Transversity signals in two hadron correlation at COMPASS

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on behalf of the

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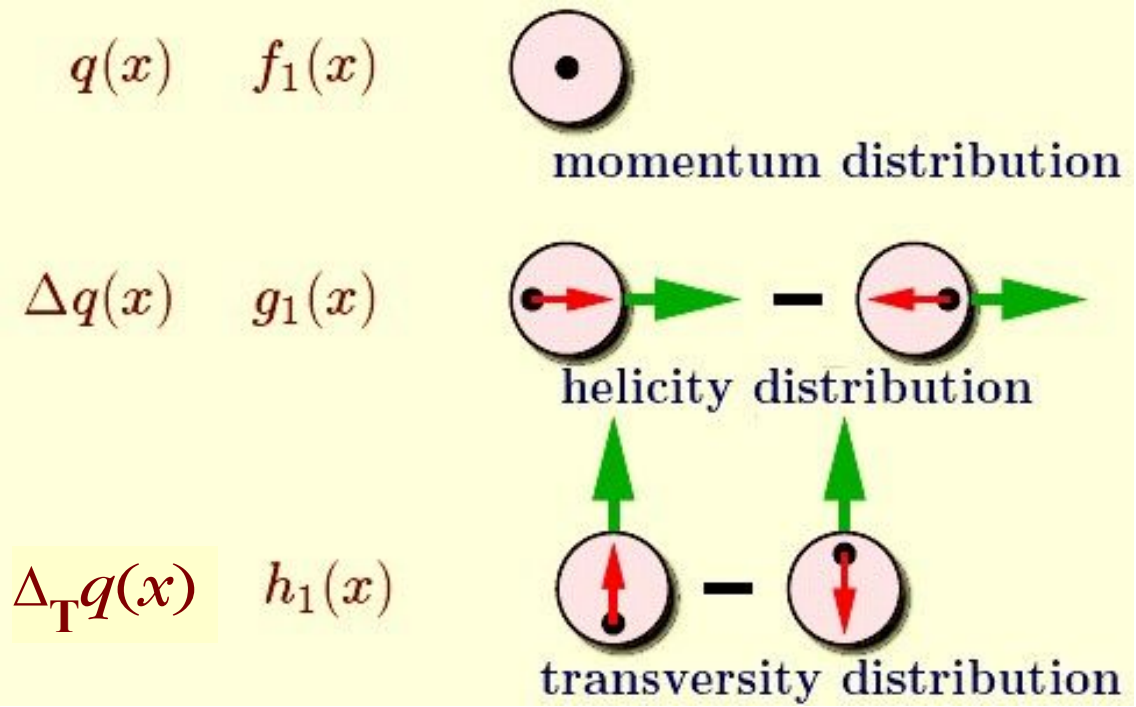
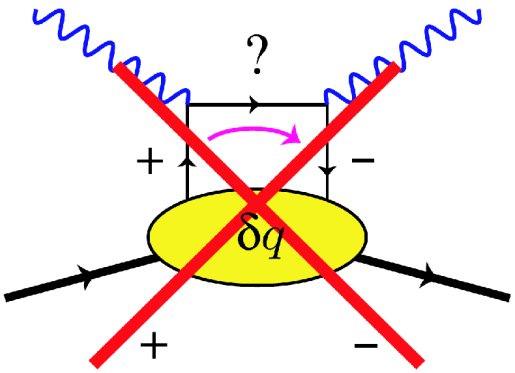
Transverse Spin Physics

3 distribution functions are necessary to describe the spin structure of the nucleon at LO:



All of equal importance !



$h_1(x)$ decouples from inclusive DIS because helicity of quark must flip

$\Rightarrow$ **SIDIS**

Transverse Spin Physics in SIDIS

Two processes:

Scattering of the lepton on a quark $\rightarrow$ distribution function

Hadronization of struck quark $\rightarrow$ fragmentation function

2 probes for transversity:

1-hadron SIDIS: $\Delta_T q_i(x) \Delta_T^0 D_i^h(z, p_T^{h\,2})$ Collins effect

2-hadron SIDIS: $\Delta_T q_i(x) H_i^{\sphericalangle h}(z, M_h^2)$ Interference FF

Fragmentation functions to be measured at e^+e^- facilities (e.g. BELLE)

today only models

Transverse Spin Physics at COMPASS

3 possible quark polarimeters suggested using SIDIS:

- Azimuthal distribution of single (leading) hadrons

  → Presented by P.Pagano

- Azimuthal dependence of the plane containing hadron pairs

  First results on the effect proposed by e.g.

  Collins et al., Nucl. Phys. B 420 (1994) 565.

  Jaffe et al., Rev. Lett. 80 (1998) 1166.

  (A. Bacchetta and M. Radici, hep-ph/0407345 and references therein)

- Measurement of transverse polarization of spin $\frac{1}{2}$ baryons

  (e.g. Λ hyperon)

The Coordinate System

Breit frame where:

- z is the virtual photon direction
- the x-z plane is the lepton scattering plane

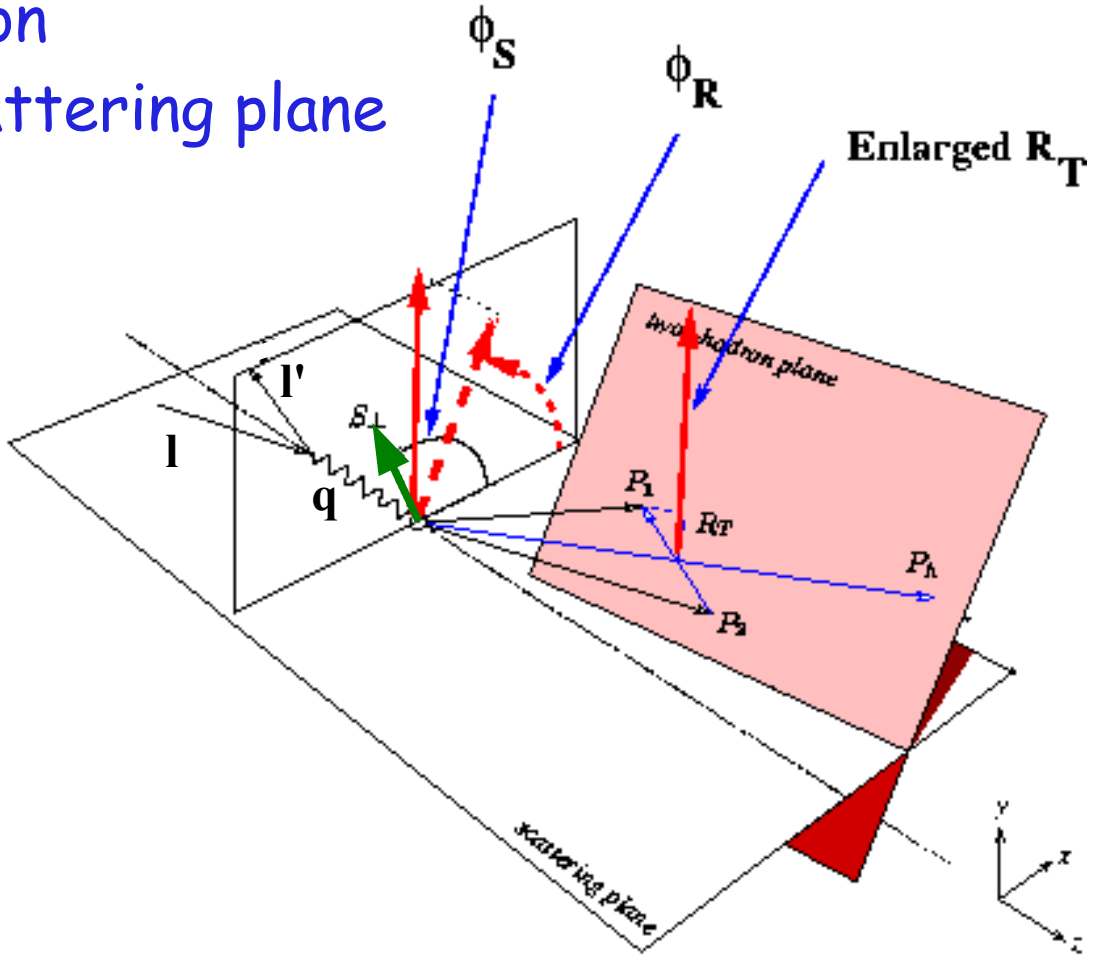
$\phi_{S'}$ = azimuthal angle of spin vector of ***fragmenting*** quark with $\phi_{S'} = \pi - \phi_S$ (spin flip)

