Hard Exclusive Reactions and Deeply Virtual Compton Scattering measured by HERMES

bmb+f - Förderschwerpunkt
HERMES
Großgeräte der physikalischen Grundlagenforschung

PaNIC 02, XVI Particles and Nuclei International Conference
September/30 - October/4 2002, Osaka, Japan

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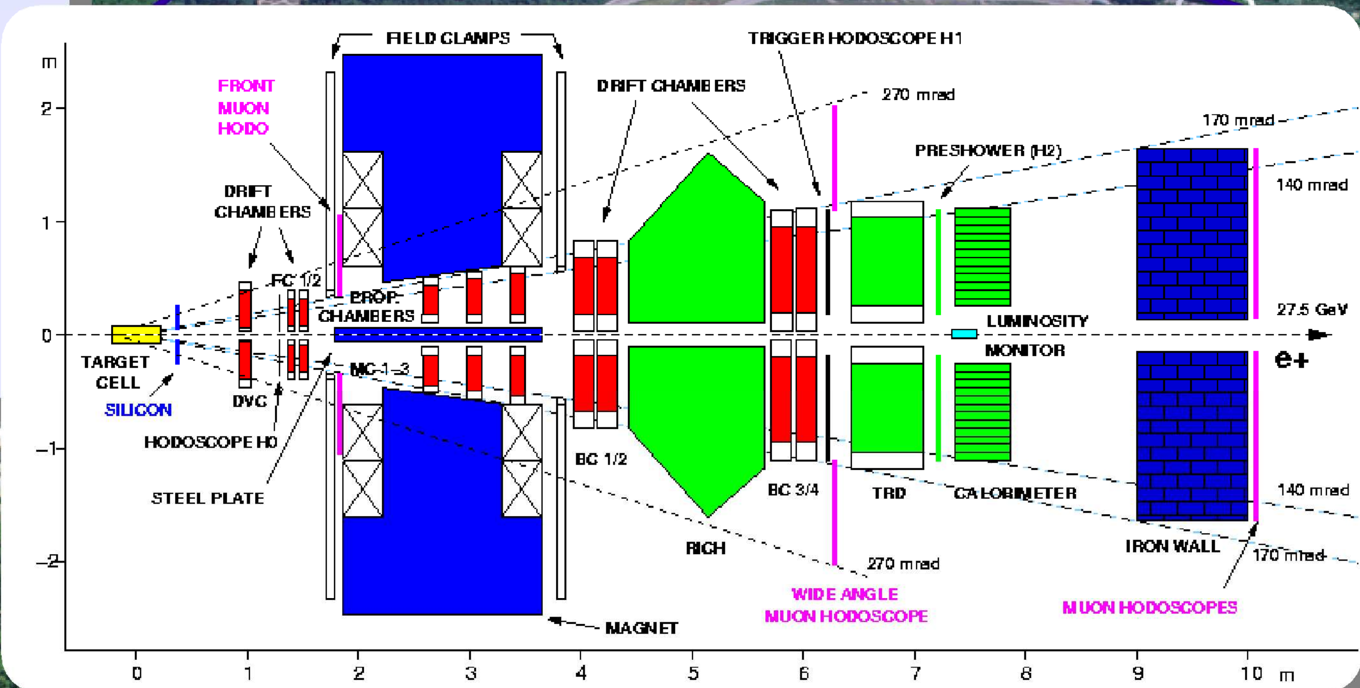
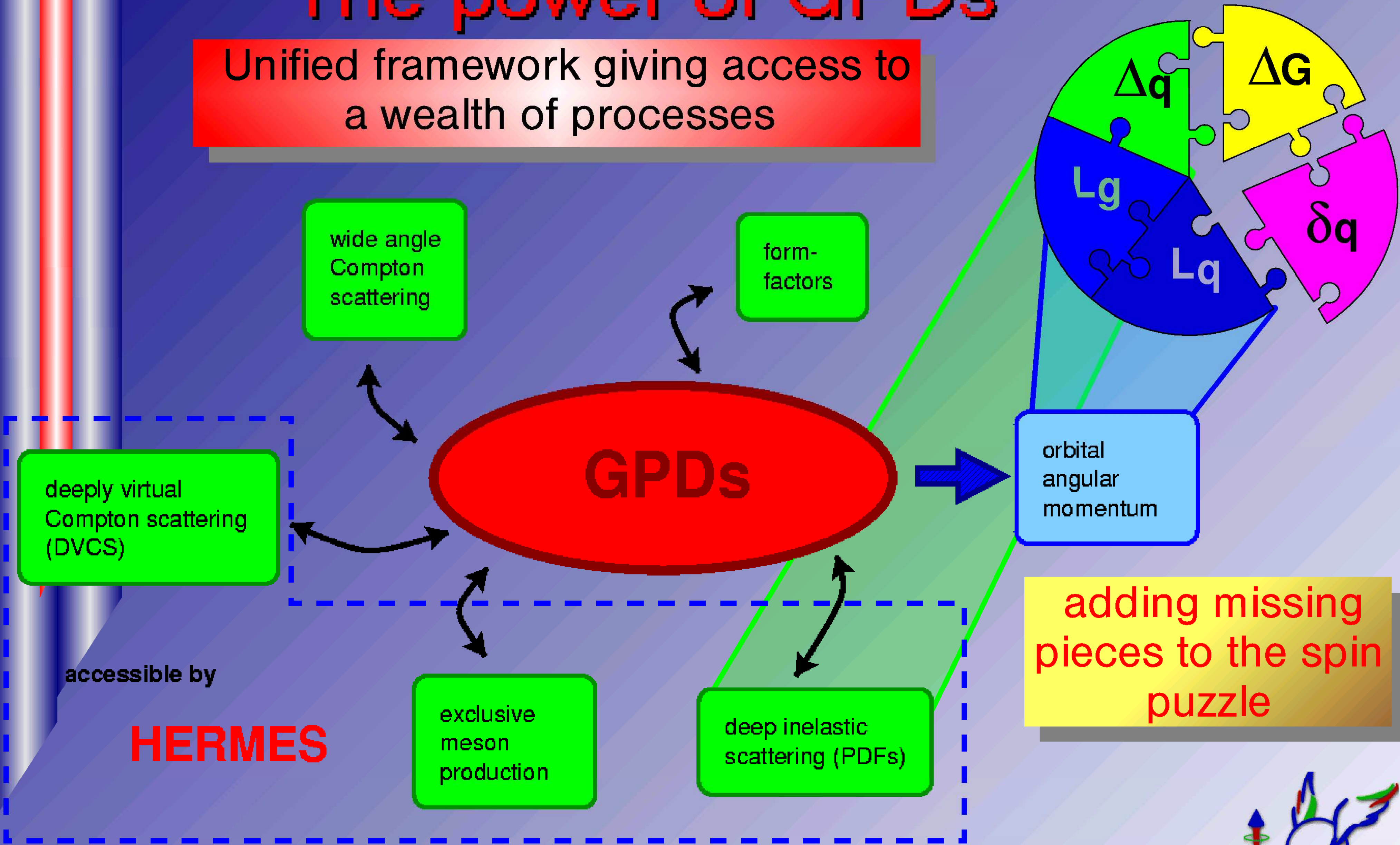
The HERMES experiment

