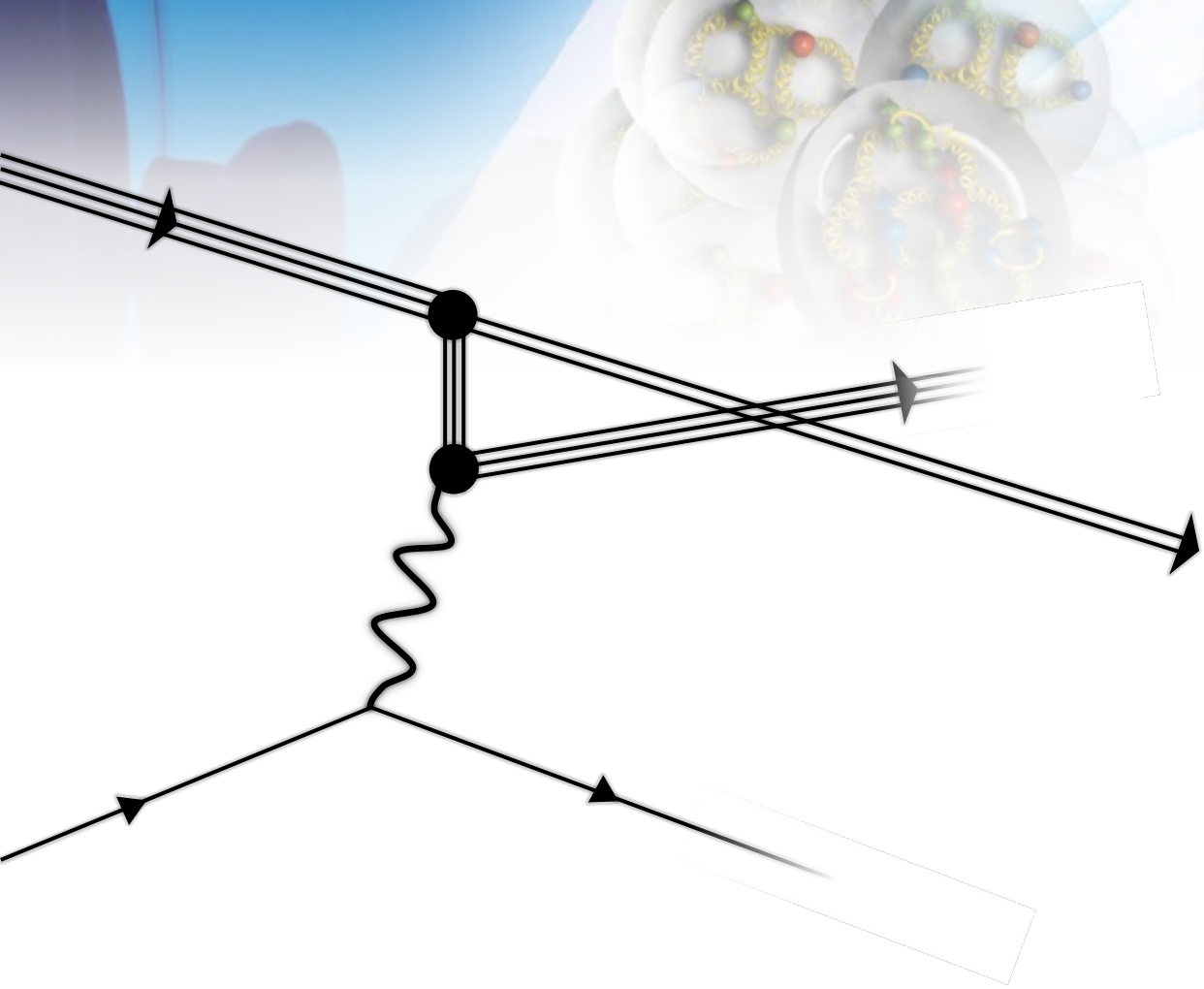

ZDC Requirements for *u*-channel Physics at the EIC

Zachary Sweger
University of California, Davis

Supported in part by

Backward (*u*-channel) Tomography

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Backward Tomography at the EIC

Backward (*u*-channel) Tomography

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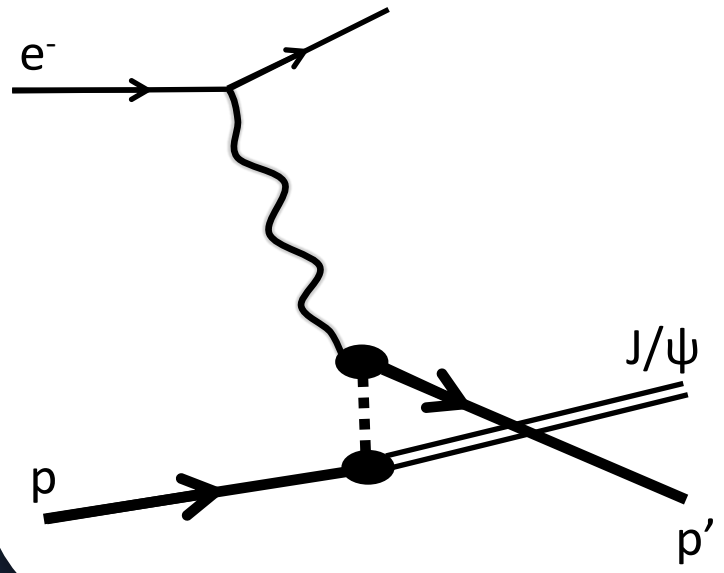
Backward Tomography at the EIC

Backward scattering/production



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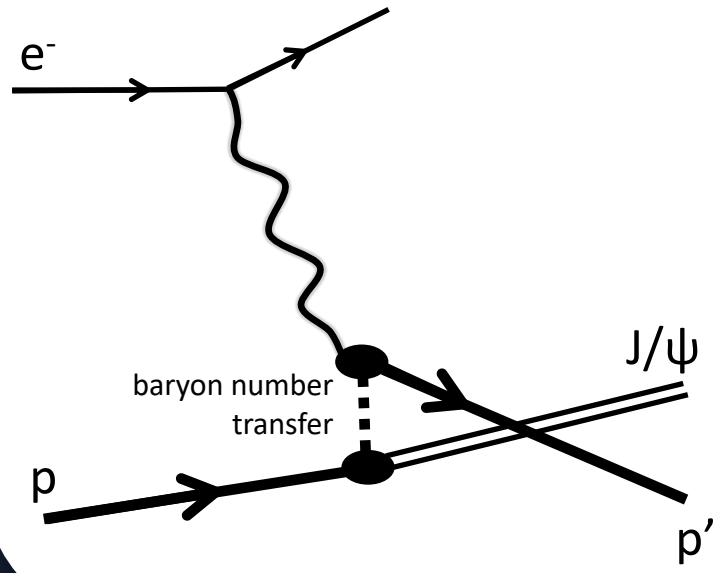