ϕ_R = is defined by:

$$\cos \phi_R = \frac{(\mathbf{q} \times \mathbf{l})}{|\mathbf{q} \times \mathbf{l}|} \cdot \frac{(\mathbf{q} \times \mathbf{R_T})}{|\mathbf{q} \times \mathbf{R_T}|}$$

$$\sin \phi_R = \frac{(\mathbf{l} \times \mathbf{R_T}) \cdot \mathbf{q}}{|\mathbf{q} \times \mathbf{l}|\,|\mathbf{q} \times \mathbf{R_T}|}$$

$\phi_{RS} = \phi_R - \phi_{S'} = \phi_R + \phi_S - \pi$



A. Bacchetta and M. Radici, Proceedings of the DIS 2004, hep-ph/0407345

Predicted Asymmetry

The fragmentation of a quark q into a pair h of two hadrons h_1 and h_2 has a spin dependent part:

$$H_q^{\sphericalangle h}(z,M_h^2)\,\sin\phi_{RS}$$

Causing a count rate difference:

$$\frac{N^+(\phi_{RS}) - R\cdot N^-(\phi_{RS}+\pi)}{N^+(\phi_{RS}) + R\cdot N^-(\phi_{RS}+\pi)} = A_{UT}^{\sin\phi_{RS}}\cdot\sin\varphi_{RS}$$

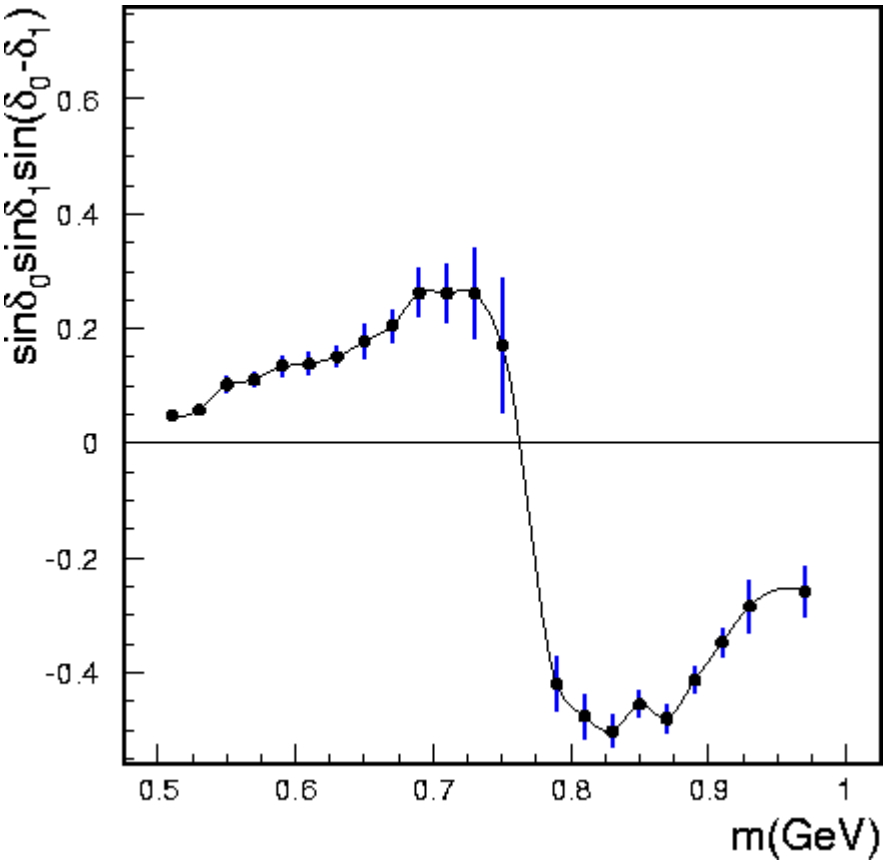
From this we get:

$$\frac{A_{UT}^{\sin\phi_{RS}}}{D_{NN}\cdot f\cdot P} = A_{RS} = \frac{\sum_i e_i^2\,\Delta_T q_i(x)\,H_i^{\sphericalangle h}(z,M_h^2)}{\sum_i e_i^2\,q_i(x)\,D_i^h(\vec{z},M_h^2)}$$

f dilution factor; P target polarization; $D_{NN} = (1-y)/(1-y+y^2/2)$ Depolarization factor

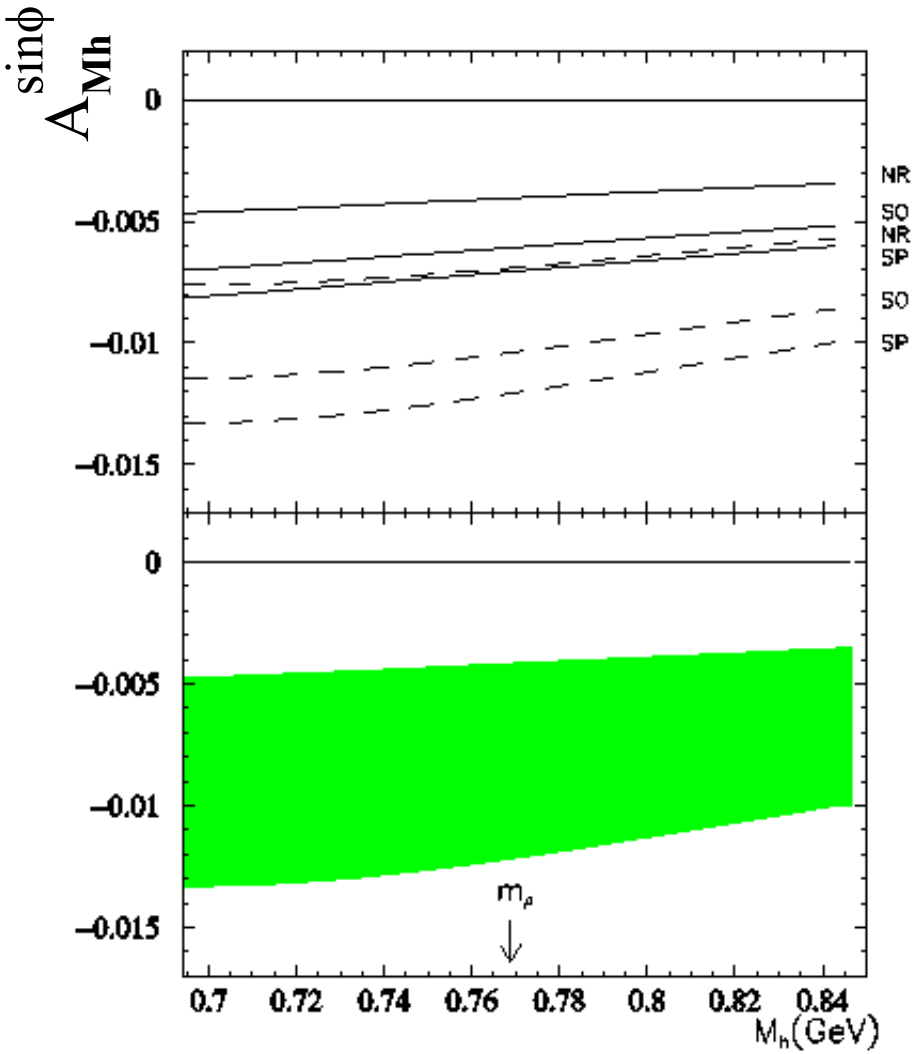
Interference Fragmentation Function $H_q^{\sphericalangle h}(z,M_h^2)$

One model !



R. L. Jaffe, X. Jin and J. Tang,
Phys. Rev. Lett. 80, 1166 (1998)

Another model !



