Unpolarized TCS physics case

Why unpolarized TCS is needed?

• need basis of unpolarized cross section for global fits
→ 2 independent observables: σ_{unpol} and circularly polarized $\Delta\sigma_{\odot U}$

• universality studies on GPD H
→need of high precision for twist 3 accuracy on the measurement and comparison with DVCS
→need many independent observables from DVCS and TCS (polarized...) to bring constrain on correlations and beyond twist 2, LO formalism.
→Comes from both high precision unpolarized experiment and polarized measurements: unpolarized TCS is not enough (kinematic factors), DVCS is not enough (one limited process)

• Easier to measure than polarized target cross section (not a good argument)
→ First step prior polarized experiment
→ need for systematics on similar experiment than polarized one

• New observables:
→with high precision: CT parity with θ asymmetry and comparison with DVCS charge asymmetries. Need to go to .1% accuracy at least on interference sensitivity

What can be better than Hall B and SoLID?

• **Hall B:**

- poor statistics and had to be extended to low Q'^2 region (>1/2 data on tape)
→ OK for a first measurement, but global fits cannot be performed nor unbiased CFFs extraction

- Physics case based on misleading argument of extracting Re($\mathcal{H}$) to compare with DVCS charge
→ it is wrong and TCS will do worse than DVCS in same conditions at extracting CFFs and Re($\mathcal{H}$)
→ Unpolarized x-sec: Im + Re, more difficult to access Re, mostly from correlations
→charge asymmetries in DVCS are not related to cosine projection of TCS

• **SoLID:**

- expected high statistics, should reach precision for global fits

- nothing wrong in physics case but optimistic on Q'^2 and higher twist. Not good for dedicated exp.

cons:

- no real photon beam →angular corrections... make harder precision measurements

- large acceptance range: good, but loose on precision. Proton may not be detected: projections for both case with and without. First precision measurement better using dedicated setup

• **What can be better:**

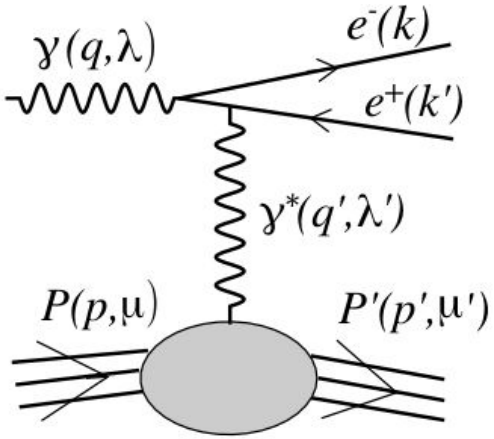
- real photon + better precision, limited acceptance focus all statistic at high intensity on few points

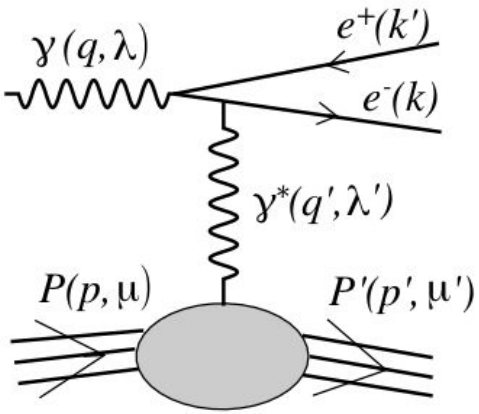
- possibility to enlarge e+e- angles to reach new kinematic regions with high enough statistics

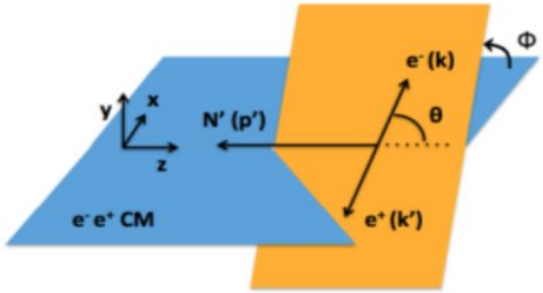
⇒ high precision in ξ and lepton momenta on few selected points