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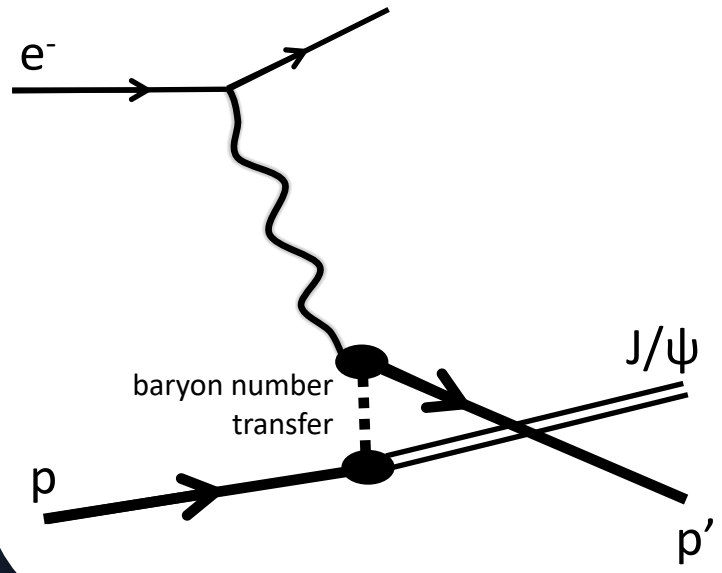
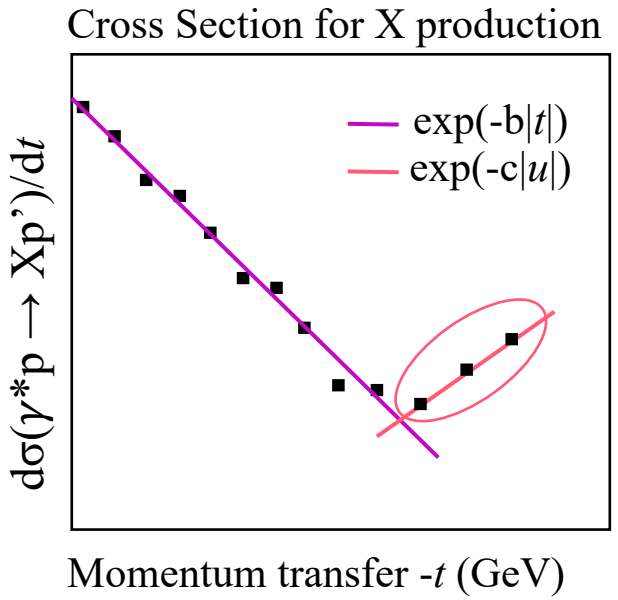


Cross section measurement



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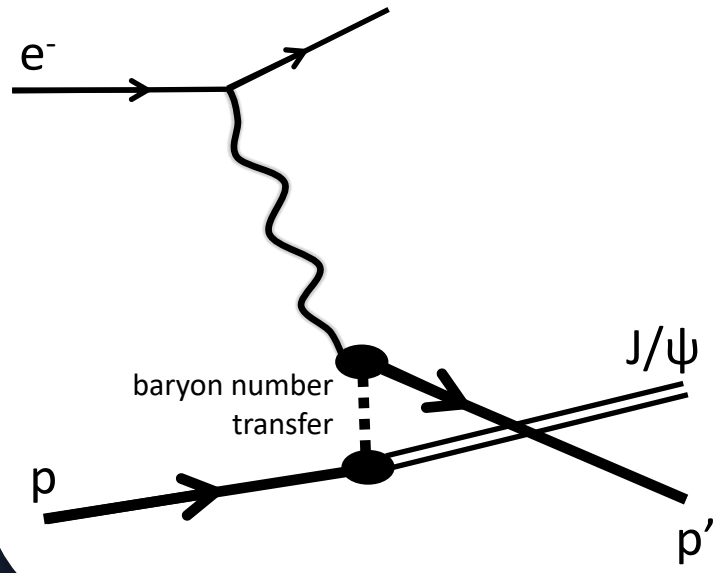
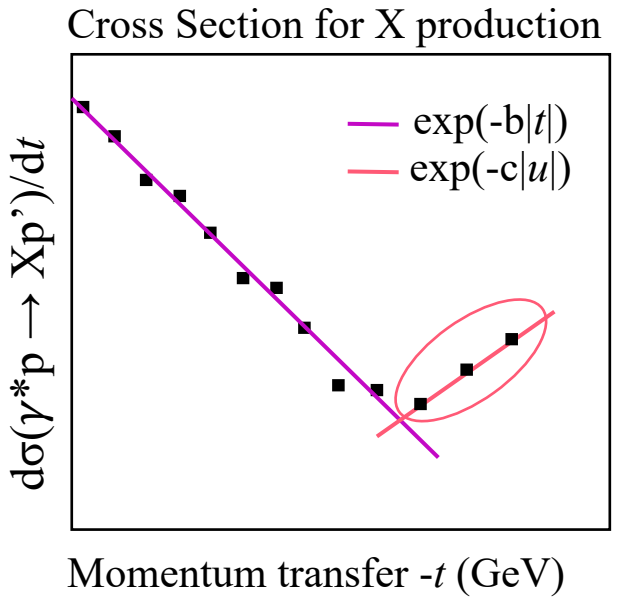
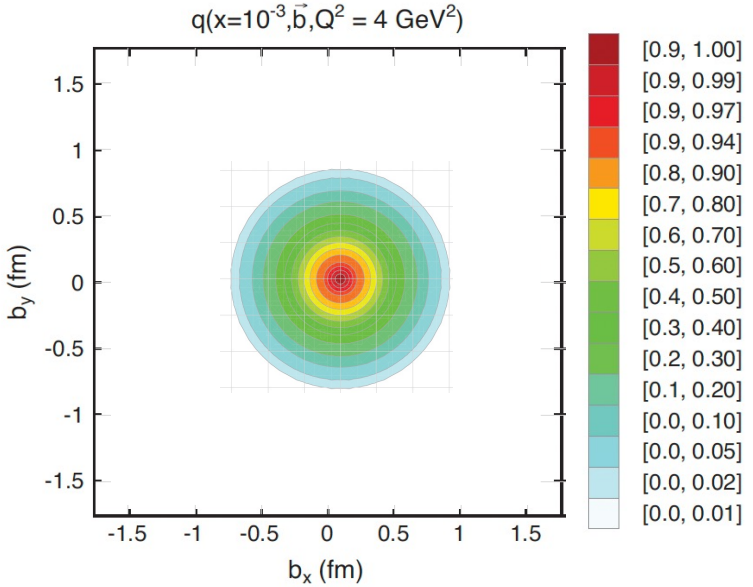
Backward scattering/production



Cross section measurement

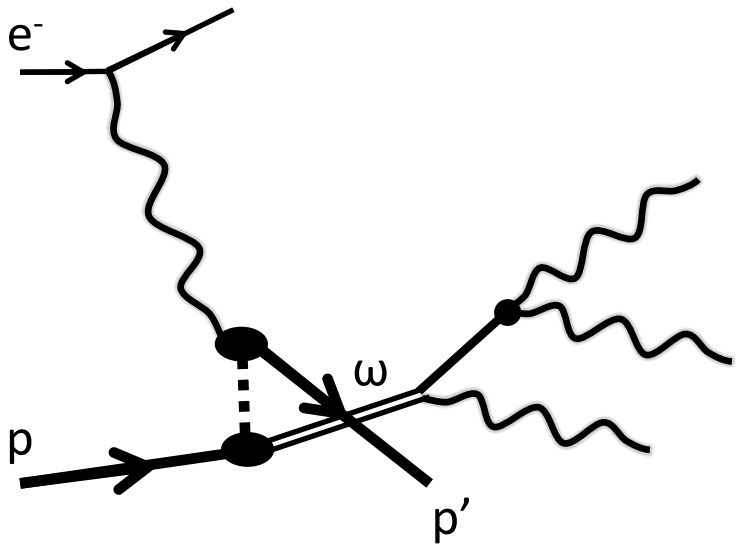


(Partonic correlations)/ (diquark clusters)/(baryon number) in transverse plane



u-channel Processes Requiring ZDC

- Omega meson production: $\omega \rightarrow \gamma\gamma\gamma$ Phys. Rev. C 106, 015204 (2022)

