# DVCS with positrons in Hall C

NPS Meeting, April 16 (2022)

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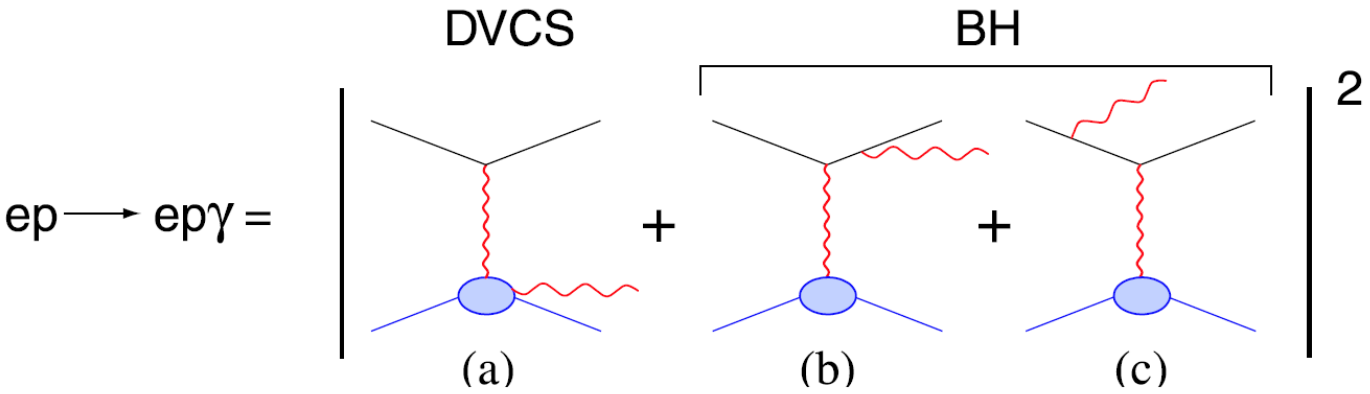
Proposal for PAC48 (2020)

# From PAC40 (2013)

## Motivation #1

$$\sigma(ep \to ep\gamma) = \underbrace{|BH|^2}_{\text{Known to } \sim 1\%} + \underbrace{\mathcal{I}(BH \cdot DVCS)}_{\text{Linear combination of GPDs}} + \underbrace{|DVCS|^2}_{\text{Bilinear combination of GPDs}}$$




The $\mathcal{I}$ and DVCS$^2$ terms mix as a function of the azimuthal angle $\varphi$, but:

- $\mathcal{R}e(\mathcal{I}) \propto 1/y^3 = (E_b/\nu)^3$
- $\mathcal{D}VCS^2 \propto 1/y^2 = (E_b/\nu)^2$

# Motivation

$$\mathcal{I} = \frac{e^6}{x_B y^3 \mathcal{P}_1(\phi_{\gamma\gamma})\mathcal{P}_2(\phi_{\gamma\gamma}) t} \left\{ c_0^{\mathcal{I}} + \sum_{n=1}^{3} \left[ c_n^{\mathcal{I}}(\lambda) \cos(n\phi_{\gamma\gamma}) - \lambda s_n^{\mathcal{I}} \sin(n\phi_{\gamma\gamma}) \right] \right\}$$

Leading beam-energy dependence

$$\left|\mathcal{T}^{DVCS}(\lambda)\right|^2 = \frac{e^6}{y^2 Q^2} \left\{ c_0^{DVCS} + \sum_{n=1}^{2} \left[ c_n^{DVCS} \cos(n\phi_{\gamma\gamma}) + \lambda s_n^{DVCS} \sin(n\phi_{\gamma\gamma}) \right] \right\}$$

