EICUG: Second Detector Working Group
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DVCS on Nuclei with a 2nd EIC Detector

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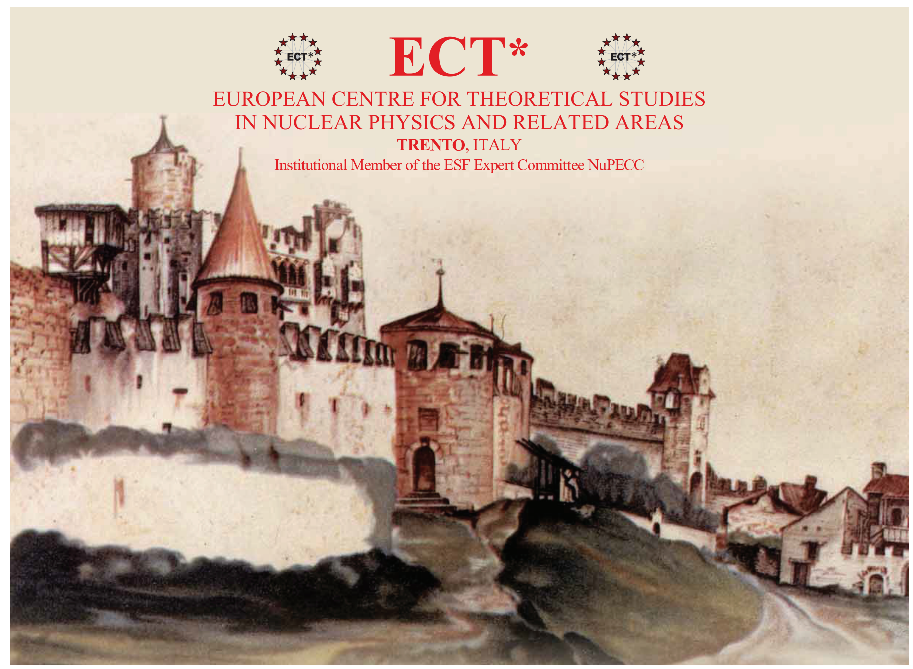
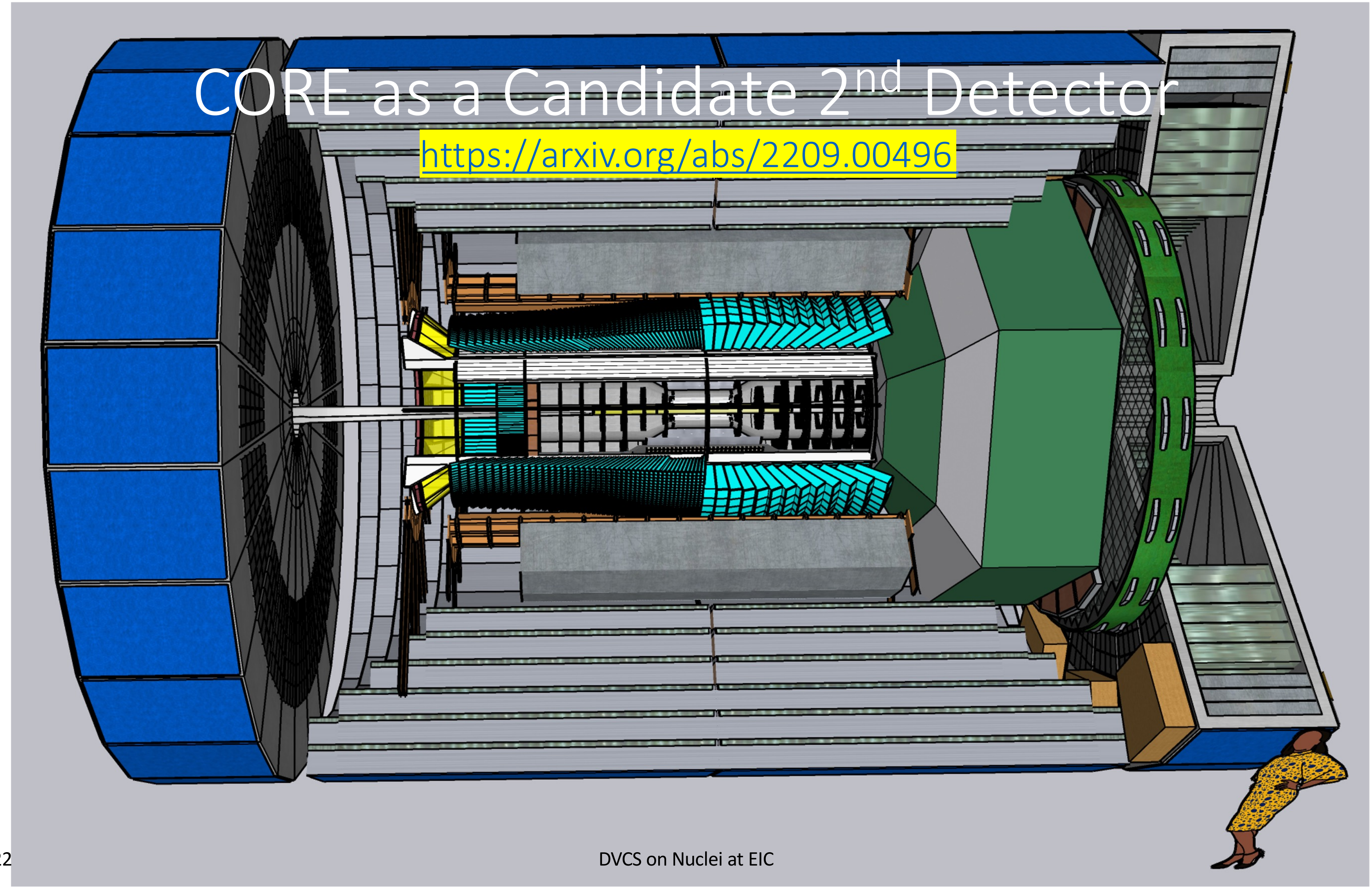