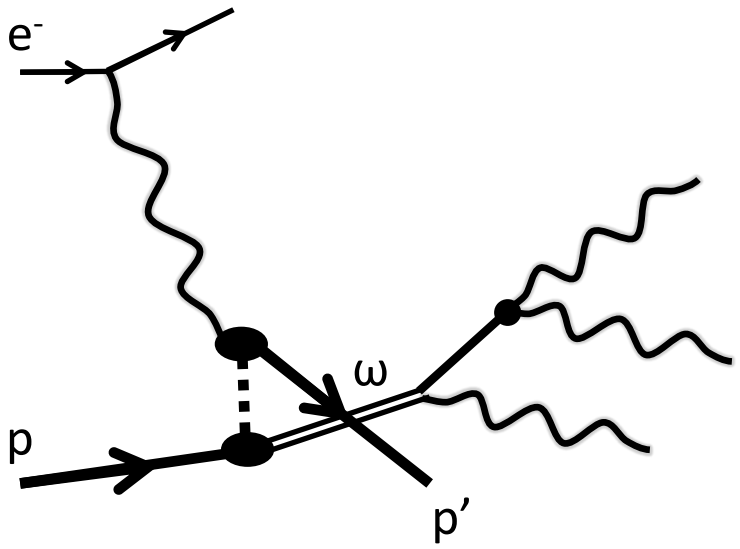


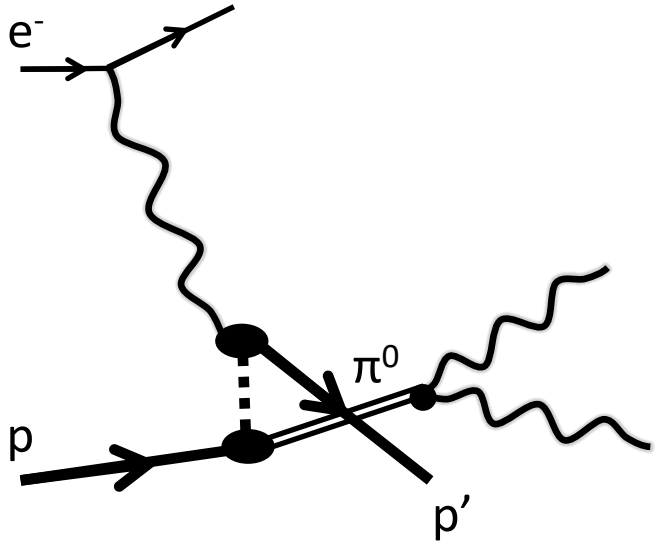
u-channel Processes Requiring ZDC

- Omega meson production: $\omega \rightarrow \gamma\gamma\gamma$
- Pion production: $\pi^0 \rightarrow \gamma\gamma$

Phys. Rev. C 106, 015204 (2022)

arXiv:2308.10478





u-channel Processes Requiring ZDC

- Omega meson production: $\omega \rightarrow \gamma\gamma\gamma$
- Pion production: $\pi^0 \rightarrow \gamma\gamma$
- DVCS: γ

} Phys. Rev. C 106, 015204 (2022)

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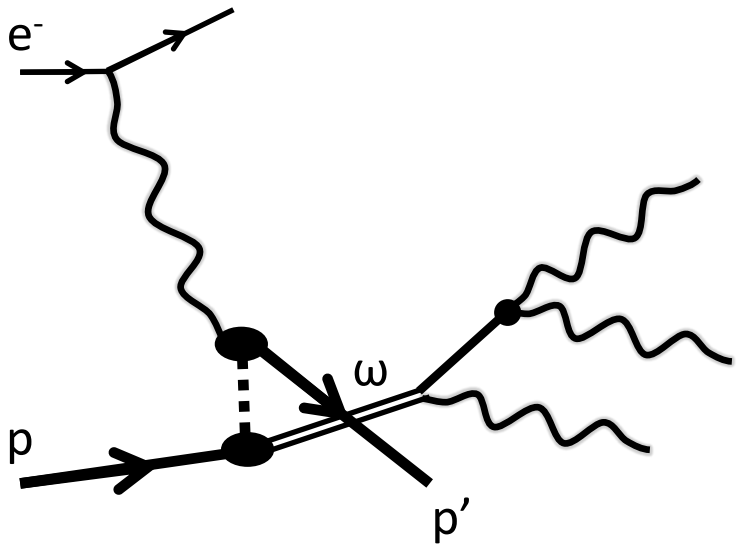
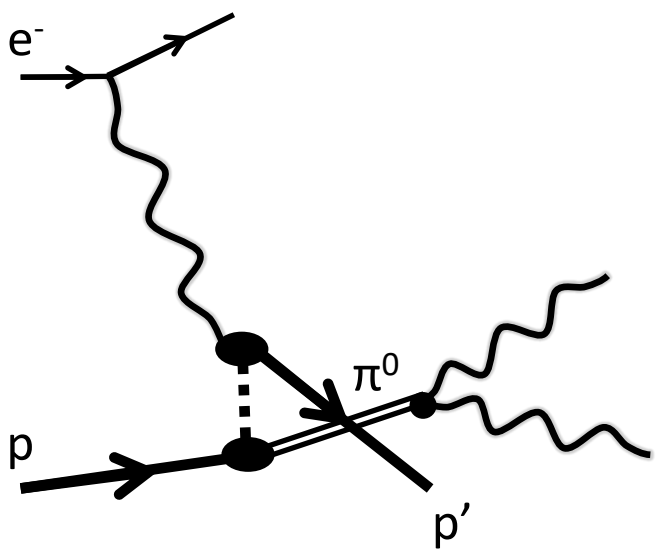
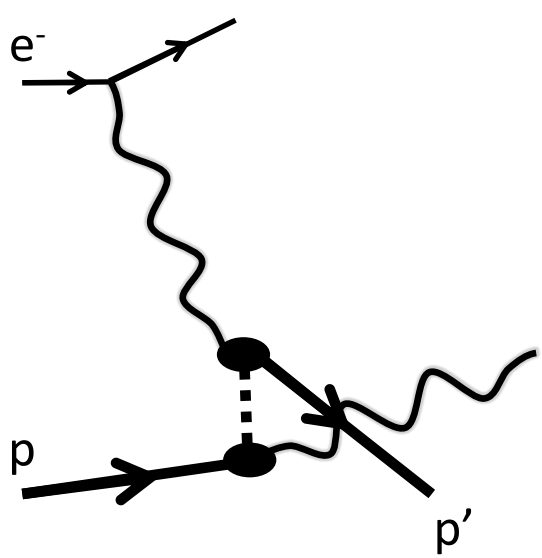
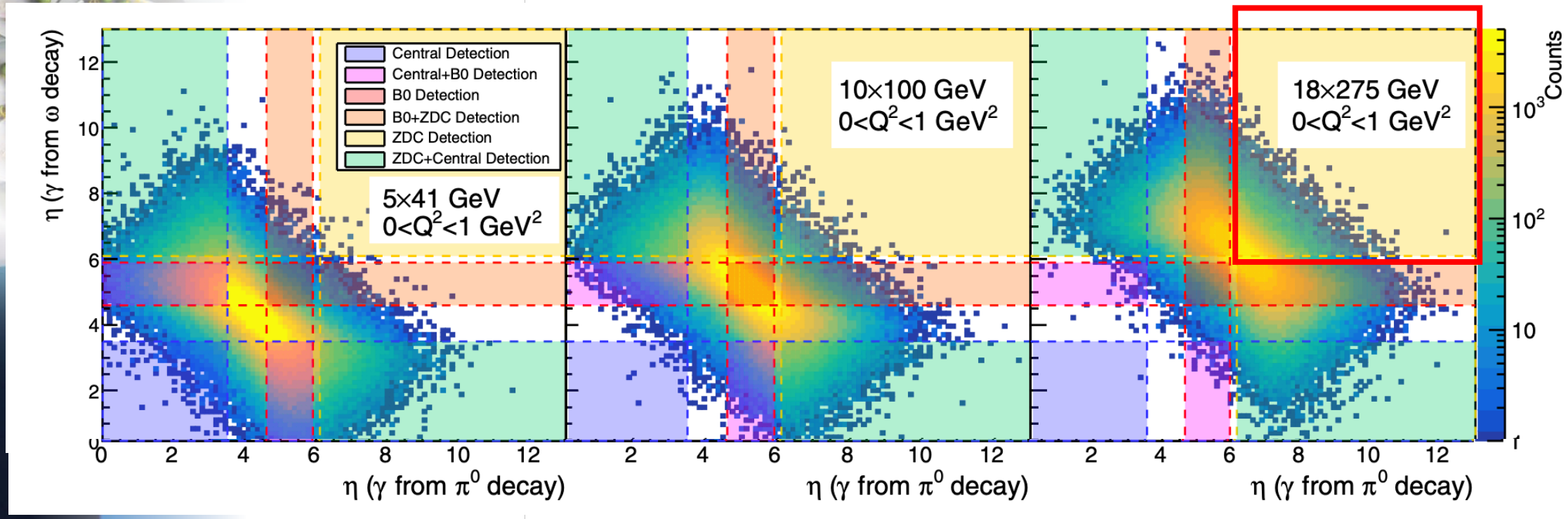






