

EICUG: Second Detector Working Group
30 September 2022

DVCS on Nuclei with a 2nd EIC Detector

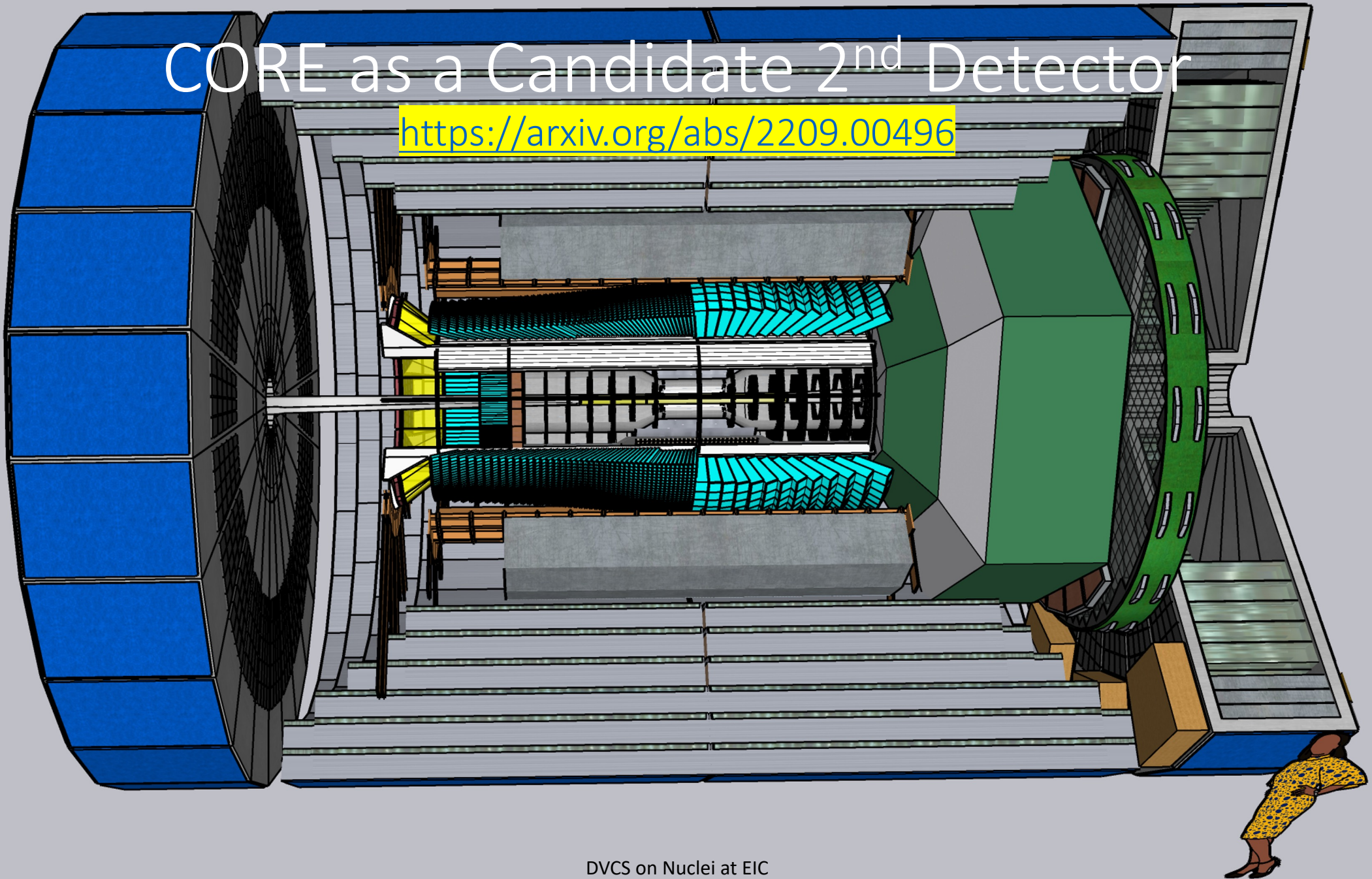
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CORE as a Candidate 2nd Detector