- 27.5 GeV pol e+ or e-
- pure pol. H,D and various unpol. targets
- 57 tracking planes ($\delta P/P < 1.6\%$)
- PID using RICH, TRD, CALO (ε_e>0.98, π, K, p separation)
- $0.8 < Q^2 < 12\ GeV^2$
- $0.02 < x < 0.7$
- $1 < W^2 < 45\ GeV^2$



The power of GPDs

Unified framework giving access to a wealth of processes



adding missing pieces to the spin puzzle

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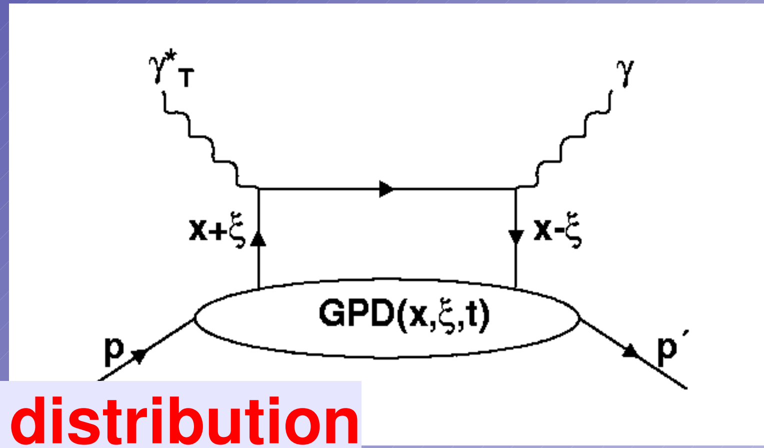
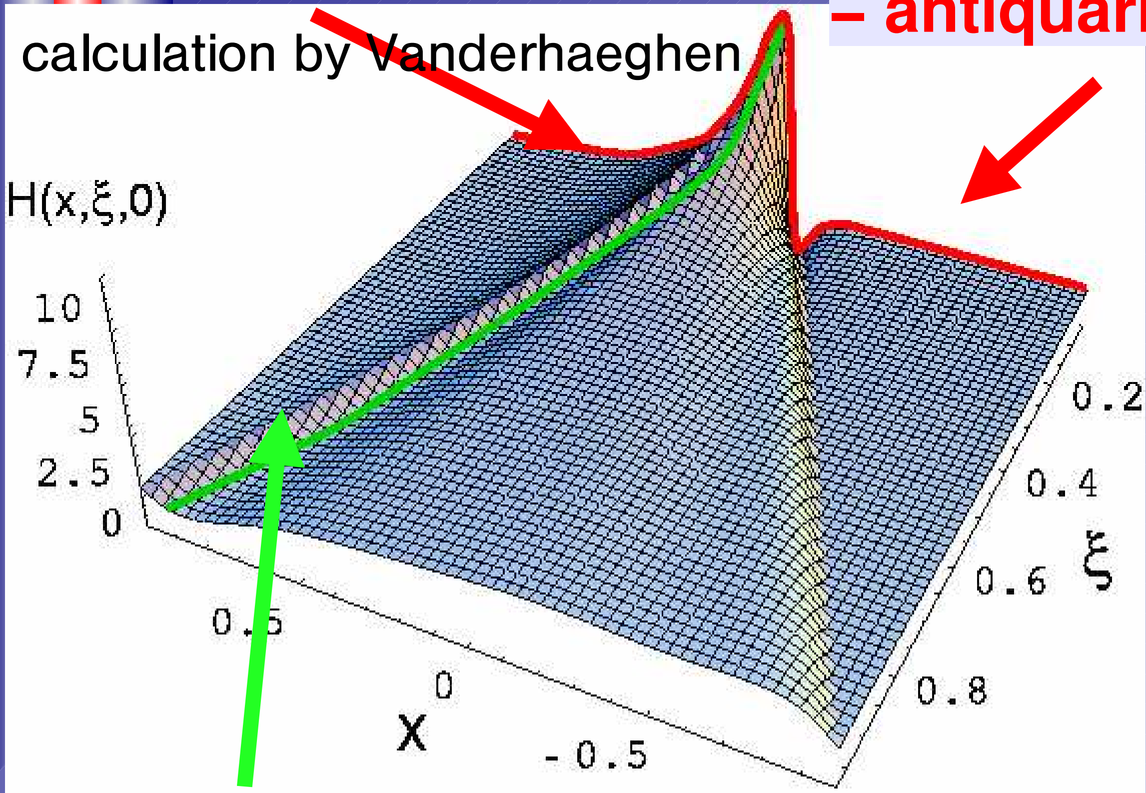
What could a GPD look like ?

for t=0 and ξ=0:
- forward scattering (DIS)
- x >0 scattering on quarks
- x < 0 scattering on antiquarks



quark distribution

– antiquark distribution



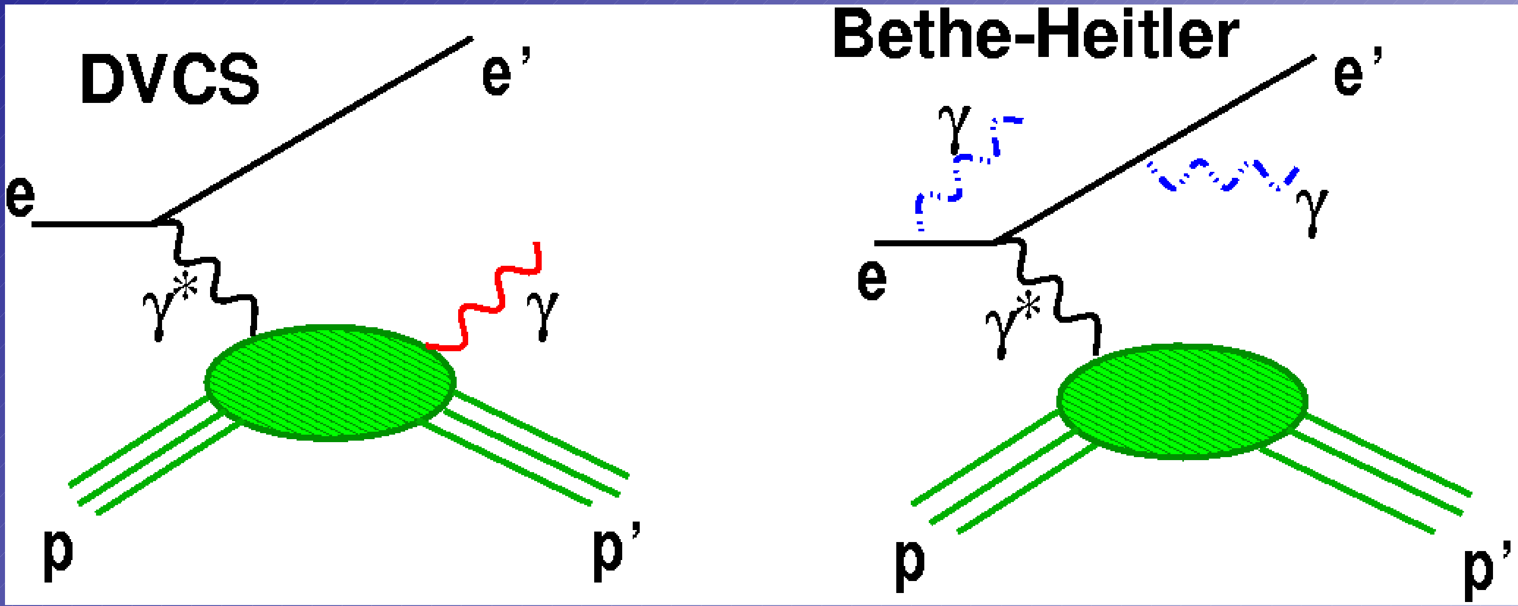
$$Q^2 = -q^2 \approx 4EE' \sin^2\left(\frac{\theta}{2}\right)$$

