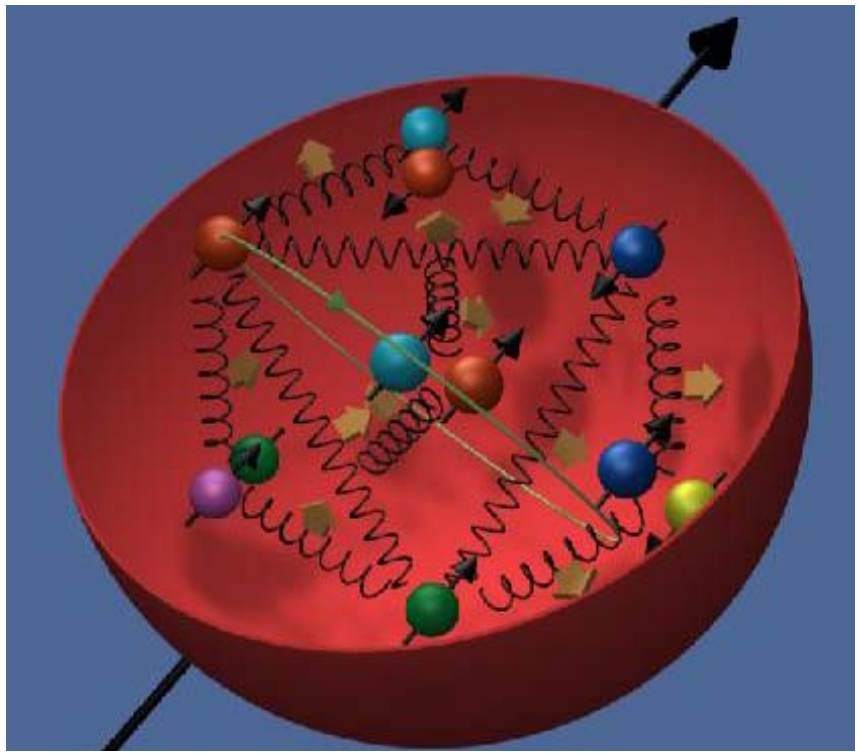
Hard Exclusive Measurements with a Polarised Target at HERMES

Morgan Murray
University of Glasgow

UNIVERSITY *of* GLASGOW

Generalised Parton Distributions



$$\tfrac{1}{2} = J^Q + J^G$$

$$J^Q = \sum_q J^q$$

$$J^q = \lim_{t\to 0} \int_{-1}^{1} x\left[H^q + E^q\right]dx$$

⇨ we can understand better the spin structure of the nucleon.

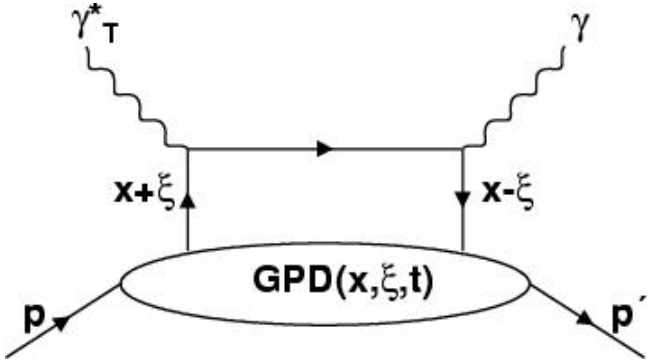
Generalised Parton Distributions

Unpolarised GPDs	H	E
Polarised GPDs	$\tilde{H}$	$\tilde{E}$

$$H^q(x,0,0) = q(x) \qquad \int_{-1}^{1} H^q(x,\xi,t)\,dx = F_1^q(t) \qquad \int_{-1}^{1} \tilde{H}(x,\xi,t)\,dx = G_A^q(t)$$

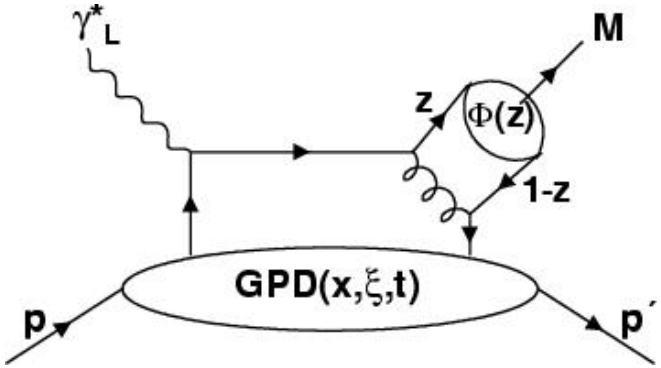
$$\tilde{H}^q(x,0,0) = \Delta\Sigma \qquad \int_{-1}^{1} E^q(x,\xi,t)\,dx = F_2^q(t) \qquad \int_{-1}^{1} \tilde{E}(x,\xi,t)\,dx = G_P^q(t)$$