• Similar apparatus than polarized TCS: not an argument for the PAC, but for systematics and interpretation of polarized results

Relation between TCS structure and DVCS charge asymmetries



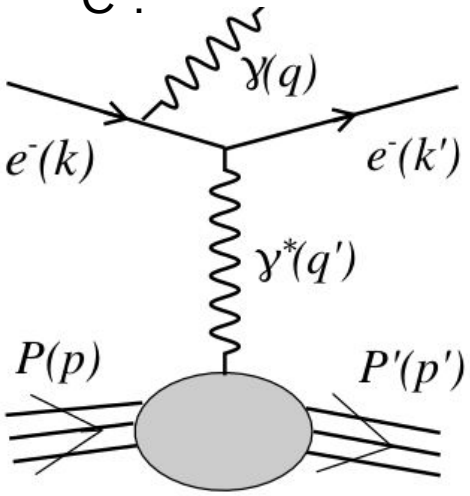




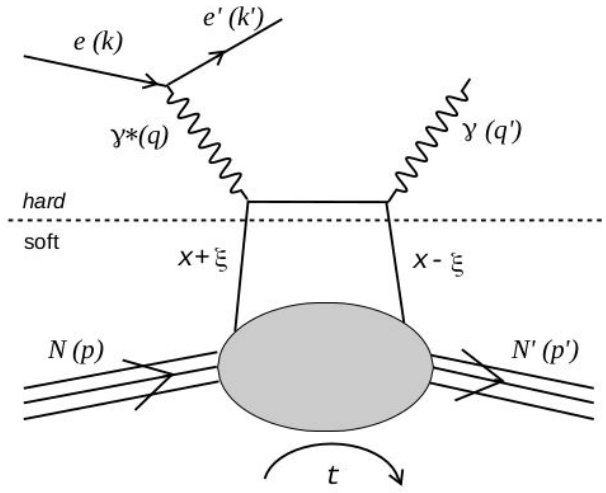
θ: refers to e-

⇒ C-odd interference
integration over θ: flat
integration φ: θ interference change sign

"C":



