

HERMES による Deeply Virtual Compton Scattering ビームスピン非対称度の測定

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内容

- 1 Deeply Virtual Compton Scattering と GPD
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- 3 DVCS ビームスピン非対称度測定
- 4 反跳粒子検出器
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核子スピンの謎

(Semi-)Inclusive Pol. DIS

HERMES, SMC, COMPASS, SLAC

High Pt, Open Charm, PGF, ...

HERMES, RHIC/Spin, COMPASS

Parton Distribution Function: PDF

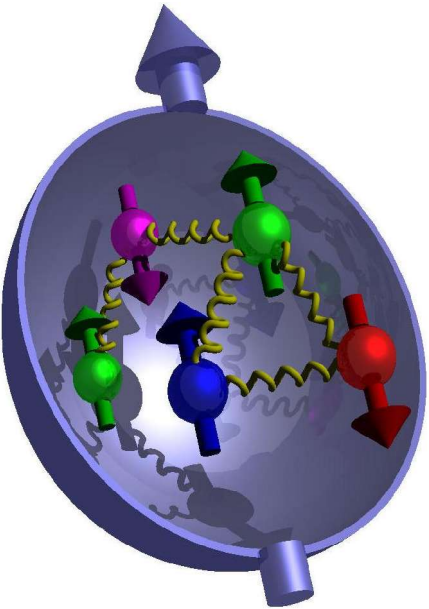
$$\frac{1}{2} = \frac{1}{2} \cdot \Delta \Sigma + L_q + \Delta G + L_g$$

Sivers distribution function

Deeply Virtual Compton Scattering

Generalized Parton Distribution Function (GPD)

HERMES, CLAS, COMPASS

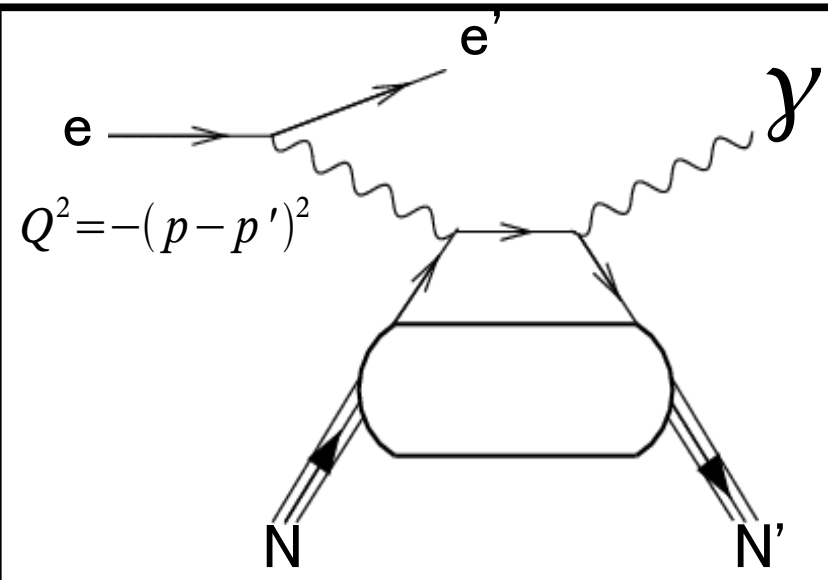


Deeply Virtual Compton Scattering

- Hard Exclusive 過程と GPD -

$e + N \rightarrow e' + N'$
 弾性散乱 \longleftrightarrow 核子形状因子
 電荷分布 etc
 $F_1(t), F_2(t)$

$\gamma^* + N \rightarrow (h\dots) + X$
 深非弾性散乱 \longleftrightarrow 核子構造関数
 パarton分布関数
 $q(x), g(x), \Delta q(x), \delta q(x), \Delta g(x)$



$\gamma^* + N \rightarrow \gamma + N'$
Deeply Virtual Compton Scattering
 (Hard Exclusive Process)

\longleftrightarrow
 一般化されたパarton分布関数
 $H(x, \xi, t), E(x, \xi, t), \tilde{H}(x, \xi, t), \tilde{E}(x, \xi, t)$