But $c_n$'s also depend on $y$

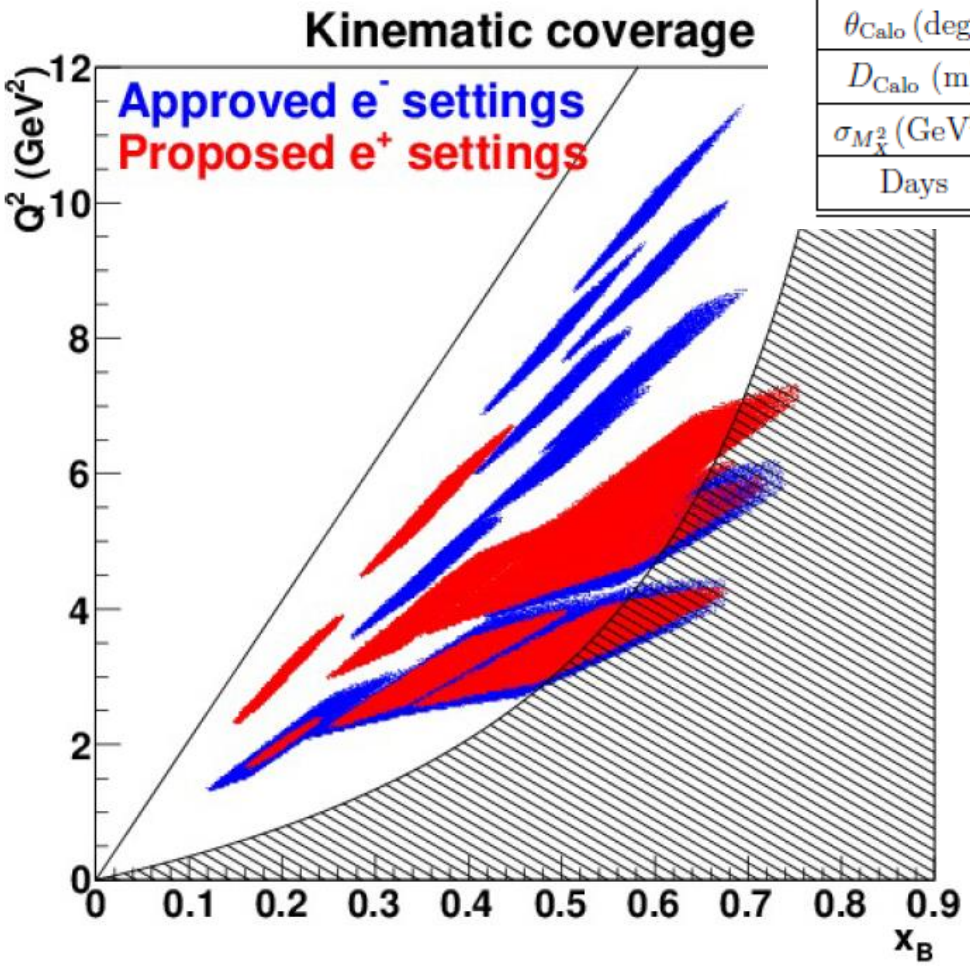
However:

$$\frac{d^5\sigma(\lambda, \pm e)}{d^5\Phi} = \frac{d\sigma_0}{dQ^2 dx_B} \left| \mathcal{T}^{BH}(\lambda) \pm \mathcal{T}^{DVCS}(\lambda) \right|^2 / |e|^6$$

$$= \frac{d\sigma_0}{dQ^2 dx_B} \left[ \left| \mathcal{T}^{BH}(\lambda) \right|^2 + \left| \mathcal{T}^{DVCS}(\lambda) \right|^2 \mp \mathcal{I}(\lambda) \right] \frac{1}{e^6}$$