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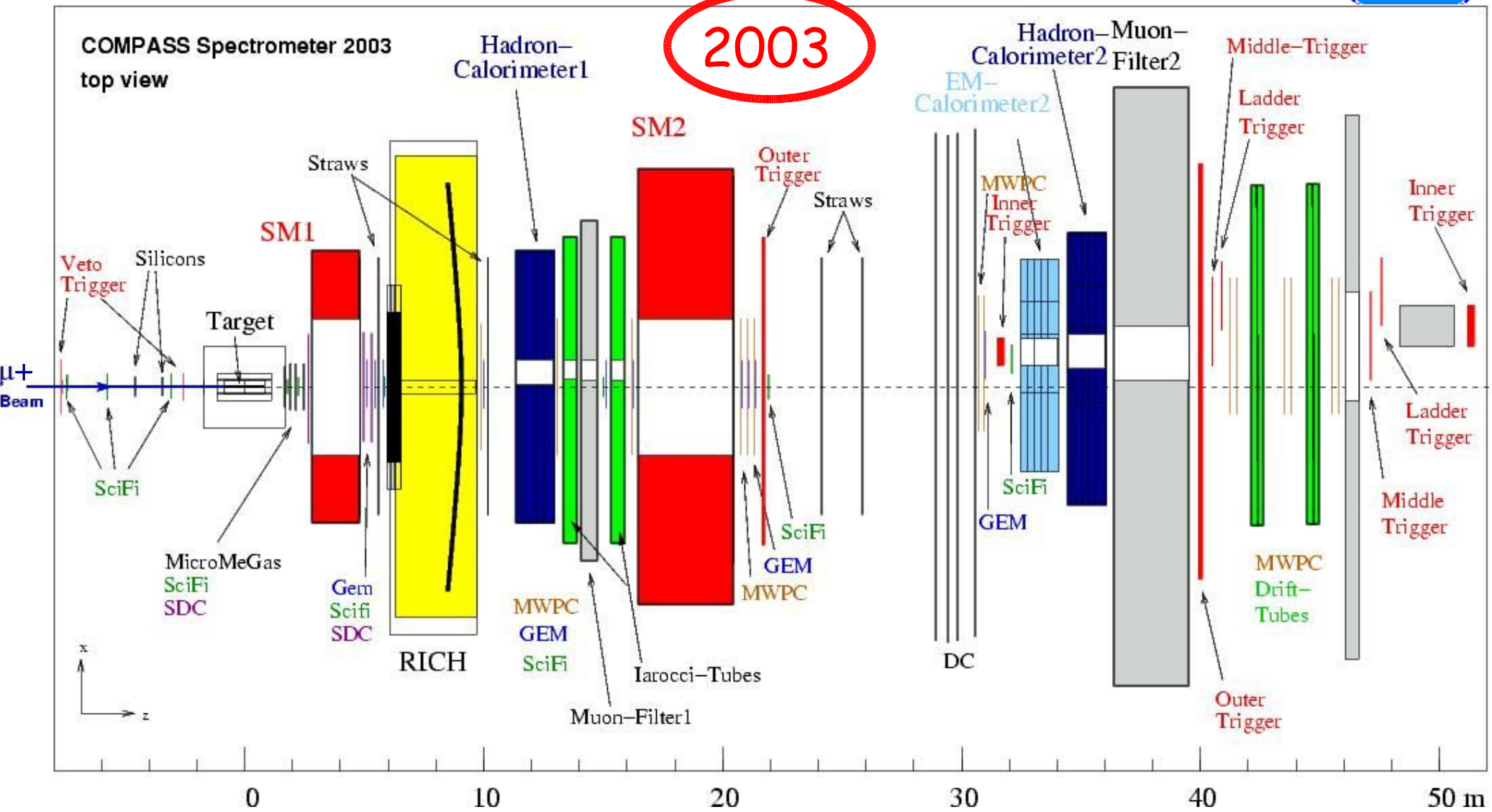
$$H^{\sphericalangle}(z,M^2_{\pi^+\pi^-}) \sim \sin\delta_0 \sin\delta_1 \sin(\delta_0-\delta_1)\hat{H}^{\sphericalangle}(z,M^2_{\pi^+\pi^-})$$

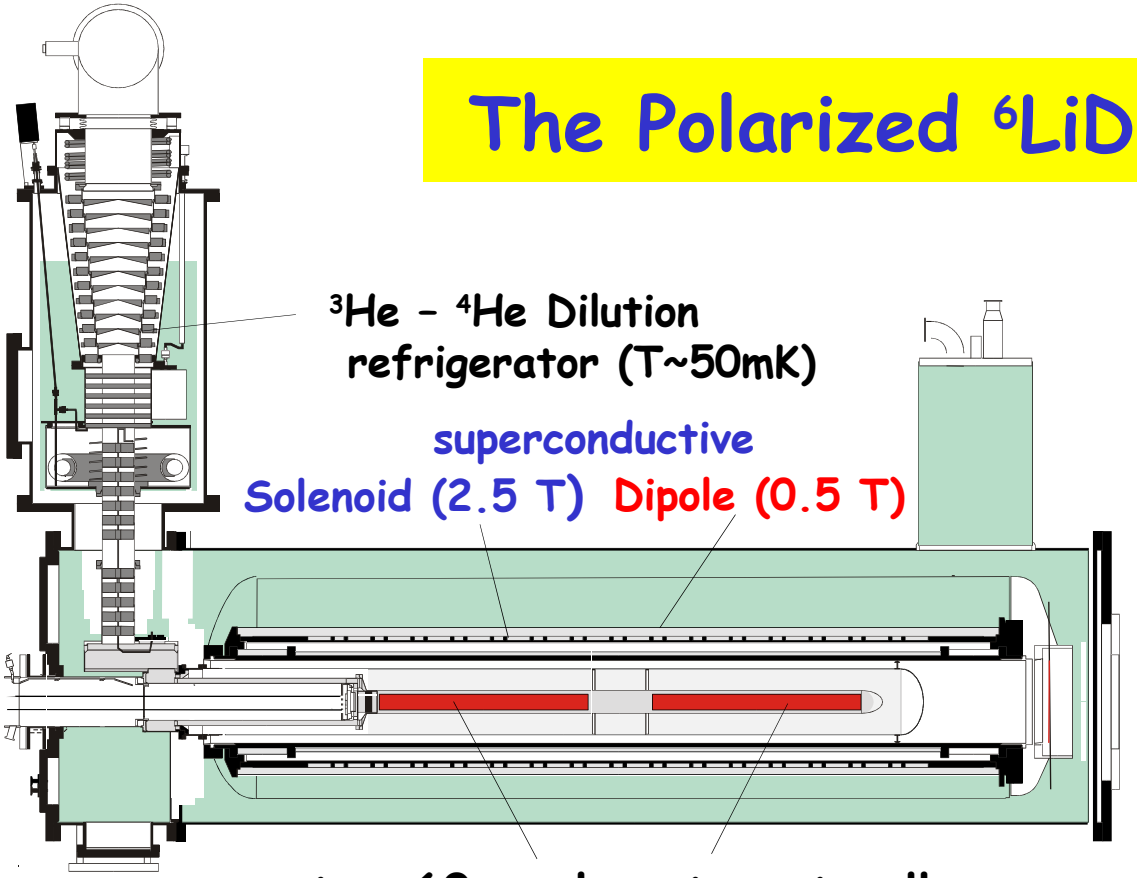
The COMPASS Experiment



Beam: $2 \cdot 10^8$ μ^+/ spill (4.8s / 16.2s) **Beam momentum:** 160 GeV/c

Luminosity: ~$5 \cdot 10^{32}$ cm^{-2} s^{-1} **Beam polarization:** -76%

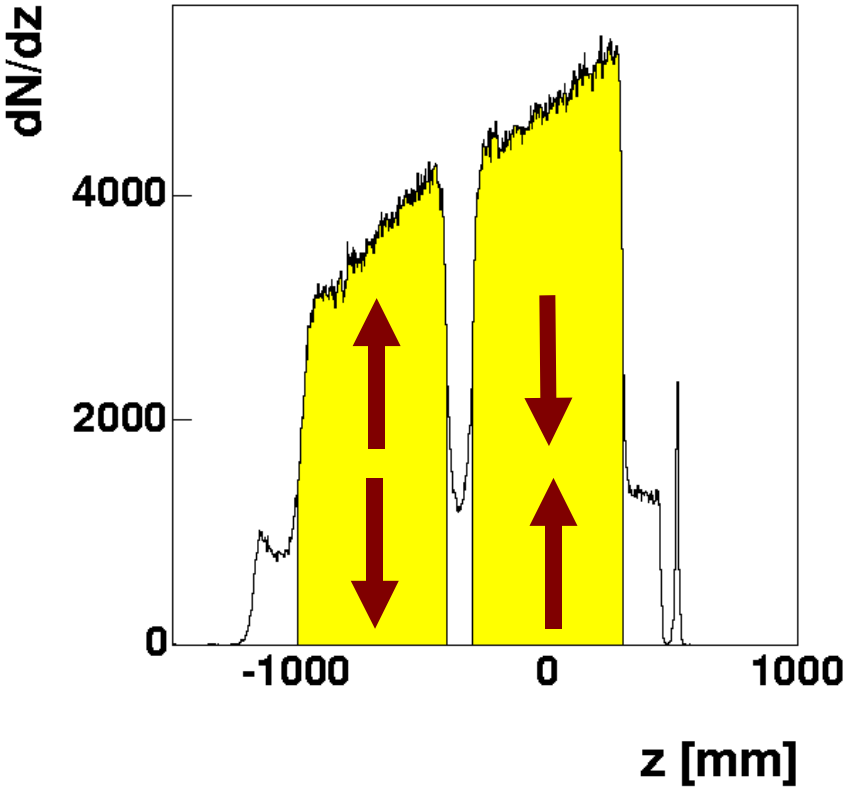
The Polarized ^{6}LiD-Target



Polarization: 50%
Dilution factor: 0.38

Relaxation time:

transversal runnina > 2000 hrs



Transverse target polarization:

(dipole field)

changed by microwave reversal

(once a week)

Data Sample

2002: 12+7 days of data taking
with transversely polarized ^{6}LiD target

- $1.8 * 10^9$ raw events

2003: 14 days of data taking

2003 trigger upgrade to gain sensitivity
on large x_{Bj} & large Q^2 events !