CORE as a Candidate 2^{nd} Detector

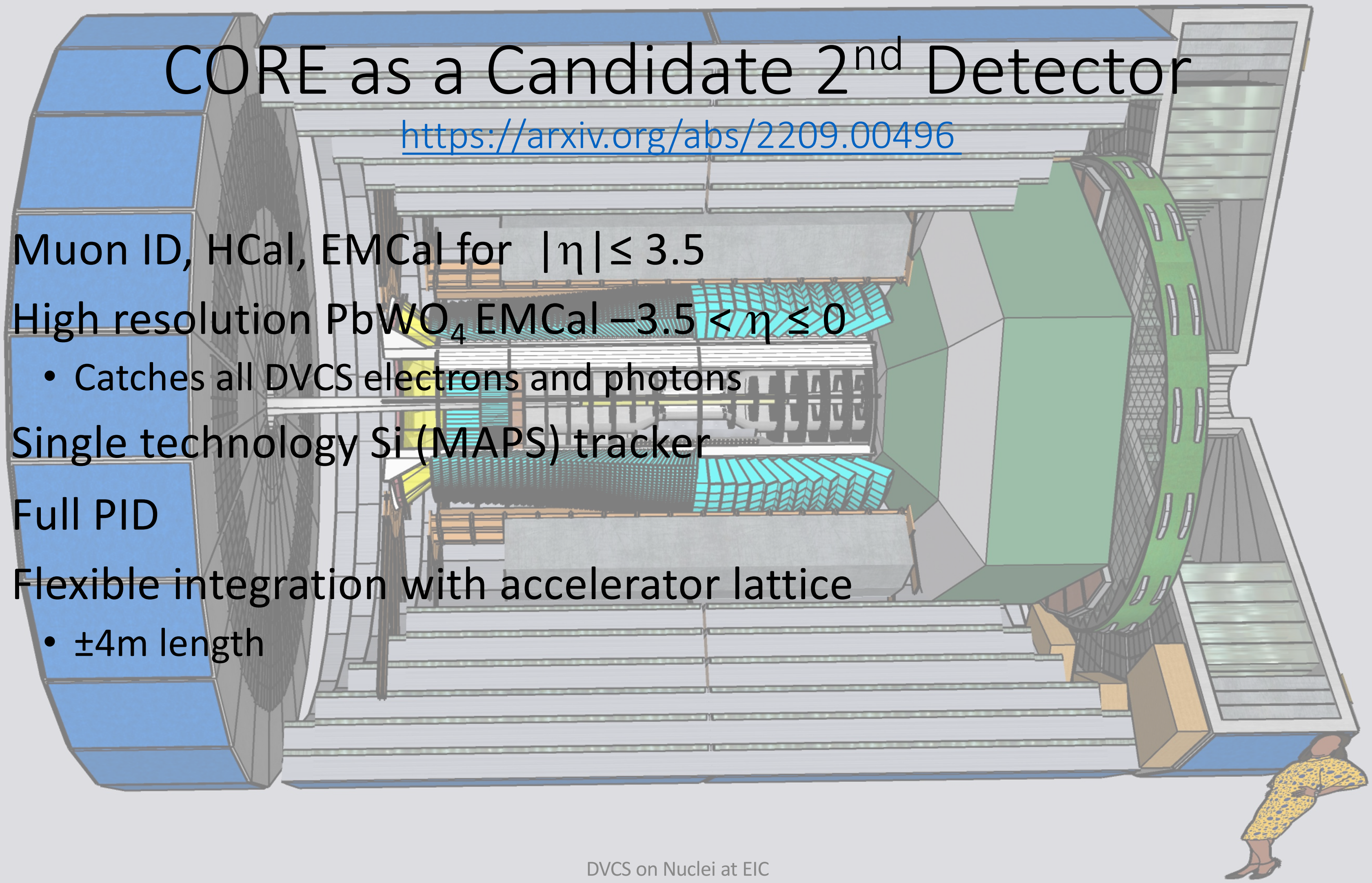
https://arxiv.org/abs/2209.00496



CORE as a Candidate 2nd Detector

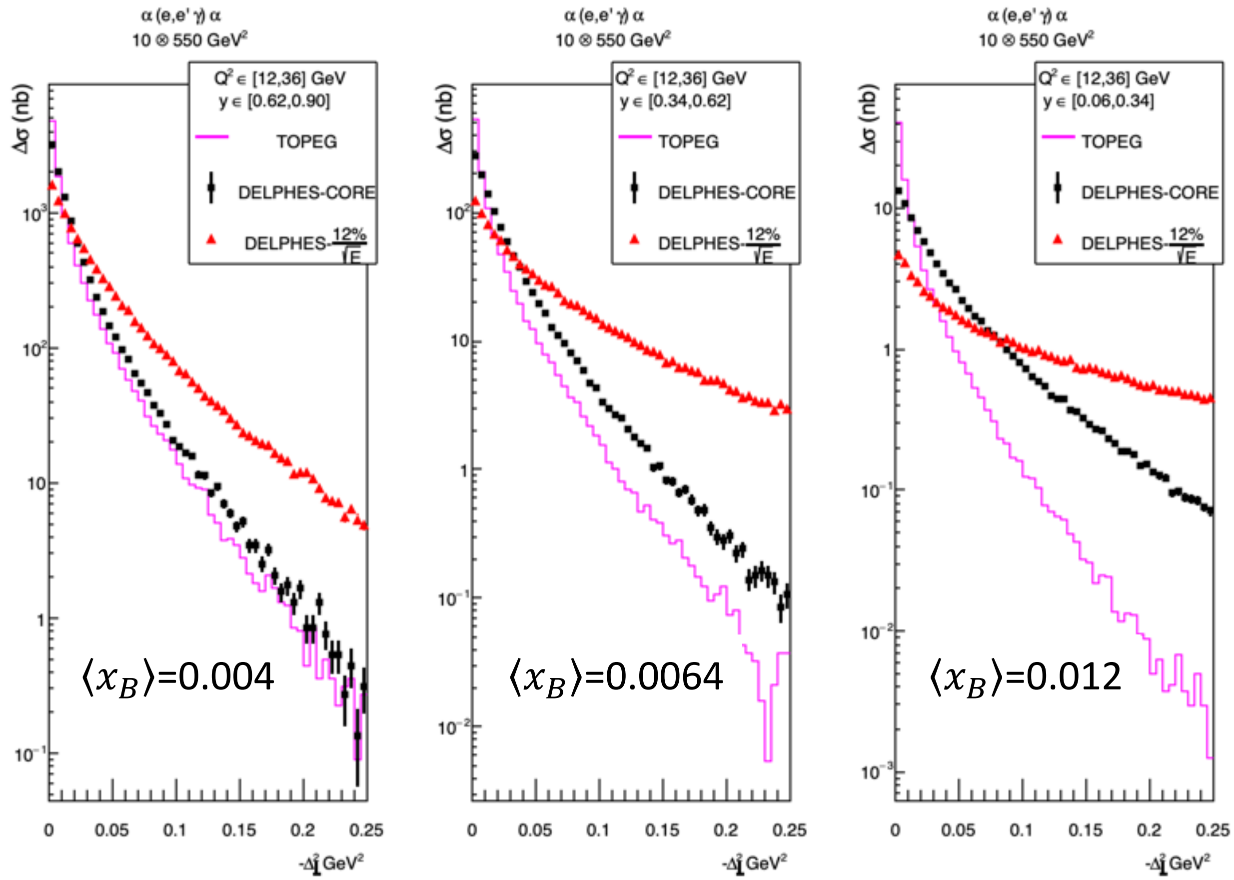
https://arxiv.org/abs/2209.00496

- Muon ID, HCal, EMCal for $|\eta| \leq 3.5$