$$x = \frac{Q^2}{2M \cdot \nu} \qquad \xi \rightarrow \frac{x}{(1 - x/2)}$$

$$t = (p - p')^2$$

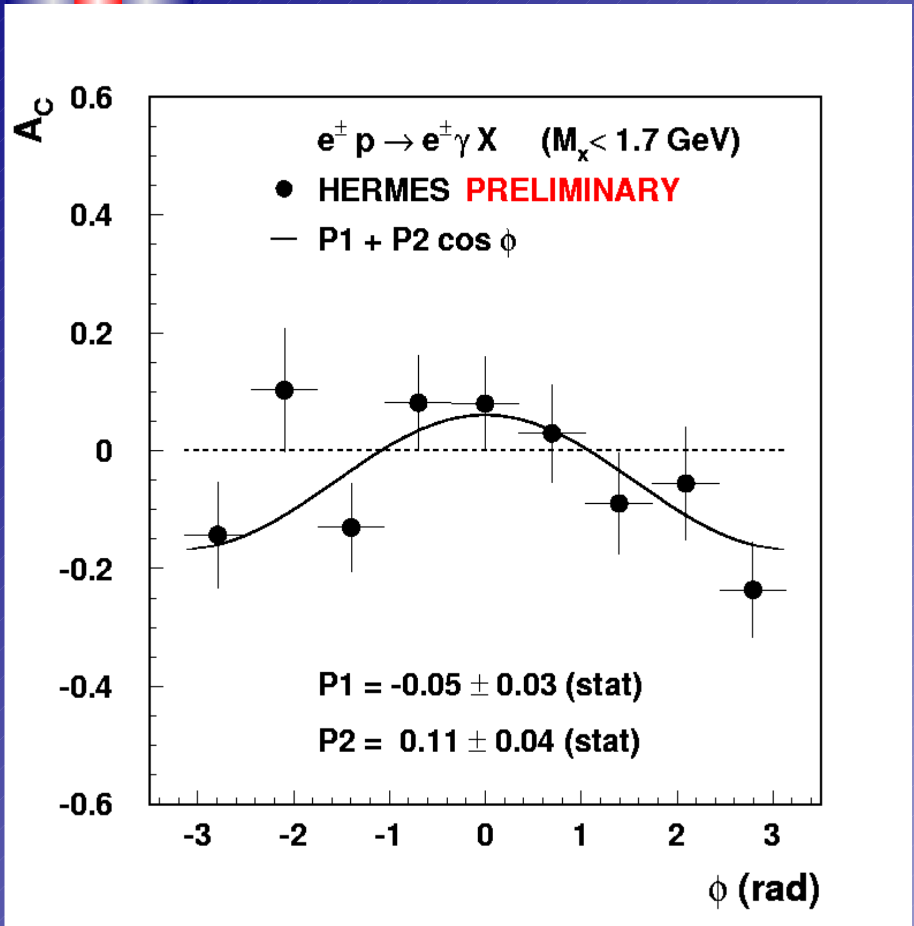
accessible by HERMES DVCS measurement

Aiming for the amplitudes: DVCS–BH



- measure interference of different wave functions p, p‘
- cleanest process: DVCS
- same final state: quantummechanical interference
- large BH serves as lever arm for DVCS
- interference on amplitude level -> direct access to amplitudes
- spin/flavour filter: Hard Exclusive Meson production

Getting real:
Beam Charge Asymmetry



- proportional to cos ϕ
- proportional to real part of DVCS amplitude
- unique feature at HERMES (different beam charges possible)
- precision presently limited by e^- data
- very sensitive to details of GPD models (Polyakov–Weiss D–Term)

$$d\,\Delta\sigma_{ch} \equiv d\,\sigma(e^+ p) - d\,\sigma(e^- p) \sim \cos\phi \times \Re e\,(A)$$