Straight-forward separation with e+/e-

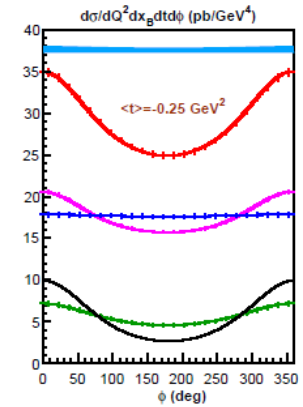
# Proposed kinematics

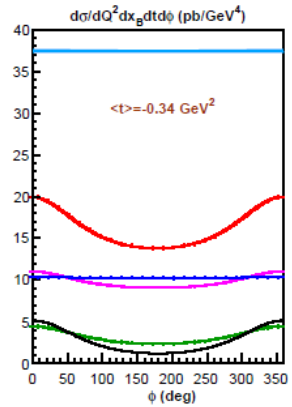


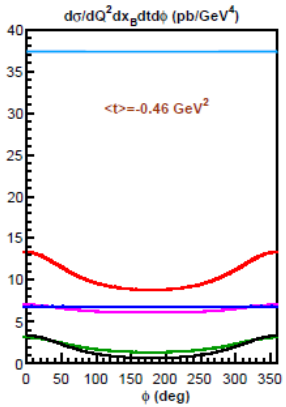

| $x_{\mathrm{Bj}}$ | 0.2 | | 0.36 | | | 0.5 | | 0.6 | |
|---|---|---|---|---|---|---|---|---|---|
| $Q^2\ (\mathrm{GeV})^2$ | 2.0 | 3.0 | 3.0 | 4.0 | 5.5 | 3.4 | 4.8 | 5.1 | 6.0 |
| $k$ (GeV) | 11 | | 8.8 | | 11 | 11 | | 8.8 | 11 |
| $k'$ (GeV) | 5.7 | 3.0 | 4.4 | 2.9 | 2.9 | 7.4 | 5.9 | 4.3 | 5.7 |
| $\theta_{\mathrm{Calo}}$ (deg) | 10.6 | 6.3 | 14.7 | 10.3 | 7.9 | 21.7 | 16.6 | 17.8 | 17.2 |
| $D_{\mathrm{Calo}}$ (m) | 4 | 6 | 3 | 4 | 4 | 3 | 3 | 3 | 3 |
| $\sigma_{M_X^2}\ (\mathrm{GeV}^2)$ | 0.17 | 0.22 | 0.13 | 0.15 | 0.19 | 0.09 | 0.11 | 0.09 | 0.09 |
| Days | 2 | 2 | 4 | 2 | 10 | 4 | 10 | 2 | 20 |