- High resolution $PbWO_4$ EMCal $-3.5 < \eta \leq 0$
  - Catches all DVCS electrons and photons
- Single technology Si (MAPS) tracker
- Full PID
- Flexible integration with accelerator lattice
  - ±4m length



DVCS Bin Migration Comparison

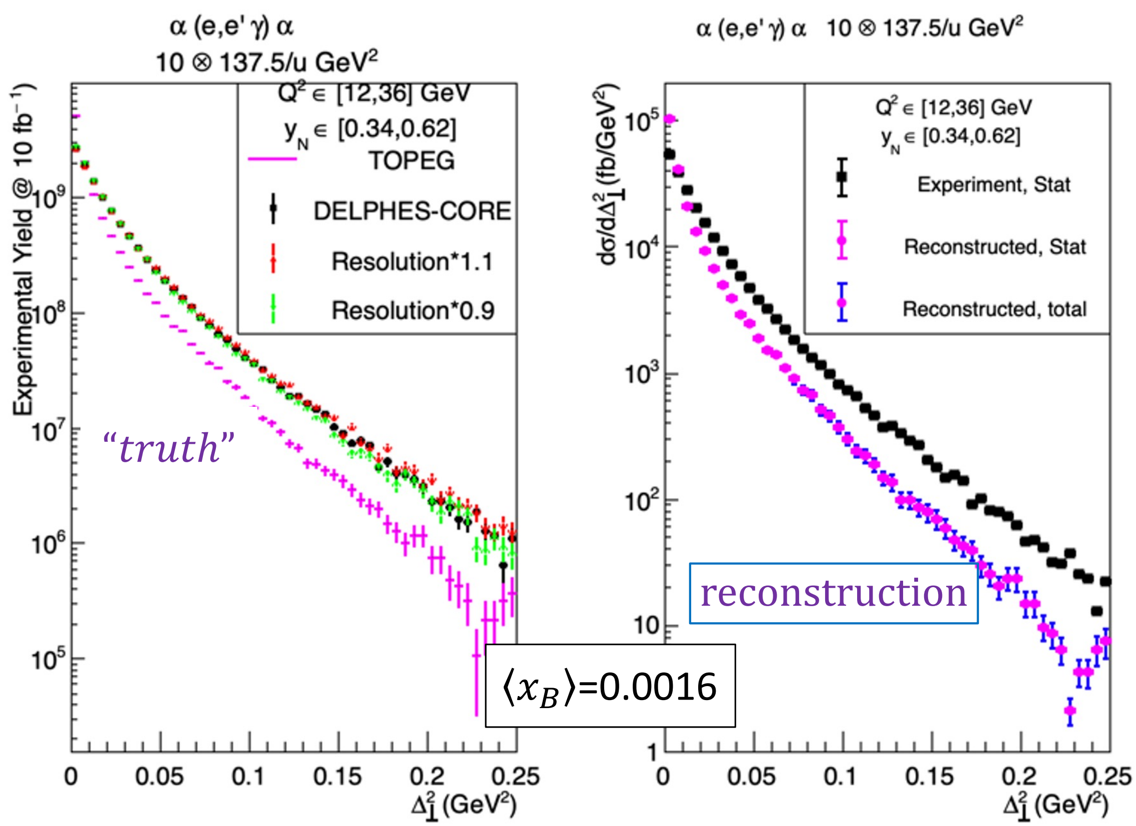
- $\alpha(e,e'\gamma)\alpha$:
  - (10 GeV)x(137.5 GeV/u)
  - $Q^2 \in [12,36]$ GeV^2
  - Orsay-Perugia (TOPEG) Generator
  - $PbWO_4$: $1\% \oplus \frac{2\%}{\sqrt{E}} \oplus \frac{1\%}{E}$
  - EMCal: $\frac{12\%}{\sqrt{E}}$
- Bin Migration grows with x_B and strongly depends on EMCal resolution.



