Transversity signals in two hadron correlation at COMPASS

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on behalf of the

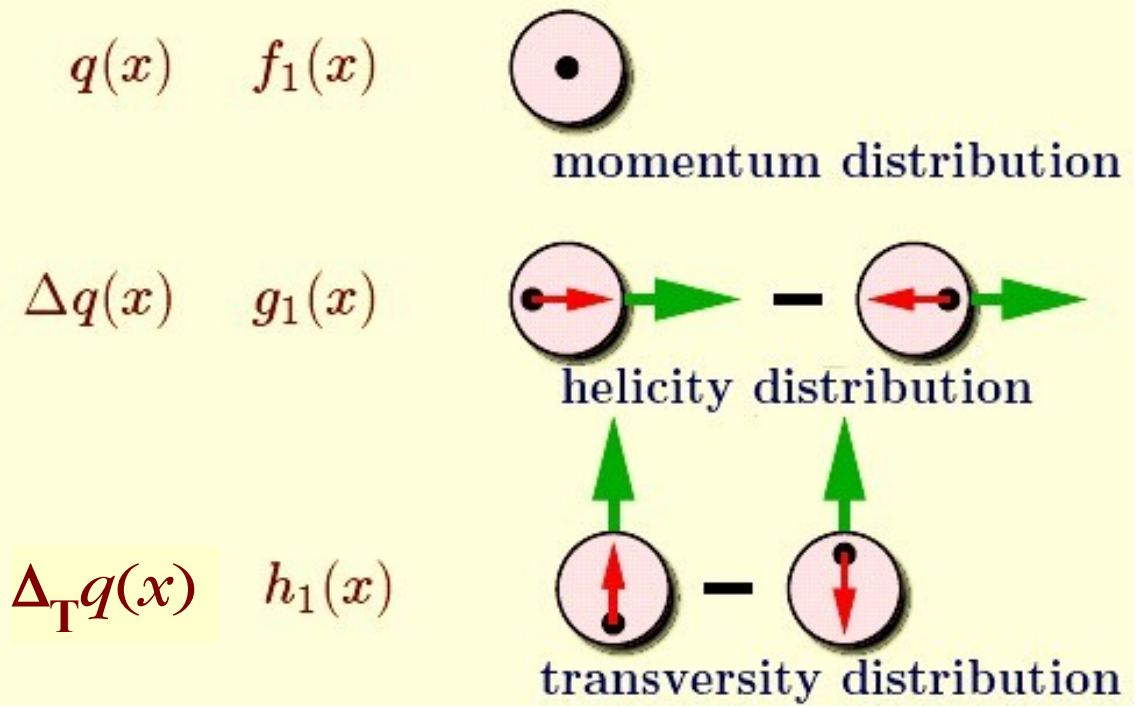
COMPASS Collaboration

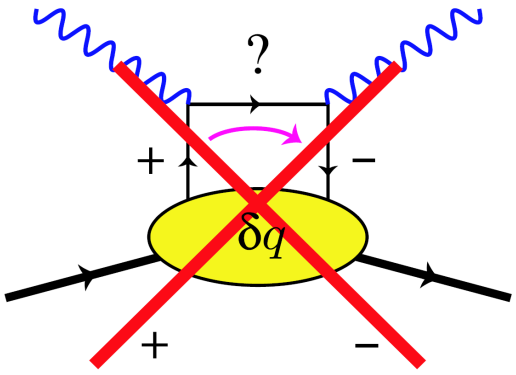
bmb+f - Förderschwerpunkt
COMPASS
Großgeräte der physikalischen Grundlagenforschung

