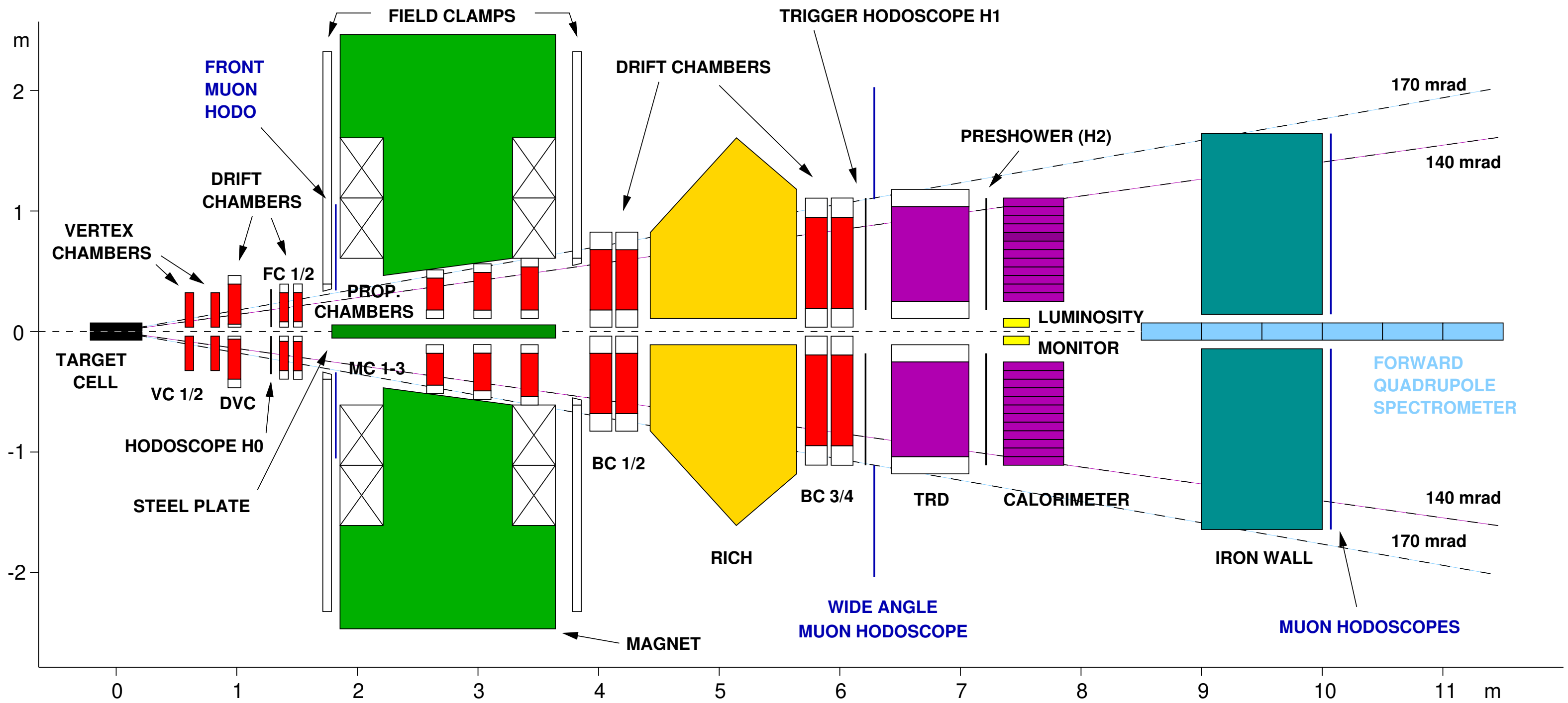
DVCS off the proton, deuteron and Neon measured at HERMES

Björn Seitz

bjoern.seitz@exp2.physik.uni-giessen.de

II. Physikalisches Institut, Universität Gießen

The HERMES Experiment



Long. pol. $e^{\pm}$ beam
$\langle P_B \rangle \approx 0.55$
Long. pol. p, d targets
$\langle P_T \rangle \approx 0.85$
Unpol. $p, d, {}^{20}Ne$