e± → T-odd charge

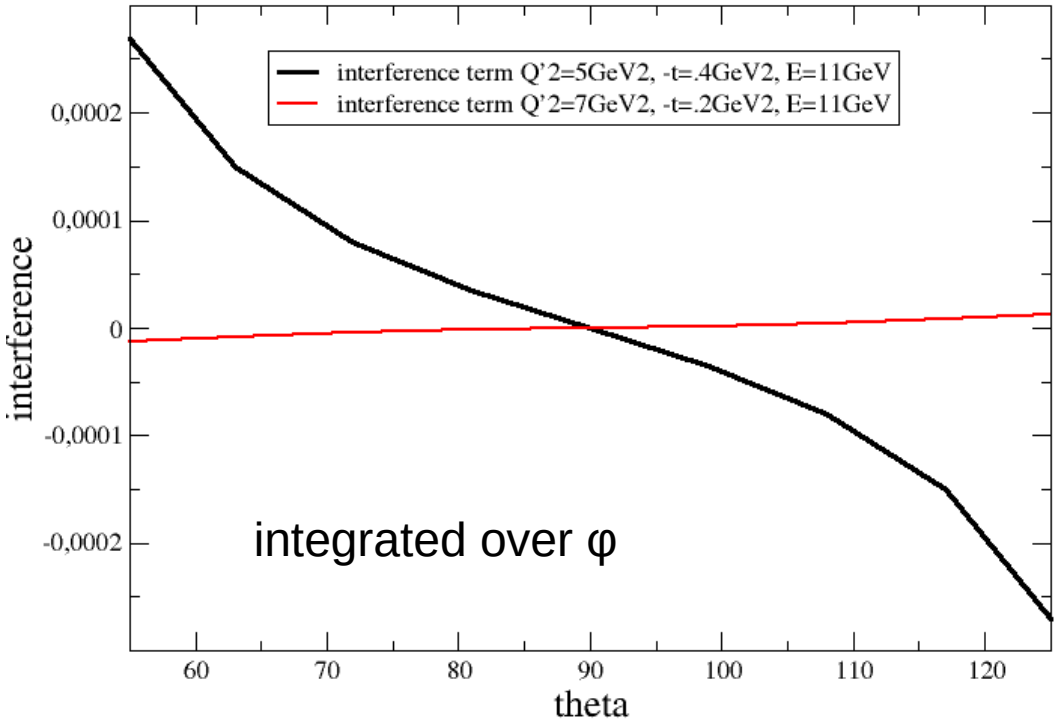


From Oleg Teryaev:
- TCS θ similar to FB asymmetries at LHC
- relation between parity in θ distributions of TCS and switching DVCS lepton charge assuming "CT" equivalent

⇒ TCS+BH interference behavior in θ
⇒ most accessible observable and precision needed?

Behavior of interference in θ

Δσ (interference)

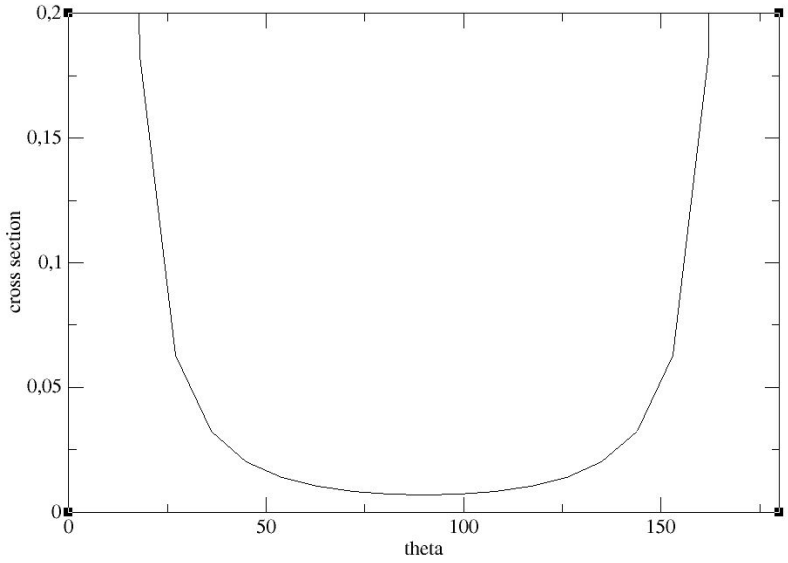


⇒ can be extracted from projections such as momenta of e+e-

⇒ the most important result that unpolarized TCS can bring,
beyond global fits and universality studies

needs high precision in θ and momentum

note: φ integrated x-sec is symmetric



Comparison of above parity violating interference to DVCS charge asymmetries

→ universality studies: CPT conserved

→ should enhance Re($\mathcal{H}$) in global fits but need theory proof

To do: fitter code is allowing to extract CFFs from both φ and θ distributions, but at fixed φ and interpretation of uncertainties not yet proven using θ distributions as well

Other important input for the physics case:

- quasi-model independent global fits and uncertainty interpretations → work with Michel Guidal
- higher twist and universality studies → work with Simonetta Liuti

⇒ both need high precision in ξ in particular for real CFFs and universality

Main modification needed to polarized setup

- Magnet for e+e-p
- LH2 target 10 cm
- Different angles for the calorimeters, other possibilities with 1 calorimeter only

→ phase space studies in progress, ideal setup is different angles than polarized TCS