Coherent DVCS on light nuclei. Unfolding the Bin Migration

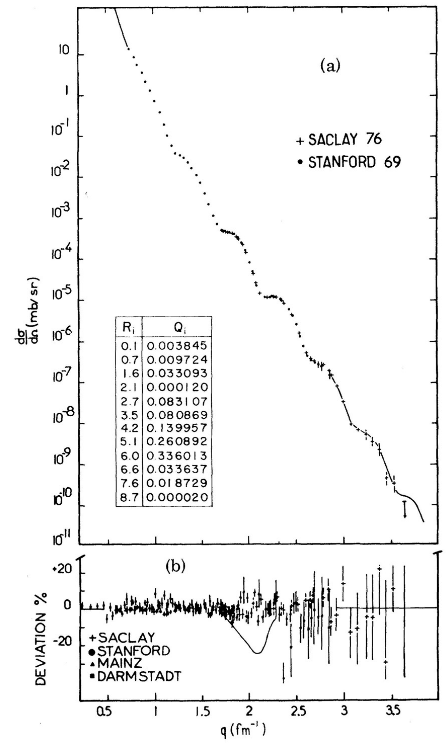
TOPEG event generator
DELPHES FastMC

- Systematic uncertainty in reconstructed cross section estimated by varying $PbWO_4$ resolution event-by-event ±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’γ)Z
  - Even for light nuclei, the diffractive patterns have different minima: Charge distribution ≠ Mass distribution: $q - \overline{q} \neq q + \overline{q}$
  - 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 $\overrightarrow{d\sigma} - \overleftarrow{d\sigma}$