$Q^2 > 0.8$ GeV^2, $0.02 < x < 0.7$
Resolution $\Delta P/P < 1.6$ %
excellent PID ($\epsilon_e > 0.97$ with hadron contamination < 1%)

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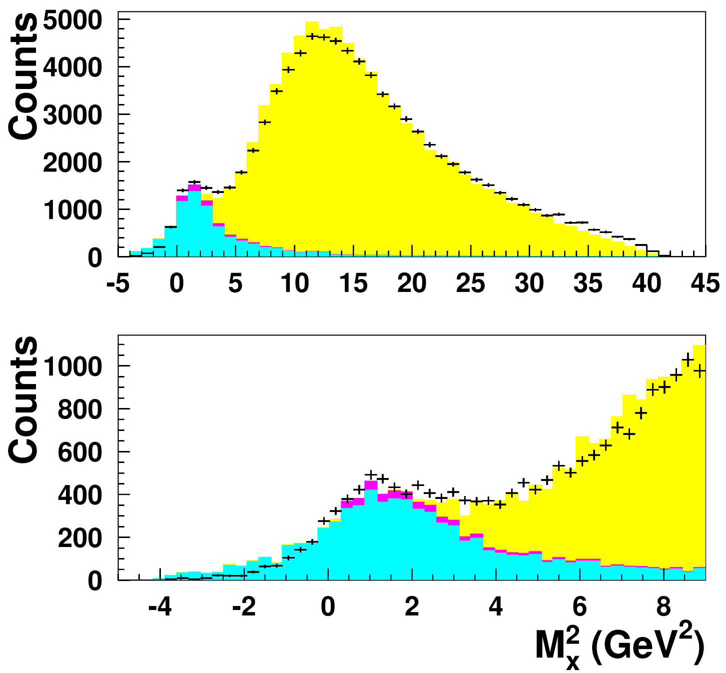
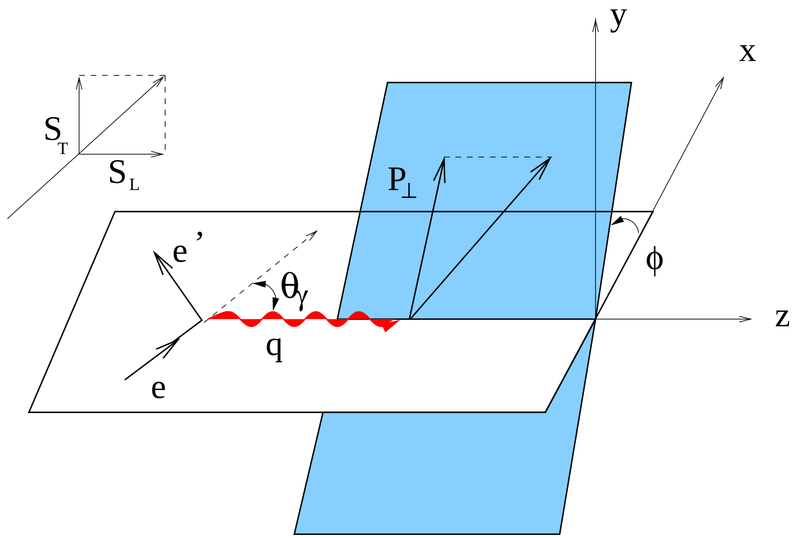
Event Selection

Measure $ep \quad \Rightarrow \quad e'\gamma X$



Identify reaction by M_X^2



Measure asymmetries wrt. angle ϕ between leptonic plane and photon plane

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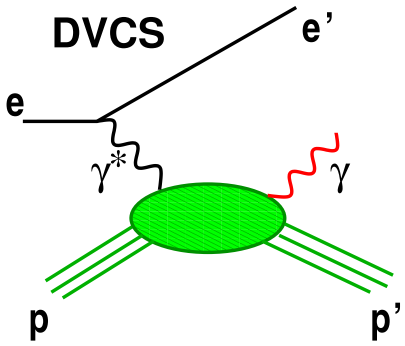
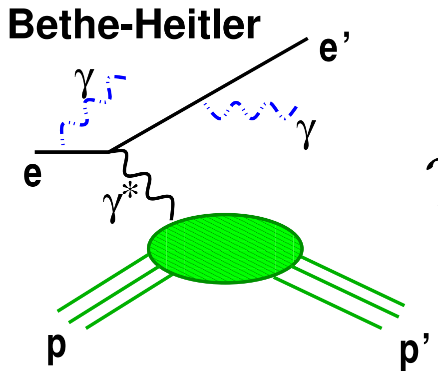
The Power of Asymmetries





$$\mathcal{T}^2 = |\tau_{BH}|^2 + |\tau_{DVCS}|^2 + \tau_{DVCS}\tau_{BH}^* + \tau_{DVCS}^*\tau_{BH}$$