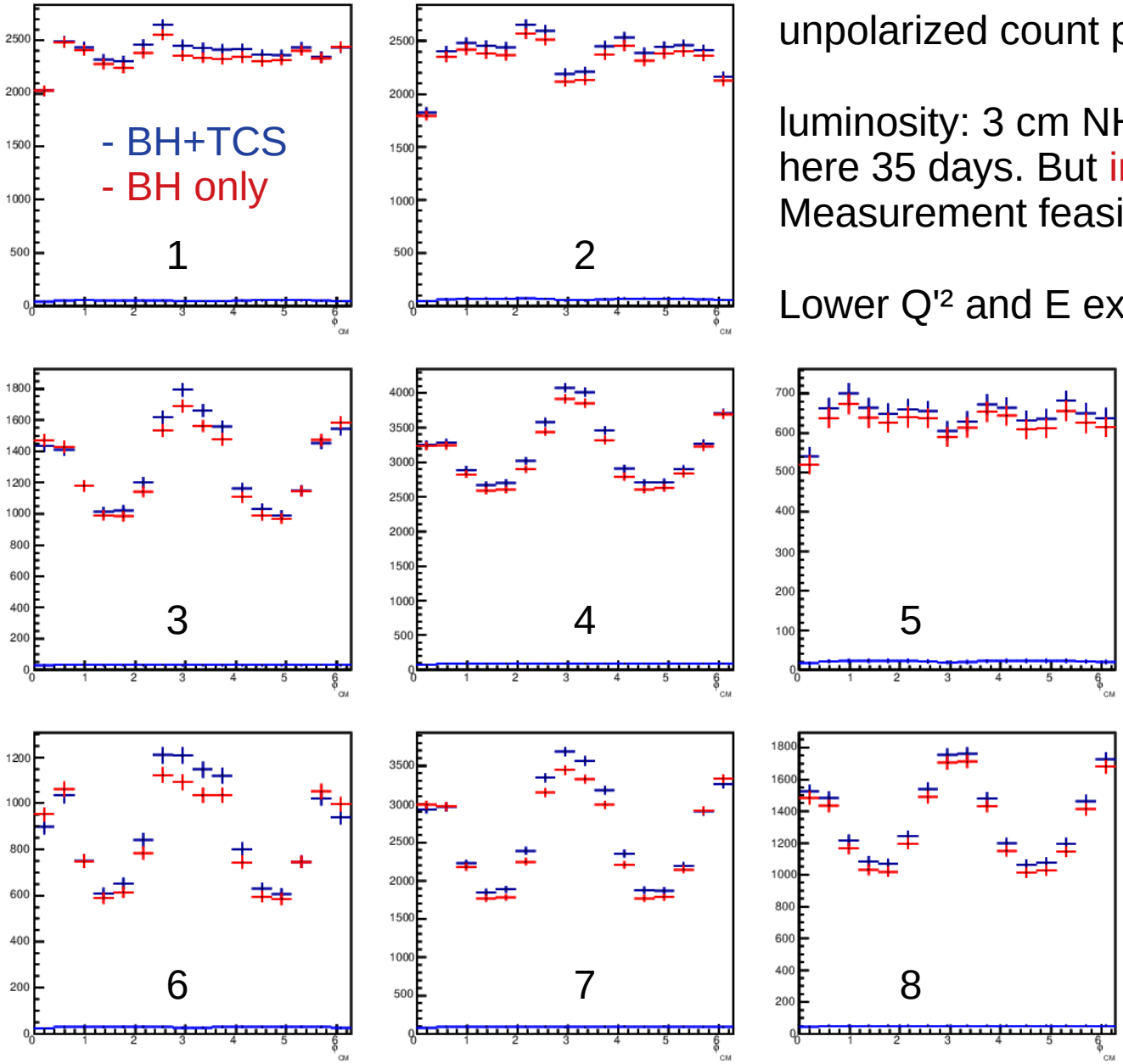
- Photon: CPS or 10% radiator? → depend on the statistics requirements and background