- 2002 data doubled

2004: 14 days of data taking

DAQ improved and online filter added

- ~ 2002+2003 data doubled

Data Sample

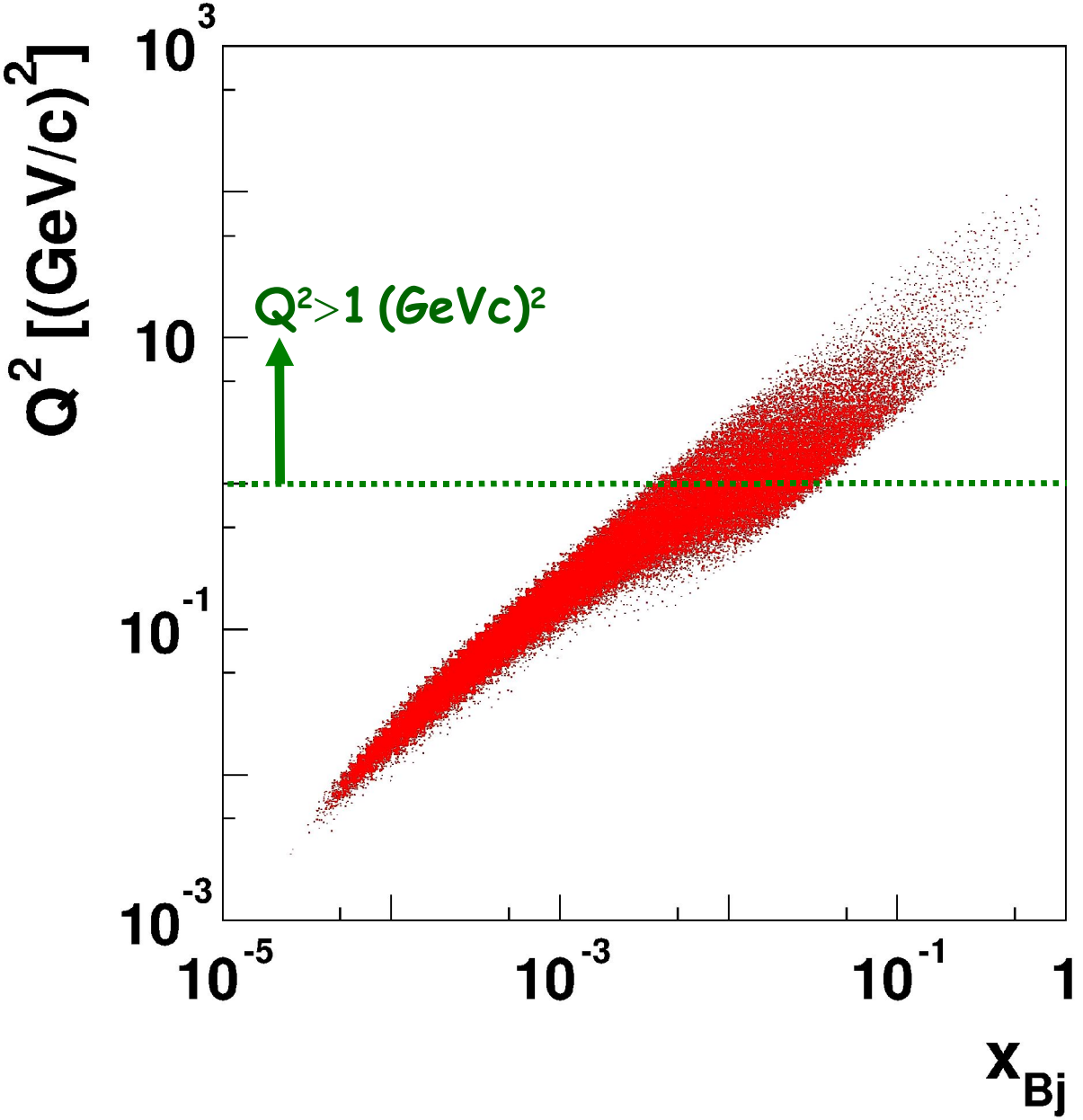
Measure count rate asymmetry between two subperiods of opposite polarization for each target cell separately (weighted mean taken)

- each period with spin reversal halfway through
- separate analysis for all periods of data taking
  - weighted mean of asymmetry values at end

Event sample after all cuts (2002 and 2003 data):

$2.8 * 10^6$ hadron combinations

Transversity Acceptance



Kinematic variables:

Q^2

$\nu = (E_l - E_{l'})$

$x_{Bj} = Q^2/2M\nu$

$y = \nu/E_l$

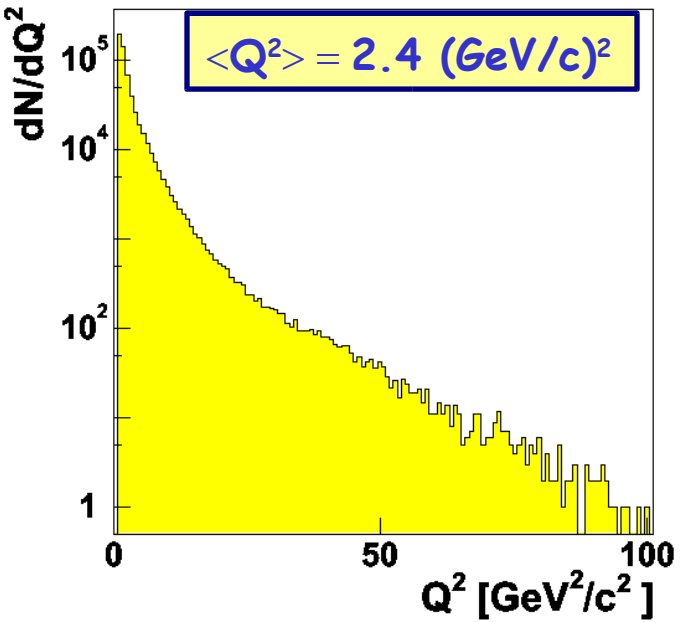
$z = E_h/\nu$

Event Selection - DIS Sample

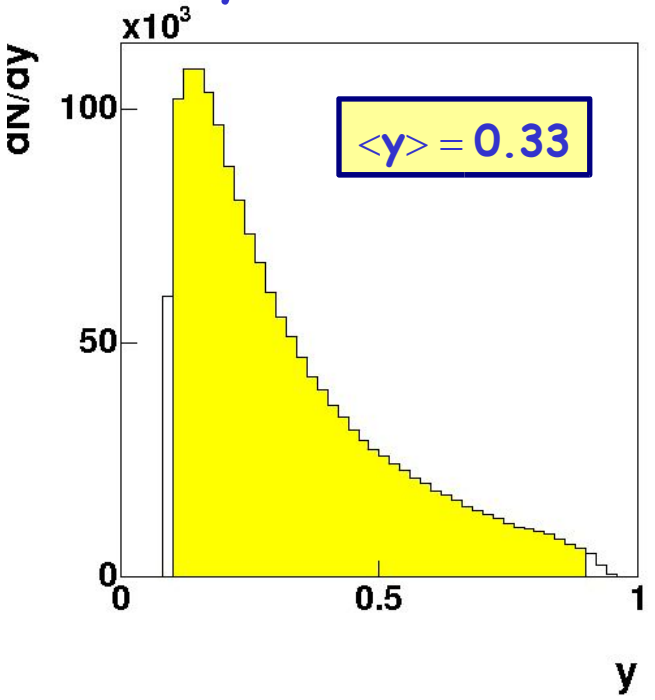
- Primary vertex with identified μ, μ' within target cell

Kinematical cuts:

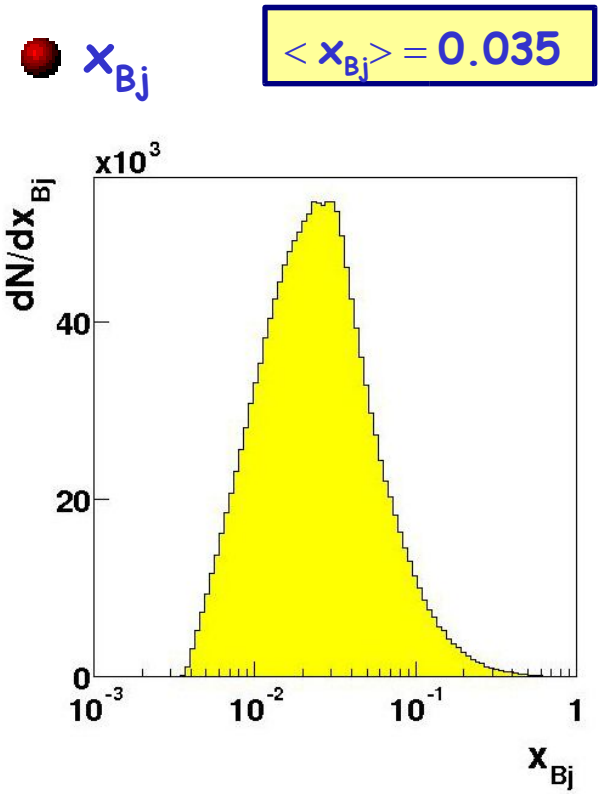
- $Q^2 > 1\ (GeV/c)^2$



- $0.1 < y < 0.9$



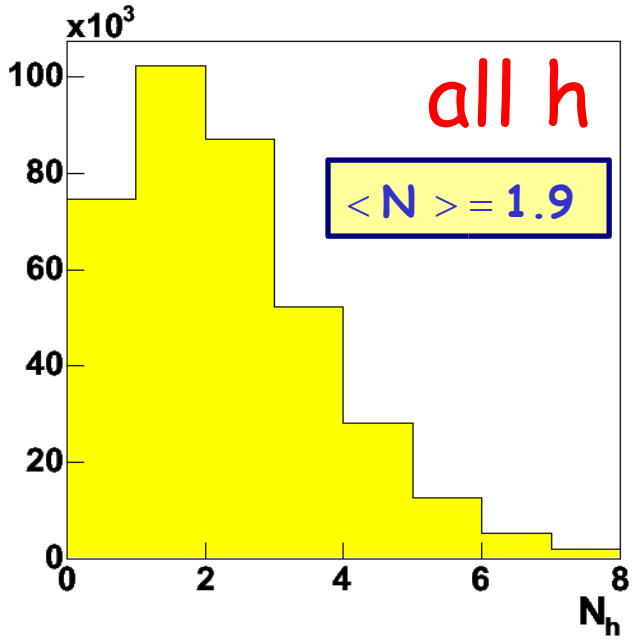
- x_{Bj}

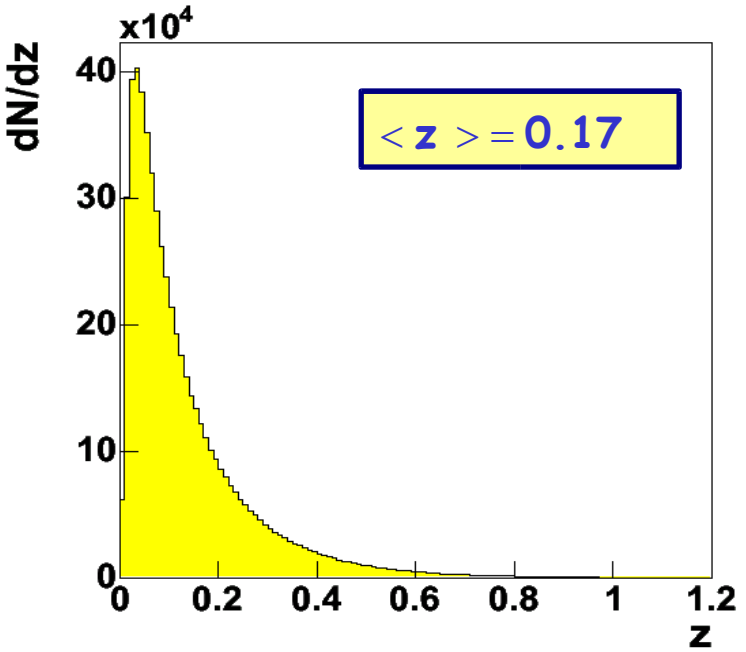


Hadron Selection

Selection of hadrons:

➔ **Rejection of muon tracks based on traversed material along the flight path and energy loss in the two calorimeters**



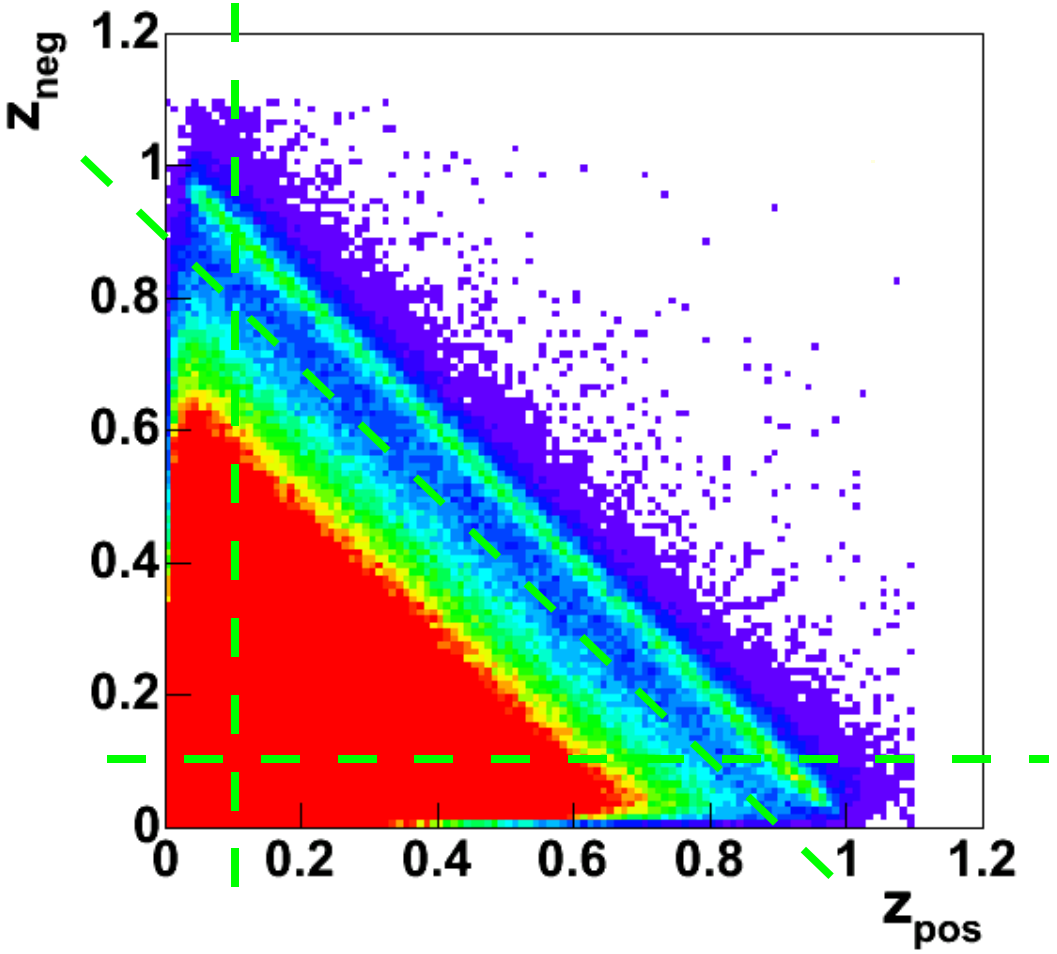


Presently no π / K / p separation by RICH

Selection of Hadron Pairs

Select all combinations of positive (h_1) and negative (h_2) hadrons with:

- $z_1 > 0.1$ & $z_2 > 0.1$ and $x_{f1} > 0.1$ & $x_{f2} > 0.1$
- $z = z_1 + z_2 < 0.9$