<https://arxiv.org/abs/2209.00496>



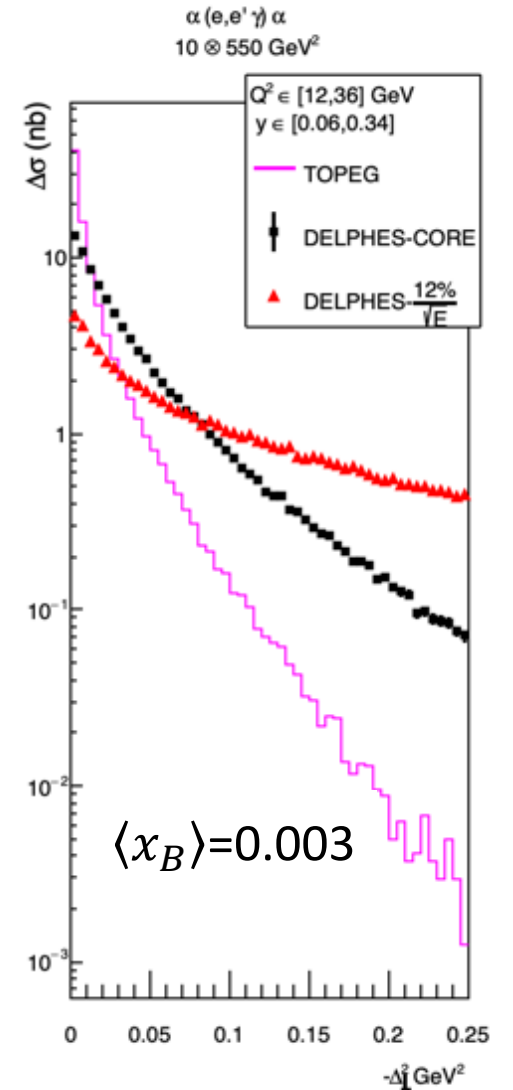
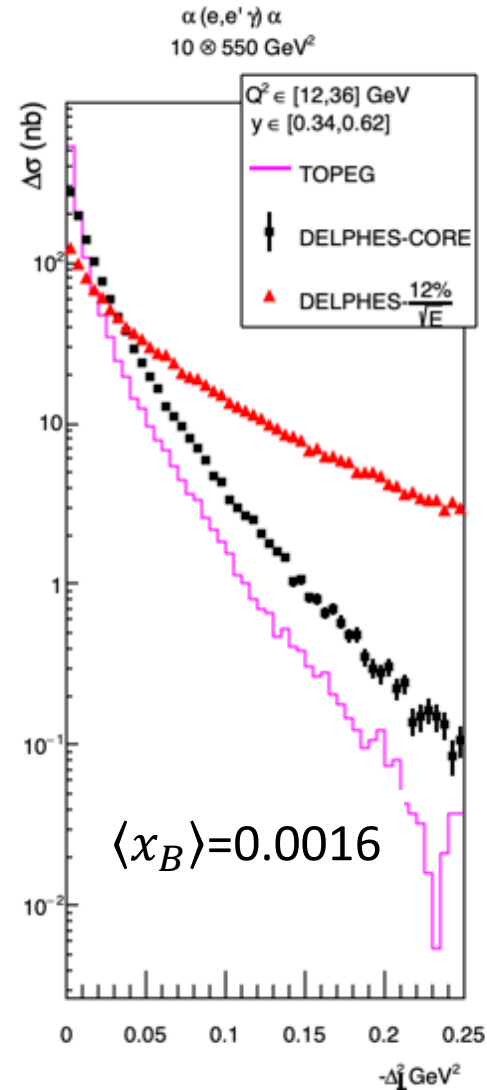
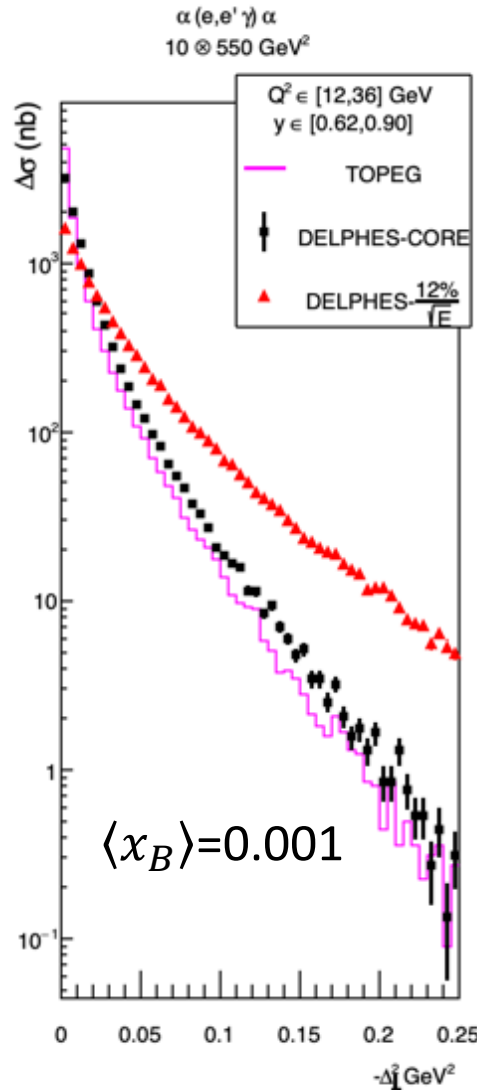
CORE as a Candidate 2nd Detector