- measure interference of different wave functions p, p'
- same final state: quantummechanical interference
- large BH serves as lever arm for DVCS
- interference on amplitude level -> direct access to amplitudes
- BH suppressed in asymmetry measurements

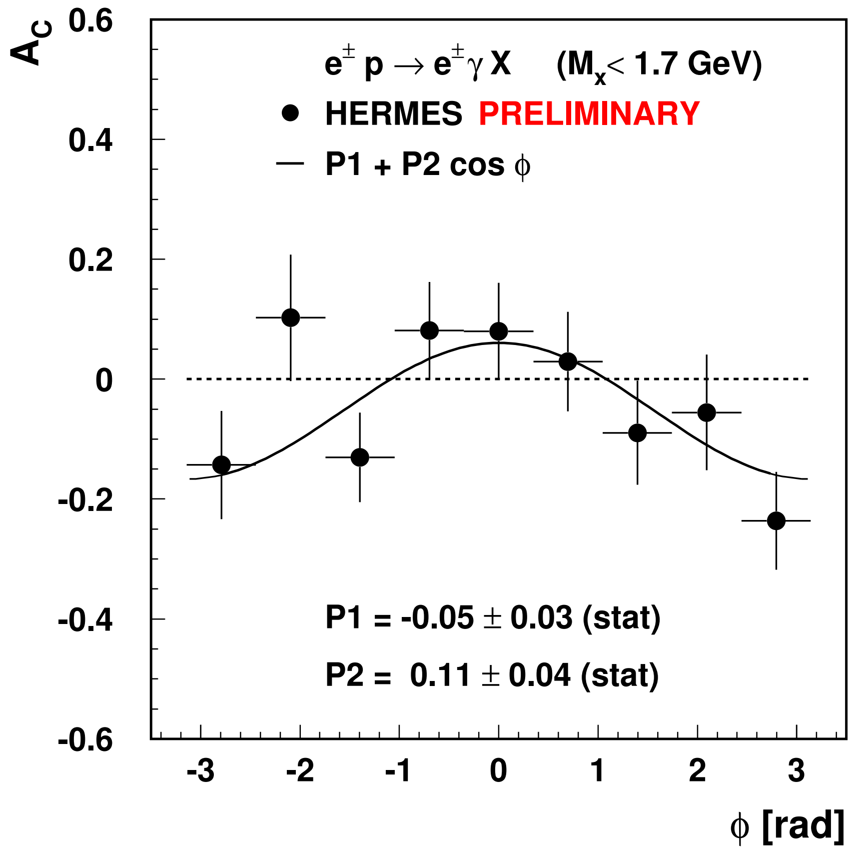
Getting real: Beam Charge Asymmetry

Unpol. beam and Unpol. target
using e^+ and e^- beam

$$A_C(\phi) = \frac{N^{e^+}(\phi) - N^{e^-}(\phi)}{N^{e^+}(\phi) + N^{e^-}(\phi)}$$