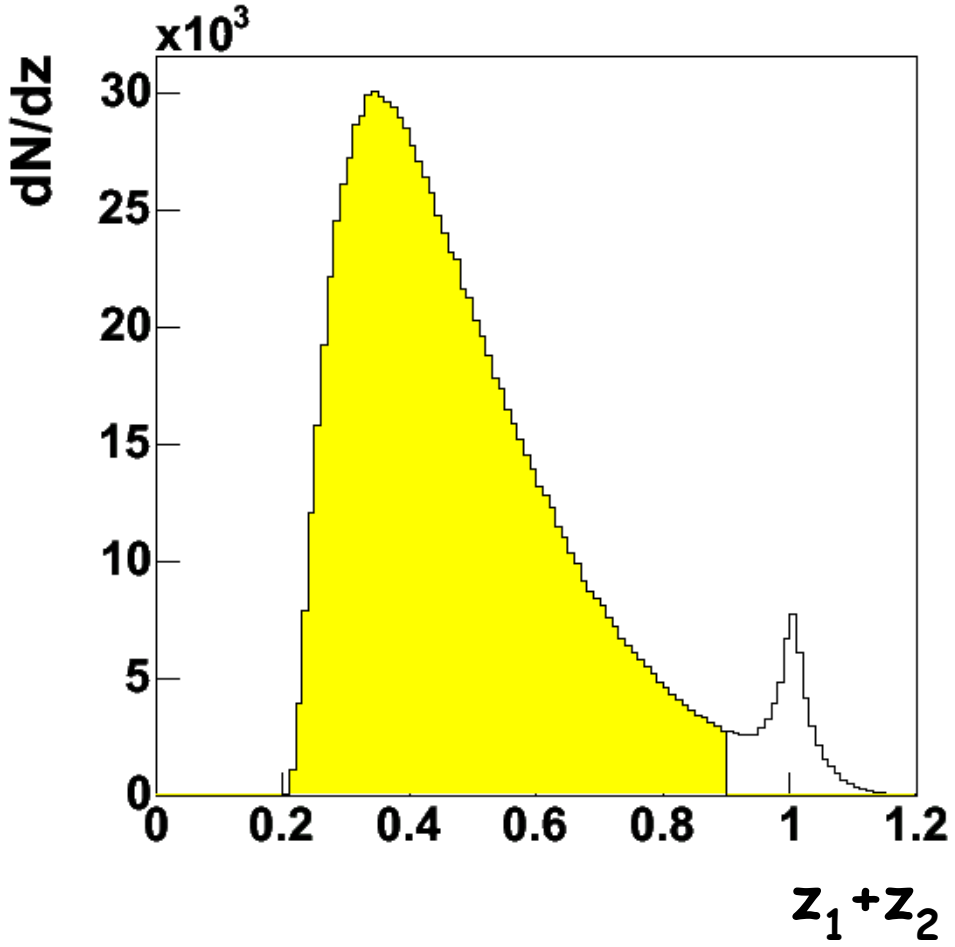
1.02 combinations/DIS event

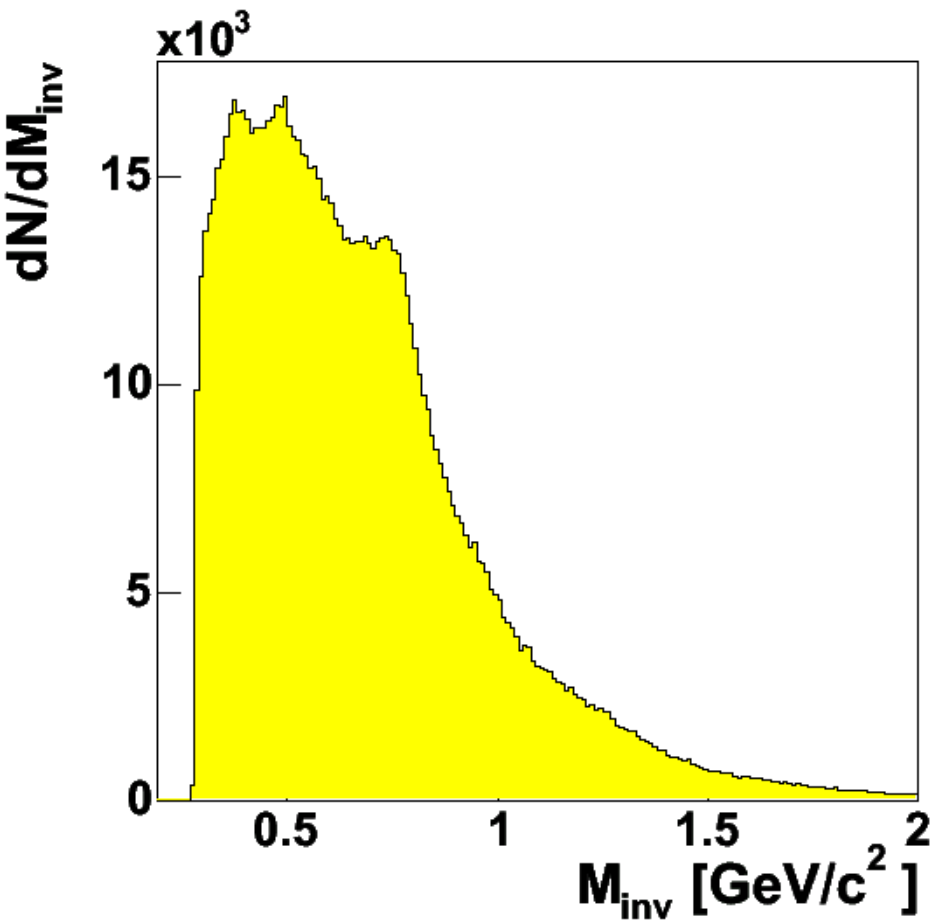
0.22 combinations/DIS event

Final Sample

2002-2003:

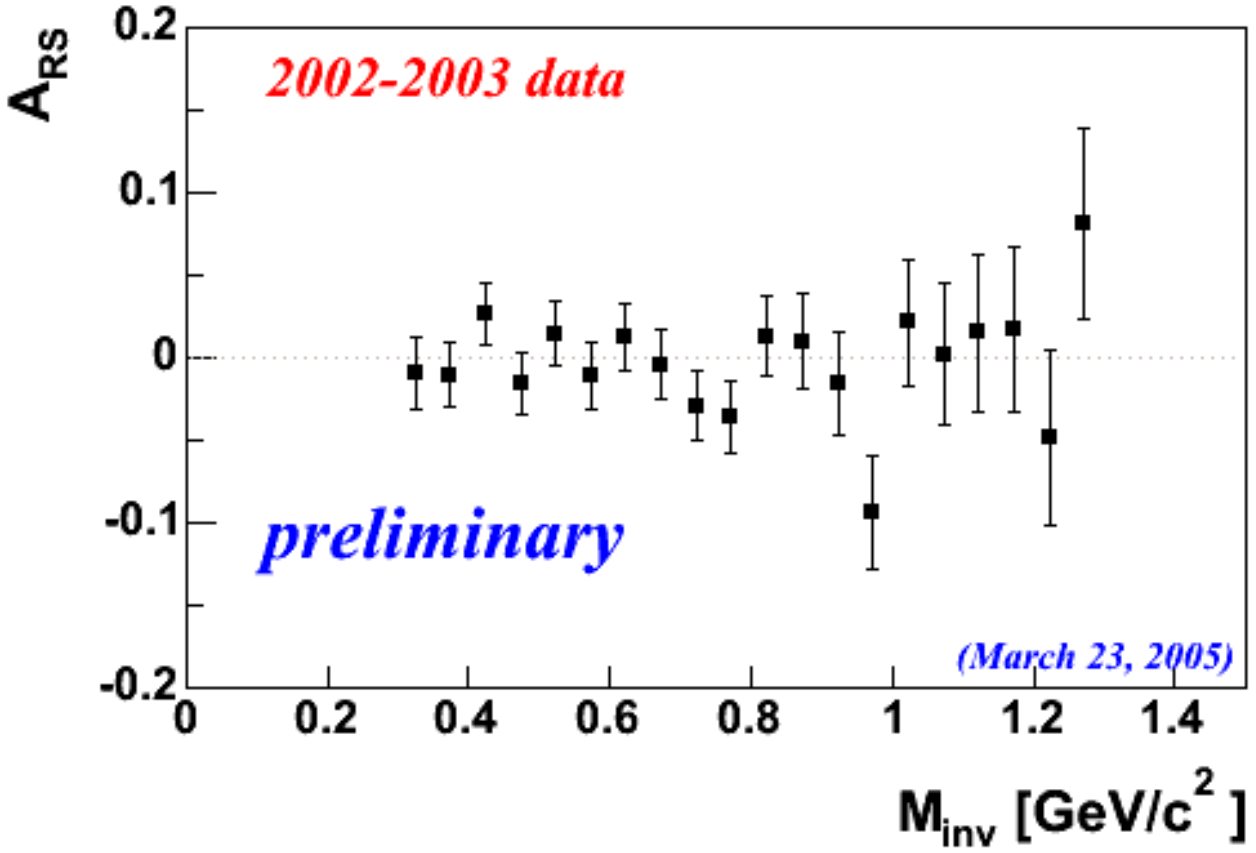
2.8 10^6 combinations



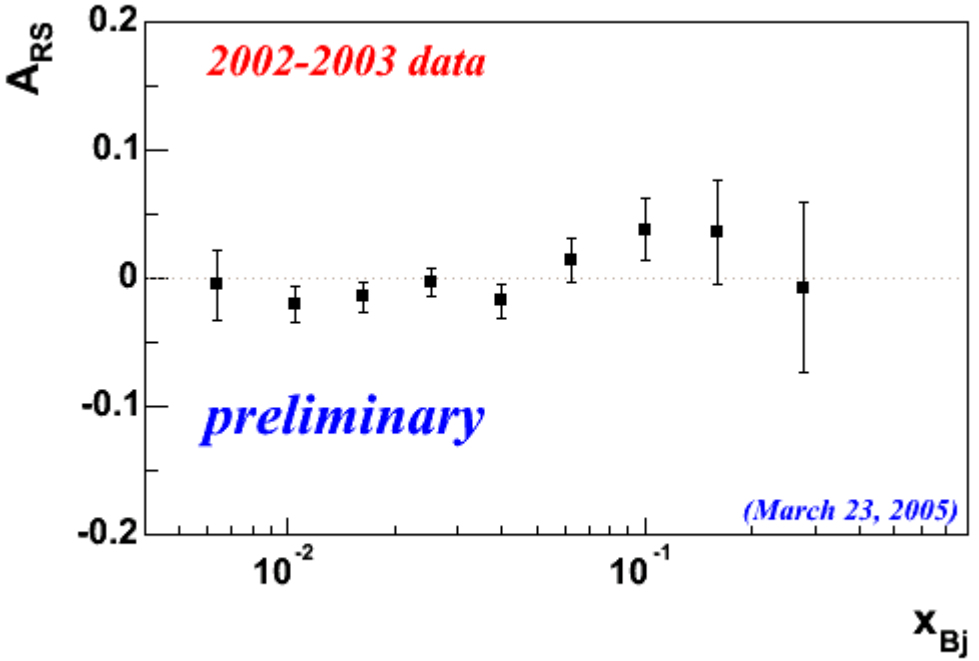


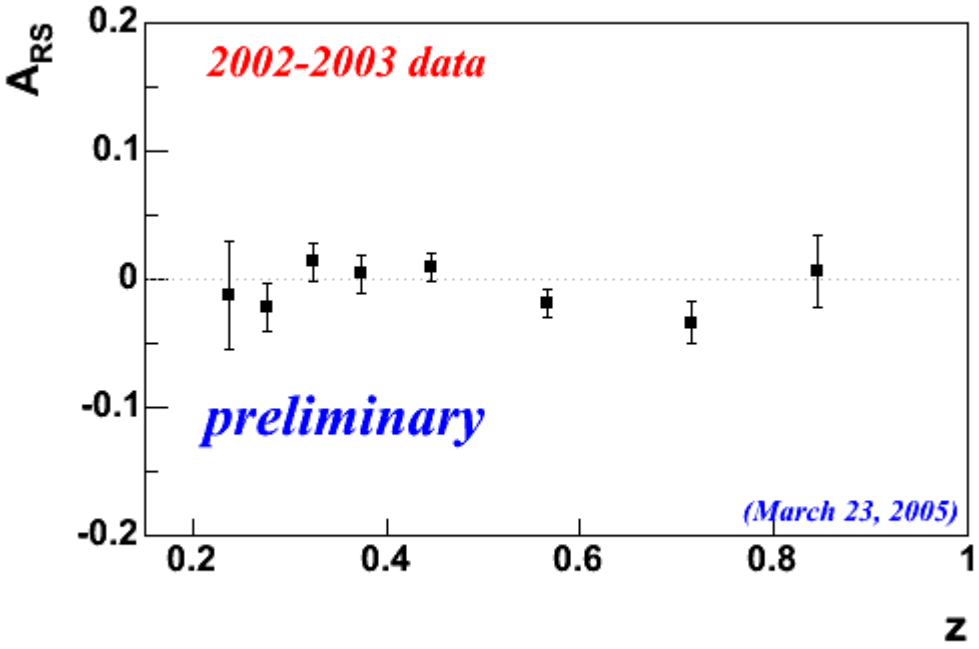
2-Hadron Asymmetry vs M_{inv}

$$A_{RS} = \frac{A_{UT}^{\sin\phi_{RS}}}{D_{NN} \cdot f \cdot P}$$



2-Hadron Asymmetry vs x_{Bj} and z





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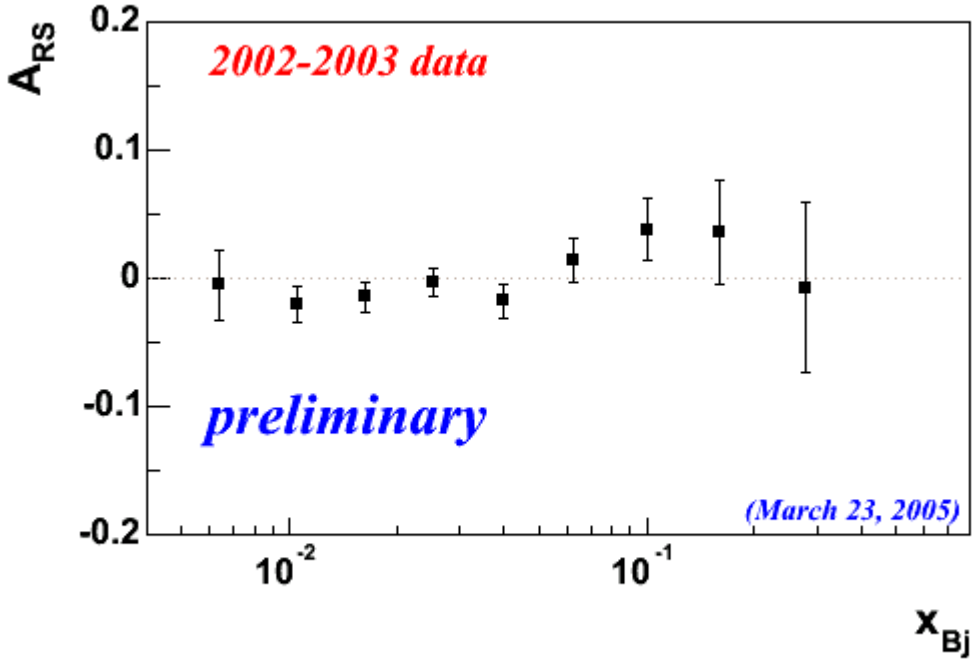

