Measurement of DVCS Asymmetries with the HERMES Recoil Detector

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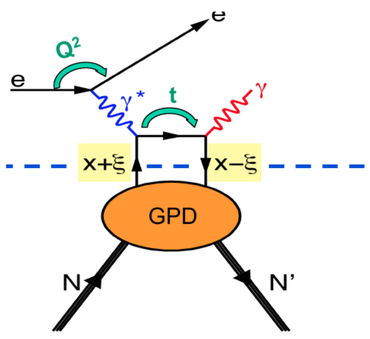
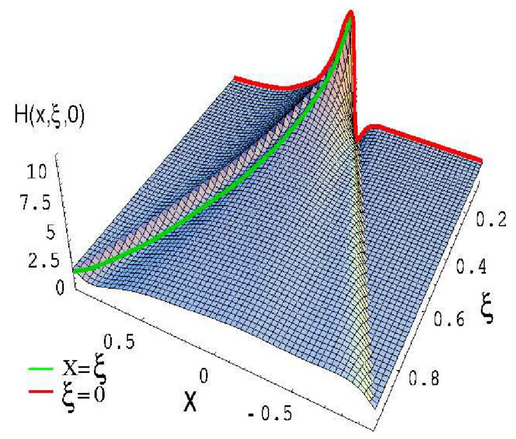
Access to GPDs through DVCS Asymmetries

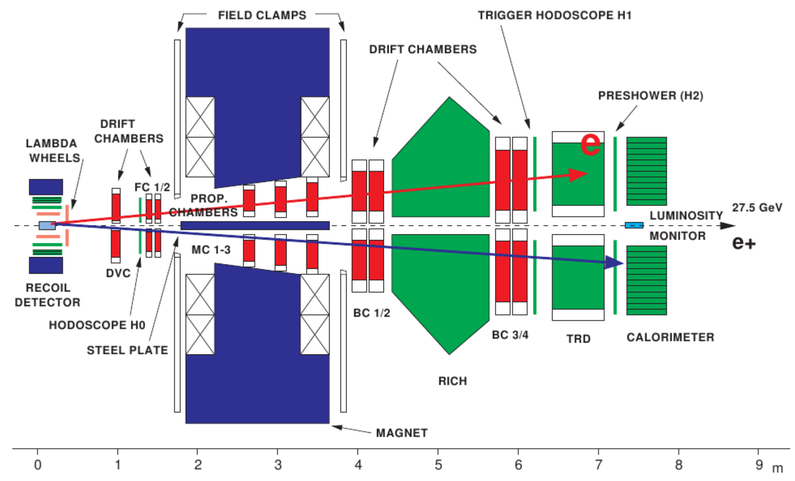


Handbag diagram separates
- hard scattering process (QED & QCD) (NLO) and
- non-pertubative structure of the nucleon: GPD(x,ξ,t,Q²)



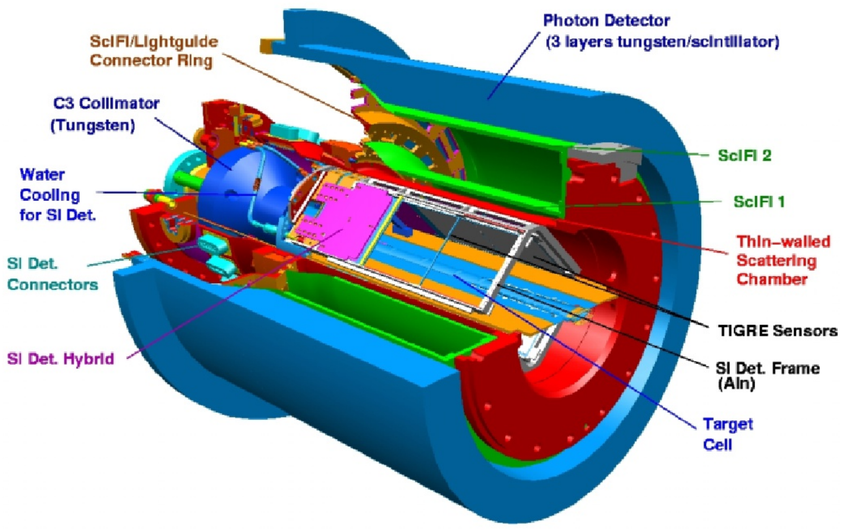
A quark carries a momentum fraction x of the proton. Afer an interaction with the stronghly interacting proton it emits a real photon and falls back into the proton. The theoretical description is possible with the Generalised Parton Distributions (GPDs). These objects parametrise all features of the proton that are necessary to describe exclusive processes as DVCS.
For each quark flavour there are 4 GPDs: H^q, E^q, $\tilde{H}^q$, $\tilde{E}^q$. The GPDs can be accessed by measurements of cross section asymmetries.