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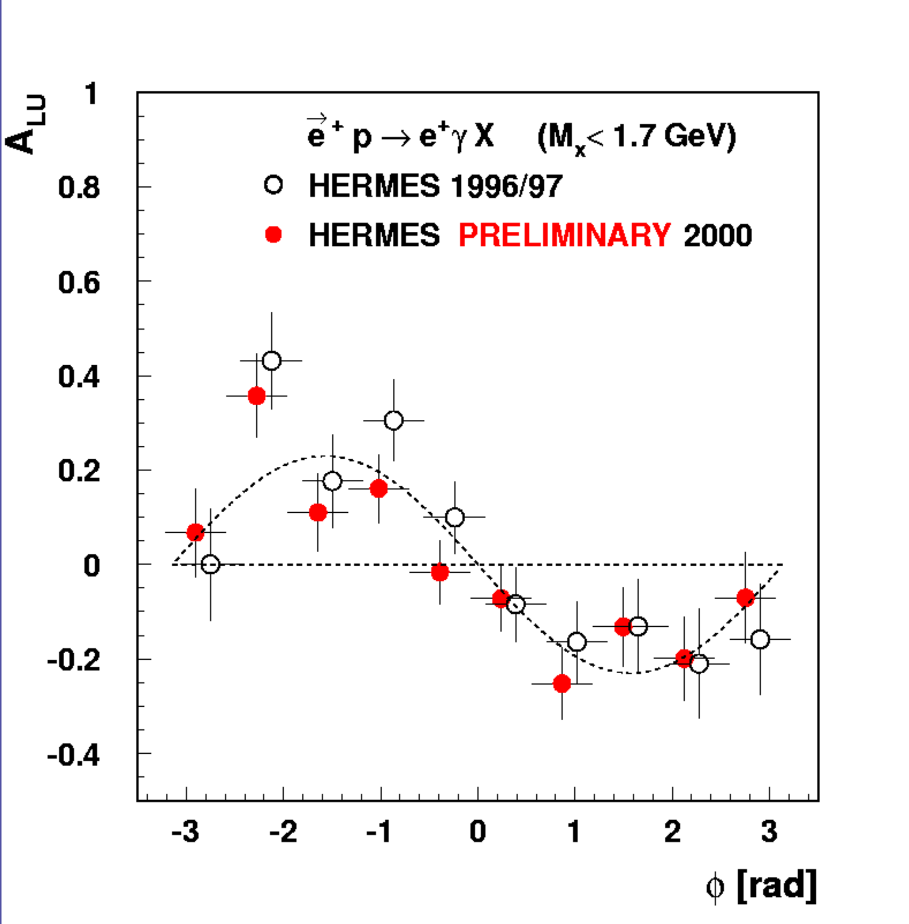
Only imaginary: Beam Spin Asymmetry