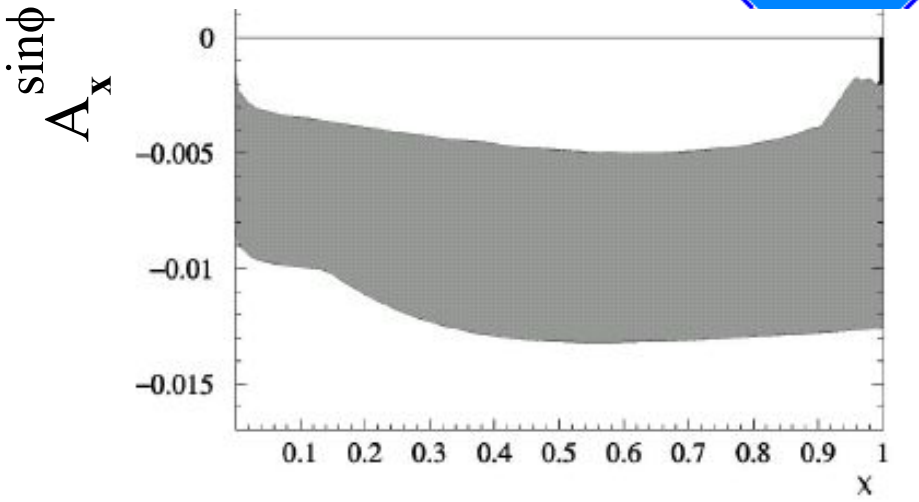

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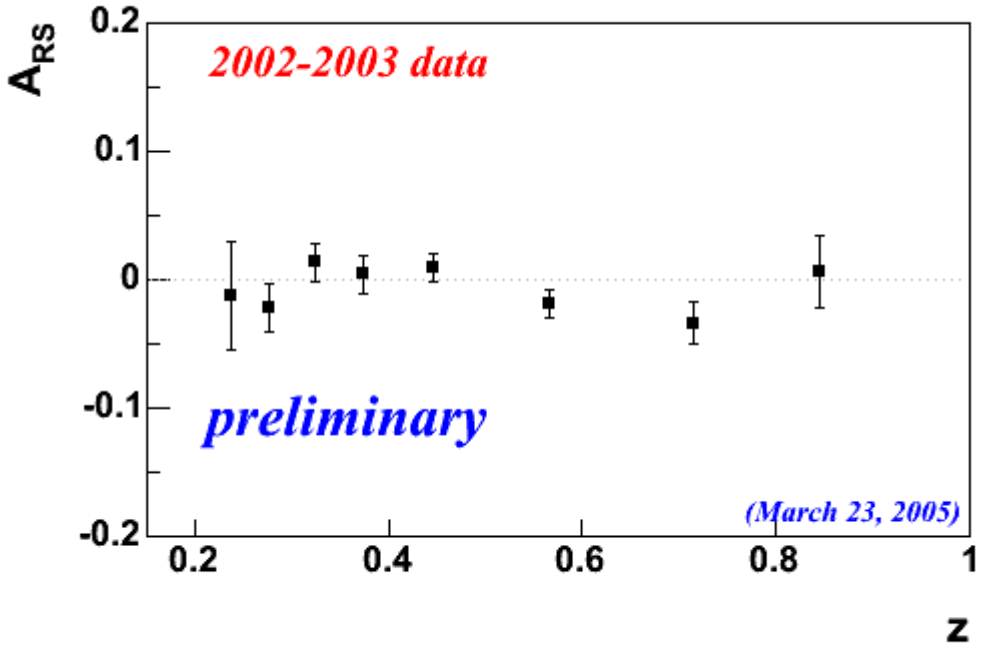
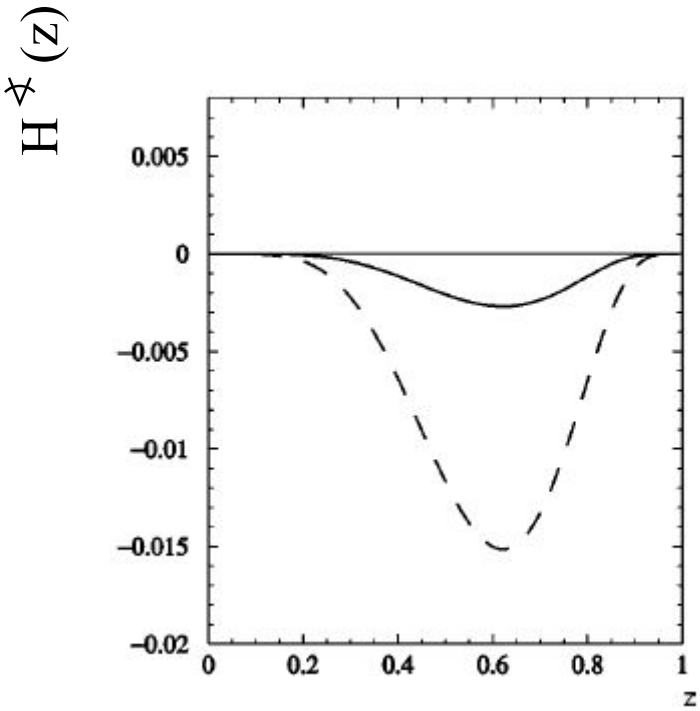




Summary

- First results of the analysis of our transverse target data concerning two hadron asymmetries were shown.
- The observed asymmetries are small.
- Systematics checks performed on the data show, that systematic effects are smaller than the statistical error.

Outlook

- Including 2004 data will double the statistics
  → sensitivity improvement by factor ~ 1.4 expected

- The analysis is ongoing with a focus on hadron identification using the RICH information.

- Analysing the data using different cuts on the x_{Bj} and z-regions is possible with our gathered statistics and on the way.

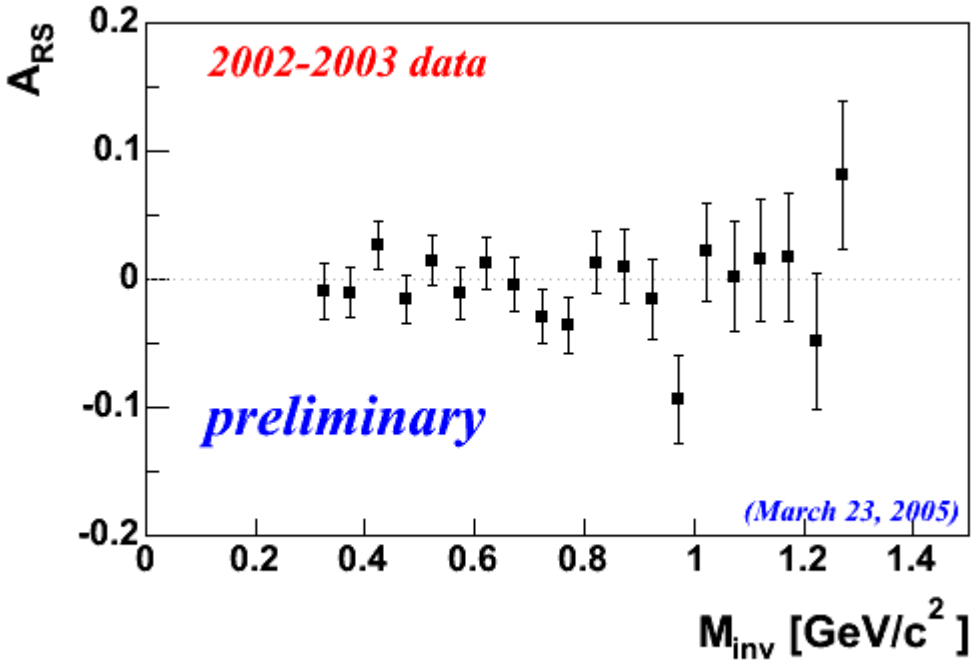
- **COMPASS after 2005:**

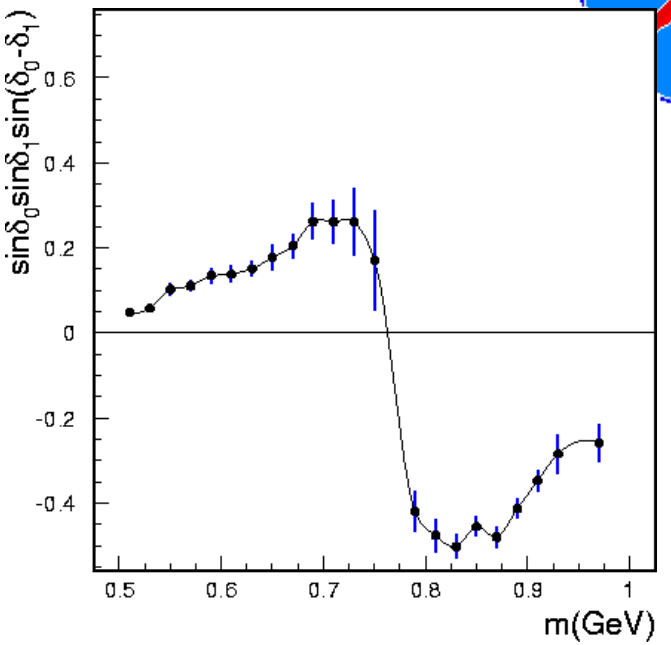
  → **complementary measurements with proton target in 2006.**

Many results on (2-hadron) transverse spin physics can be expected from COMPASS in the next future

END of talk

2-Hadron Asymmetry vs M_{inv}





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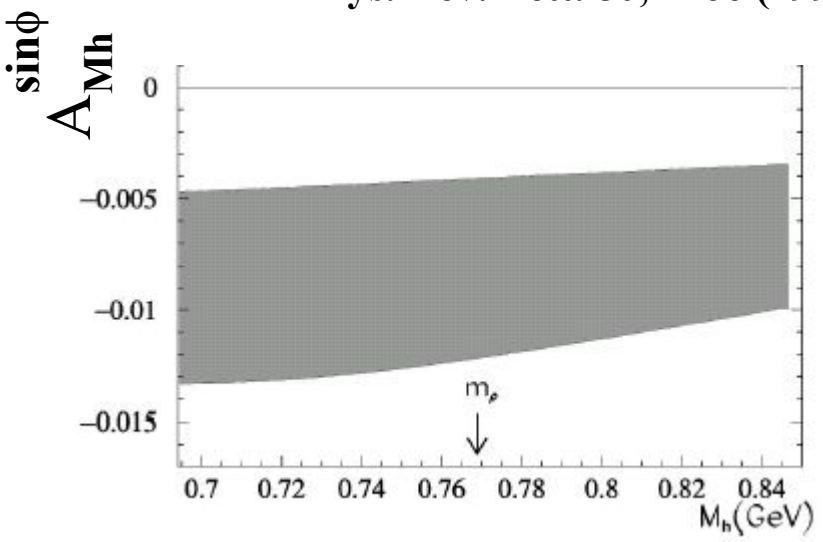

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