What needs to be done (physics):

- most relevant observables: σ, Δσ + "θ" from leptons →under discussion
- most relevant kinematics→ likely lead to modification of the setup
- resolution on observables, exclusivity
- max accuracy on interference part and observable to access it
- global fits integrated over φ

conclusion: not straightforward physics case and likely to require setup modification

Unpolarized counts versus φ: Hall C

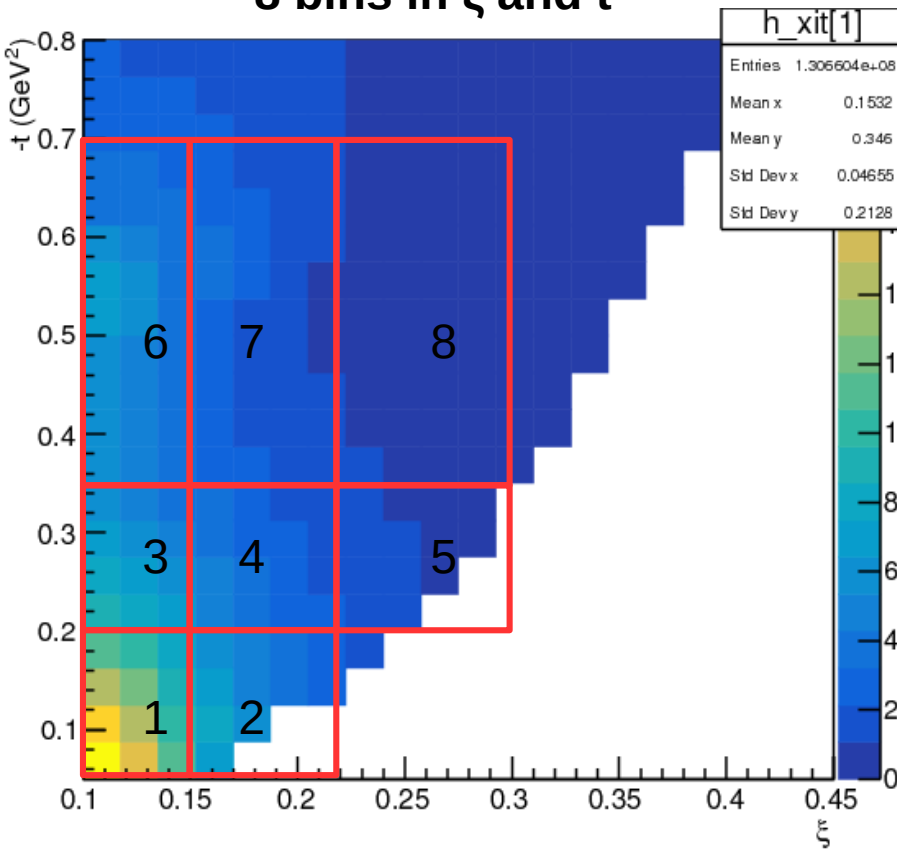


unpolarized count projection for Hall C ⊥ polarized (2018)

luminosity: 3 cm NH3 ≈ same order mag 10 cm LH2
here 35 days. But intensity can be larger (x10?)
Measurement feasible ~ 15 days for σ if same intensity