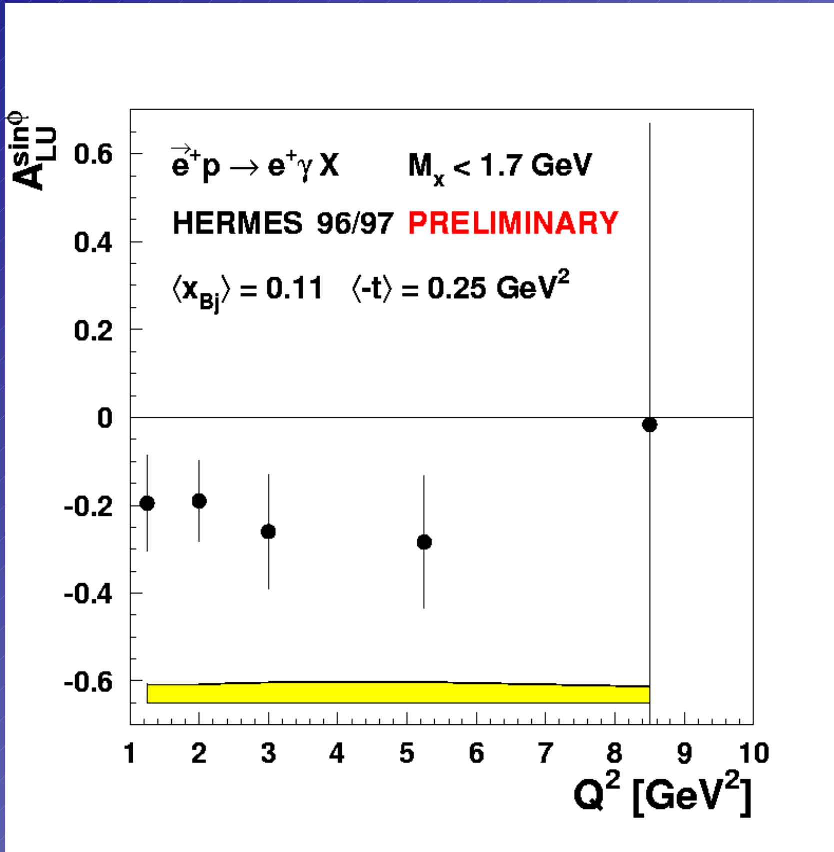


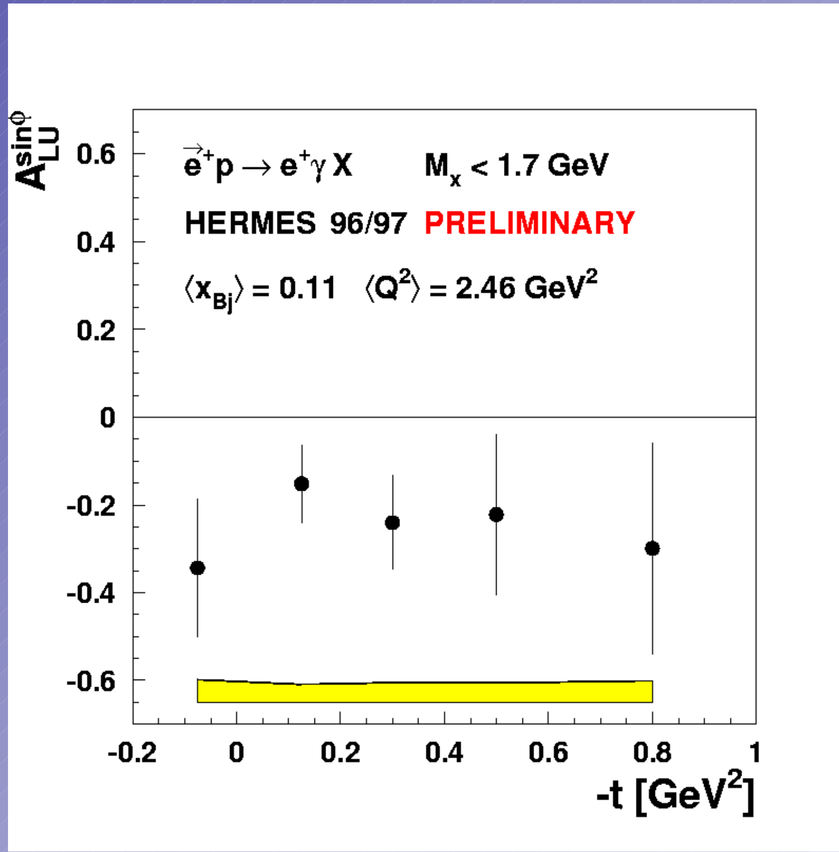
- proportional to sin ϕ
- direct access to imaginary part of DVCS amplitude
- directly proportional to a linear combination of GPDs
- amplitude independent of beam charge

BCA + BSA:
real and imaginary part of DVCS amplitude thanks to interference with BH

$$d\,\Delta\sigma_{LU} \equiv d\,\sigma_{\leftarrow}(ep) - d\,\sigma_{\rightarrow}(eq) \sim \sin(\phi) \times \Im m(A)$$

DVCS:BSA kinematical dependence





- combined statistics of 1997/2000 Hydrogen running
- no significant t, x or Q^2 dependence observed
- t dependence limited by resolution
  -> detector upgrade with improved resolution