一般化されたパートン分布関数



- Generalized Parton Distribution (GPD) -

Generalized Parton Distributions

Vector	$H(x, \xi, t)$
Tensor	$E(x, \xi, t)$
Axial vector	$\tilde{H}(x, \xi, t)$
Pseudo scalar	$\tilde{E}(x, \xi, t)$

for quarks and gluon

Forward Limit: $\xi \rightarrow 0, t \rightarrow 0$

$$H^q(x, 0, 0) = q(x)$$
$$\tilde{H}^q(x, 0, 0) = \Delta q(x)$$

Form Factors:

$$\int_{-1}^{+1} dx H^q(x, \xi, t) = F_1^q(t) \quad \text{Dirac}$$

$$\int_{-1}^{+1} dx E^q(x, \xi, t) = F_2^q(t) \quad \text{Pauli}$$

$$\int_{-1}^{+1} dx \tilde{H}^q(x, \xi, t) = g_A^q(t) \quad \text{Axial vector}$$

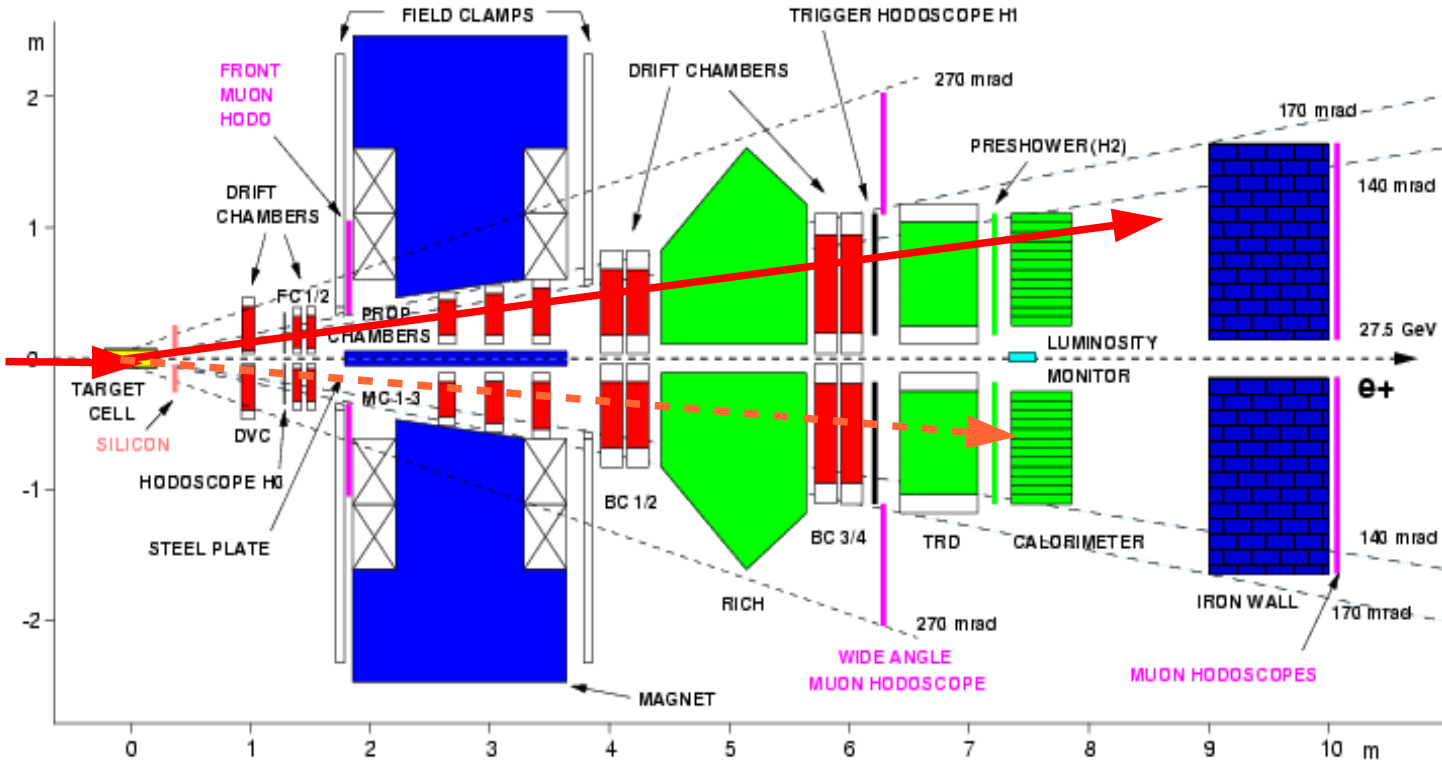
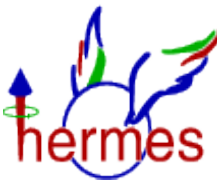
$$\int_{-1}^{+1} dx \tilde{E}^q(x, \xi, t) = h_A^q(t) \quad \text{Pseudoscalar}$$