$$A_C(\phi) \propto \cos\phi * \Re(\mathcal{A})$$

Sensitive to Polyakov–Weiss D–Term



Unique @ HERMES
Limited by e^- statistics

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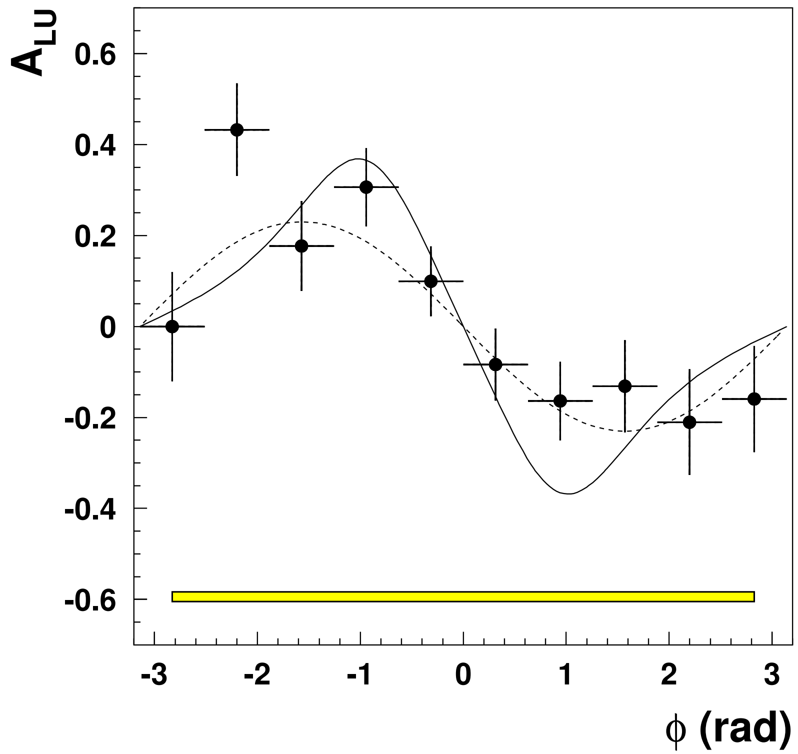
Only imaginary: Beam Spin Asymmetry

Long. pol. beam,
Unpol. target
Sign dependend on beam charge

$$A_{LU}(\phi) = \frac{N^+(\phi) - N^-(\phi)}{N^+(\phi) + N^-(\phi)}$$

$$A_{LU}(\phi) \propto \sin\phi * \Im(\mathcal{A})$$



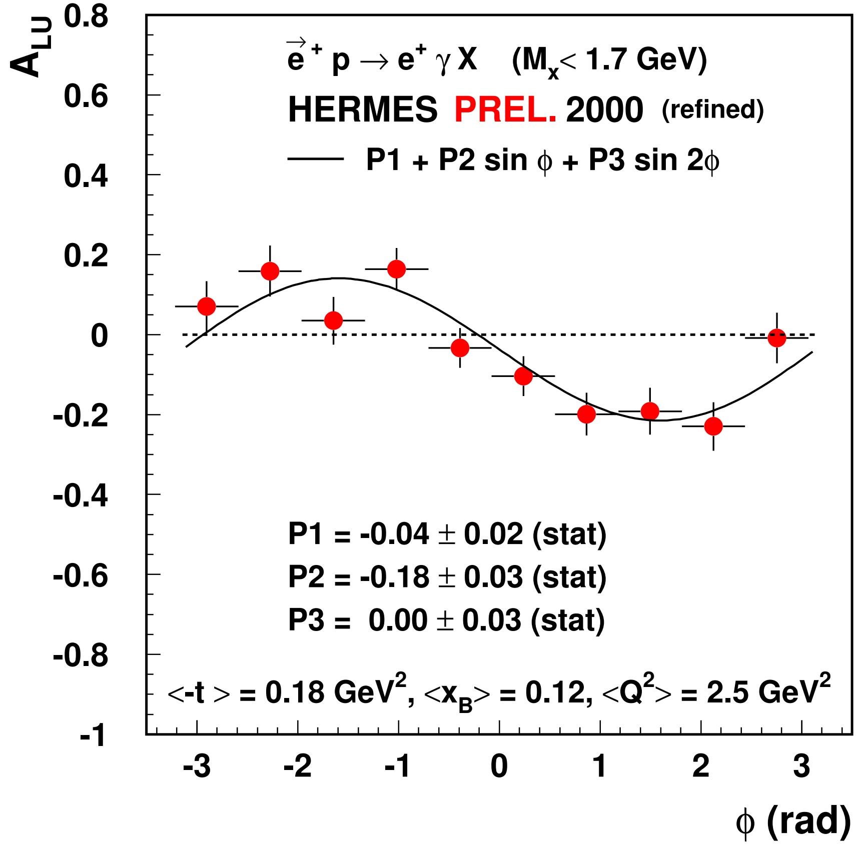
BCA and BSA together: access to full amplitude

