Beam spin asymmetry in interference fragmentation

Tomohiro Kobayashi
Tokyo Institute of Technology
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(Slides include suggestions in the meeting.)

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Single-spin asymmetries in interference fragmentation

2 hadron semi-inclusive DIS

$$d\sigma_{UU} \propto \sum_q e_q^2 \left\{ A(y) f_1 D_1 - V(y) \cos\phi_R \sin\theta \frac{|R|}{Q} \left[\frac{f_1}{z} \tilde{D}^{\sphericalangle} + \frac{M_x}{M_h} h H_1^{\sphericalangle} \right] \right\}$$

$$d\sigma_{UL} \propto \sum_q e_q^2 \sin\phi_R \left\{ |S_L| V(y) \sin\theta \frac{|R|}{Q} \left[\frac{M_x}{M_h} h_L H_1^{\sphericalangle} + \frac{1}{z} g_1 \tilde{G}^{\sphericalangle} \right] \right\}$$

$$d\sigma_{UT} \propto \sum_q e_q^2 |S_\perp| \left\{ B(y) \sin(\phi_R + \phi_S) \sin\theta \frac{|R|}{M_h} h_1 H_1^{\sphericalangle} + V(y) \sin\phi_S \frac{M_h}{Q} \left[h_1 \left(\frac{1}{z} \tilde{H} + \sin^2\theta \frac{|R|^2}{M_h^2} H_1^{\sphericalangle o(1)} \right) - \frac{M}{M_h} x f_T D_1 \right] \right\}$$

$$d\sigma_{LU} \propto \sum_q e_q^2 \lambda_e W(y) \sin\phi_R \sin\theta \frac{|R|}{Q} \left[\frac{M_x}{M_h} e H_1^{\sphericalangle} + \frac{1}{z} f_1 \tilde{G}^{\sphericalangle} \right]$$

$$A(y) = 1 - y + \frac{y^2}{2}$$
$$B(y) = 1 - y$$
$$V(y) = 2(2-y)\sqrt{1-y}$$
$$W(y) = 2y\sqrt{1-y}$$

In Wandzura–Wilzcek approx., function with tilde vanish.

Beam spin asymmetry A_{LU}:

$$A_{LU} \propto \frac{W(y) \sin\phi_R \sin\theta \frac{|R|}{Q} \left[\frac{M_x}{M_h} e H_1^{\sphericalangle} + \frac{1}{z} f_1 \tilde{G}^{\sphericalangle} \right]}{A(y) f_1 D_1 - V(y) \cos\phi_R \sin\theta \frac{|R|}{Q} \left[\frac{f_1}{z} \tilde{D}^{\sphericalangle} + \frac{M_x}{M_h} h H_1^{\sphericalangle} \right]}$$

fit with $a_1 + \dfrac{a_2 \sin\phi_R \sin\theta}{1 - a_3 \cos\phi_R \sin\theta}$

Should chose linearized fit parameters.

$$p_1 + p_2 \sin\phi_R \sin\theta + p_3 \sin(2\phi_R) \sin^2(\theta)$$

$$a_1 + \frac{a_2 \sin\phi_R \sin\theta}{1 - a_3 \cos\phi_R \sin\theta} \approx a_1 + a_2 \sin\phi_R \sin\theta \times (1 - a_3 \cos\phi_R \sin\theta)$$

$$= a_1 + a_2 \sin\phi_R \sin\theta + \frac{a_2 a_3}{2} \sin(2\phi_R) \sin^2\theta$$

Event selection

$\vec{e}p \rightarrow e'\pi^+\pi^- X$ (at least two pions π^+, π^-)

data set : 00d0 production

target mode : unpol H, high density H

trigger : smTrack.bTrigMask & 0x100000 == 1

data quality : badbit & 0x527e73de == 0

geometric cuts :

- g1Track.rVertD < 18 cm
- | g1Track.rVertZ | < 0.75 cm
- | smTrack.rXpos + 463 smTrack.rXslope | < 175.0 cm
- 30cm < | smTrack.rYpos + 463 smTrack.rYslope | < 108 cm
- | smTrack.rxOff + 172.0 cos(g1Track.rPhi) tan(g1Track.rTheta) | < 31.0
- | smTrack.ryOff + 181.0 sin(g1Track.rPhi) tan(g1Track.rTheta) | > 7.0 cm
- | smTrack.ryOff + 383.0 sin(g1track.rPhi) tan(g1Track.rTheta) | < 54.0 cm
- | smTrack.rYpos + 108.0 smTrack.rYslope | <= 54.0 cm
- | smTrack.rXpos + 108.0 smTrack.rXslope | <= 100.0 cm