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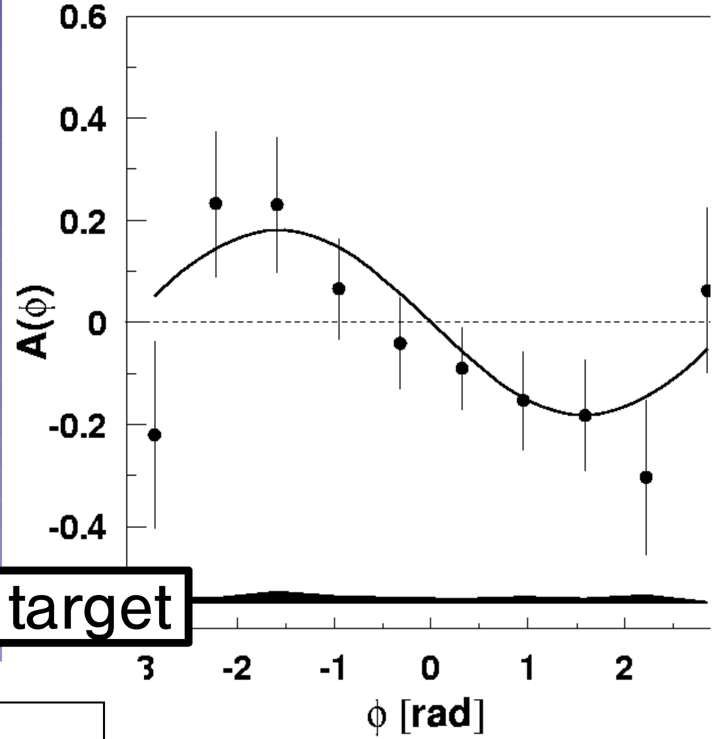
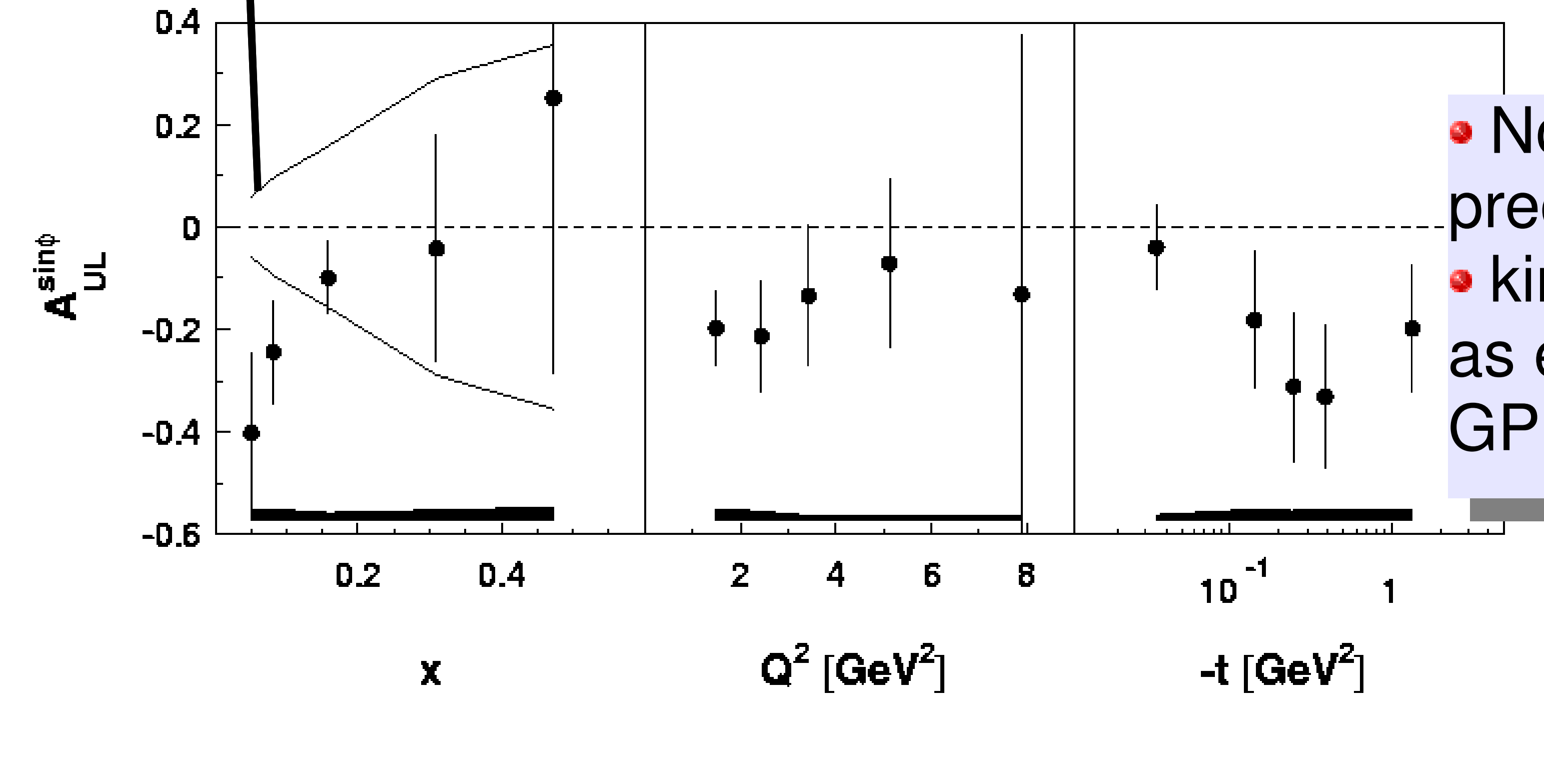
Target SSA in $ep \rightarrow n\pi^+e'$

- unpol. beam on long. pol. proton target
- exclusivity ensured by substraction method on p target
- precacious scaling expected