The HERMES Spectrometer



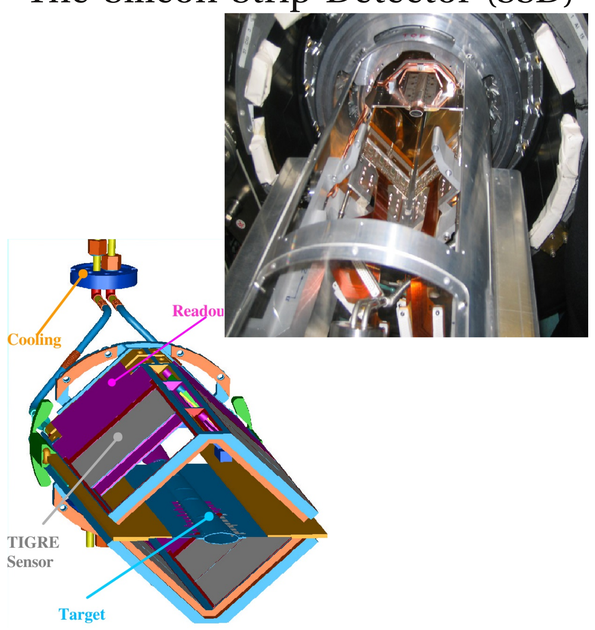
The HERMES spectrometer is a fixed target experiment and collected data on inclusive and semi-inclusive deep inelastic scattering of polarised positrons and electrons (beam momentum of 27.6 GeV/c and up to 65% beam polarisation) with polarised or unpolarised targets of H, D, and heavier targets. These data provide information on the spin structure of the nucleon.

The Recoil Detector



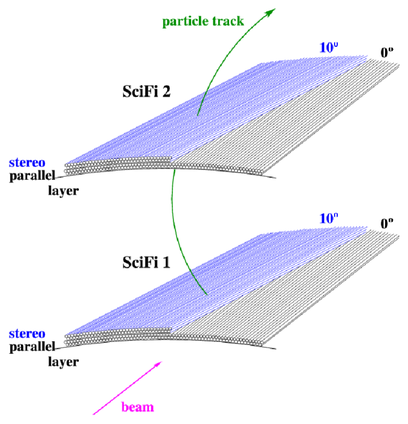
The Recoil Detector can detect recoiling protons (125-400MeV/c), improves (Mandelstam) t-resolution and suppress the background. It consists of a Silicon Strip Detector (SSD), a Scintillating Fibre Tracker (SFT) and a Photon Detector (PD). A solenoid magnet provides a 1T longitudinal magnetic field for the measurement in the SFT and allowes to reduce the background from Møller electrons in the SSD.

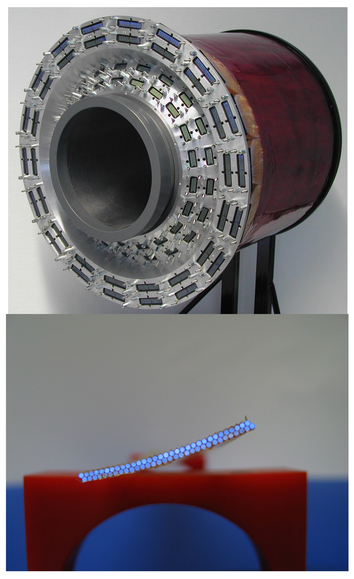
The Silicon Strip Detector (SSD)



The SSD consisted of 8 modules of 2 double-sided silicon strip detectors (TIGRE) arranged in two layers around the target cell. It was used for position and energy measurement and identification of low momentum protons (125-450 MeV/c).
It covered nearly the complete range in polar angle and 76% in azimuthal angle.

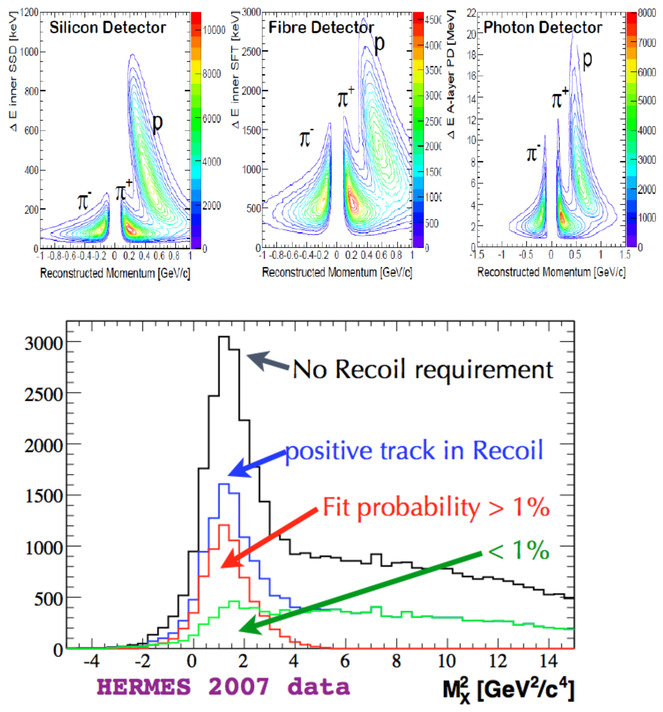
The Scintillating Fibre Tracker (SFT)





