DVCS on longitudinally polarised proton and Micromegas trackers for EIC

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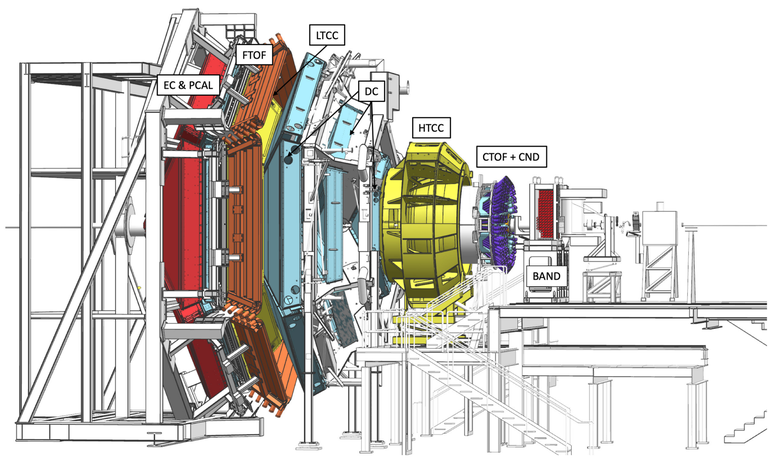
CLAS12 experiment

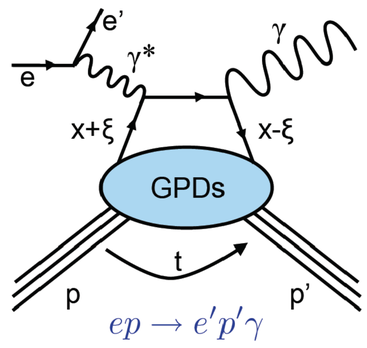


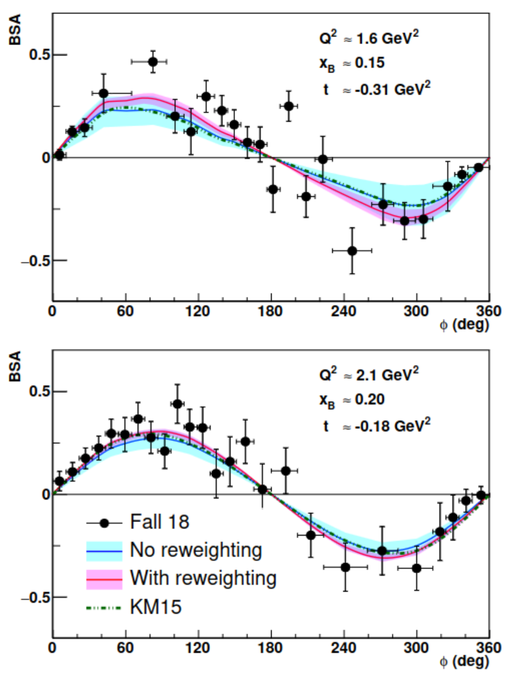
Burkert, V. D. et al. The CLAS12 Spectrometer at Jefferson Laboratory. Nuclear Instruments and Methods (2020).

- CLAS12 is a spectrometer on the $11GeV$ polarised electron beam of Jefferson Laboratory, VA, USA
- Large acceptance, ideal to study exclusive and semi-inclusive processes
- One of the main goals is the study of Generalised Parton Distributions (GPDs)
- GPDs encode the distribution in spin and momentum of quarks, antiquarks and gluons inside the nucleon in 3D

Proton DVCS

- Deeply Virtual Compton Scattering (DVCS): the electron exchanges a virtual photon with a quark in the proton. The proton remains intact and a real photon is emitted
- Interference with the Bethe-Heitler process where the real photon is radiated by the incoming or scattered electron.
- DVCS is factorised in a hard part computed in QCD and a soft part described by 4 GPDs: H, $\tilde{H}$, E, $\tilde{E}$ functions of x, ξ, t. Only accessible through Compton Form Factors $\mathcal{H}$, $\tilde{\mathcal{H}}$, $\mathcal{E}$, $\tilde{\mathcal{E}}$ functions of ξ,t





- Measuring asymmetries in the cross section between electron/proton spin configurations we can extract information on the GPDs
- Beam-Spin asymmetry: polarised electrons on unpolarised protons. F_1, F_2 are the nucleon form factors, ϕ is the angle between the leptonic and hadronic planes:

$$A_{LU}(\phi) = \frac{d\sigma^{\Uparrow} - d\sigma^{\Downarrow}}{d\sigma^{\Uparrow} + d\sigma^{\Downarrow}} = \frac{s_1^{\mathcal{I}} sin\phi}{c_0^{BH} + (c_1^{BH} + c_0^{\mathcal{I}} + ...)cos\phi...}$$

$$s_1^{\mathcal{I}} \propto \Im\{F_1\mathcal{H} + \xi(F_1 + F_2)\tilde{\mathcal{H}} + \frac{t}{4M^2}F_2\mathcal{E}\}$$

← Recent CLAS12 measurement on an unpolarised Hydrogen target.