PID :

lepton : 1 < rPID3 + rPID5 < 100
charge == beam charge
DIS lepton = leading lepton

pion : −100 < rPID3 + rPID5 < 0
smRICH.rQp > 0
smRICH.iType == 3

kinematic cuts :

$Q^2 \geq 1$ GeV²

$W^2 \geq 4$ GeV²

$x \geq 0.023$

$0.1 < y < 0.85$

$p_{track} > 2.5$ GeV (for DIS lepton)

$p_{track} > 1$ GeV (for Hadron)

$\Delta E > 2$ GeV

$$\Delta E = \frac{M_x^2 - M_p^2}{2M_p}$$

Evaluate A_{LU}

After cuts

#DIS = 2390616, #pion pair = 32211 at $P_{beam} > 0$

#DIS = 4133751, #pion pair = 56110 at $P_{beam} < 0$

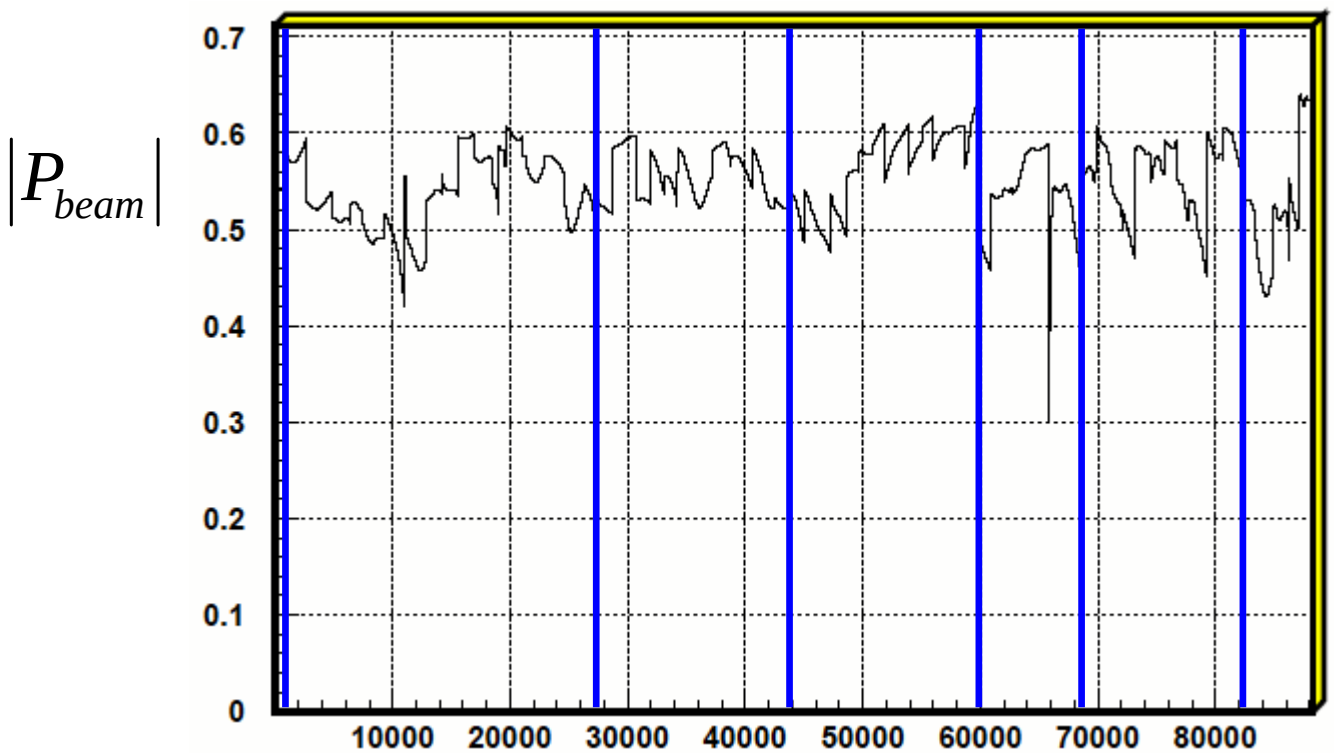
What is measured

$$A_{LU}(\phi_{R\perp},\theta) = \frac{1}{|P_{beam}|}\frac{\vec{N}(\phi_{R\perp},\theta)/\vec{N}_{\mathrm{DIS}} - \overleftarrow{N}(\phi_{R\perp},\theta)/\overleftarrow{N}_{\mathrm{DIS}}}{\vec{N}(\phi_{R\perp},\theta)/\vec{N}_{\mathrm{DIS}} + \overleftarrow{N}(\phi_{R\perp},\theta)/\overleftarrow{N}_{\mathrm{DIS}}}$$