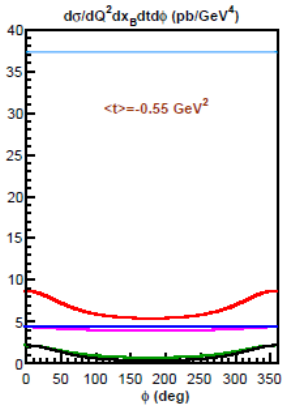
- 56 days
- 5 uA (unpolarized) beam

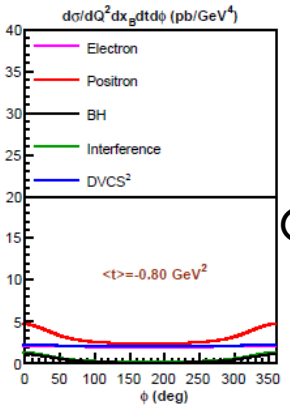
# Projections



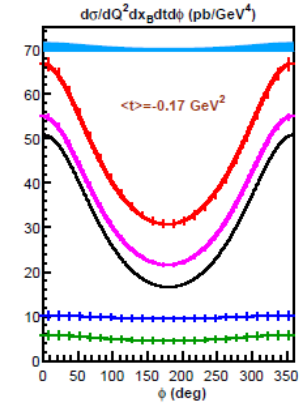



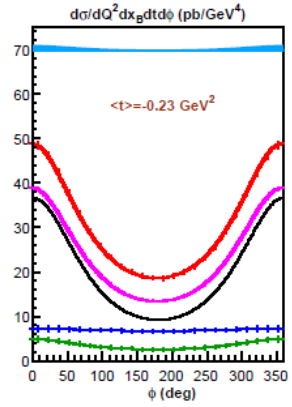



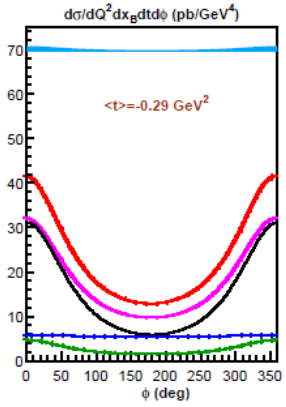



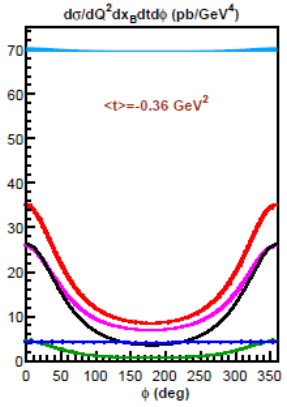



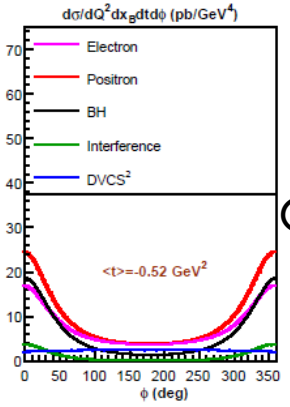

$x_B$=0.2, $Q^2$=2 GeV², 2 days



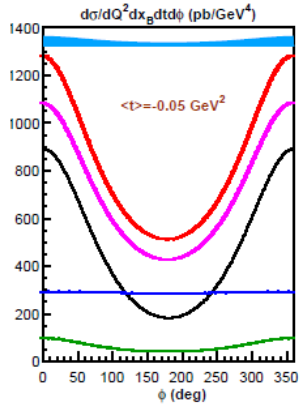



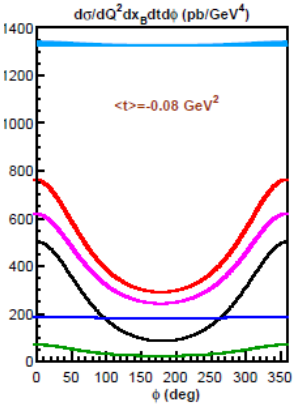



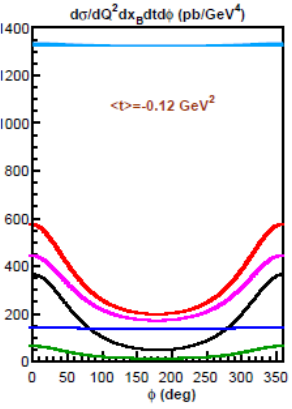



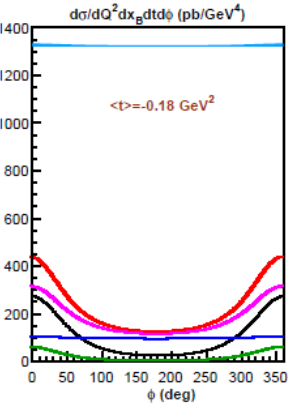



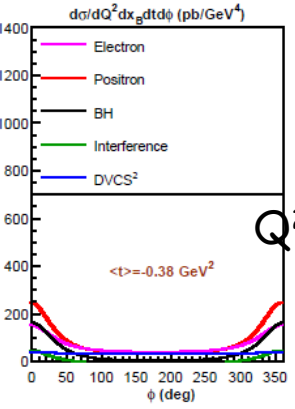

$x_B$=0.36, $Q^2$=4 GeV², 2 days




$x_B$=0.5, $Q^2$=3.4 GeV², 4 days

# Systematic uncertainities

From electron proposal (PR12-13-010):

| Source | pt-to-pt (%) | scale (%) |
|---|---|---|
| Acceptance | 0.4 | 1.0 |
| Electron/positron PID | <0.1 | <0.1 |
| Efficiency | 0.5 | 1.0 |
| Electron/positron tracking efficiency | 0.1 | 0.5 |
| Charge | 0.5 | 2.0 |
| Target thickness | 0.2 | 0.5 |
| Kinematics | 0.4 | <0.1 |
| Exclusivity | 1.0 | 2.0 |
| $\pi^0$ subtraction | 0.5 | 1.0 |
| Radiative corrections | 1.2 | 2.0 |
| Total | 1.8–1.9 | 3.8–3.9 |

- Discussion ongoing with accelerator people (J. Grames, Y. Roblin) to estimate possible additional uncertainties due to positron beam (momentum spread, beam emittance…)

# Outlook

- Hope to circulate a draft of the proposal within 3-4 weeks
- PAC deadline: June 1st

Please join !