<https://arxiv.org/abs/2209.00496>

- Muon ID, HCal, EMCal for $|\eta| \leq 3.5$
- High resolution PbWO₄ EMCal $-3.5 < \eta \leq 0$
 - Catches all DVCS electrons and photons
- Single technology Si (MAPS) tracker
- Full PID
- Flexible integration with accelerator lattice
 - $\pm 4\text{m}$ length

DVCS Bin Migration Comparison

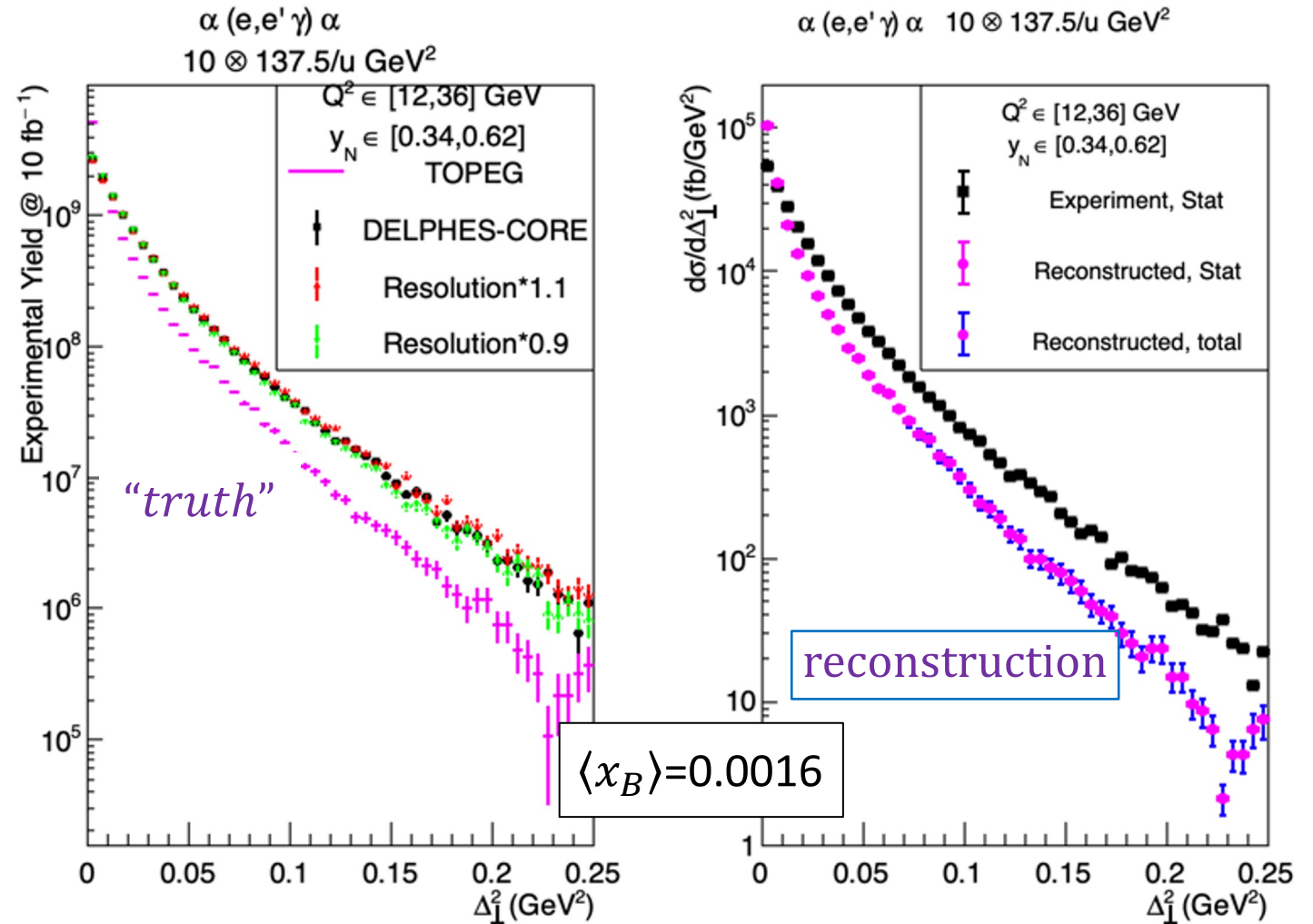
- $\alpha(e,e'\gamma)\alpha$:
 - (10 GeV)x(137.5 GeV/u)
 - $Q^2 \in [12,36] \text{ GeV}^2$
 - Orsay-Perugia (TOPEG) Generator
 - PbWO₄: $1\% \oplus \frac{2\%}{\sqrt{E}} \oplus \frac{1\%}{E}$
 - EMCal: $\frac{12\%}{\sqrt{E}}$
- Bin Migration grows with x_B and strongly depends on EMCal resolution.