Theoretical prediction:
— N. Kivel et al.
Phys. Rev. **D 63** (2001) 114 014

Starting Simple: bare proton BSA

HERMES update
improved statistics from 2000 run
refined CALO treatement

$$\langle x \rangle = 0.12$$
$$\langle -t \rangle = 0.18 \text{ GeV}^2$$
$$\langle Q^2 \rangle = 2.5 \text{ GeV}^2$$
$$A^p_{LU} = -0.18 \pm 0.03$$



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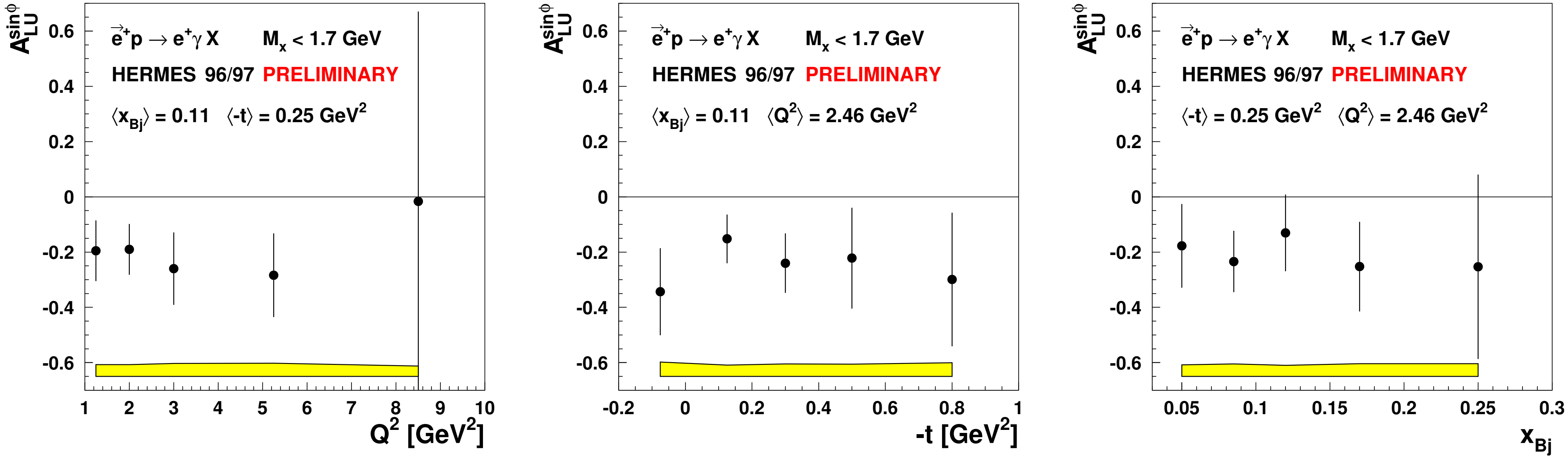
Kinematical dependence: Proton BSA



- combined statistics of 1997/2000 Hydrogen running
- no significant t, x or Q^2 dependence observed
- t dependence limited by resolution $\Rightarrow$ detector upgrade to improve t–resolution