GPD とパートン全角運動量

$$J_{q,g} = \frac{1}{2} \int_{-1}^1 dx x [H^{q,g}(x, \xi, t \rightarrow 0) + E^{q,g}(x, \xi, t \rightarrow 0)]$$



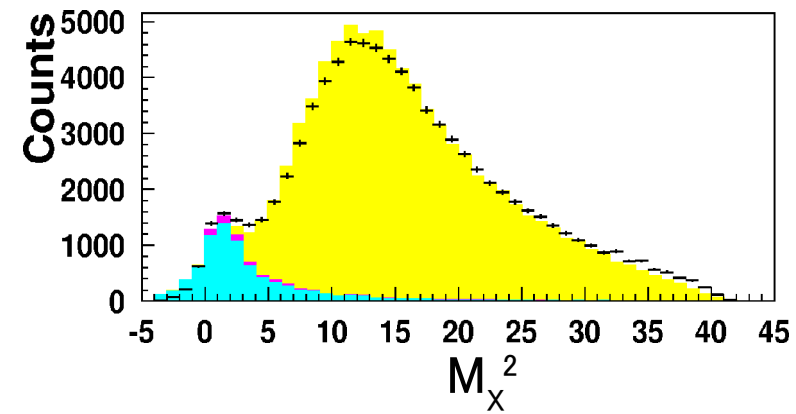
HERMES 実験について



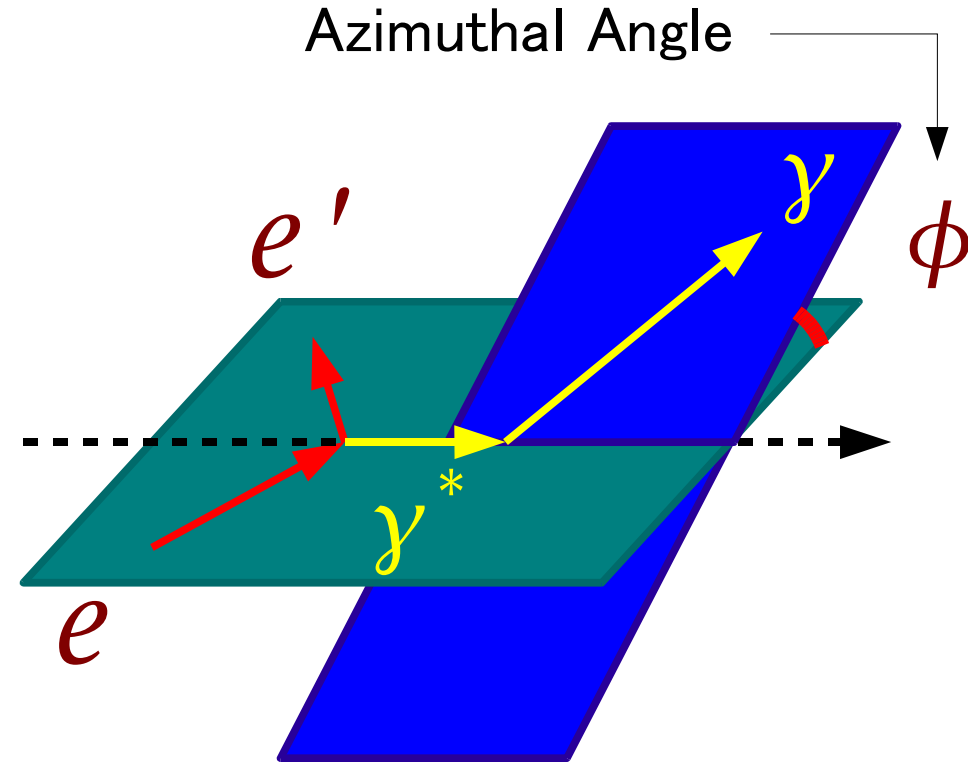
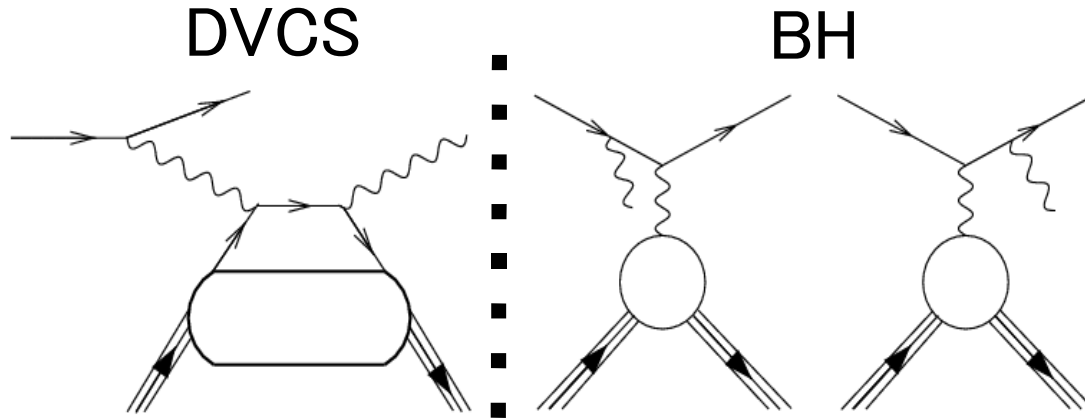
(陽)電子ビーム
27.6 GeV
偏極 / 非偏極
核子標的
(重)水素ガス
偏極 / 非偏極