Coherent DVCS on light nuclei. Unfolding the Bin Migration

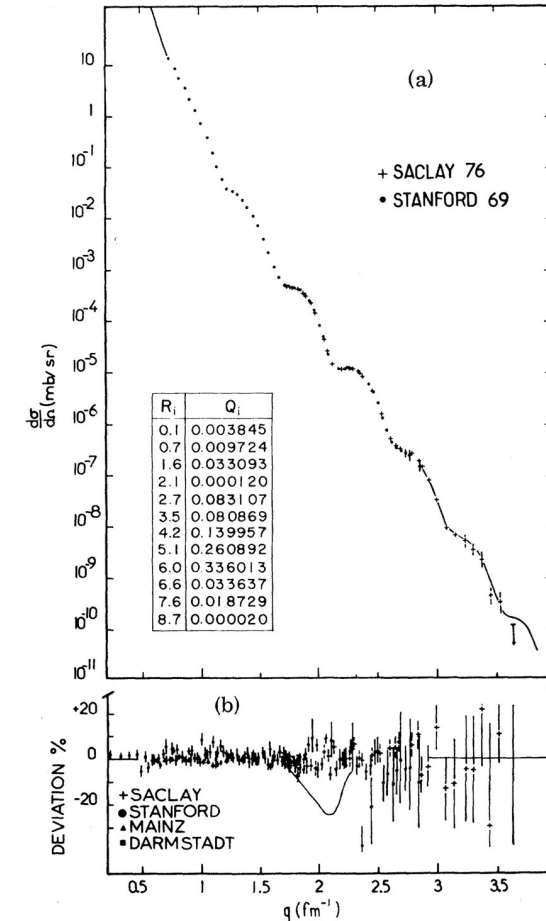
TOPEG event generator
DELPHES FastMC

- Systematic uncertainty in reconstructed cross section estimated by varying PbWO_4 resolution event-by-event $\pm 10\%$
- Error bars from uncertainty of bin-migration remain small.