Lower Q'^2 and E extension? → background & resonances

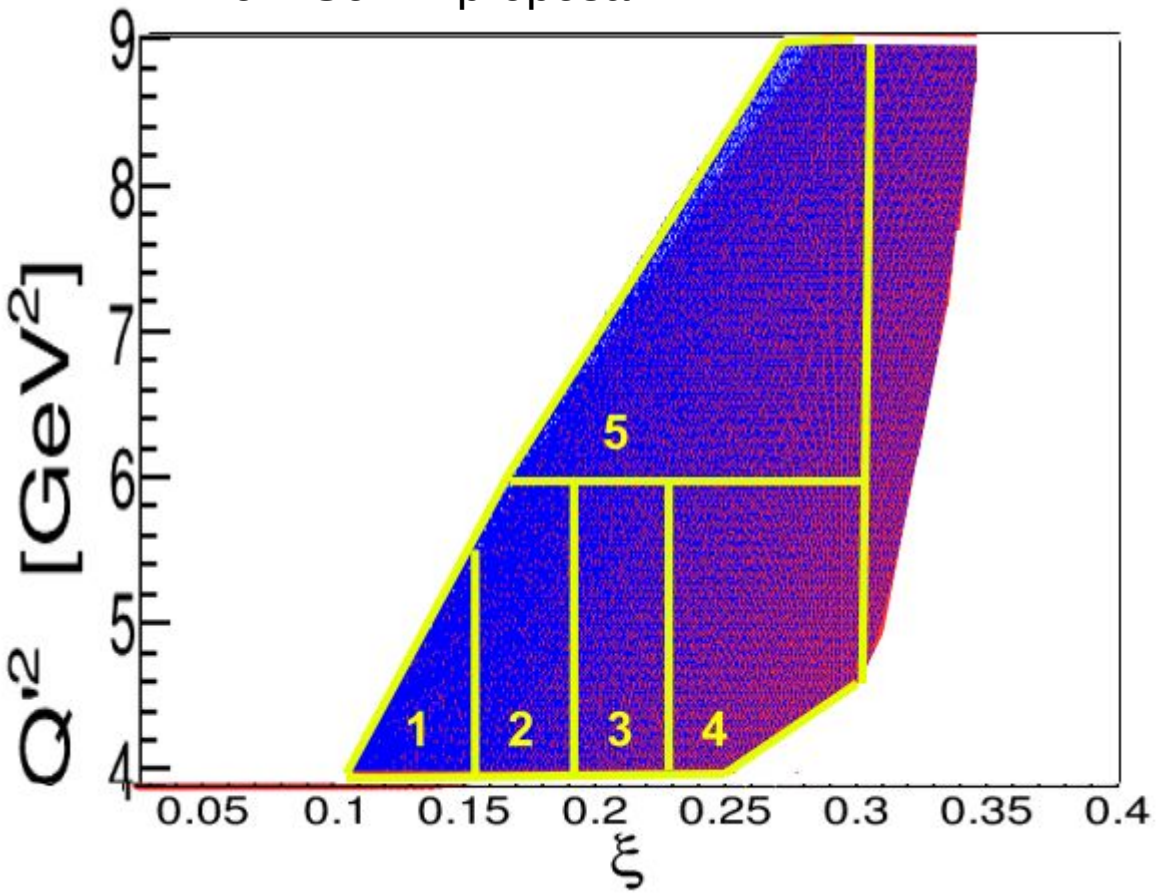
8 bins in ξ and t



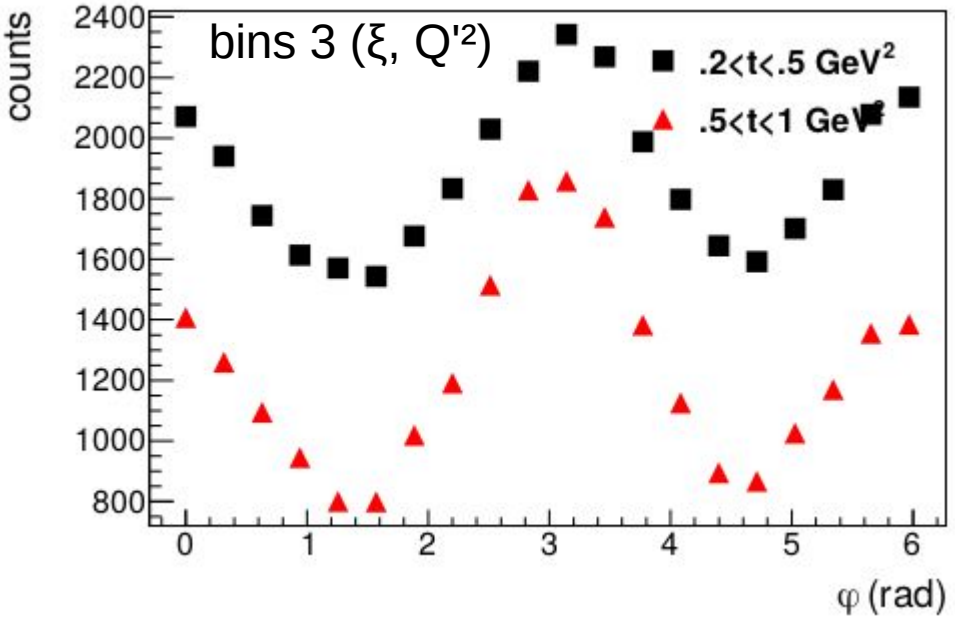
Integrated over φ, split by momentum in θ "FB"
≈ 10^4 to 10^5 events / bin

Unpolarized counts versus φ: Hall A

from SoLID proposal

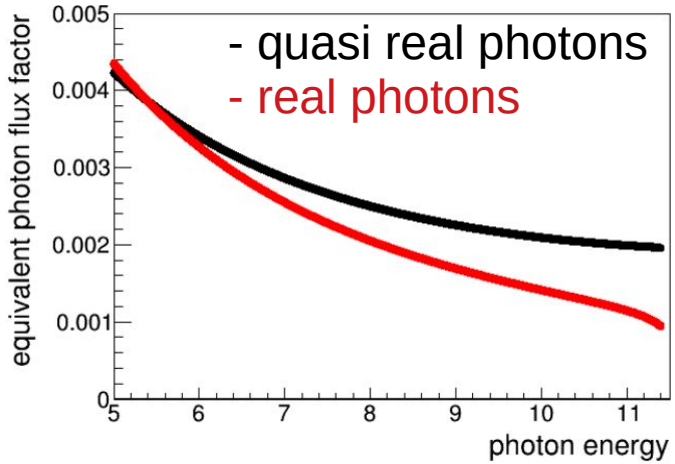


N	$\xi(\eta)$ limits	Q'^{2} limits (GeV^2)	-t limits (GeV^2)
1.	0.10, 0.15	4, 6	$[0.1, 0.2], [0.2, 0.5]$