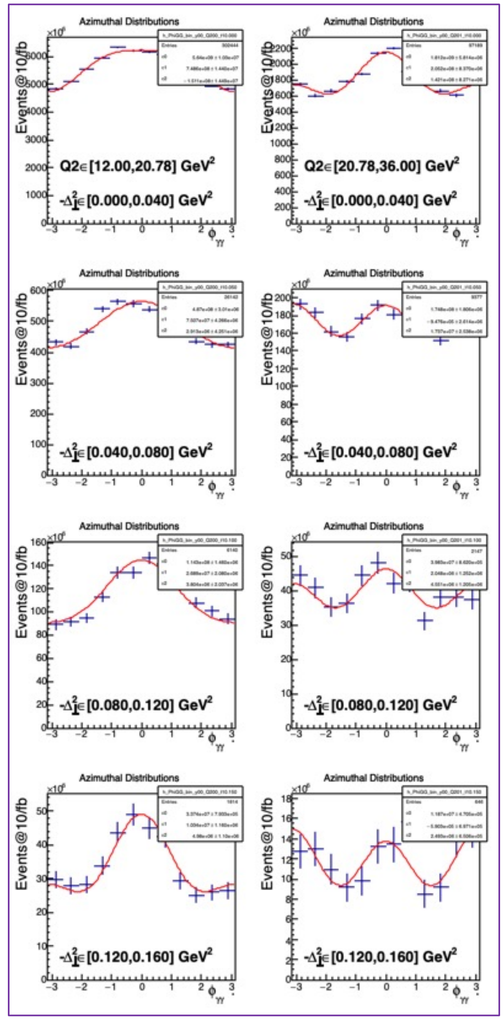


R_i	Q_i
0.1	0.003845
0.7	0.009724
1.6	0.033093
2.1	0.000120
2.7	0.083107
3.5	0.080869
4.2	0.139957
5.1	0.260892
6.0	0.336013
6.6	0.033637
7.6	0.018729
8.7	0.000020

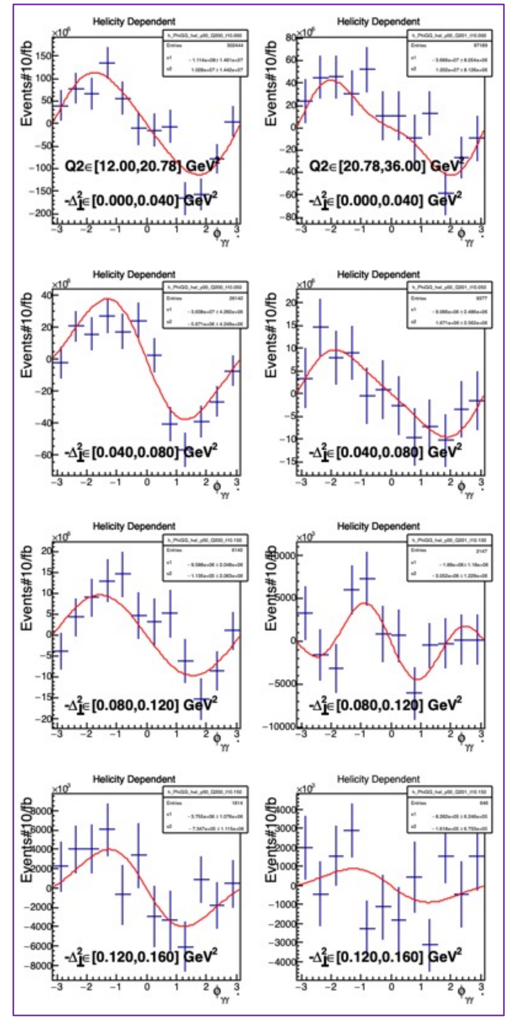
Example Azimuthal Distributions: $\alpha(e, e'\lambda)\alpha$

- (10 GeV)x(137.5 GeV/u)
- $y \in [0.62, 0.90]$
- $\langle x_B \rangle \approx 0.004$
- Projected counts at 10/fb/nucleus
- Error bars are MC, (not data) statistics!
- Fits are simple Fourier, not |BH+DVCS|^2