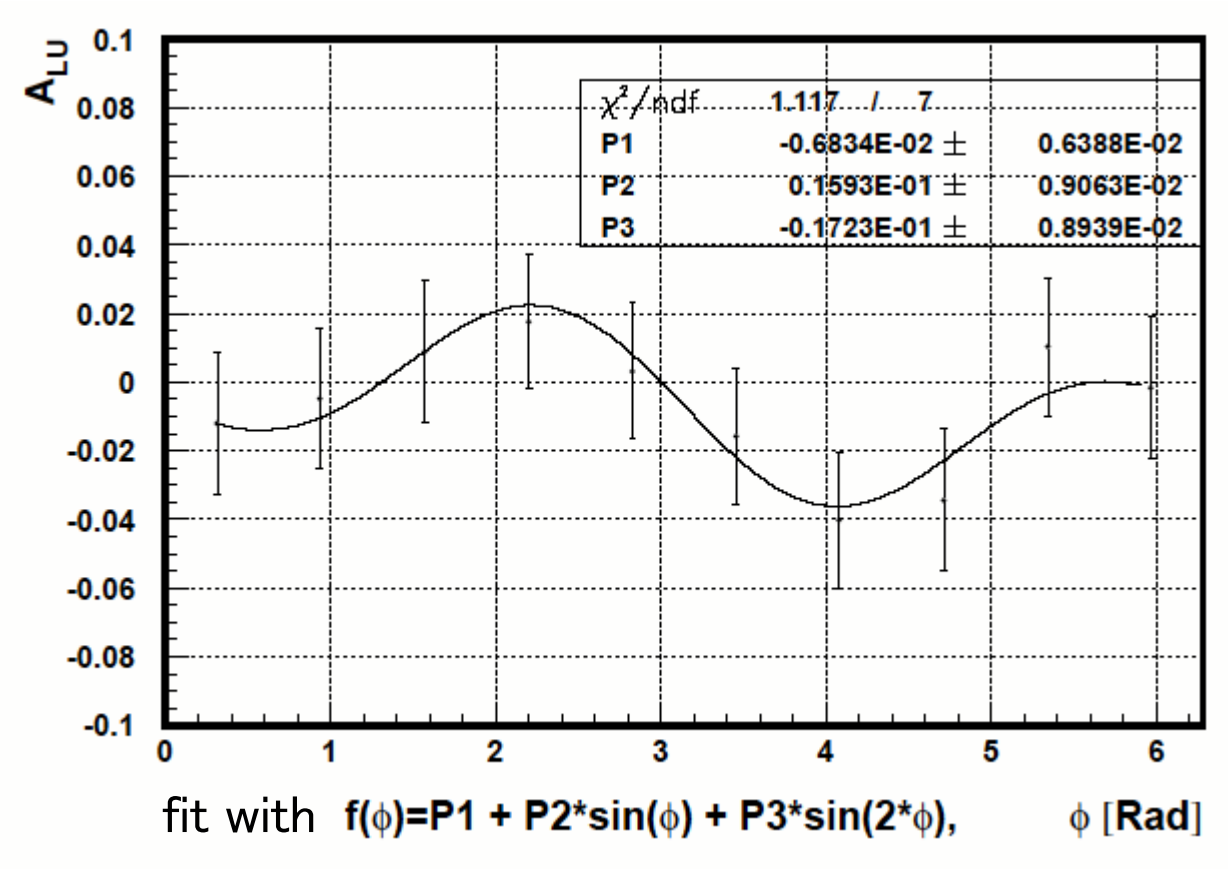
where $|P_{beam}|$ is the average beam polarization. ($|P_{beam}| = 54.8\%$)

Beam polarization (g1Beam.rPolFit)

beam helicity : −1 +1 −1 +1 −1 +1



A_{LU} vs. Phi



no θ binning

fluctuation (χ^2) is too small. strange.

- Can check by dividing data to some parts.
- Deuteron target case should be checked.
- Deed more statistics... Analyze 1996...2004 data

A_{LU} vs. Phi

Divide data set to two half :

odd number of events

even number of events

χ^2 are still too small.

Can clarify by checking chi distribution by dividing data set to a lot of parts.