2.	0.15, 0.19	4, 6	$[0.1, 0.2], [0.2, 0.5], [0.5, 1]$
3.	0.19, 0.23	4, 6	$[0.2, 0.5], [0.5, 1]$
4.	0.23, 0.30	4, 6	$[0.2, 0.5], [0.5, 1]$
5.	0.15, 0.30	6, 9	$[0.2, 0.5], [0.5, 1]$



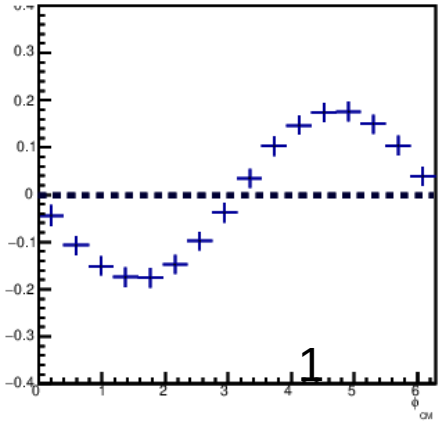
Statistics similar looking at this figure, but:
SoLID has wider bins in t, a bit narrower in ξ
30 days off 10 cm LH2, e- beam

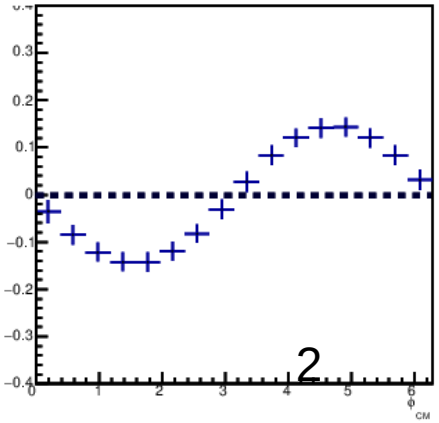
- same code used, very old version here
- not same cuts: E (factor ~2), BH peaks...