$\sigma(+) + \sigma(-)$

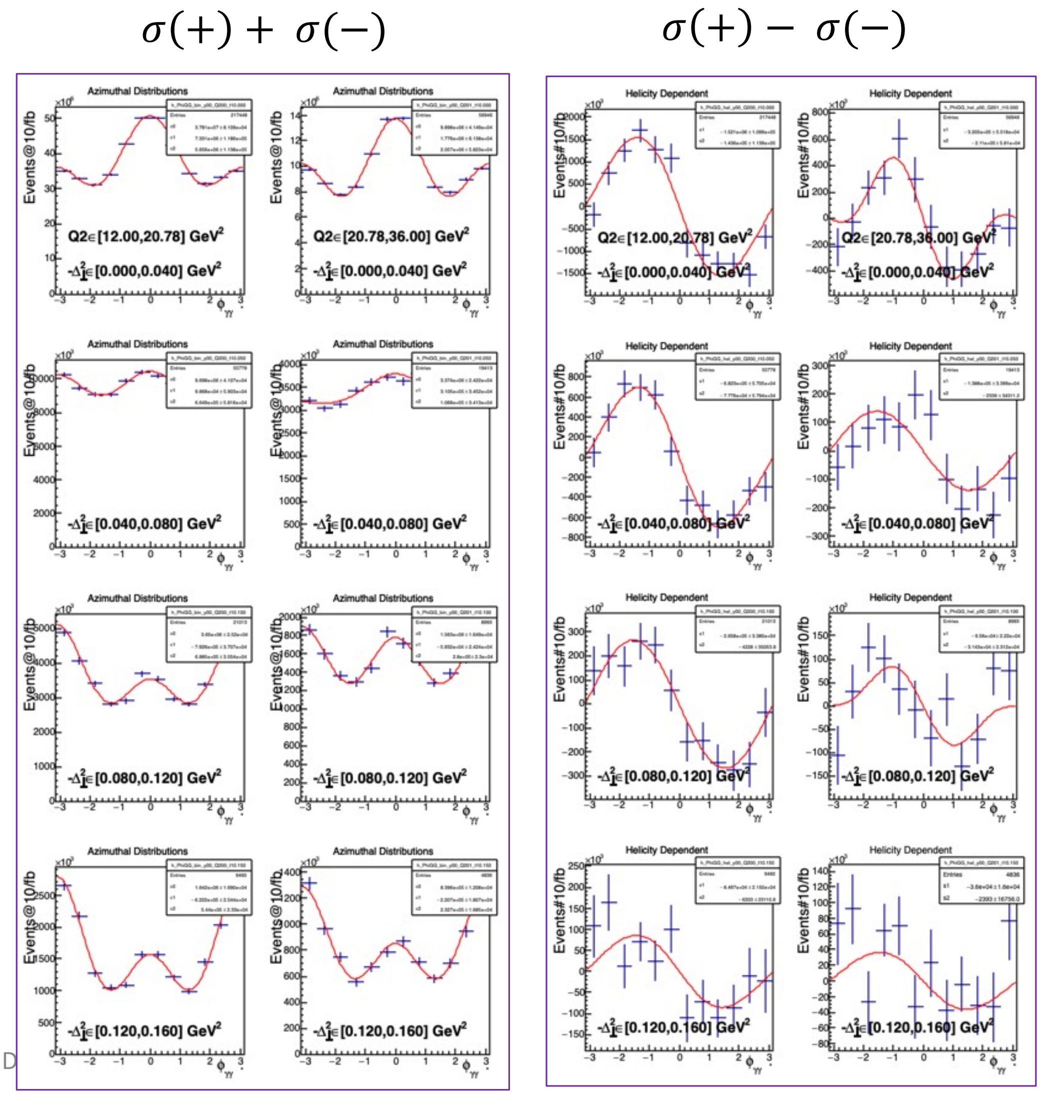


$\sigma(+) - \sigma(-)$



Example Azimuthal Distributions: $\alpha(e, e'\lambda)\alpha$

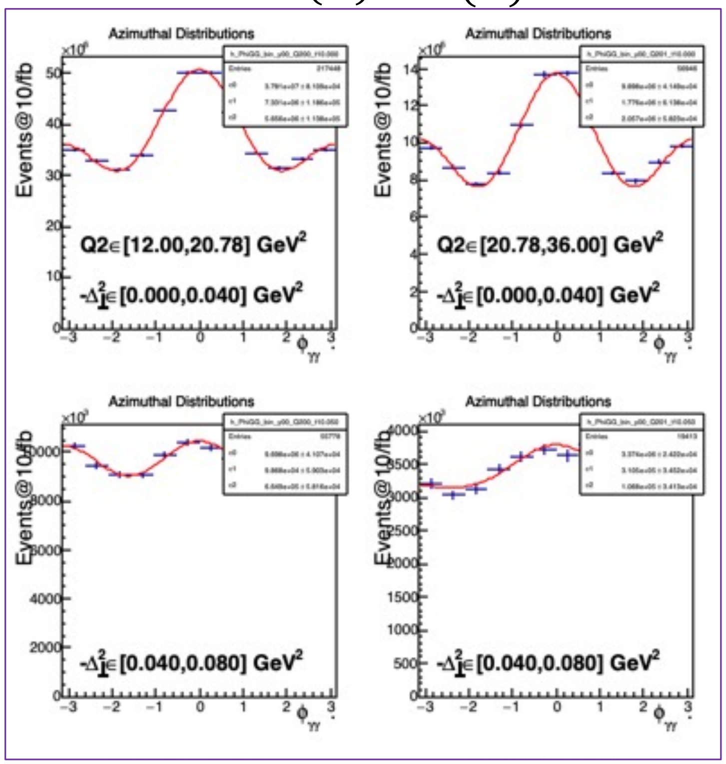
- (10 GeV)x(137.5 GeV/u)
- $y \in [0.06, 0.32]$
- $\langle x_B \rangle \approx 0.012$
- Projected counts at 10/fb/nucleus
- Error bars are MC, (not data) statistics!
- Fits are simple Fourier, not |BH+DVCS|^2