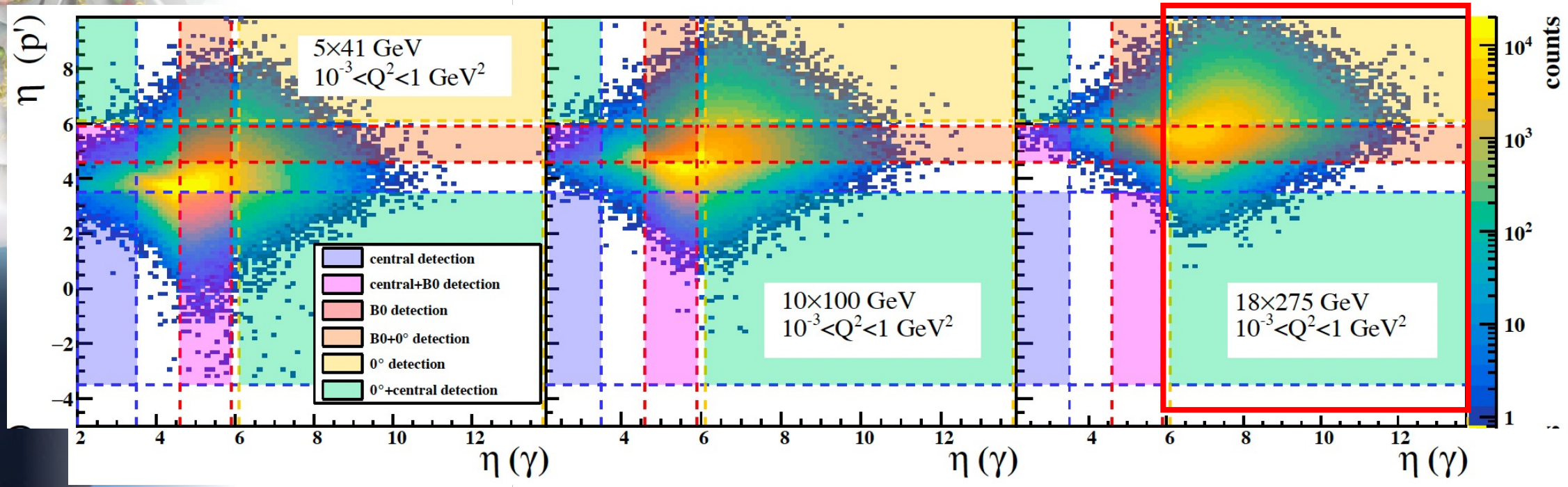
u-channel ω in the ZDC

- 18×275 GeV optimizes odds that all three photons are in the ZDC
- 6% acceptance rate for all three assuming approximate ZDC acceptance of η>6.1
- High-energy photons ~100 GeV



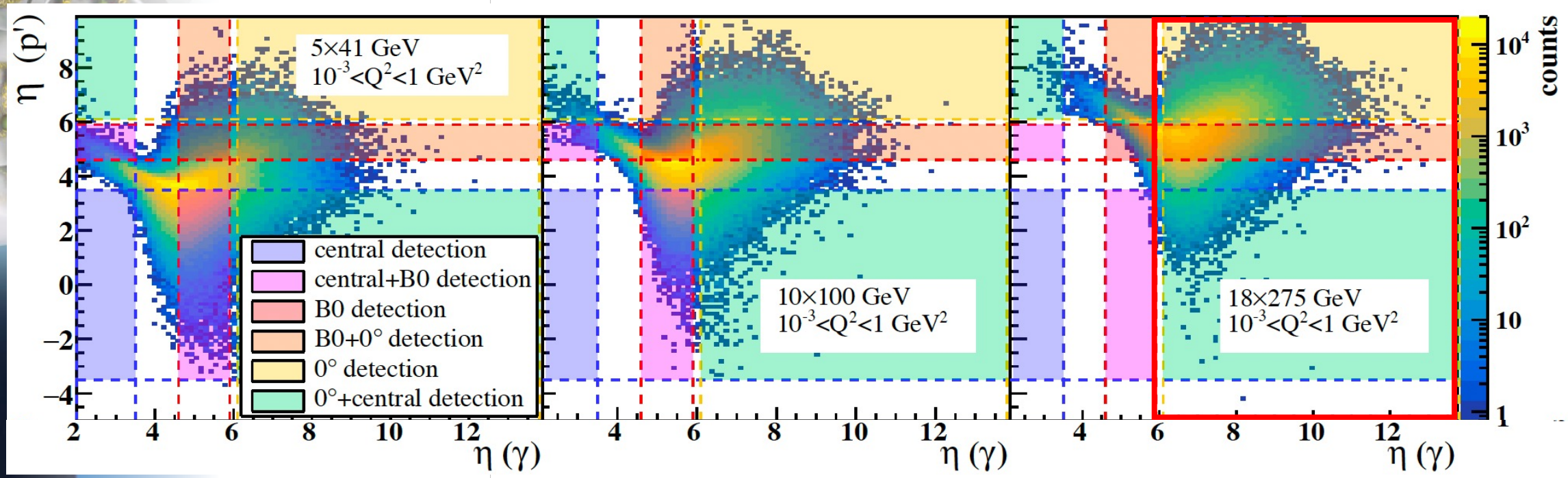
u-channel π^0 in the ZDC

- 18×275 GeV optimizes odds that both photons are in the ZDC
- 99% acceptance rate assuming approximate ZDC acceptance of $\eta>6.1$
- High-energy photons ~20-250 GeV



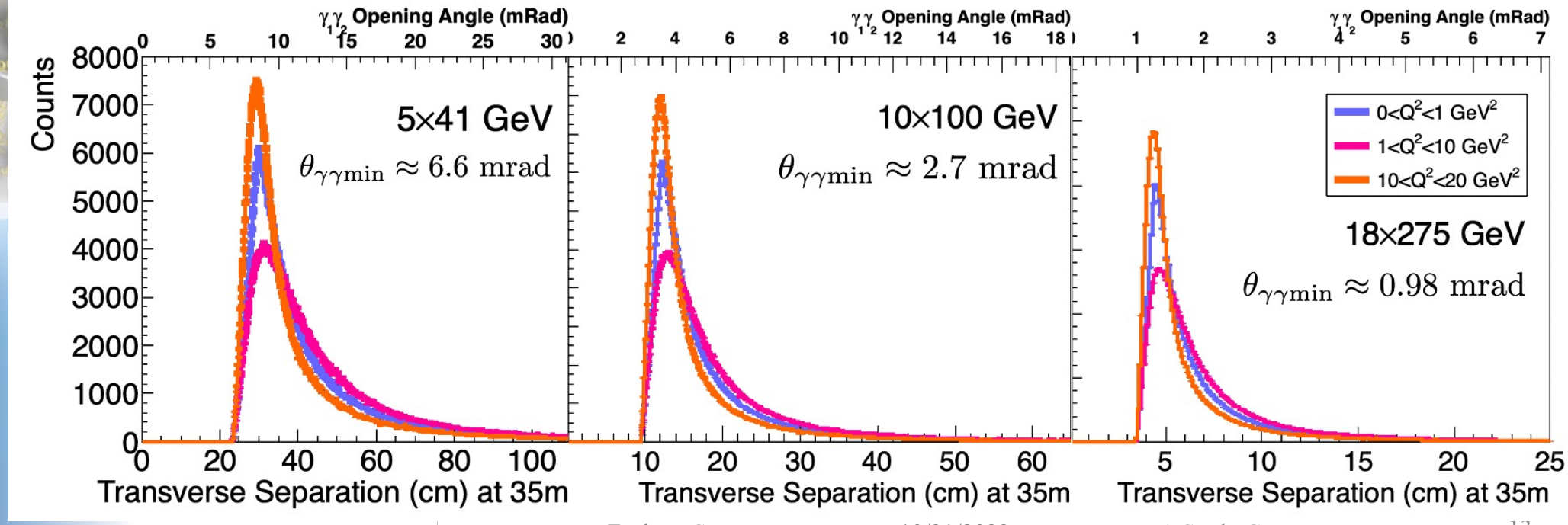
u-channel DVCS in the ZDC

- 18×275 GeV optimizes odds that the photon are is in the ZDC
- 99% acceptance rate assuming approximate ZDC acceptance of η>6.1
- High-energy photons ~20-250 GeV