Kyoto, 6.10.2006

Transverse Spin Physics

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





$\Delta_T q(x)$ decouples from inclusive DIS because helicity of quark must flip

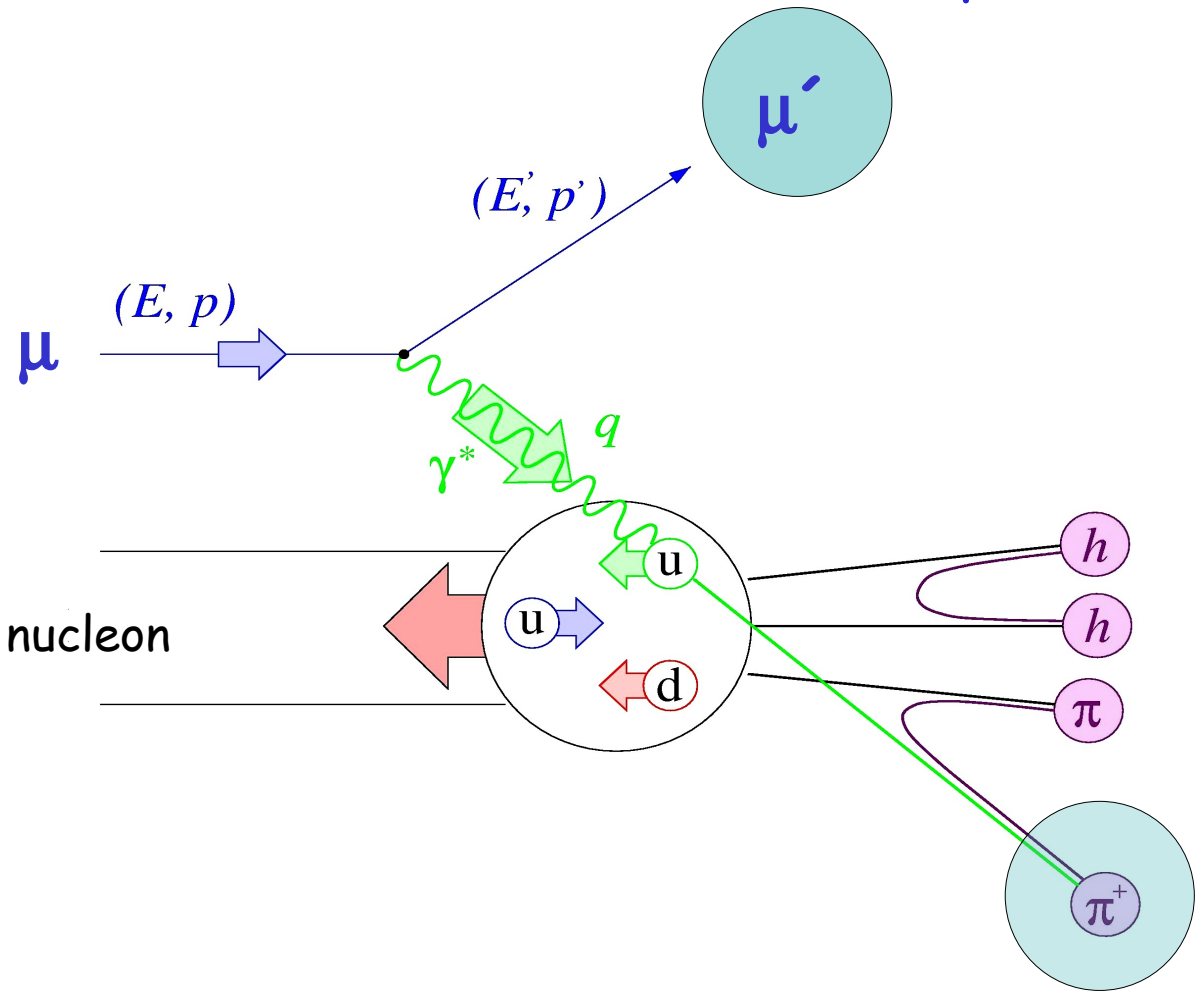
$\Rightarrow$ SIDIS

Transverse Spin Physics in SIDIS

Two processes:

Scattering of the lepton on a quark → distribution function

Production of hadrons from struck quark → fragmentation function



Kinematic variables:

$Q^2 = -q^2 \cong 4\,E\,E'\,\sin\theta/2$

Q ~ resolution

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

photon energy

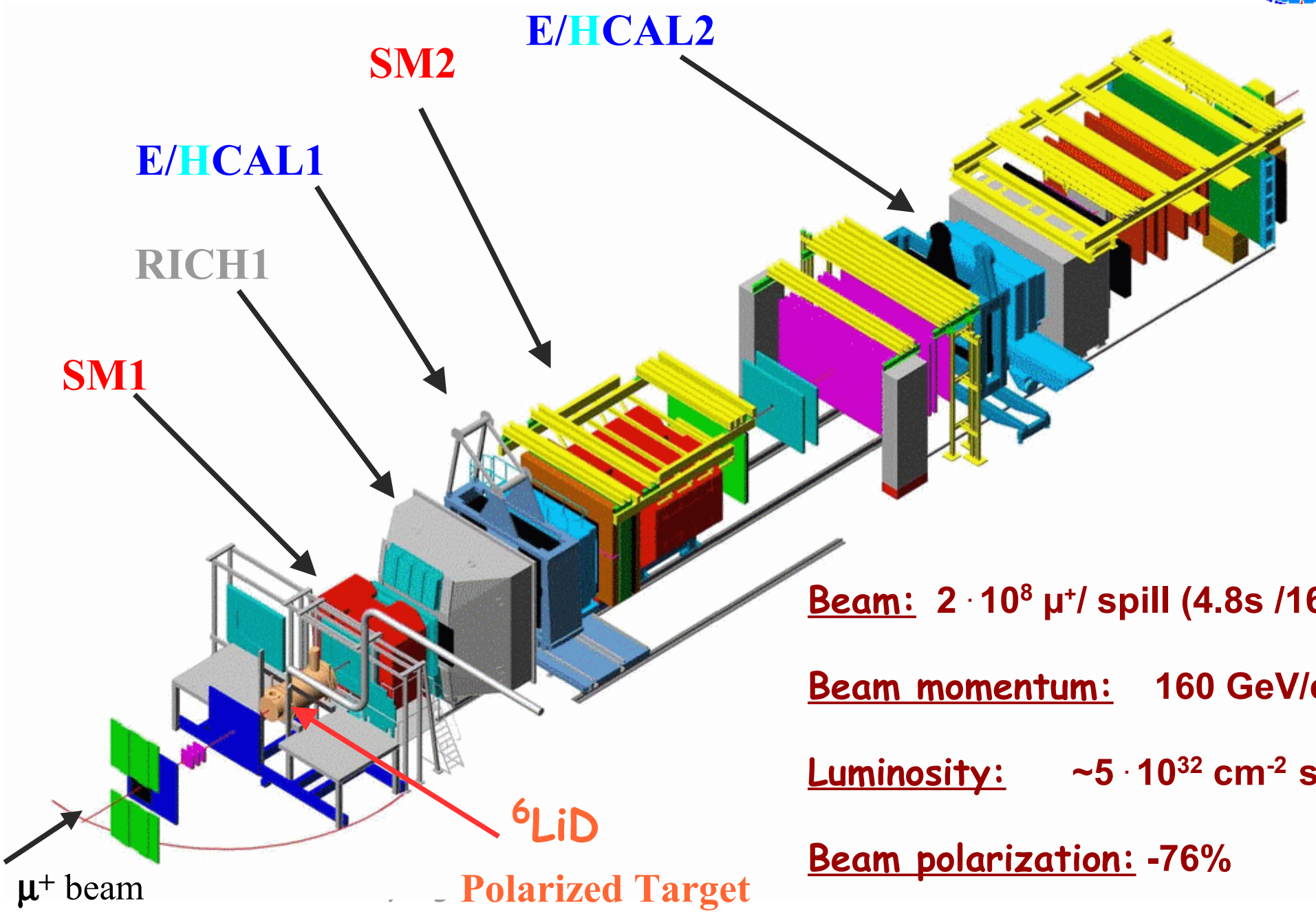
$x_{Bj} = Q^2/2M\nu$

momentum fraction of struck quark

$y = \nu/E_l$ inelasticity

$z = E_h/\nu$ exclusivity

The COMPASS Spectrometer at CERN



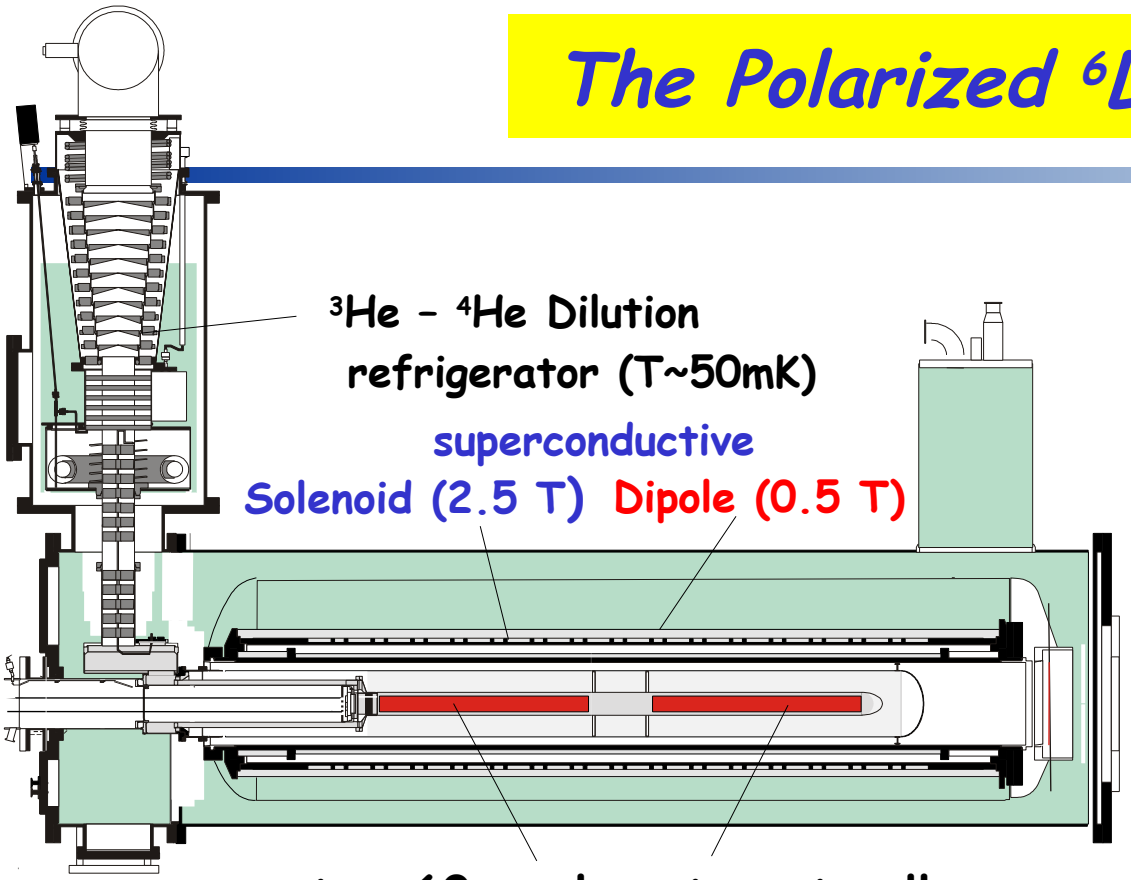
Beam: $2 \cdot 10^8$ μ^+/ spill (4.8s /16.2s)