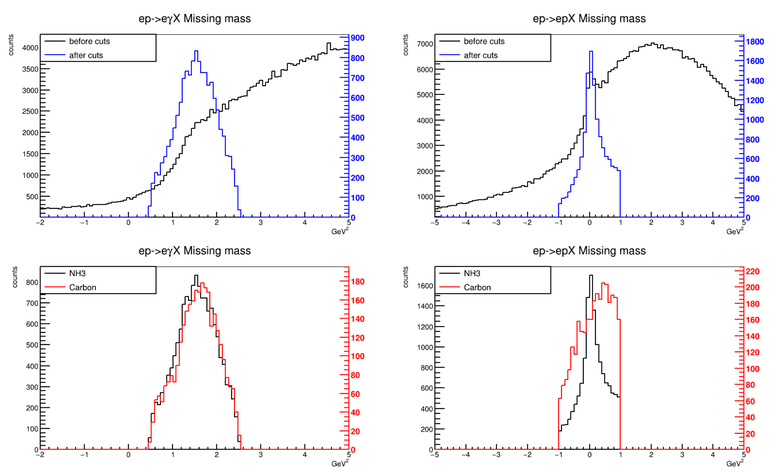
CLAS Collaboration et al. First CLAS12 measurement of DVCS beam-spin asymmetries in the extended valence region. (2022).

DVCS on polarised target

- A polarised target gives access to two other asymmetries depending on different linear combinations of the CFFs
  - Target-Spin A_{UL} - unpolarised beam on polarised proton
  - Double-Spin A_{LL} - polarised beam on polarised proton
- CLAS12 took data on longitudinally polarised targets from June 2022 to March 2023. The proton target is made of NH3 at $1K$ in a $5T$ magnetic field.
- Experimental formula for the Target-Spin Asymmetry, N are yields, P_t target polarisation and D_f dilution factor

$$A_{UL} = \frac{1}{D_f} \frac{N^{++} + N^{-+} - N^{+-} - N^{--}}{P_t^-(N^{++} + N^{-+}) + P_t^+(N^{+-} + N^{--})}$$

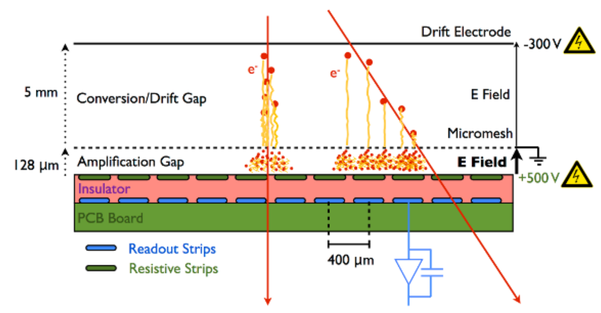
- Added complexity because not all free protons are polarised and scattering can happen on a proton inside a nitrogen nucleus.
- Quick look at the data, $\sim 2\%$ of the statistic but calibration not yet completed



Pisano, S. et al. Single and double spin asymmetries for deeply virtual Compton scattering measured with CLAS and a longitudinally polarized proton target. Phys. Rev. D 91, 052014 (2015).

Micromegas trackers

- Micromegas are gaseous detectors to measure the position of charged particles
- A particle ionises the gas in the drift gap, the low field guides the e^- to the mesh. Amplification by a high field below the mesh



Acker, A. et al. The CLAS12 Micromegas Vertex Tracker. Nuclear Instruments and Methods (2020).

- Metallic strips at the bottom to sample the signal
- In CLAS12 trackers the signal is induced on resistive strips above the readout to prevent sparks

Proposal for EIC

- The Electron Ion Collider (EIC) will be built at Brookhaven, NY, USA, first beam expected around 2030
- Strict requirements: good resolution, low material budget, reduced number of electronic channels
  $\rightarrow$ 2D Resistive charge sharing
- Signal induced on the resistive layer, read by capacitive coupling with strips in both directions
- 2D position in one detector and less strips for the same resolution