Hard Exclusive Reactions



$\gamma^*+p \longrightarrow \gamma+p'$

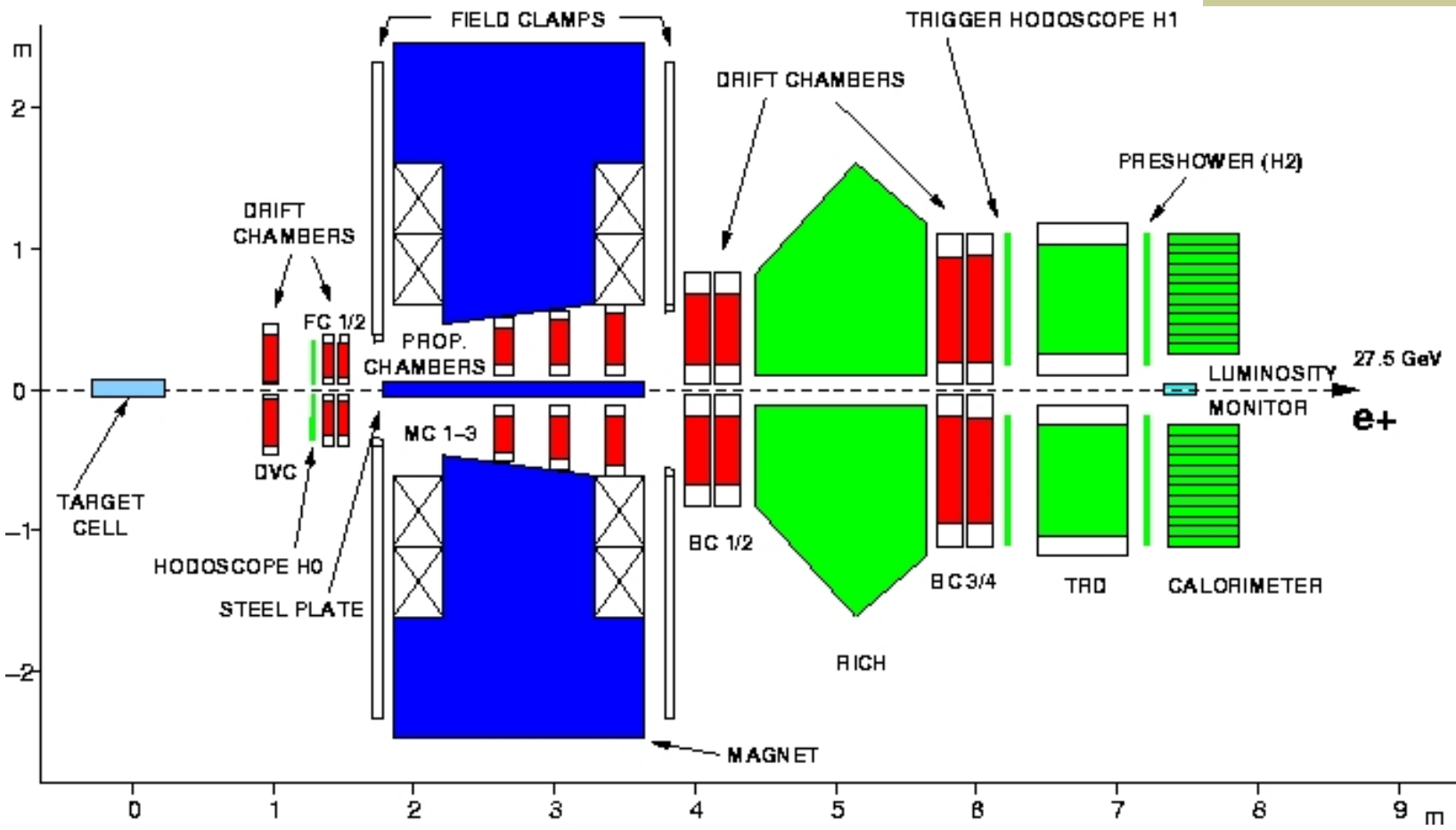
Access GPDs $H, \tilde{H}, E, \tilde{E}$