Comment on Diffractive Minima in Nuclear DVCS

- Sharp diffractive minima in (e,e') Form Factors
 - In heavy nuclei, these minima are smoothed out in the (e,e') cross section by Coulomb effects in the Dirac Equation (DWBA, not PWBA).
- DVCS & BH amplitudes interfere in $Z(e,e'\gamma)Z$
 - Even for light nuclei, the diffractive patterns have different minima: Charge distribution \neq Mass distribution: $q - \bar{q} \neq q + \bar{q}$
 - Diffractive minima will wash out in phi-averaged cross sections.
 - Diffractive minima of both BH & DVCS amplitudes should be visible in DVCS*BH interference terms, such as electron helicity difference $\overrightarrow{d\sigma} - \overleftarrow{d\sigma}$



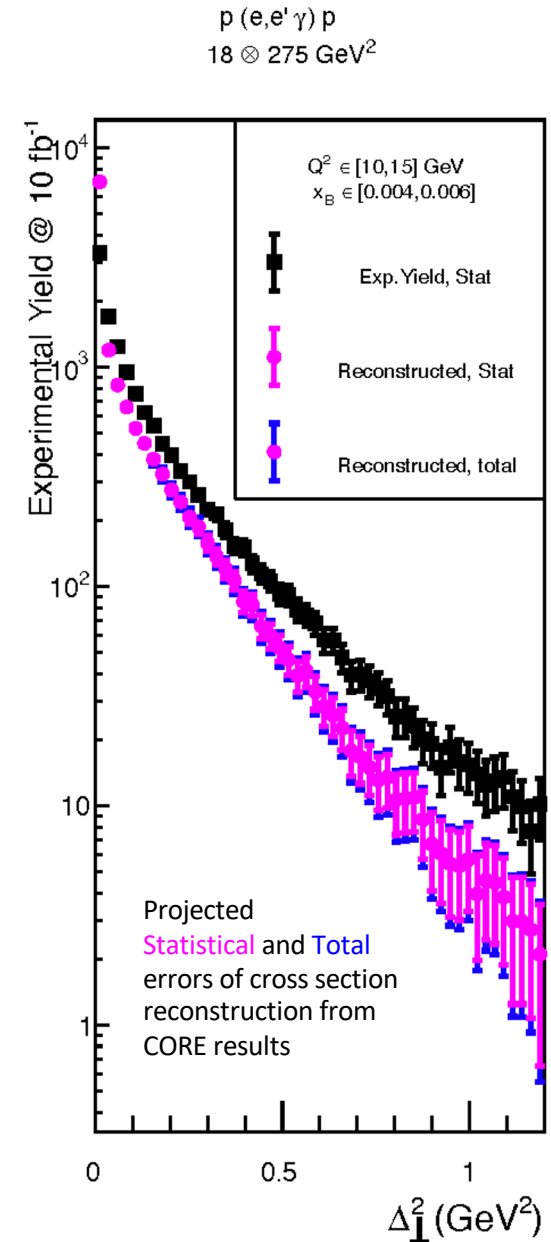
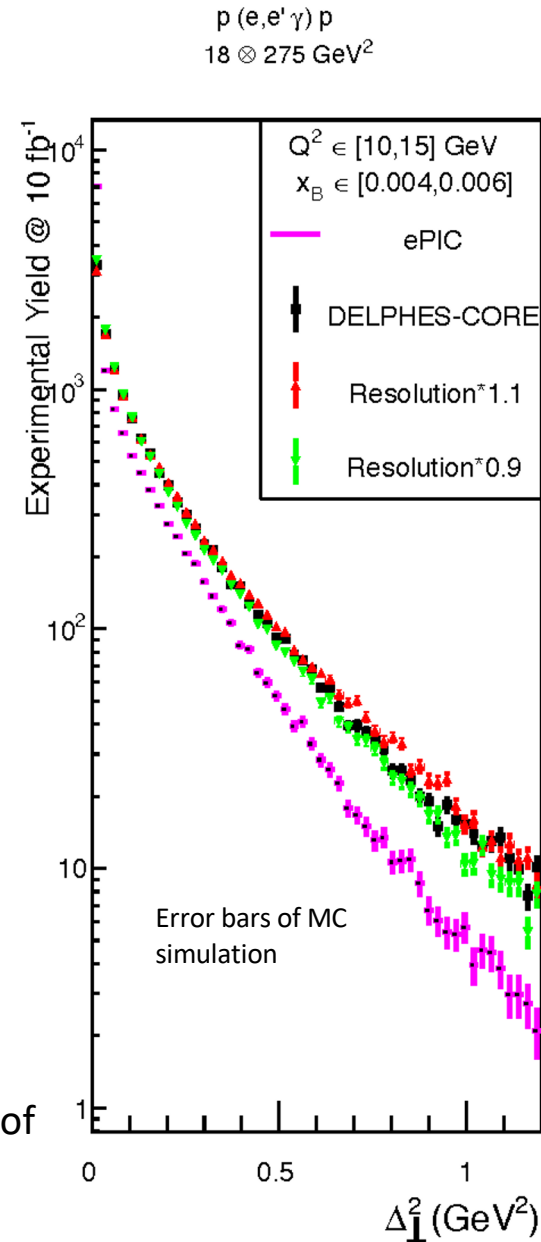
Next Steps