Beam momentum: 160 GeV/c

Luminosity: $\sim 5 \cdot 10^{32}$ cm^{-2} s^{-1}

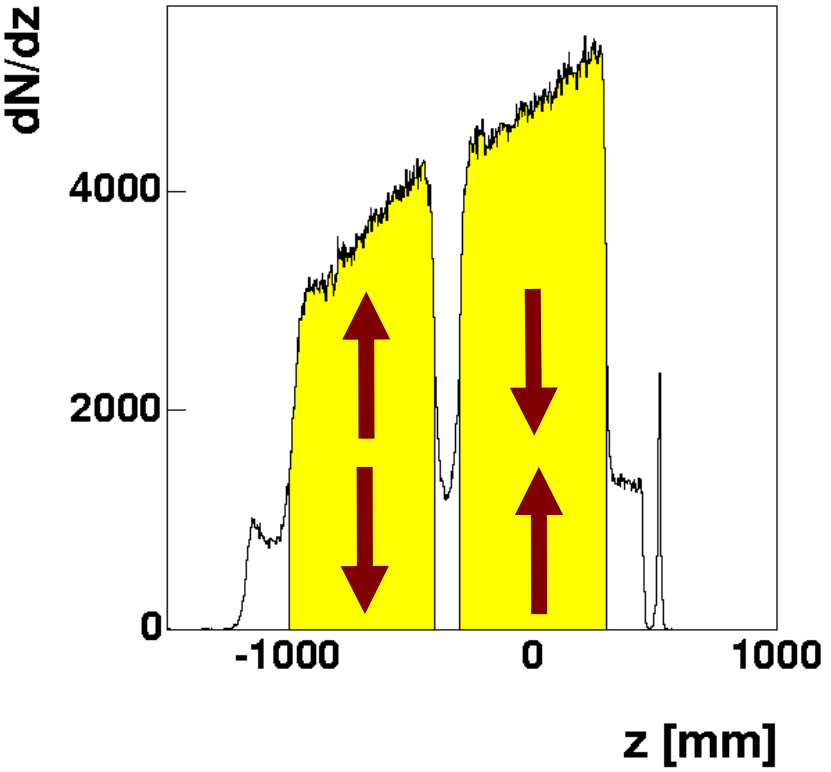
Beam polarization: -76%

The Polarized ^{6}LiD-Target



Polarization: ***50%***

Dilution factor: ***0.38***



Transverse target polarization:

(dipole field)

changed by microwave reversal

(once a week)

Transverse Spin Physics

3 possible quark polarimeters suggested using SIDIS:

- Azimuthal distribution of single hadrons

  paper on 2002 data published Phys. Rev. Lett. 94, 202002 (2005)

  Talk by F. Bradamante on Tuesday

- Azimuthal dependence of the plane containing hadron pairs

  This talk

- Measurement of transverse polarization of baryons

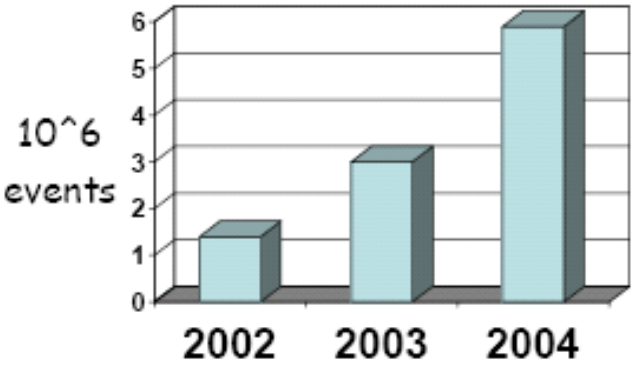
  (e.g. Λ hyperon) Talk by A. Ferrero on Friday

Transversity Data Sample

Target: ^{6}LiD (deuterium)

2002: 12+7 days of data taking

- $1.8 * 10^9$ raw events



2003: 14 days of data taking

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

- 2002 data doubled

2004: 14 days of data taking

DAQ improved and online filter added

- ~ 2003 data doubled

Transverse Spin Physics in 2 hadron production

- 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.

In SIDIS 2-hadron production: $(l\,N \rightarrow l'\,h_1h_2X)$

transversity: $\Delta_T q_i(x)$

couples to the „interference fragmentation function"

$$H_i^{\sphericalangle h}(z,\zeta,M_h^2,k_T^2,k_TP_T) \qquad \zeta = z_1/(z_1+z_2)$$

Interference fragmentation function

Integrated over $P_{h\perp}$:

$$\sigma_{UT} \propto \sum_i e_i^2 |S_T| \sin\theta \sin\phi_{RS} \; \Delta_T q_i(x) \, H_i^{\sphericalangle h}(z, M_h^2) \propto A_{UT}^{\sin\phi_{RS}} \cdot \sin\phi_{RS}$$

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

$\sin\theta$ angle of h_1 in the hadron CMS to the direction of $\vec{p}_{h1} + \vec{p}_{h2}$