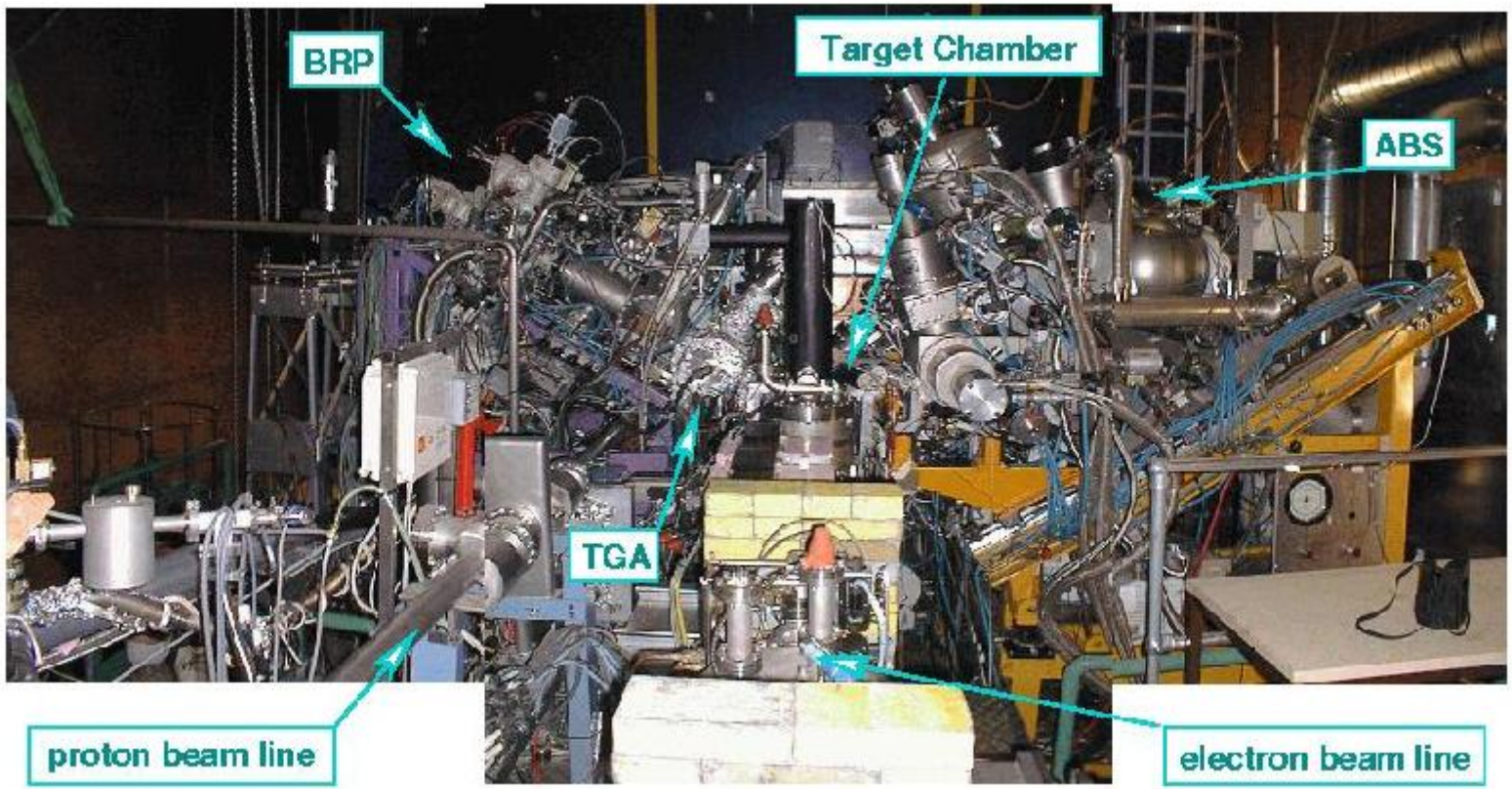
$\gamma^*+p \longrightarrow M+p$

Access GPDs $E, \tilde{E}$

The HERMES Spectrometer



The HERMES Polarised Target



Average Kinematics and Polarisation Values

$Q^2 \approx 2.5\ GeV^2$

$-t \approx 0.1\ GeV^2$

$x \approx 0.1$

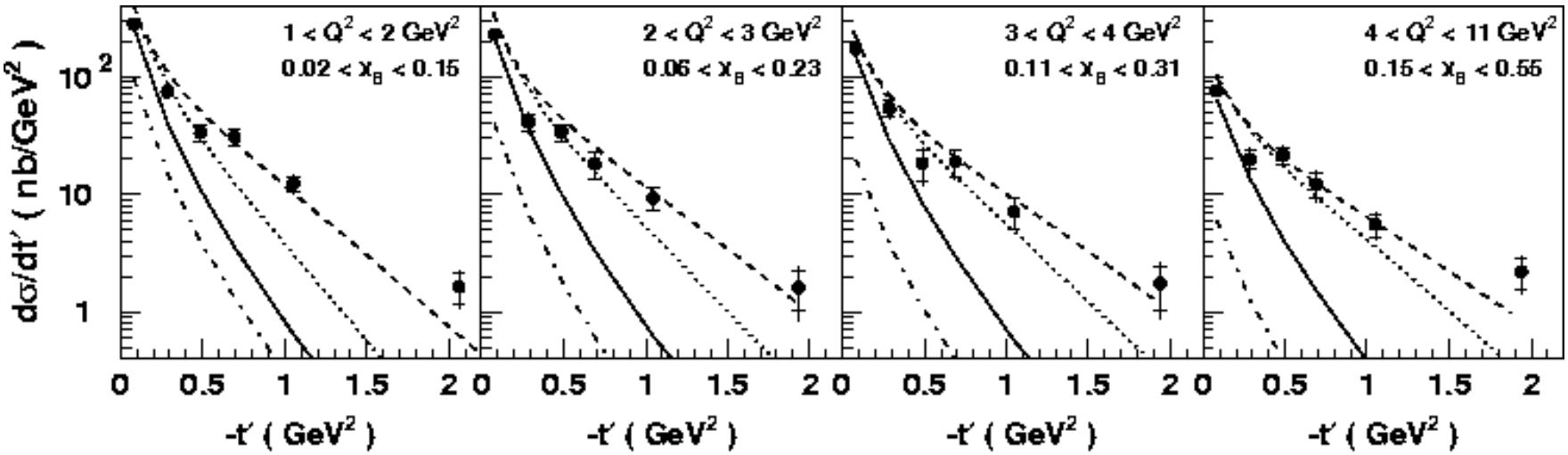
Beam Pol. ≈ 40%

Target Pol. ≈ 70%

Beam Energy ≈ 27.6 GeV

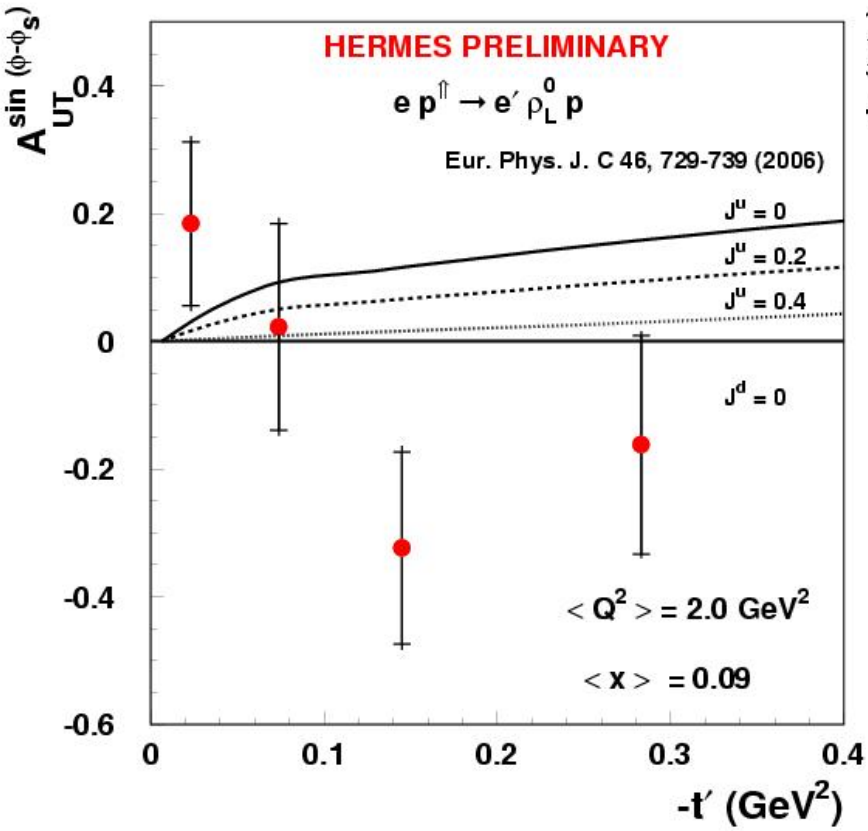
Exclusive Meson Production - π^+ Cross Section