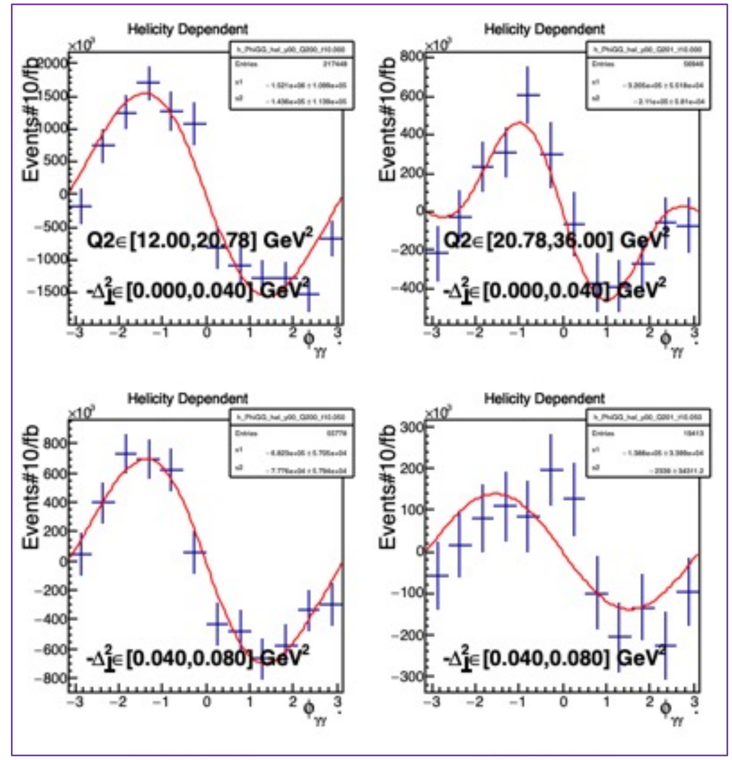
Example Azimuthal Distributions: $\alpha(e, e'\lambda)\alpha$

- Repeat
- (10 GeV)x(137.5 GeV/u)
- $y \in [0.06, 0.32]$
- $\langle x_B \rangle \approx 0.012$
- Projected counts at 10/fb/nucleus
- Error bars are MC, (not data) statistics!
- Fits are simple Fourier, not |BH+DVCS|^2

$\sigma(+) + \sigma(-)$



$\sigma(+) - \sigma(-)$



Next Steps

- Extend MC & Simulation to higher $-\Delta^2$
  - Cross sections shown are large!
- Simulate $|\text{BH}|^2$ to obtain DVCS signal(s)
- Figure out how to include Real part of Compton Form Factor in a finite amount of computation time (<1 week on JLab farm)
- 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 $\mathcal{Re}$[DVCS*BH] via s-dependence

Conclusions

- High Resolution EMCal in full range $\eta < 0$ is an enabling technology for nuclear DVCS
  - Combining DVCS and Deep Virtual ϕ or J/ψ allows separation of gluon and quark distributions in light nuclei
- Need event generators for heavier nuclei (e.g. ^{16}O), even approximate