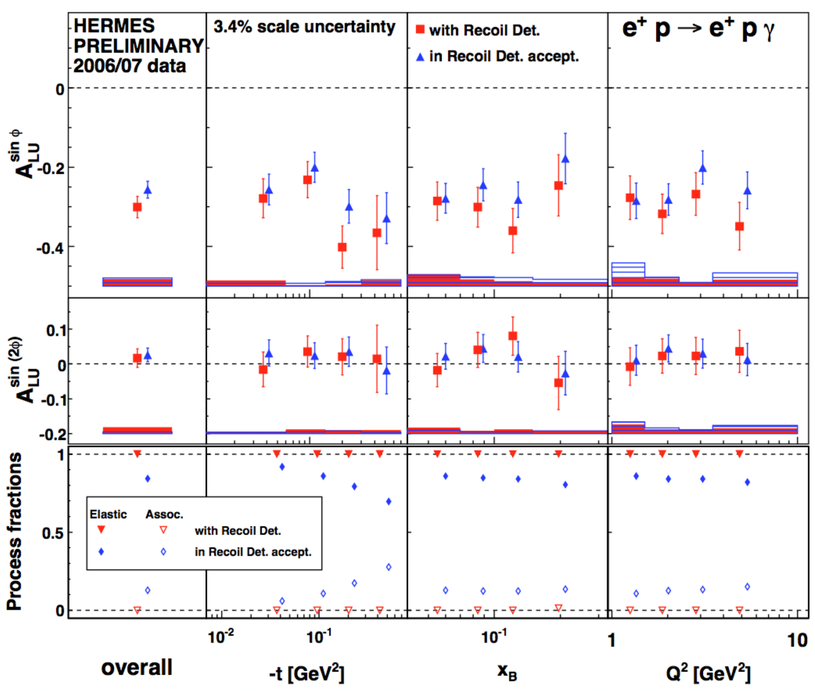
The SFT consisted of 2 barrels each with 4 layers of scintillating fibres. Each barrel had 2 parallel and 2 stereo layers for space point reconstruction.
The tracker measured from 250 to 1400 MeV/c in full azimuthal angle range and reconstructed particle tracks by bending in 1T magnetic field. Energy deposition was used for particle identification.

Beam Helicity Asymmetry



To select a clean sample of pure elastic events (ep->epγ) it is necessary to suppress the background of associated processes like ep->eΔ⁺γ with Δ⁺->pπ⁰. For this purpose the precise measurement of the recoiling particles is essential. The particle identification from the recoil data makes it possible to distinguish between pions and protons.
The upper plots show the energy deposition and the reconstructed particle momentum attributed to protons and pions.
The lower plot shows the separation of the pure elastic sample (red) from the background (green).

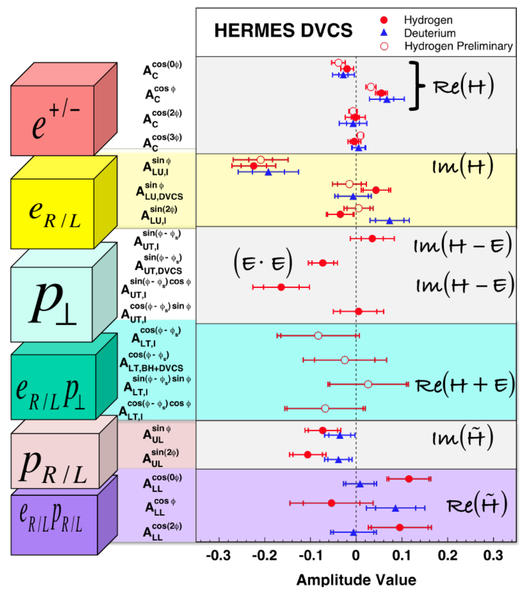
Beam Helicity Asymmetry



$$\mathcal{A}_{LU}(\phi) = \frac{d\sigma^{\rightarrow}(\phi) - d\sigma^{\leftarrow}(\phi)}{d\sigma^{\rightarrow}(\phi) + d\sigma^{\leftarrow}(\phi)}$$

The beam helicity asymmetry is calculated from the measured cross sections with different spins. It can beexpanded in Fourier series in φ, the angle between the lepton-nucleon scattering plane and the real photon production plane.
In this plot values that include recoil information are compared with values that are analysed without it.
The lowest row shows how the recoil detector helps to distinguish between pure elastic BH/DVCS (with proton remaining in the ground stat) and associated processes(with the proton being excited to a resonant state).

From Asymmetry to GPDs



Overview of all DVCS azimuthal asymmetry amplitudes measured at the HERMES experiment.

Conclusion and Outlook

HERMES performed pioneering DVCS measurements.
DVCS provides access to GPDs.
The recoil detector allows to select a pure DVCS sample.
The beam-helicity asymmetry is measured with the recoil information.
The sin(φ) asymmetry amplitude is found to be only slightly larger in magnitude compared with those measured without recoil detector information.
The beam-charge asymmetry with recoil information is under study.