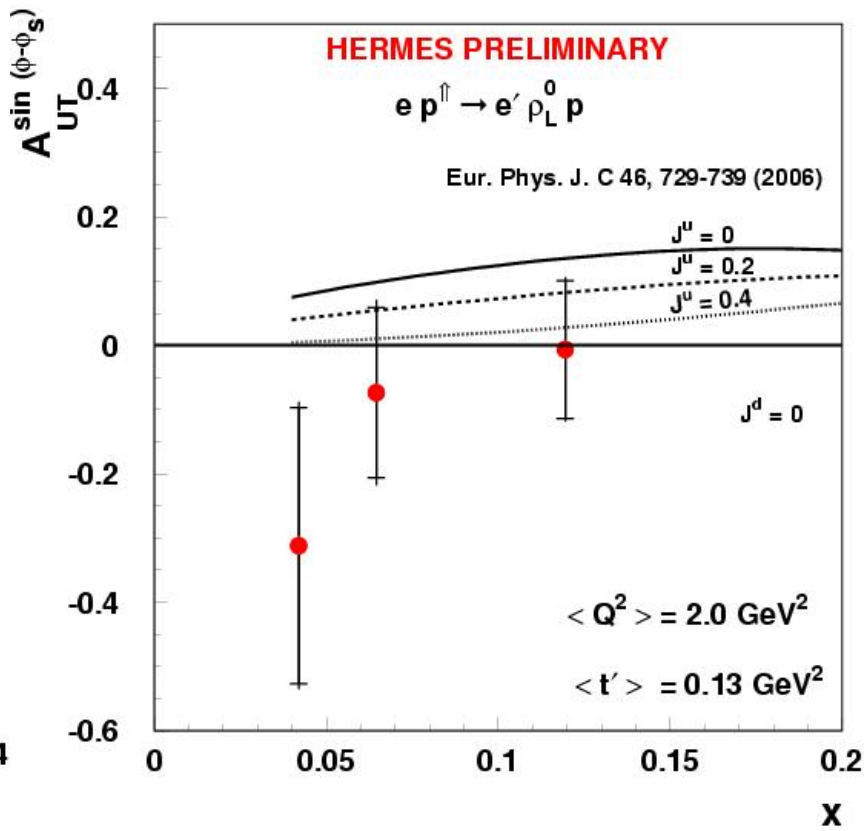
- Sensitive to the polarised GPD $\tilde{E}$
- Disfavours leading-order calculations (PRD 60 (1999) 094017)



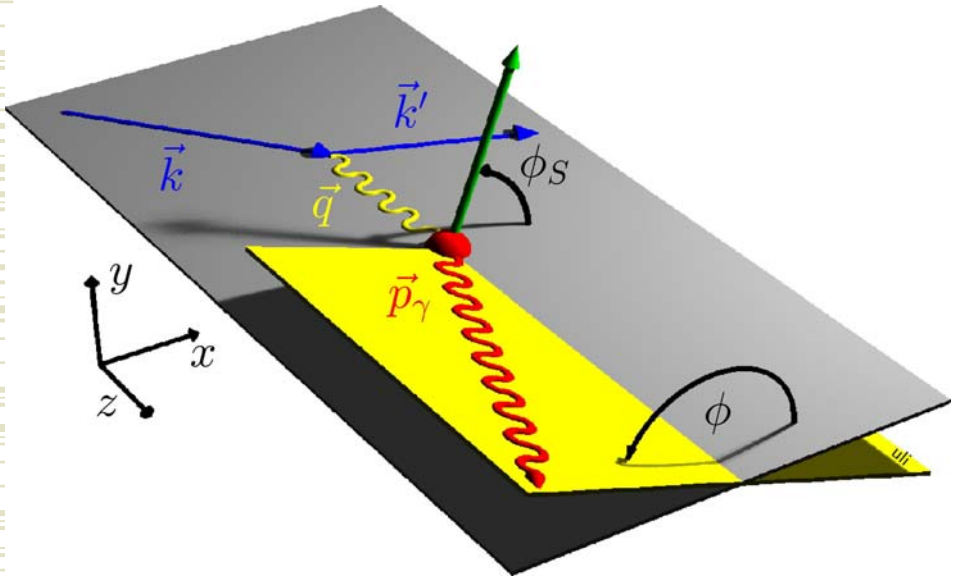
(arXiv: 0707.0222)