$$e + N \rightarrow e' + \gamma + X \quad M_X \approx M_N$$

Exclusive γ の同定



DVCS 方位角非对称度



Azimuthal Asymmetry :

Beam Spin Asymmetry:

$$d\sigma^{\rightarrow} - d\sigma^{\leftarrow} \propto \Im \left[\tau_{\text{BH}}^* \tau_{\text{DVCS}} + \tau_{\text{DVCS}}^* \tau_{\text{BH}} \right] \propto \sin(\phi)$$

Beam Charge Asymmetry:

$$d\sigma^{+} - d\sigma^{-} \propto \Re \left[\tau_{\text{BH}}^* \tau_{\text{DVCS}} + \tau_{\text{DVCS}}^* \tau_{\text{BH}} \right] \propto \cos(\phi)$$

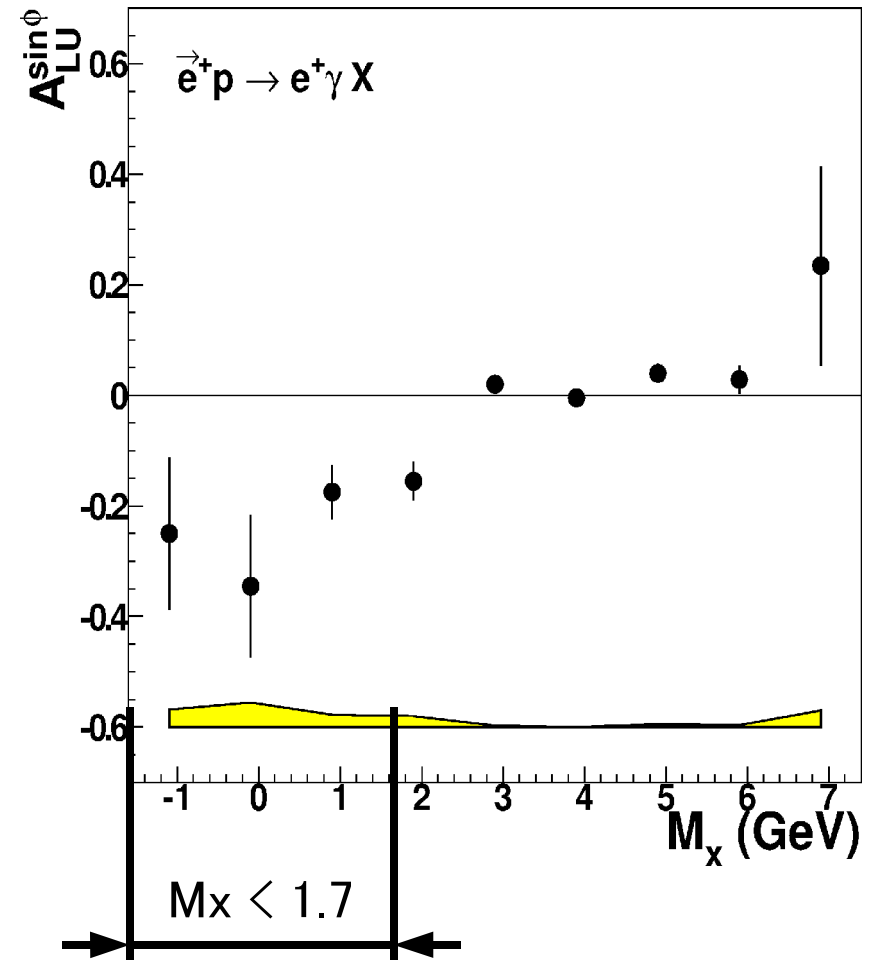
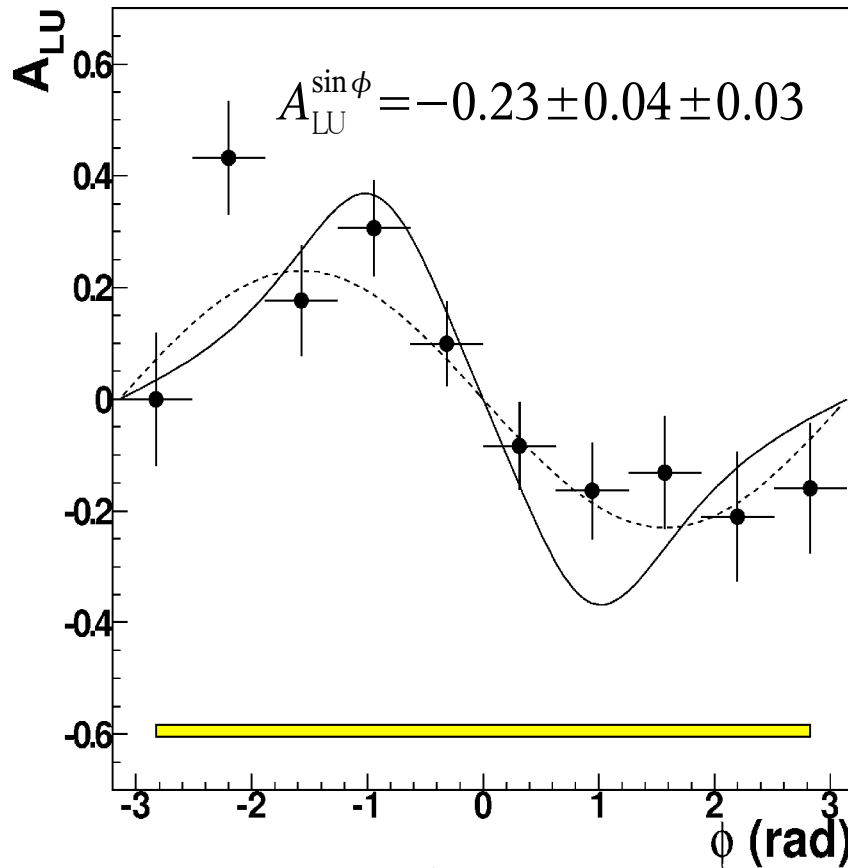
$$\Delta(d\sigma) \sim \underbrace{(\text{From Factor})}_{\text{BH}} \times \underbrace{(\text{GPD})}_{\text{DVCS}}$$