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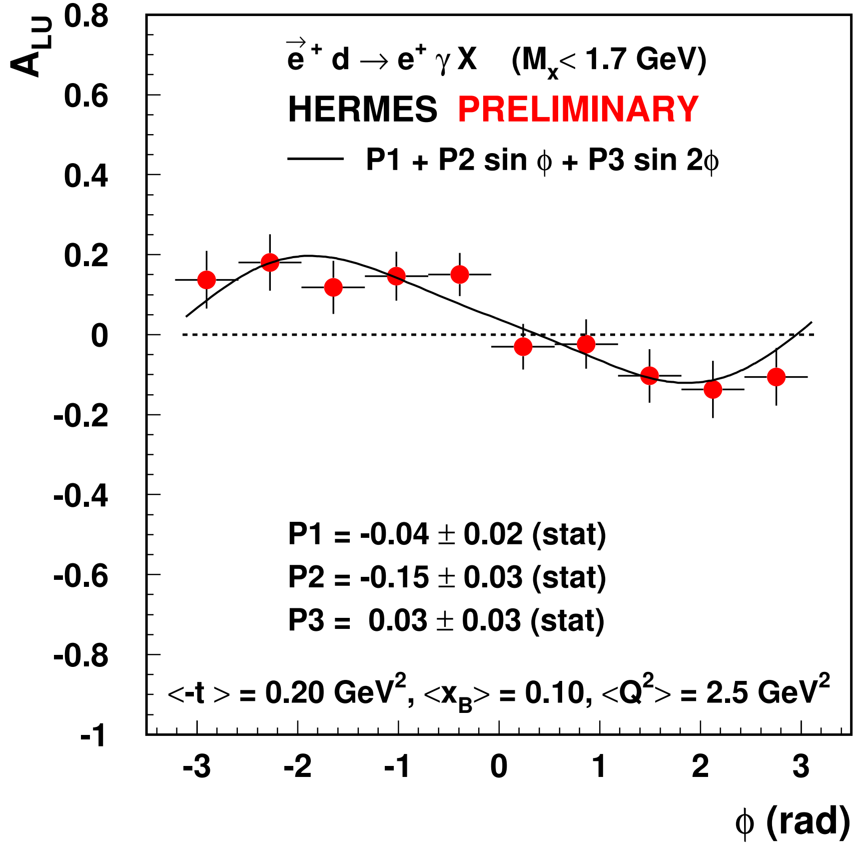
Adding the neutron: Deuteron BSA

First data from a deuteron target
same analysis algorithm as for p



$$\langle x \rangle = 0.10$$
$$\langle -t \rangle = 0.20\ \text{GeV}^2$$
$$\langle Q^2 \rangle = 2.5\ \text{GeV}^2$$
$$A^d_{LU} = -0.15 \pm 0.03$$
$$\frac{A^d_{LU}}{A^p_{LU}} = 0.74 \pm 0.24$$

A. Kirchner, D. Müller, hep-ph/0202279: ratio ≈ 0.81

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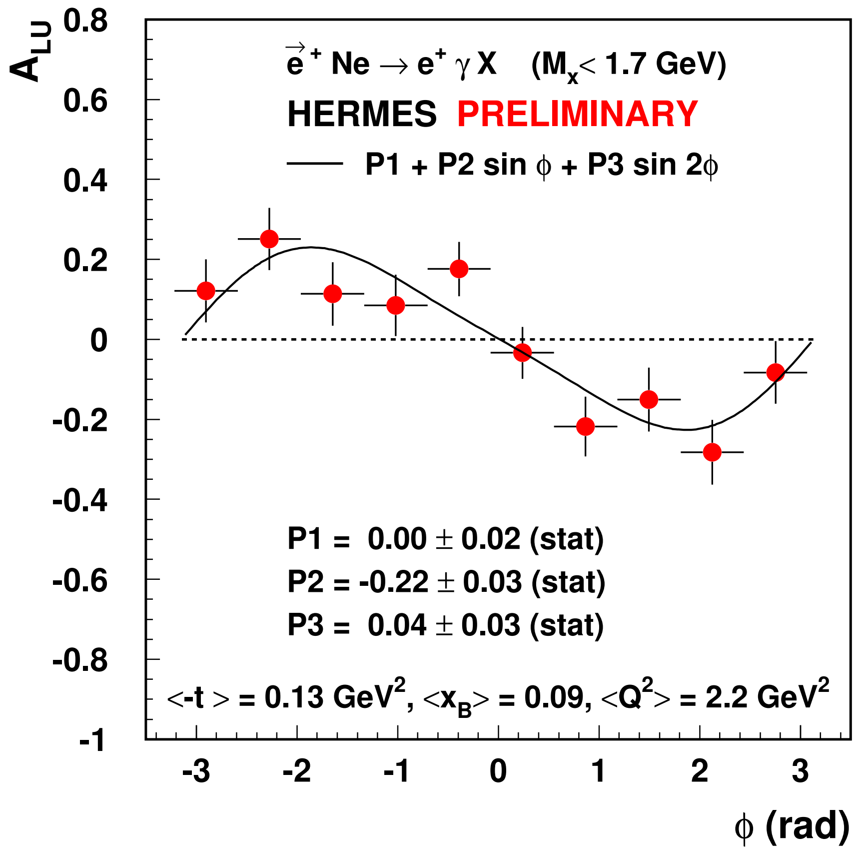
Getting heavy: Neon BSA