Exclusive Meson Production – ρ^0 Target Spin Asymmetry



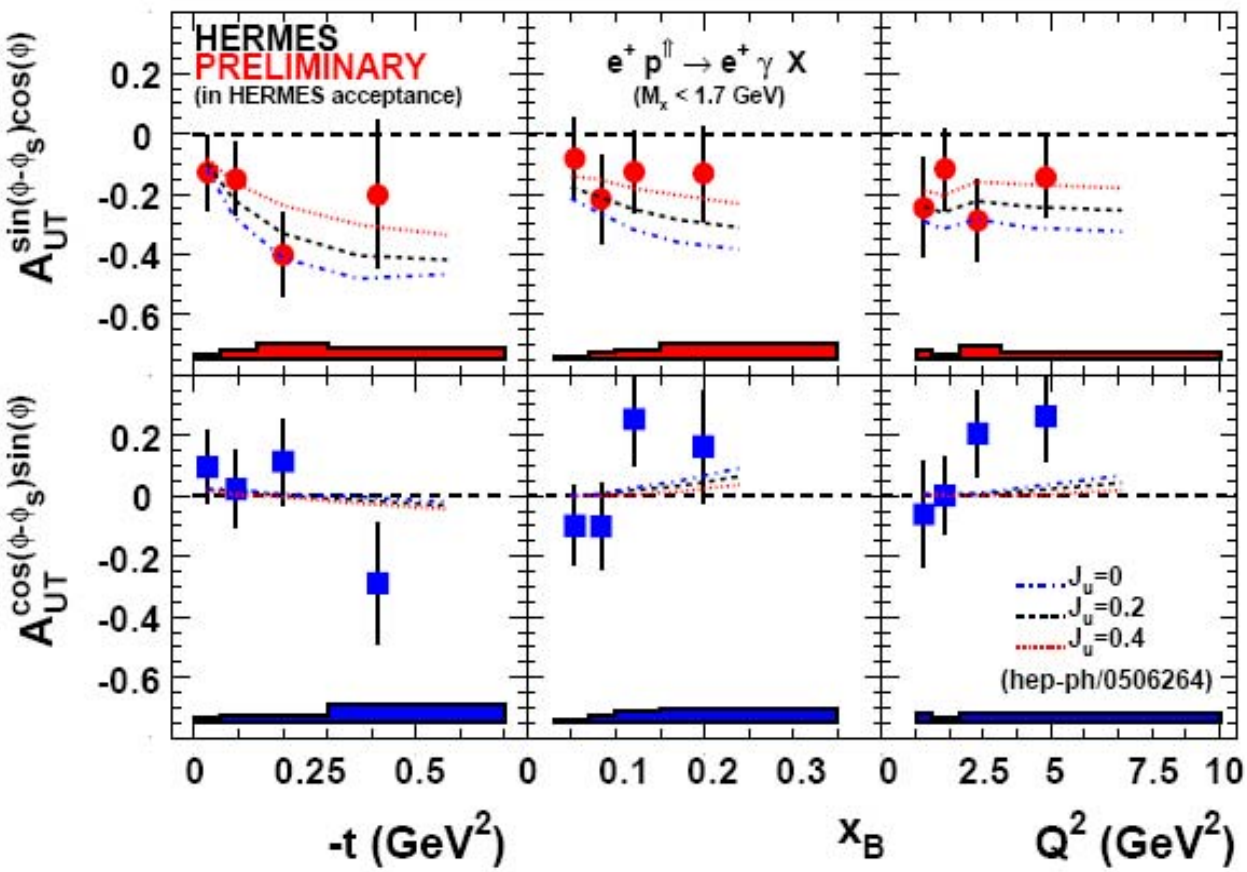


DVCS Asymmetries



- Identify by differences in angular distributions depending upon beam charge, beam spin and target spin
- Compare to theoretical models and minimise differences