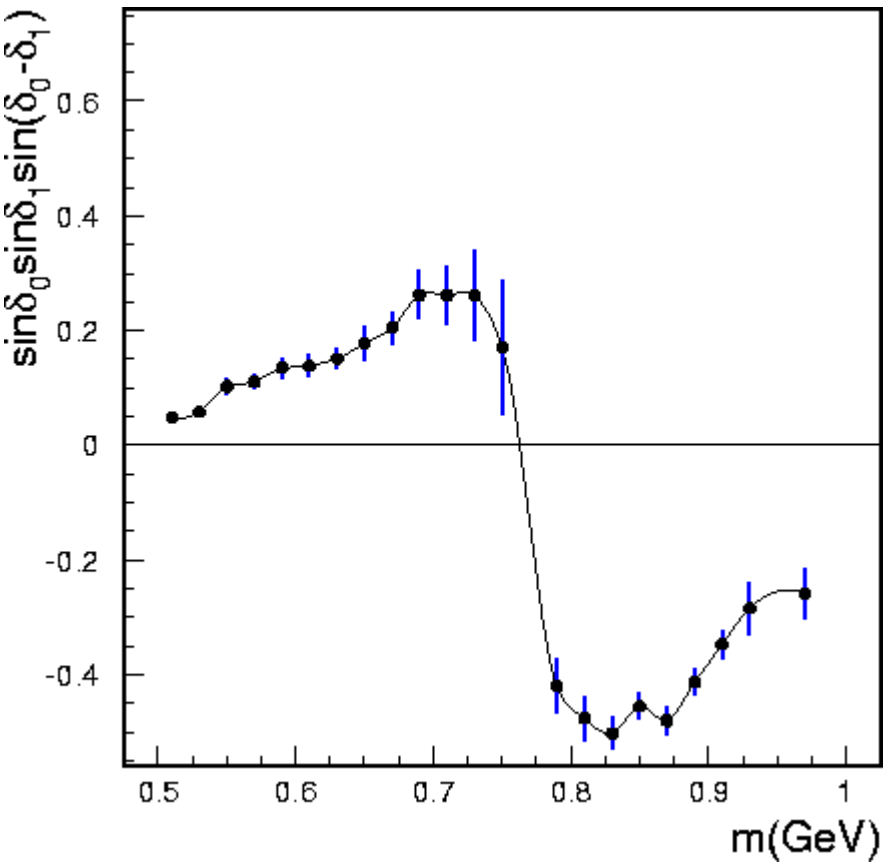
COMPASS: $\langle \sin\theta \rangle \approx 0.94$

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

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

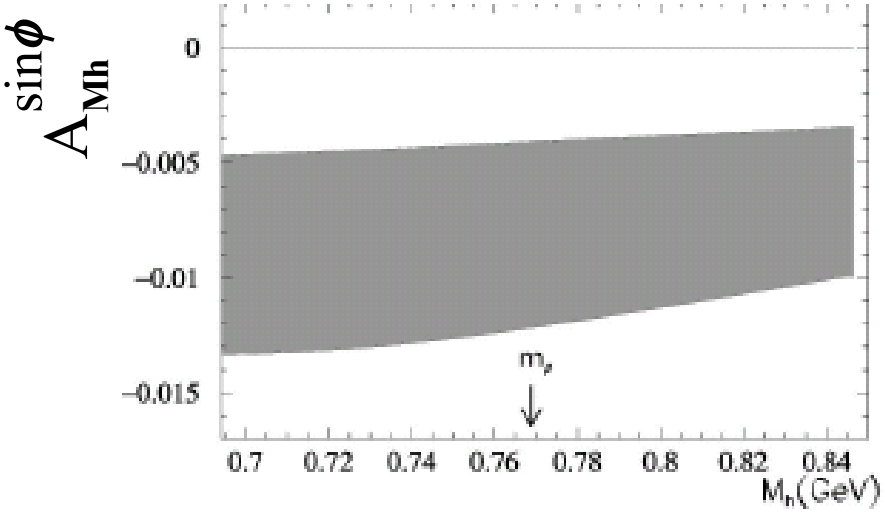
Interference Fragmentation Function $H_q^{\sphericalangle h}(z,M_h^2)$

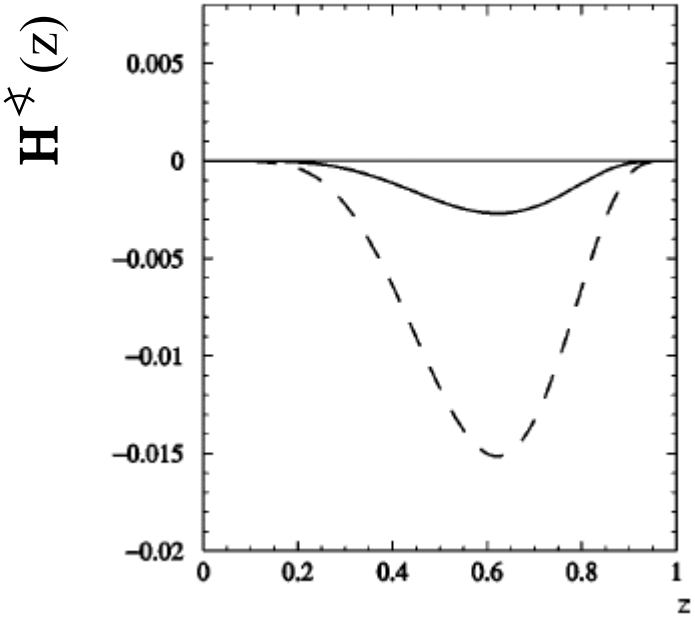
One model !