- Extract azimuthal dependencies of simulated DVCS events
 - Extract $\sin(\phi)$, $\cos(\phi)$ terms.
- Extend to heavier nuclei: ^{12}C , ^{16}O
 - Collaboration with Simonetta Liuti & Brandon Kriesten
- Three energy settings: 10x137.5, 10x100, 5x41 GeV^2
 - Higher x_B at lower s and/or higher Q^2 ?
 - Evaluate separation of $|\text{DVCS}|^2$ and $\text{Re}[\text{DVCS}^*\text{BH}]$

DVCS on the proton

Plot of the cross section for $e p \rightarrow e p \gamma$ vs. t

- $10 < Q^2 < 15 \text{ GeV}^2$ $0.004 < x_B < 0.006$
- beams 18 GeV on 275 GeV, $\int \mathcal{L} dt = 10 \text{ fb}^{-1}$
- $t = \Delta^2 = (k - k' - q')^2$
- EpIC DVCS Generator:
indico.iijclab.in2p3.fr/event/7201/contributions/22615/attachments/16627/21557/EpIC_06_01_2021.pdf
- Left panel: **Generated Yield**, CORE projections with DELPHES FastMC, and with EMCAL resolution width altered by **+10%** and **-10%**.
 - $d\sigma/dt = [\text{counts per bin}] / \{[0.024 \text{ GeV}^2] \cdot [10 \text{ fb}^{-1}]\}$
- Right Panel: CORE/DELPHES result in black, with projected experimental statistical errors.
 - **Magenta plot** is projected reconstruction of the EpIC cross section
 - Experimental **statistical** error bars
 - **Blue error bars** (barely distinguishable) include systematic error from projected $\pm 10\%$ uncertainty in EMCAL resolution.
- Conclusion: Bin-Migration has negligible effect on final reconstruction of $d\sigma/dt = [\text{counts per bin}] / \{[0.024 \text{ GeV}^2] \cdot [10 \text{ fb}^{-1}]\}$



DVCS on the proton

Systematic Errors for DVCS

- Bin Migration (previous slide)
- Neutral pion production background:
 - Non-diffractive, strongly suppressed at low x_B
- Proton (or ion) beam momentum spread:
 - In CORE, the momentum transfer to the ion can be determined from just the electron and DVCS photon kinematics, independent of ion beam effects.
 - Final state proton can be tagged in IR8 second focus for $\Delta_{\perp}^2 \gtrsim 0.3 \text{ GeV}^2$ or $x_B > 0.01$
 - Having both (p, p') and $(e, e' \gamma)$ measurements can reduce systematics.
- Acceptance errors and variation of cross section with (Q^2, x_B) .
 - Errors are minimized by high precision hermetic tracker.

COmpact detectoR for Eic (CORE)