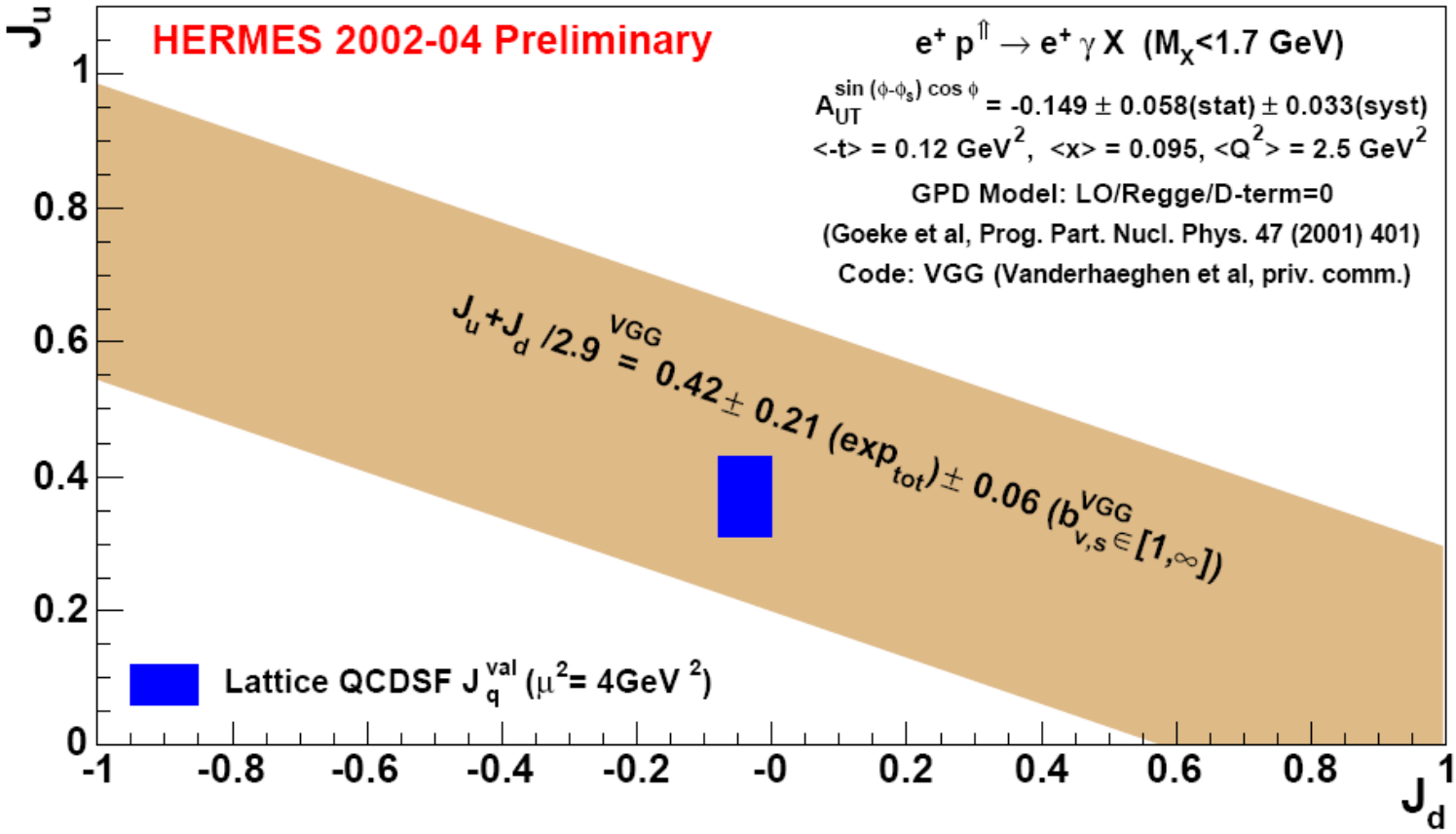
Target Spin Dependent Asymmetries



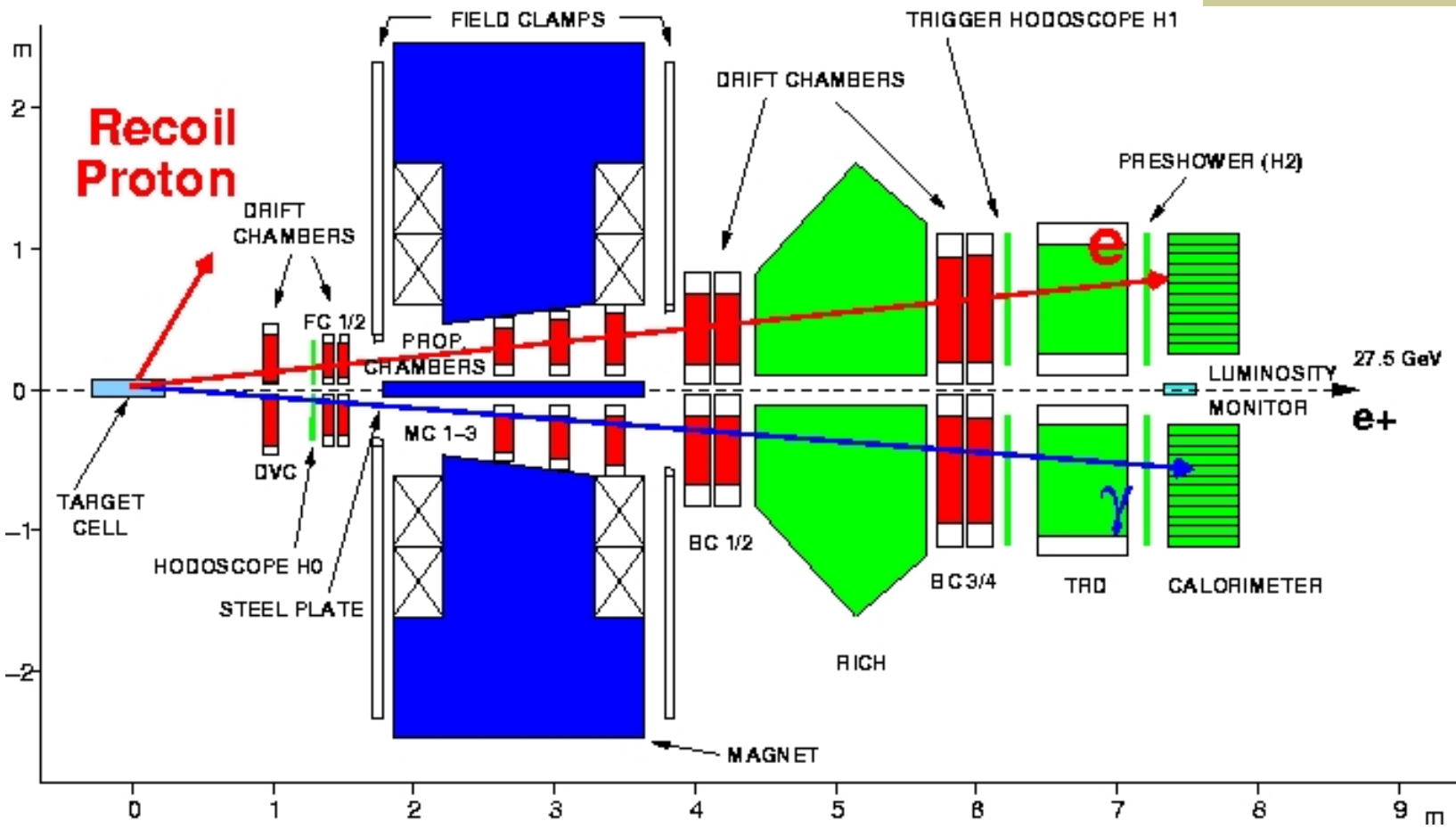
Accesses GPDs H, E

Accesses GPDs $\tilde{H}, \tilde{E}$

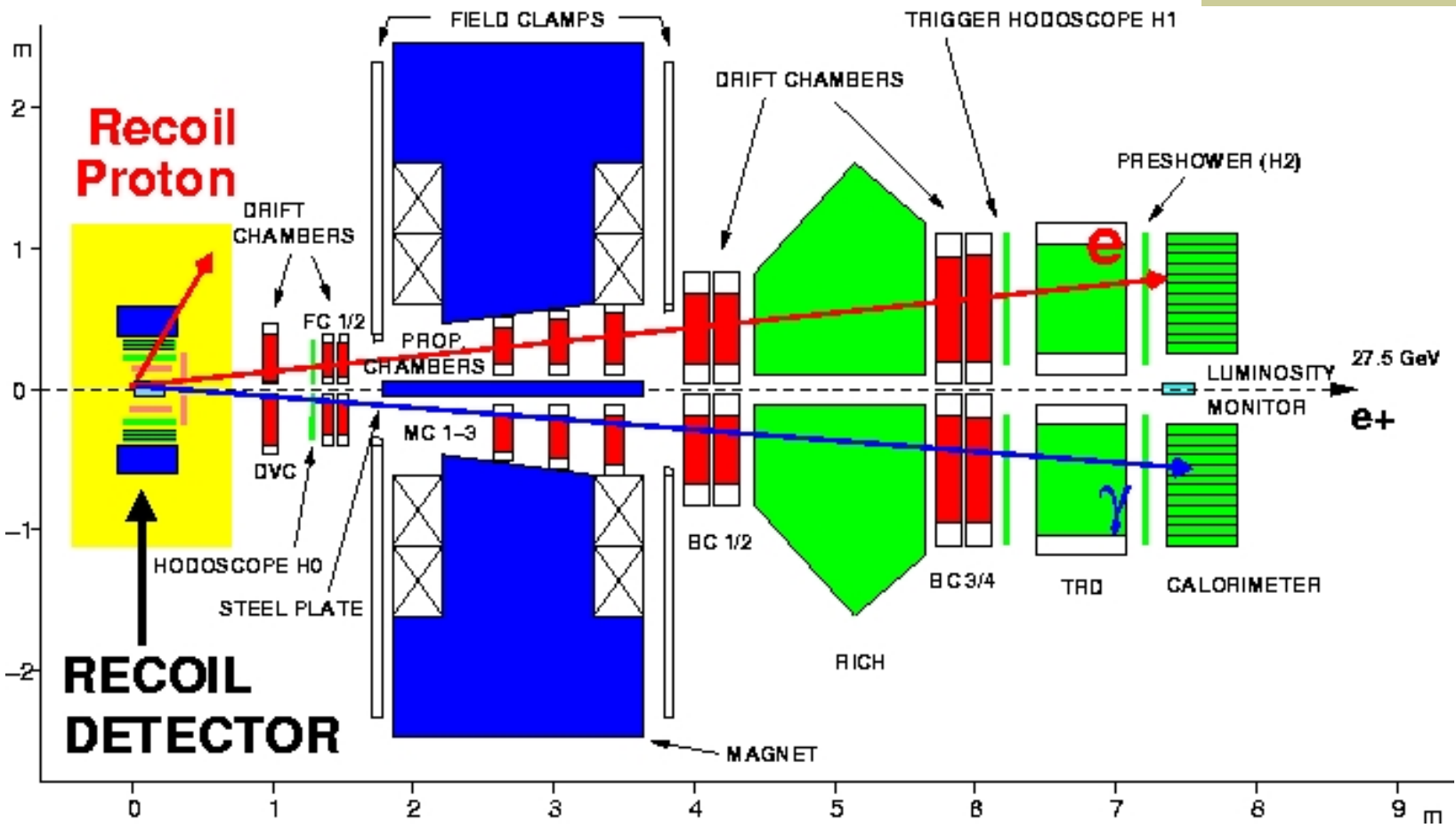
Constraint on $J_u + J_d$



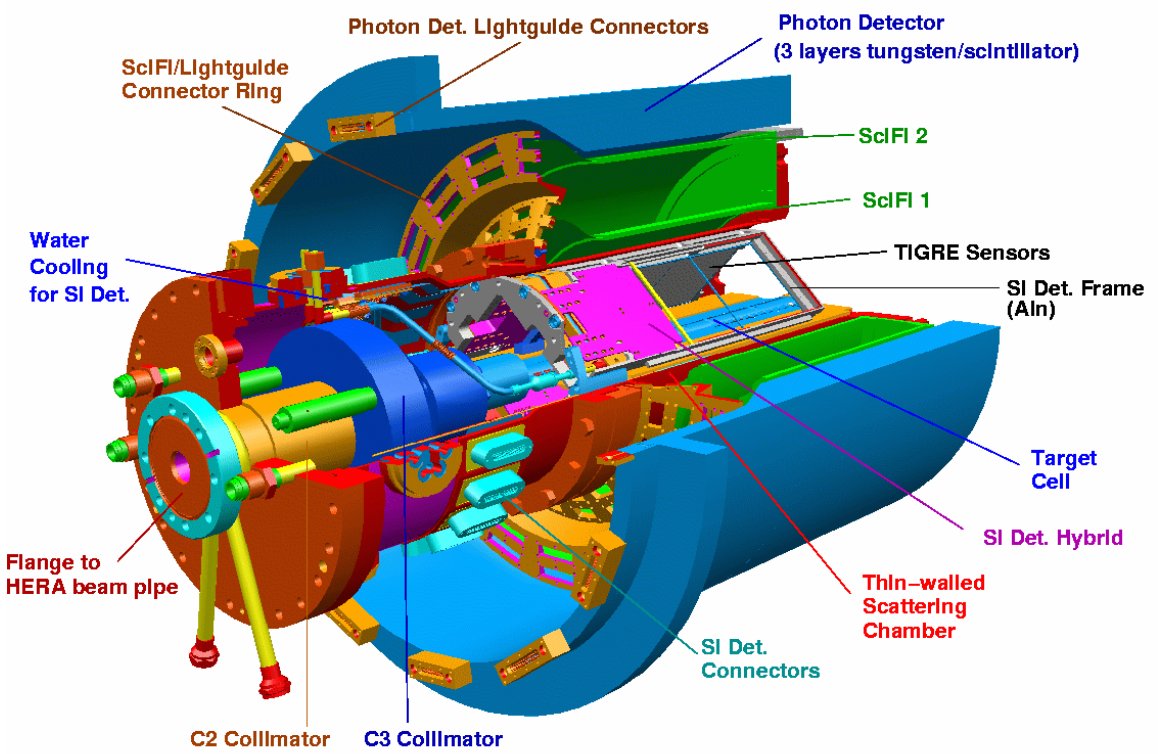
The Recoil Detector



The Recoil Detector