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

Another model !





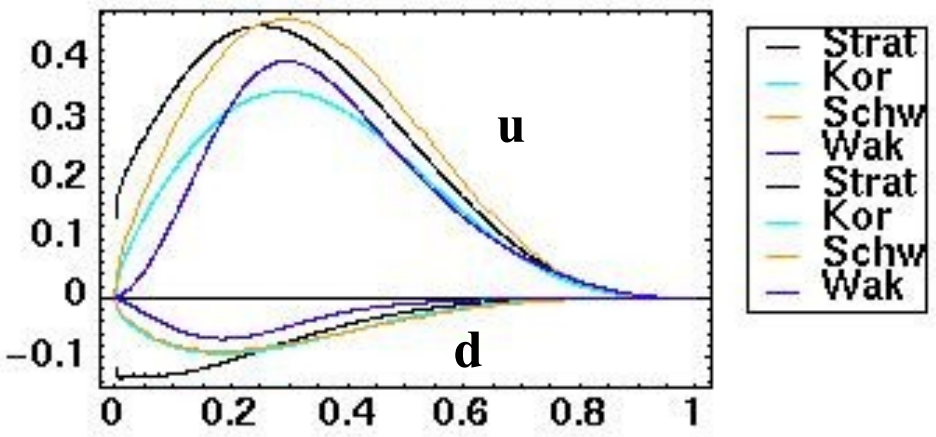
$$H^{\sphericalangle}(z,M^2_{\pi^+\pi^-}) \sim \sin\delta_0 \sin\delta_1 \sin(\delta_0-\delta_1)\hat{H}^{\sphericalangle}(z,M^2_{\pi^+\pi^-})$$

Radici, Jakob, Bianconi, PRD 65, 074031

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

A more recent model: Radici @ QCD N'06

Model for transversity:



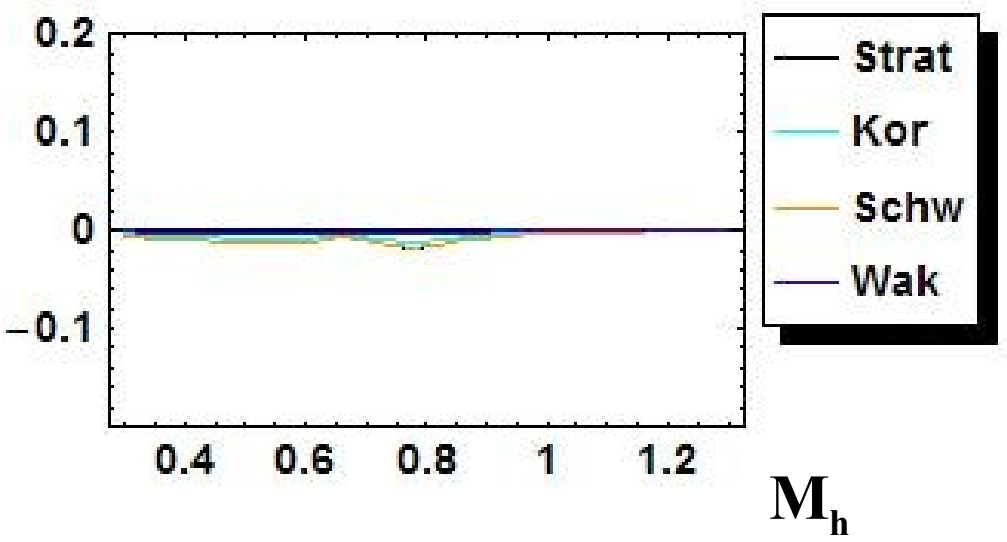
Strat
Soffer, Stratmann, Vogelsang
P.R. **D65** (02) 114024

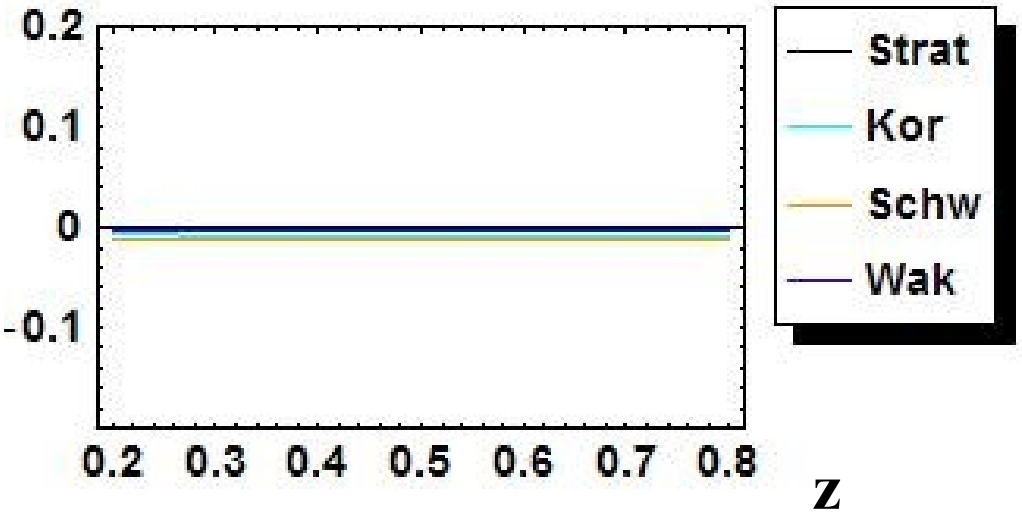
Kor
Korotkov, Nowak, Oganessian
E.P.J. **C18** (01) 639