DVCS ビームスピンの非対称度測定

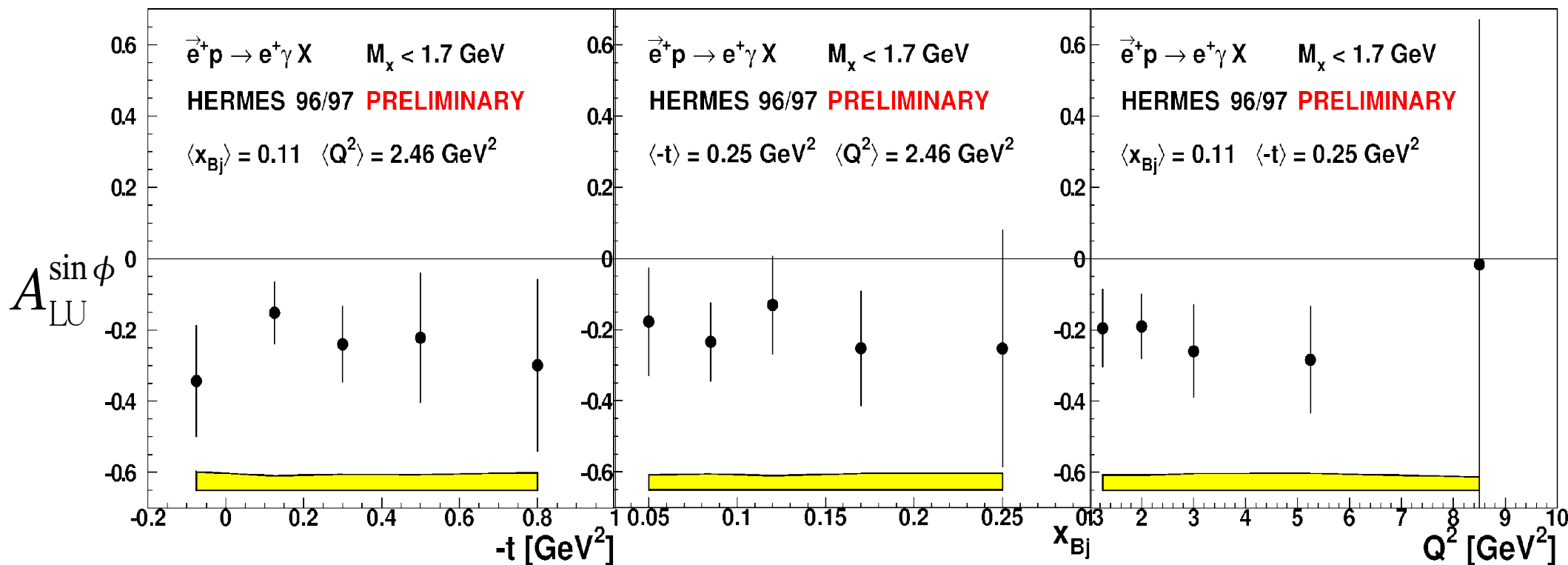
(1996, 1997, HERMES Collaboration, Phys. Rev. Lett. 87 (2001) 182001.)