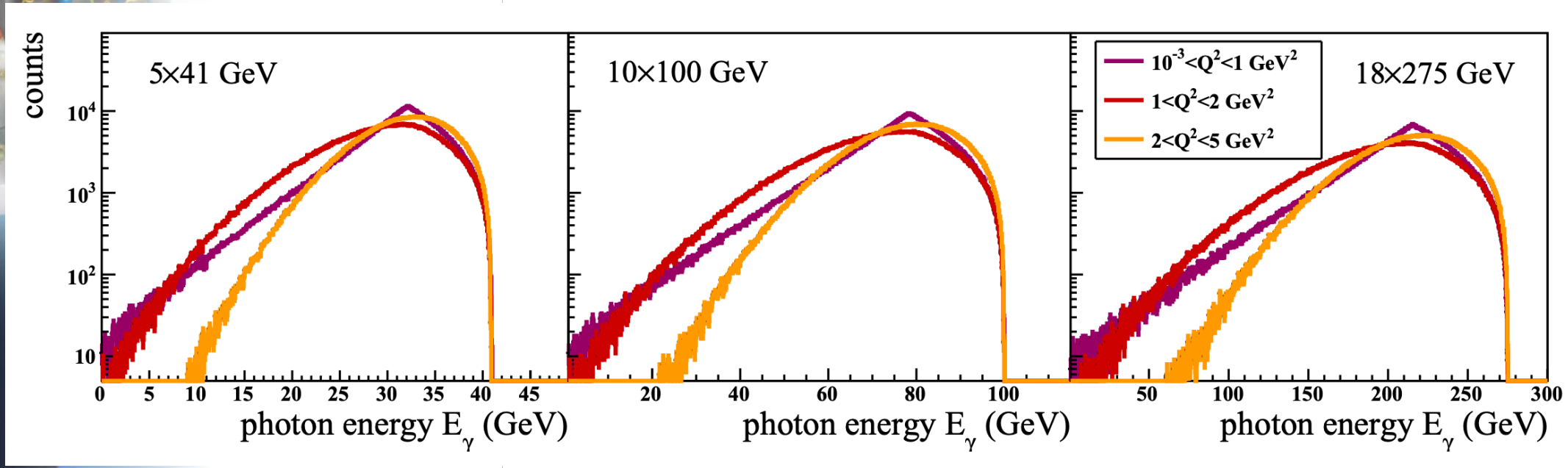
ZDC Spatial Resolution

- Our spatial resolution needs are determined by the requirement of separating two photons coming from the π^0
- The minimum possible photon separation in any *u*-channel process comes from π^0 production at 18×275 GeV
- This minimum possible separation is 3.4 cm

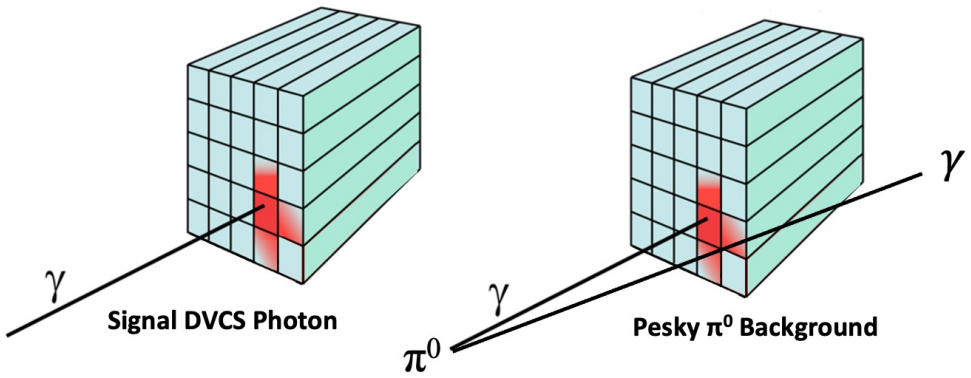


ZDC Energy Resolution

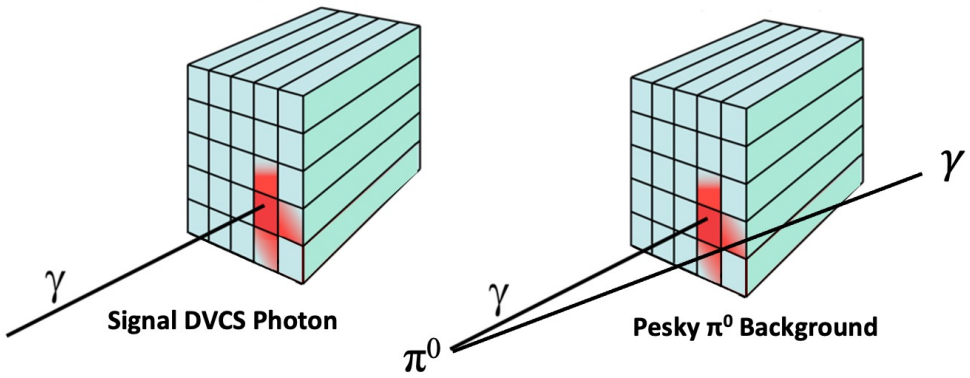
- Energy resolution needs come from the use of missing energy cuts
- ω production is a background to both backward π^0 and DVCS
- ω and π^0 production are both backgrounds to DVCS
- *u*-channel photons span the range from 0 to 275 GeV
- We especially require excellent high-energy resolution 100-250 GeV