Sch
Schweitzer et al.
P.R. **D64** (01) 034013

Wak
Wakamatsu
P.L. B509 (01) 59

Prediction for COMPASS kinematics on deuteron target:





The Coordinate System

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

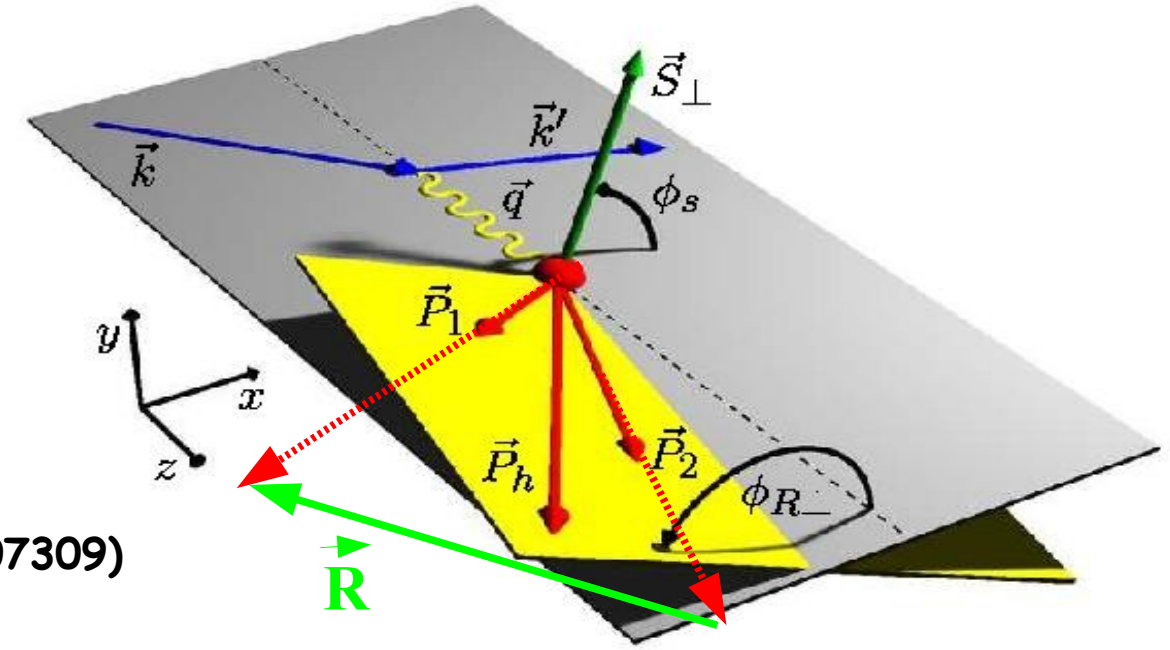
with $\phi_{S'} = \pi - \phi_S$ *(spin flip)*

ϕ_R = is defined by:

$$R = (z_1\mathbf{p}_2 - z_2\mathbf{p}_1)/(z_1+z_2)$$

(X. Artru, hep-ph/0207309)