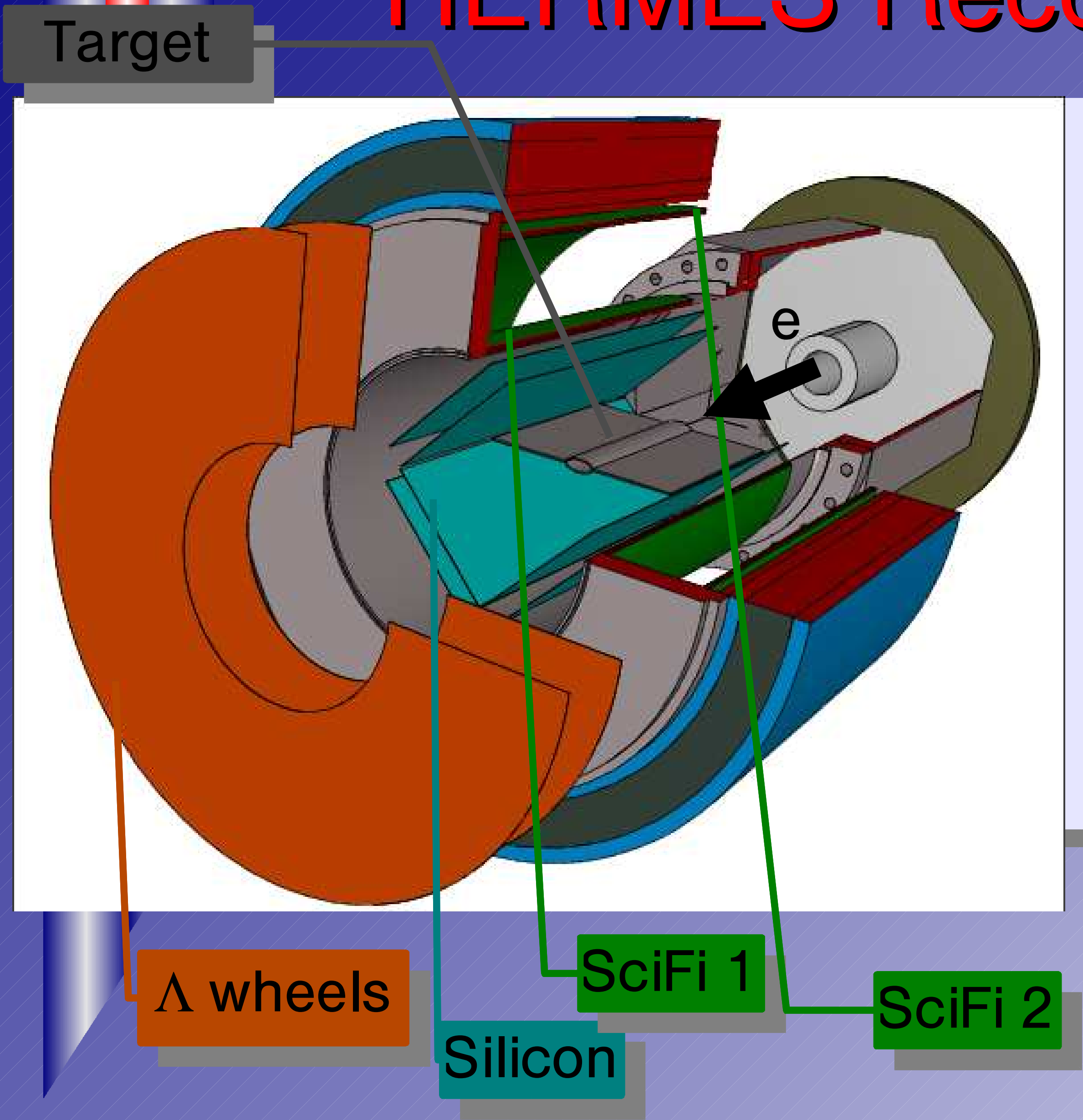
Theoretical boundary for fully transverse target



- No theoretical predictions available
- kinematic behaviour as expected from GPD framework

publ. in
Phys. Lett. B 535 (2002)
pp. 85 - 92

HERMES Recoil Project



- detect recoil p and $\pi^{\pm}$
- 2 layers of silicon
- 2 scintillating fiber barrels
- γ–detector for π^0
- 2 years Hydrogen running
- focus on exclusive reactions
- tagged structure functions
- Hyperon physics possible

HERMES will make
very interesting
pioneering experiments
to study GPDs
(DESY-PRC, May 2002)

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HERMES road to GPDs

HERMES Run 1: 5 years successful data taking

- both beam charges (e+ and e-) @ 27.5 GeV and @ 12.1 GeV
- targets: pol. H,D,^{3}He; unpol. H_2,D_2,^{4}He,^{14}N,^{20}Ne,^{84}Kr

exclusive reactions:

- BSA and BCA for DVCS from the proton (and deuteron)
- Target SSA for excl. π^+ on long. pol. proton, no theoretical prediction available
- σ_L for excl. ρ production
- all data in agreement with expectations in the GPD framework

Transverse target (till 2004)

- important data for exclusive reactions expected in all accessible exclusive channels
- high density end of fill running with different gases will continue for studying nuclear effects and beam spin asymmetries in hard exclusive reactions.

Recoildetector (2004 +)

- focus on excl. reactions
- improved resolution
- improved exclusivity for γ,ρ^0,π^0,..
- both beam charges
- high density targets
- tagged structure functions