Reducing Background



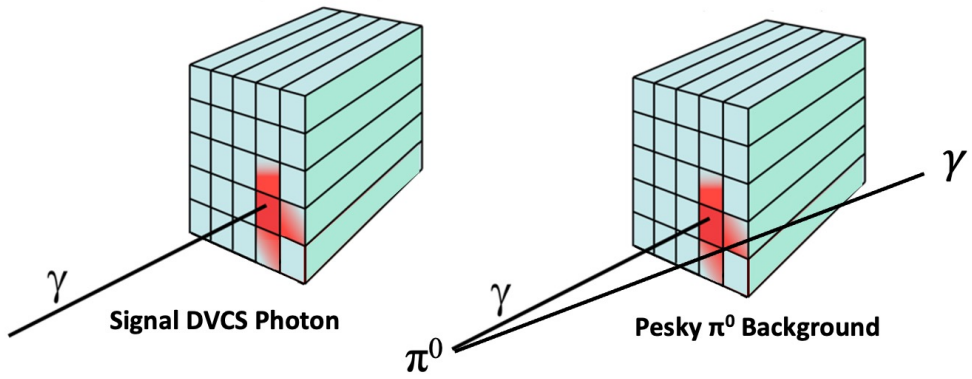
Reducing Background



apply ZDC reconstruction smearing

$$\Delta E/E \sim (2\% - 5\%)/\sqrt{E} \oplus 1\%$$

Reducing Background



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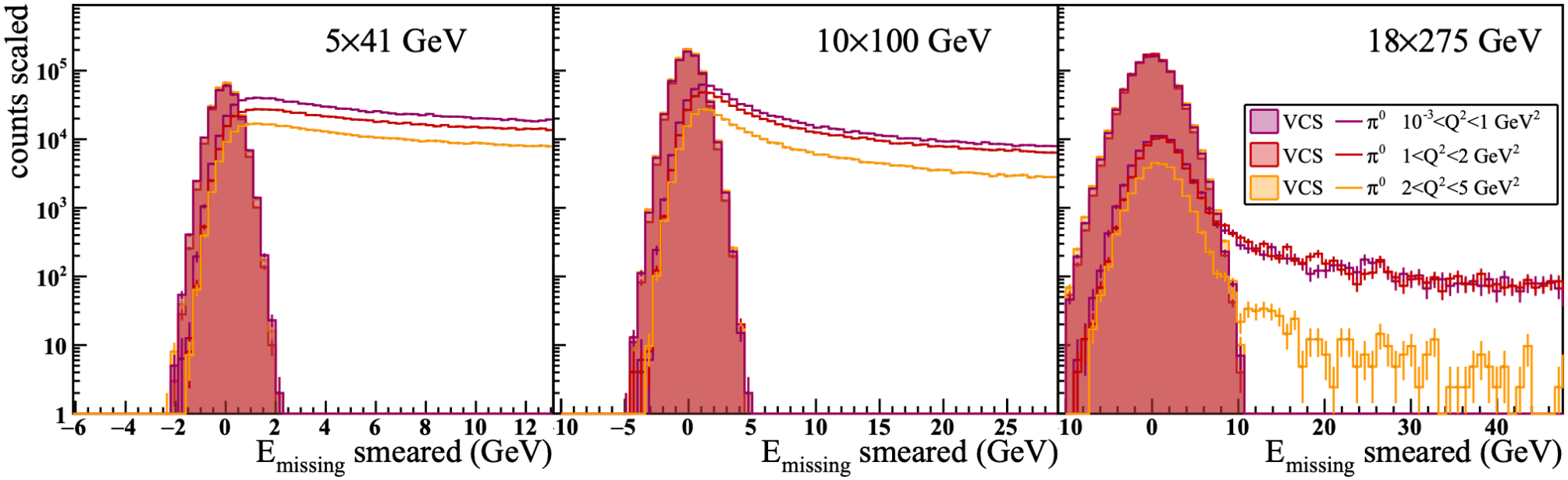
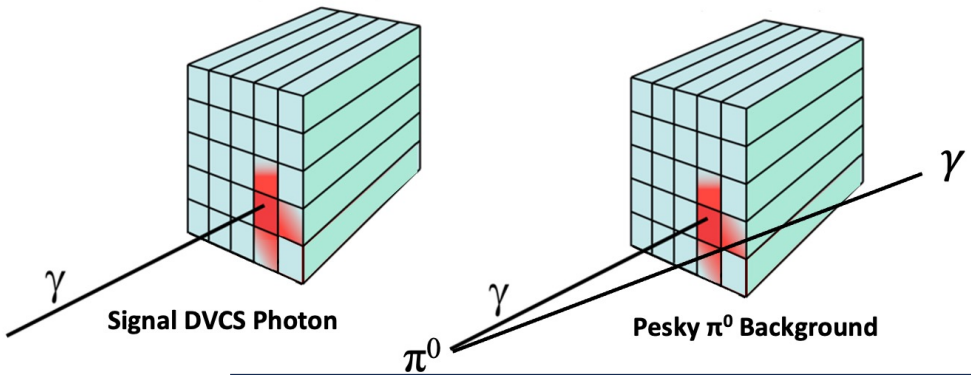


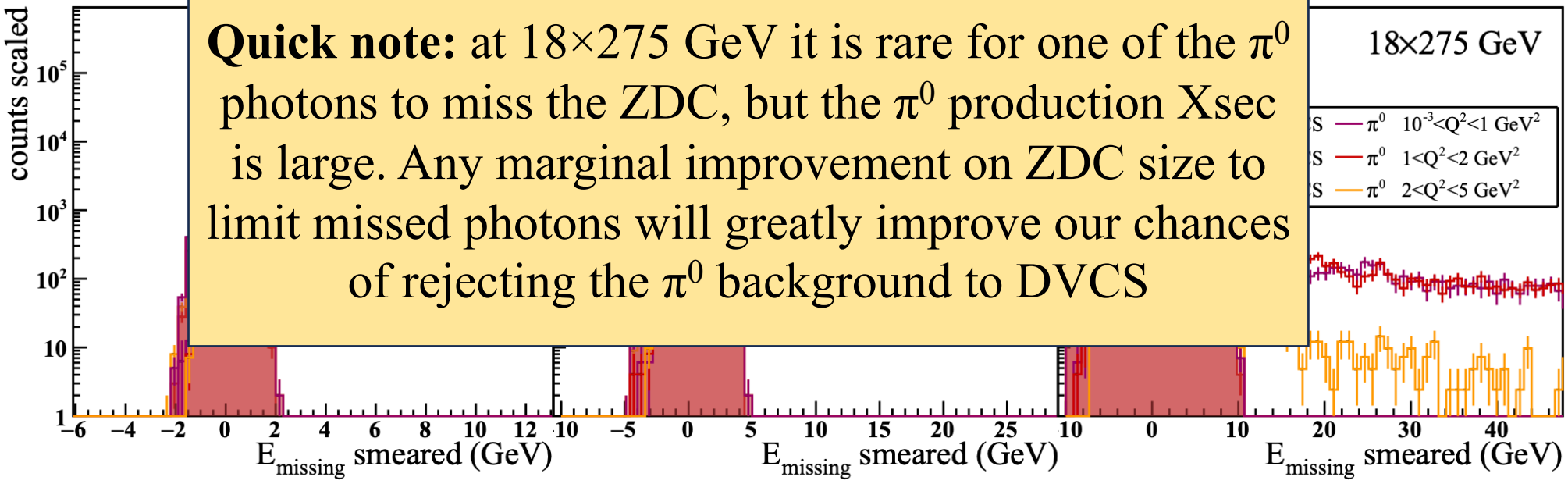
Reducing Background



apply ZDC reconstruction smearing

$$\Delta E/E \sim (2\% - 5\%)/\sqrt{E} \oplus 1\%$$

Quick note: at 18×275 GeV it is rare for one of the π^0 photons to miss the ZDC, but the π^0 production Xsec is large. Any marginal improvement on ZDC size to limit missed photons will greatly improve our chances of rejecting the π^0 background to DVCS