Using long. pol. e^+ beam and unpol. high density pure ^{20}Ne target

$$\langle x \rangle = 0.09$$
$$\langle -t \rangle = 0.13 \text{ GeV}^2$$
$$\langle Q^2 \rangle = 2.2 \text{ GeV}^2$$
$$A_{LU} = -0.22 \pm 0.03$$



Sizeable BSA observed on ^{20}Ne

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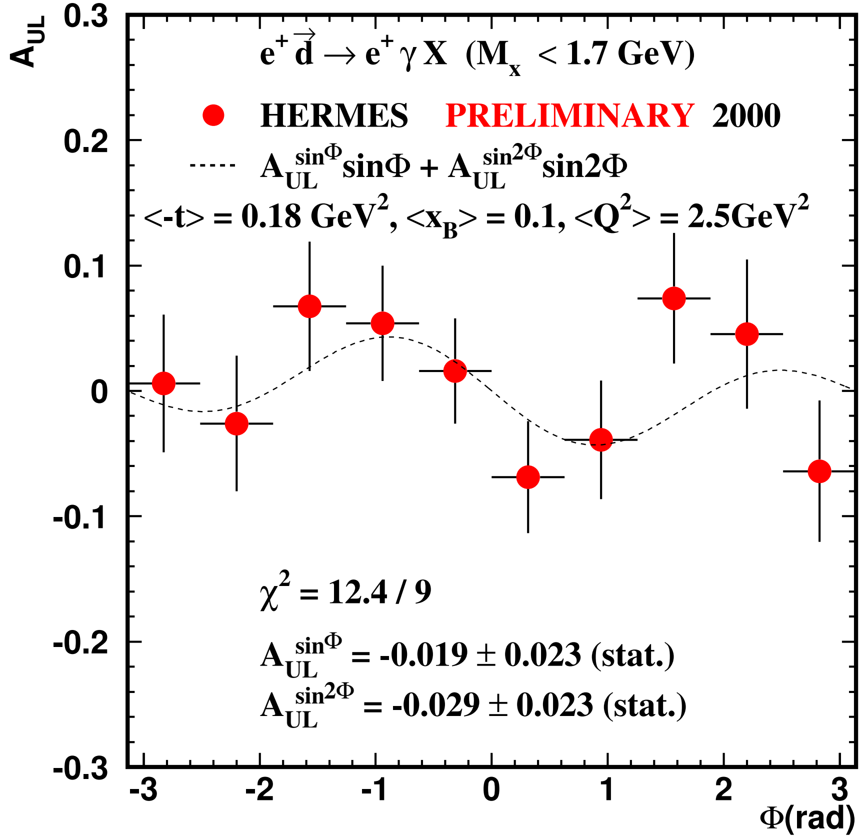
Something new: Target Spin Asymmetry

Unpol. beam from
helicity balanced runs

$$A_{UL}(\phi) = \frac{1}{P_T}\frac{\sigma^{U+} - \sigma^{U-}}{\sigma^{U+} + \sigma^{U-}}$$

$$\langle x \rangle = 0.1$$
$$\langle -t \rangle = 0.18 \text{ GeV}^2$$
$$\langle Q^2 \rangle = 2.5 \text{ GeV}^2$$



Reasonable fit assuming $\sin 2\phi$ dependence

Summary and Outlook

- Exclusive DVCS events identified at HERMES, Δ contribution small and included in syst. uncertainty
- HERMES measures BeamCharge, BeamSpin and TargetSpin Asymmetries
- BCA and BSA measured for the proton, also BSA kinematical dependencies
- BSA and TSA measured for the deuteron
- DVCS on heavy nuclei: BSA on Neon

Future HERMES DVCS measurements:

$\Rightarrow$ talk by B. Krauss on Wednesday

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