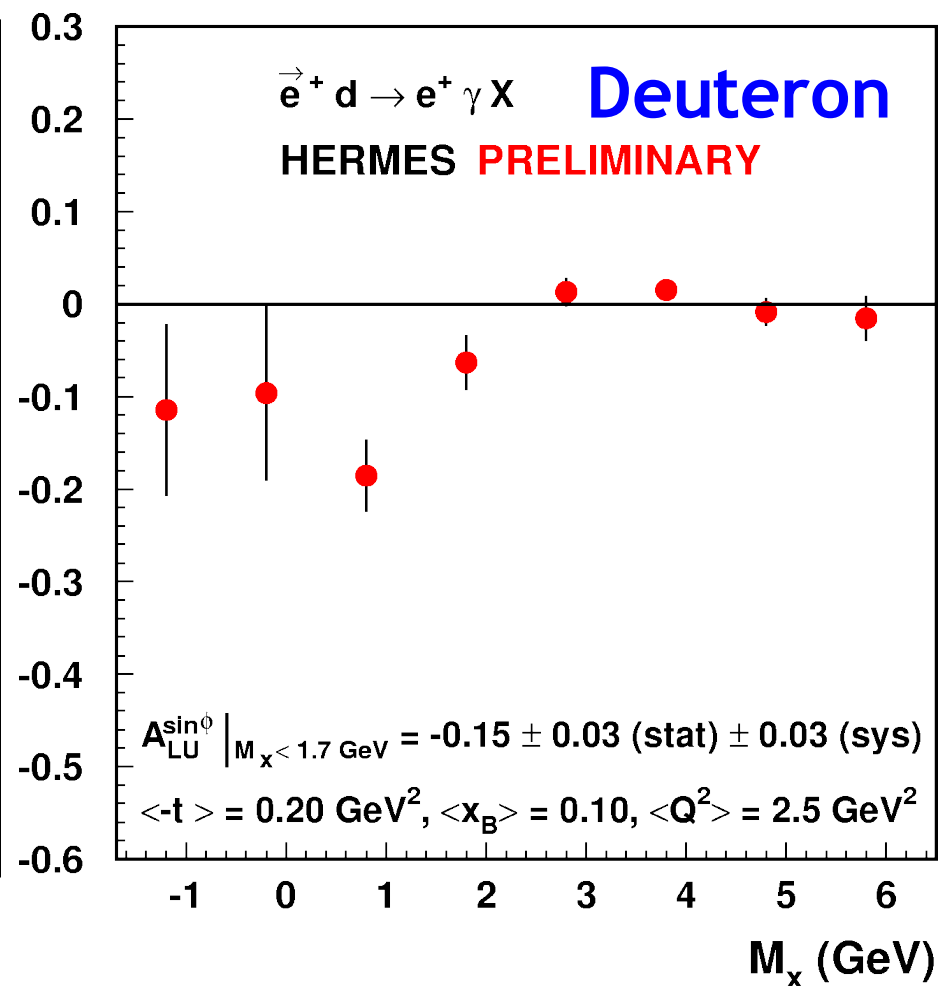
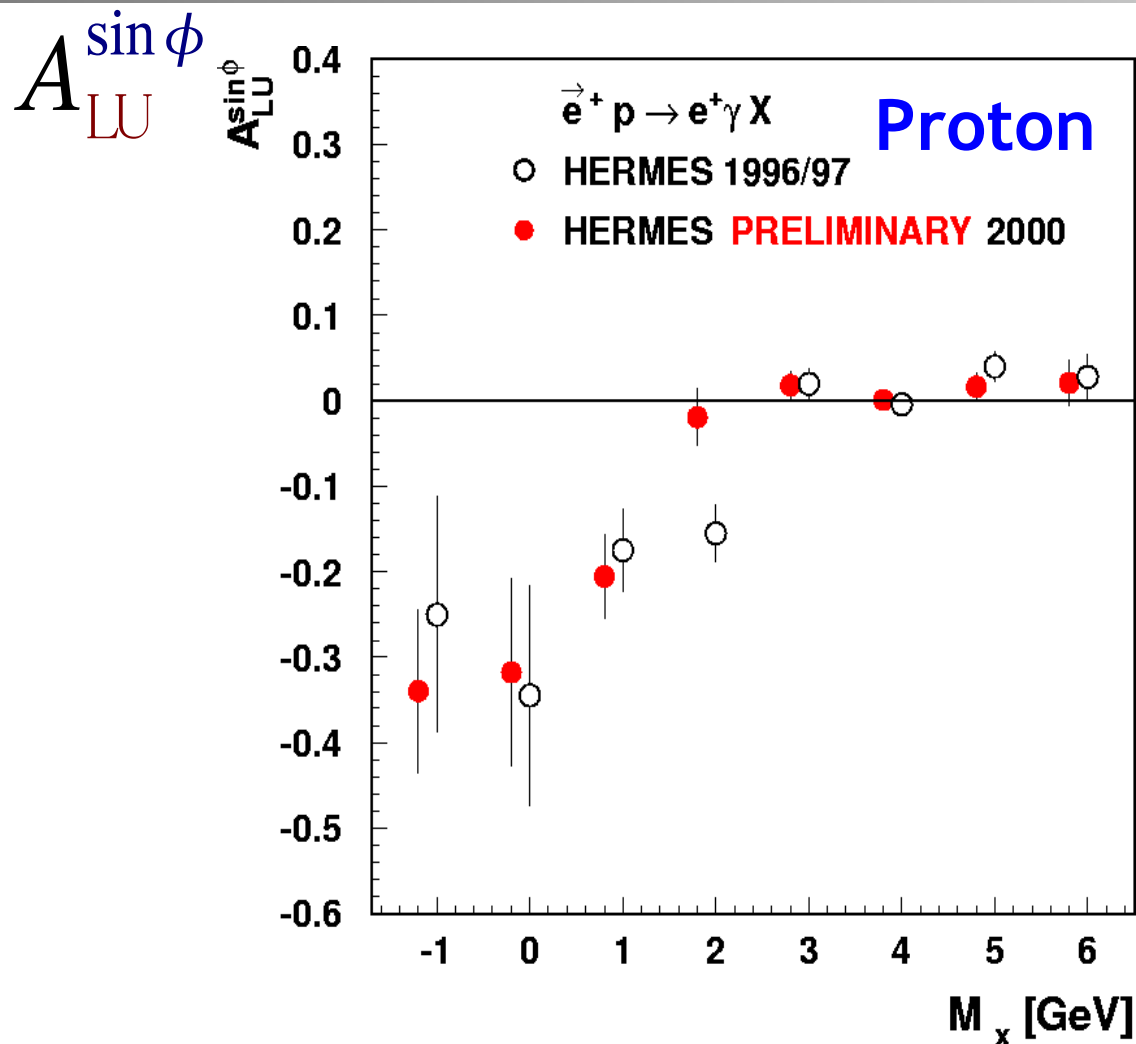
$$A_{LU}(\phi) = \frac{1}{P_B} \frac{N^{\rightarrow}(\phi) - N^{\leftarrow}(\phi)}{N^{\rightarrow}(\phi) + N^{\leftarrow}(\phi)}$$