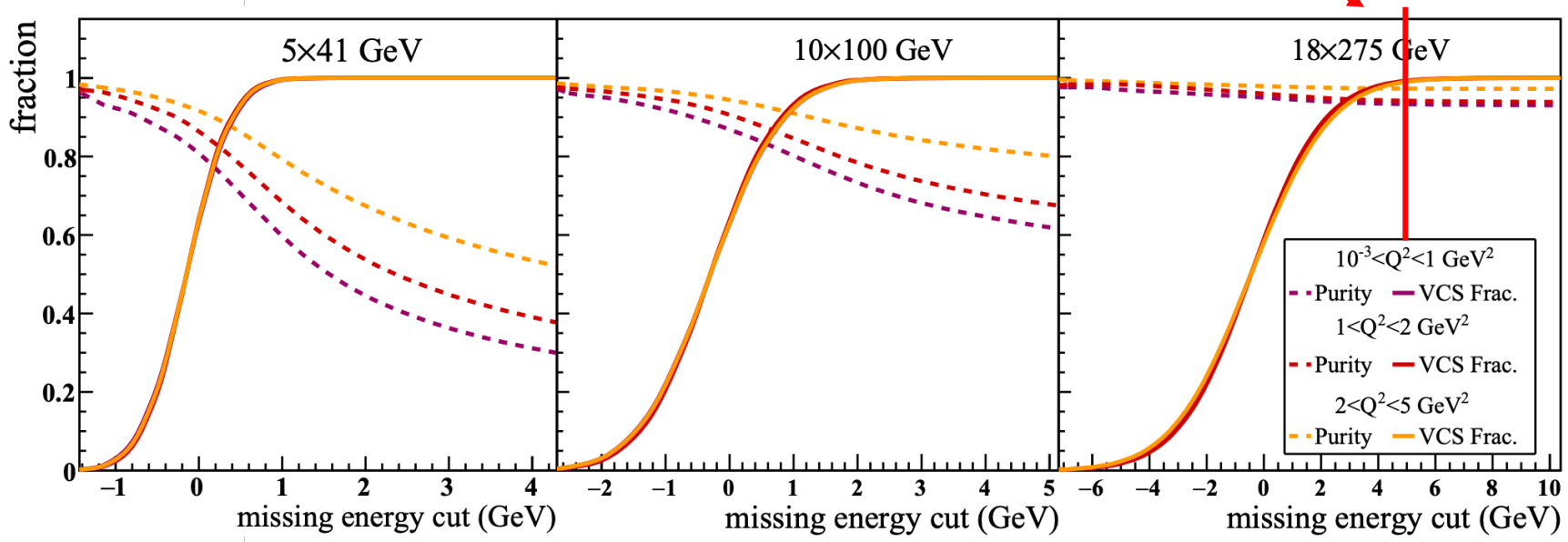


Reducing Background

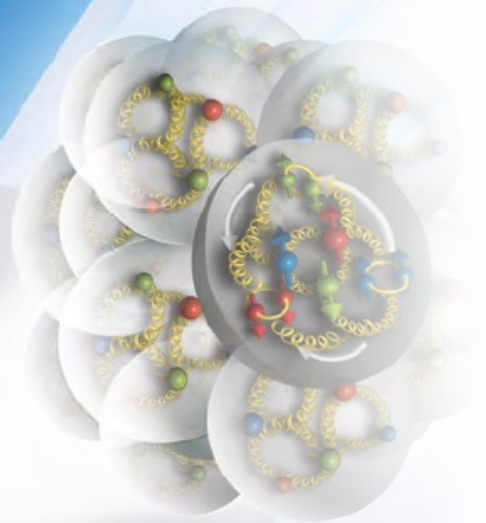
Missing energy cuts to collect entire VCS sample

- 5×41 GeV: $E_{missing} < 1$ GeV → ~70% purity
- 10×100 GeV: $E_{missing} < 2$ GeV → ~80% purity
- 18×275 GeV: $E_{missing} < 5$ GeV → ~95% purity

This is largely dependent on model cross sections



Reducing Background



We can relax the stochastic term to study effect on purity

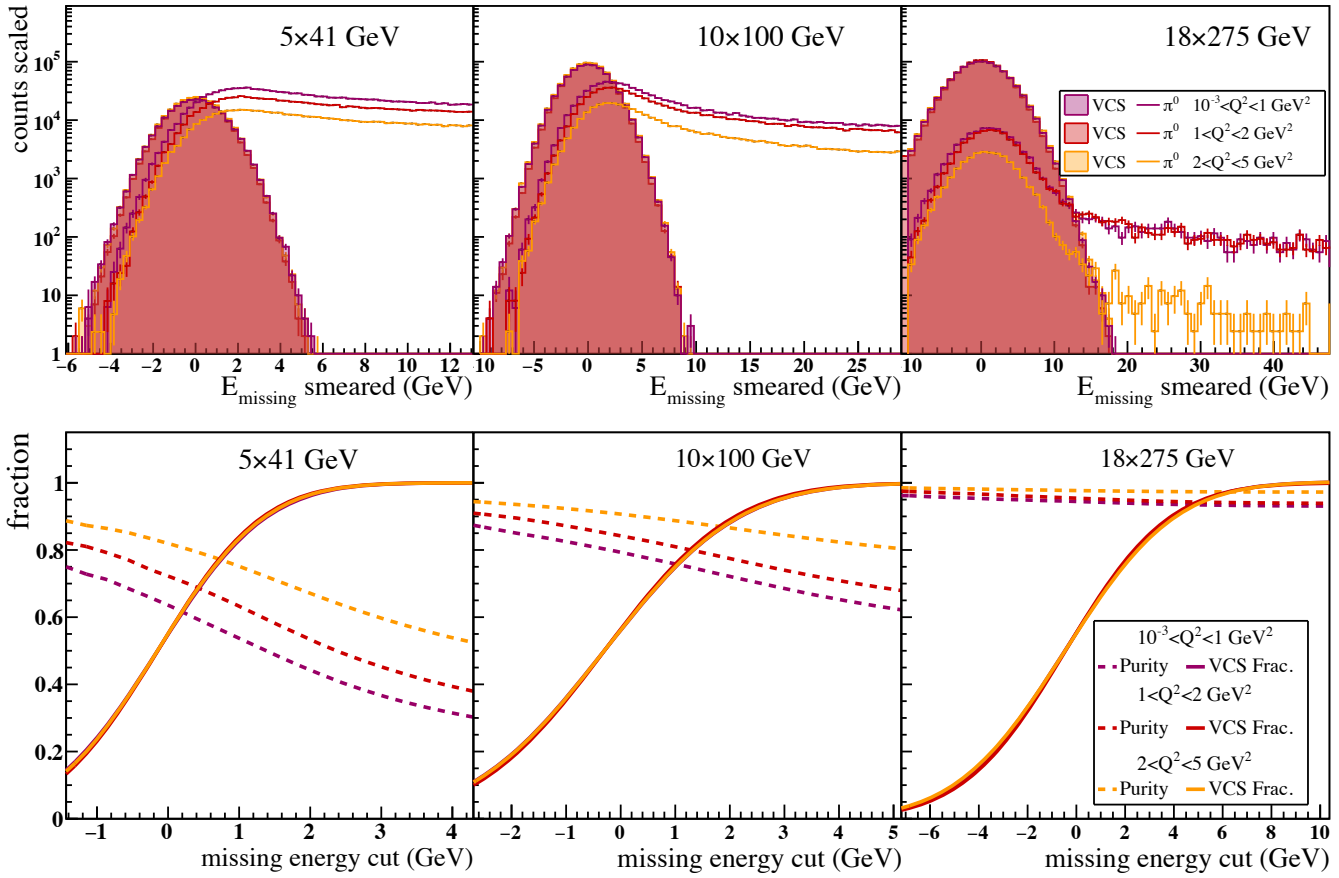
$$\Delta E/E \sim (20\%)/\sqrt{E} \oplus 1\%$$

Reducing Background

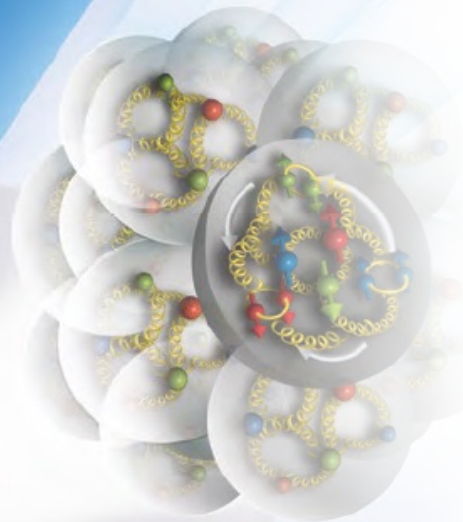
We can relax the stochastic term to study effect on purity

$$\Delta E/E \sim (20\%)/\sqrt{E} \oplus 1\%$$

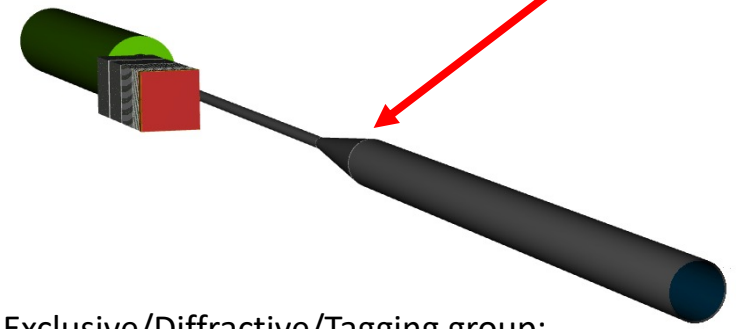
purity at 18×275 GeV is relatively insensitive