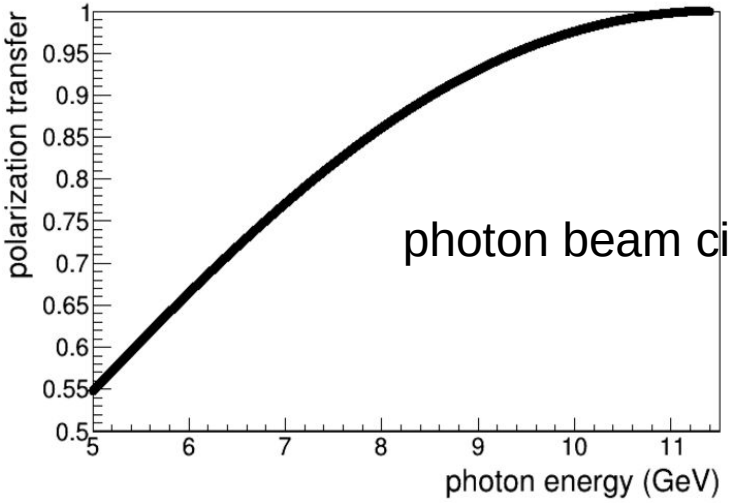


Beam spin asymmetry in Hall C

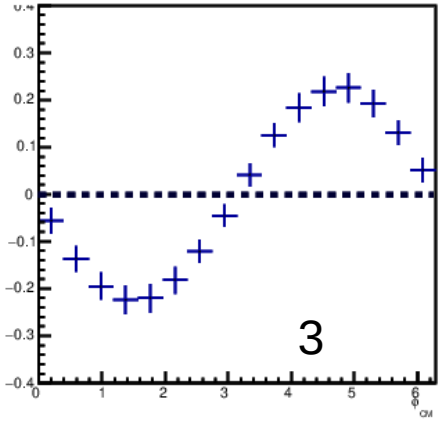
same bins, 75% dilution factor

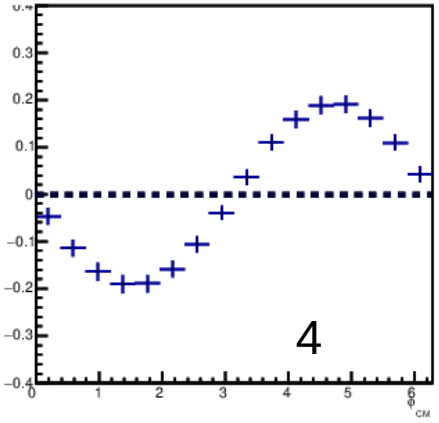


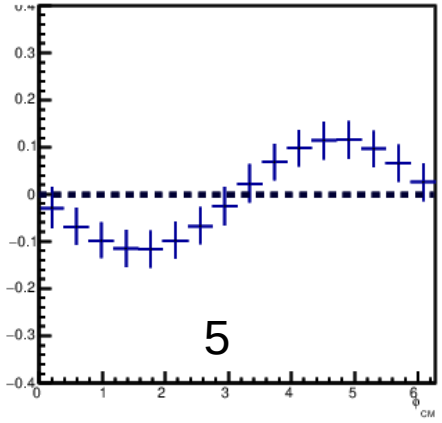




photon beam circular polarization







can reach high precision by boosting the intensity

here: enough for CFF fits
higher L: high precision Im($\mathcal{H}$)