Exclusive Regime







Preliminary:

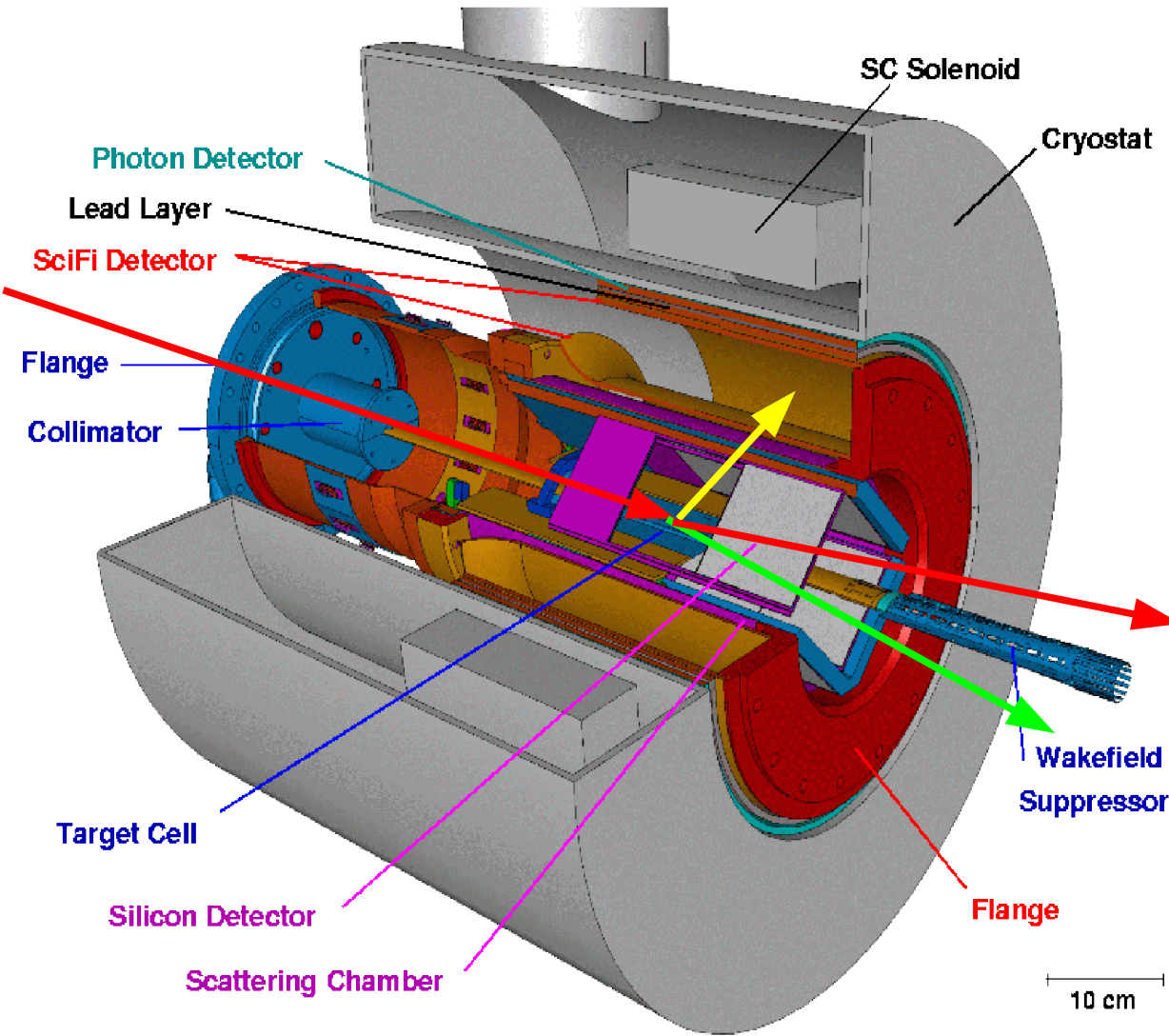
$$A_{LU}^{\sin\phi} = -0.18 \pm 0.03 \pm 0.03$$

$$A_{LU}^{\sin\phi} = -0.15 \pm 0.03 \pm 0.03$$

$$A_{LU}^{\sin\phi} = -0.23 \pm 0.04 \pm 0.03$$



反跳粒子検出器による DVCS 測定実験



反跳核子検出

Exclusive 生成の
イベントレベルでの同定

DVCS 測定実験

2004 年—2006 年



GPD の精密測定



- Deeply Virtual Compton Scattering:
 - Generalized Parton Distribution Function 測定
- HERMES による DVCS 非対称度測定:
 - 光子生成方位角依存性 \Rightarrow DVCS-BH 干渉項測定
 - DVCS ビームスピン非対称度 (Preliminary)
 - Proton: $A_{LU}^{\sin\phi} = -0.18 \pm 0.03 \pm 0.03$
 - Deuteron: $A_{LU}^{\sin\phi} = -0.15 \pm 0.03 \pm 0.03$
 - 運動学的変数への依存性
- 反跳粒子検出器による DVCS 測定
 - 2004 年 \sim 2006 年に測定実験



DVCS on Nuclei