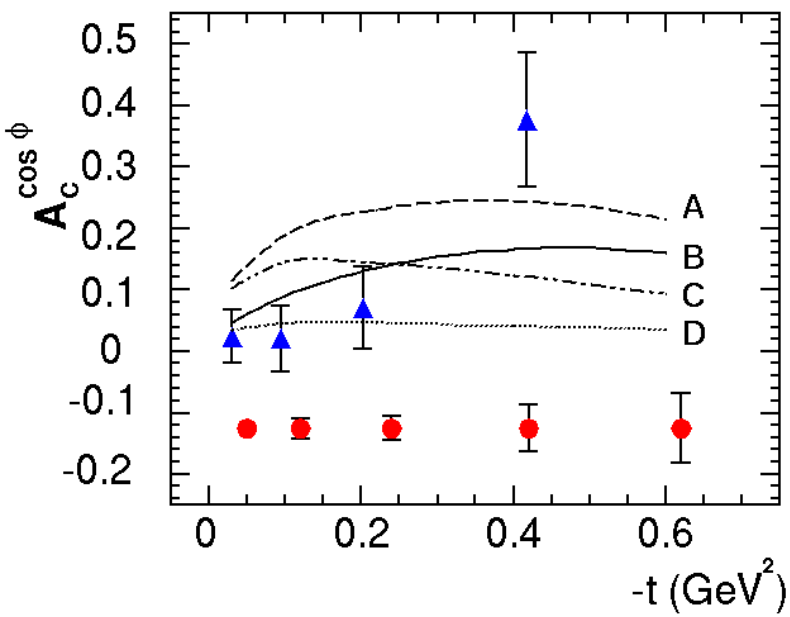


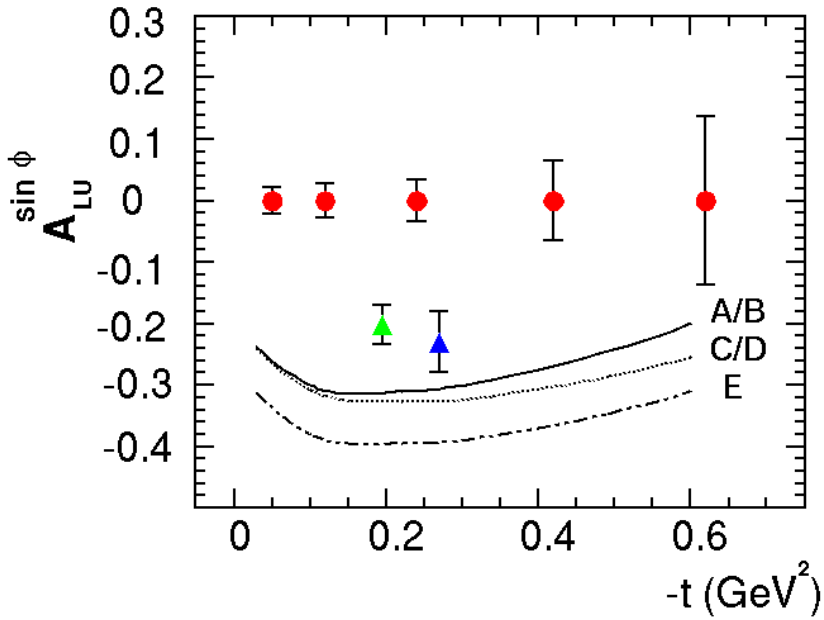
The Recoil Detector



- Designed for DVCS
- Silicon 'Calorimeter' SciFi Tracker and γ–Detector

Recoil Improvements





▲ HERMES DATA (No Recoil) (PRD 75 (2007) 011103(R))
● HERMES DATA (Recoil Projections)

▲ HERMES DATA (No Recoil) (PRL 87 18 (2001) 182001)
▲ CLAS Result (PRL 87 18 (2001) 182002)

Summary

- Exclusive measurements at HERMES allow access to GPDs
- Unique HERMES data challenges existing models and provides impetus for theoretical advancement.
- HERMES has been upgraded to decrease systematic errors and improve background subtraction.