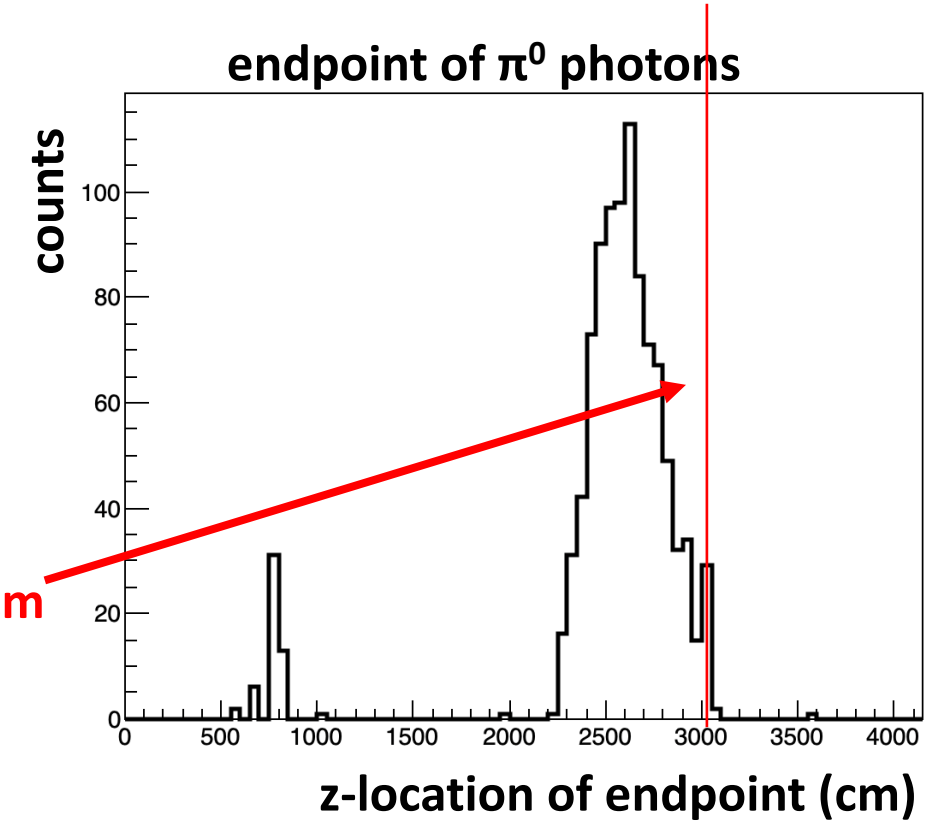


Quick Note on Beam Pipe

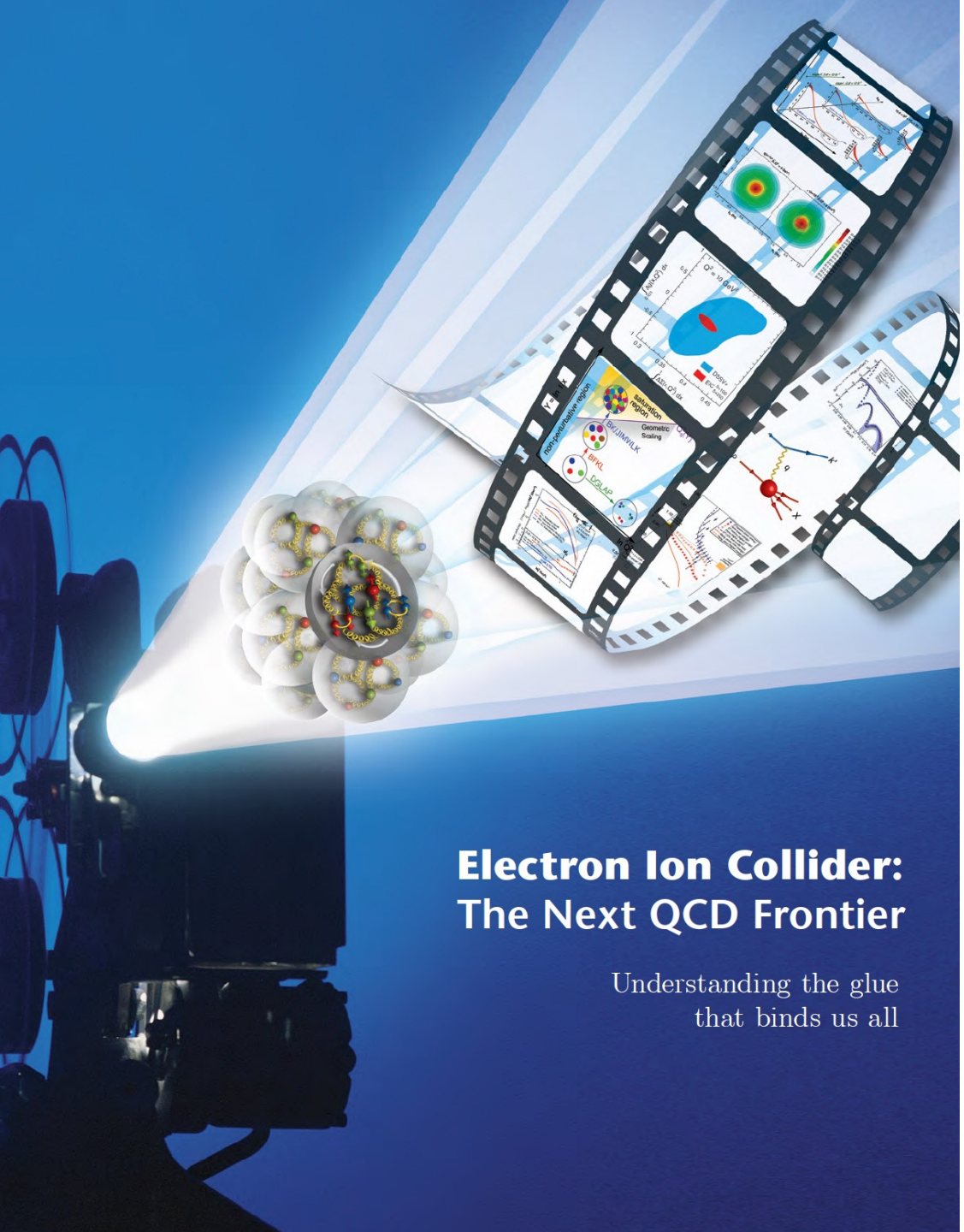


- With the help of Tyler Hague, I've looked into ePIC simulations for backward π^0 production
- The Monte Carlo photon tracks always terminate in the beam pipe material before reaching the ZDC
- This is under investigation, but it is clear that current beam pipe design is insufficient





For full presentation to Exclusive/Diffractive/Tagging group:
https://indico.bnl.gov/event/20540/contributions/81537/attachments/50096/85720/UpdateOnBenchamarks.pdf



Conclusions

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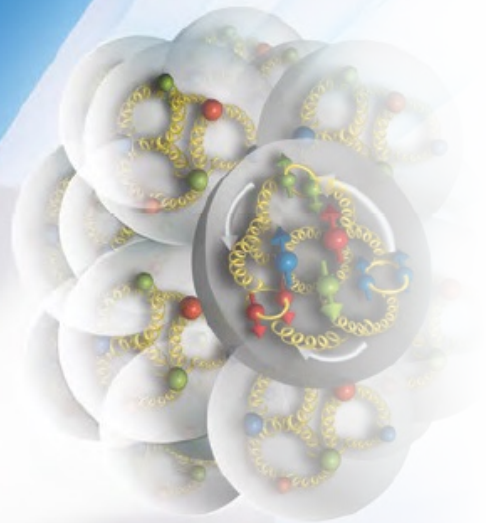
- *u*-channel is key to achieving the full capabilities of nuclear tomography at the EIC
- Here are the ZDC requirements for these channels:

Absolutely necessary:

- ❑ **hit separation resolution > ~ 3cm**
- ❑ **good high-energy resolution. Effect on π^0 reconstruction needs to be studied**

Necessary for detecting DVCS:

- ❑ **Large acceptance, not much smaller than η>6.1… every centimeter helps**



Thank you for your attention!

zwsweger@ucdavis.edu