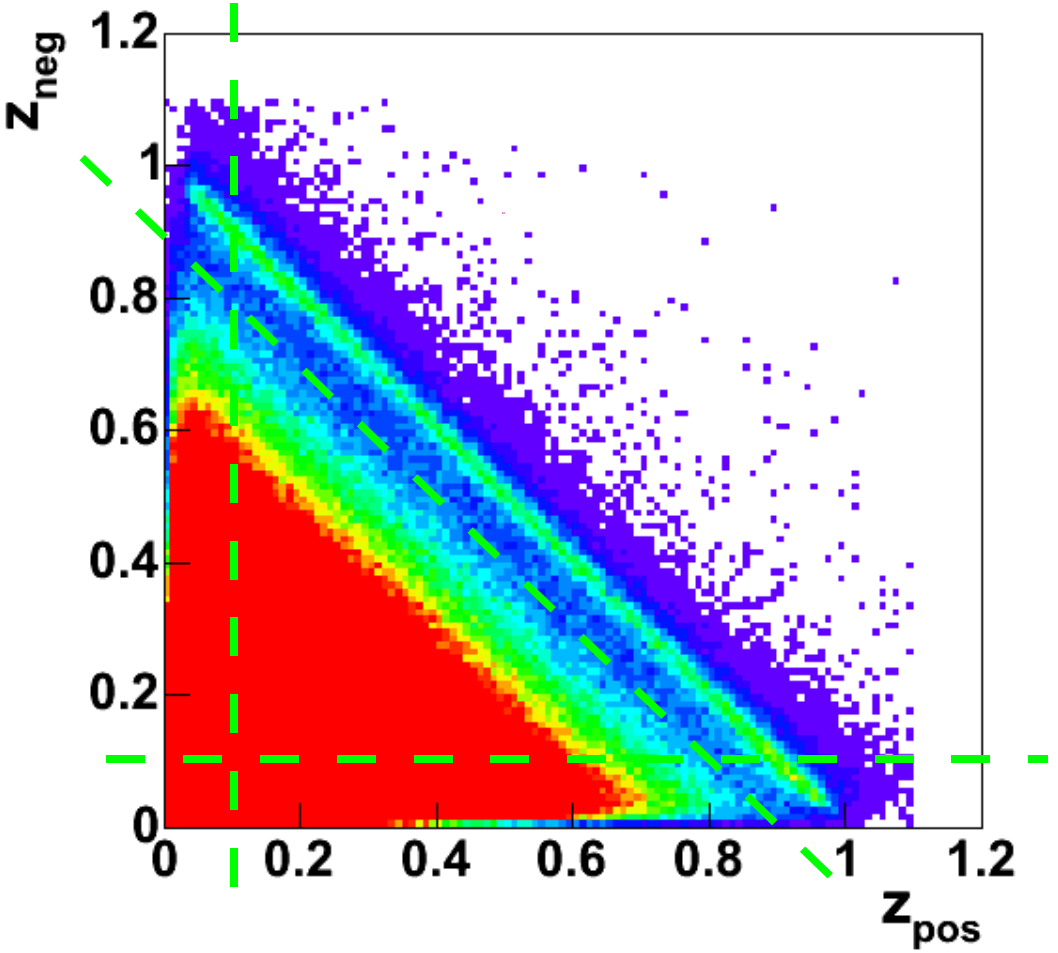
$$\phi_{RS} = \phi_R - \phi_{S'} = \phi_R + \phi_S - \pi$$



Selection of Hadron Pairs

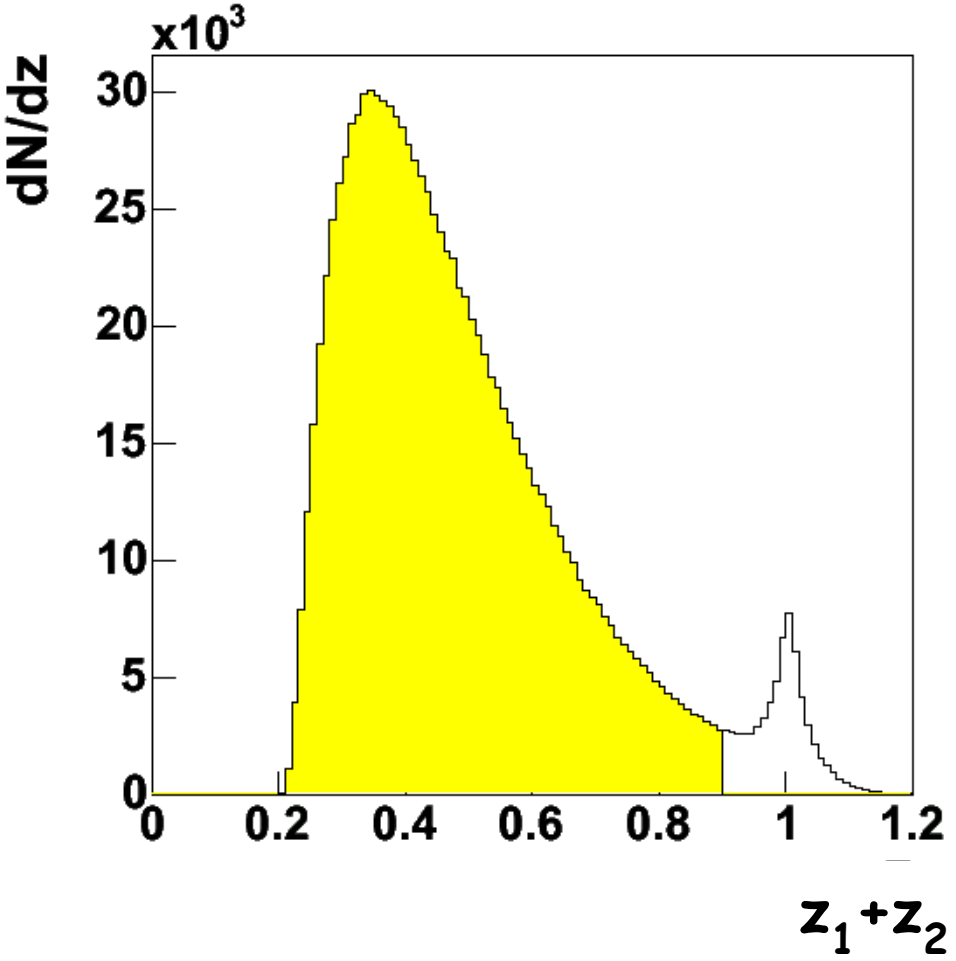
Select all combinations of positive (h_1) and negative (h_2) hadrons with:

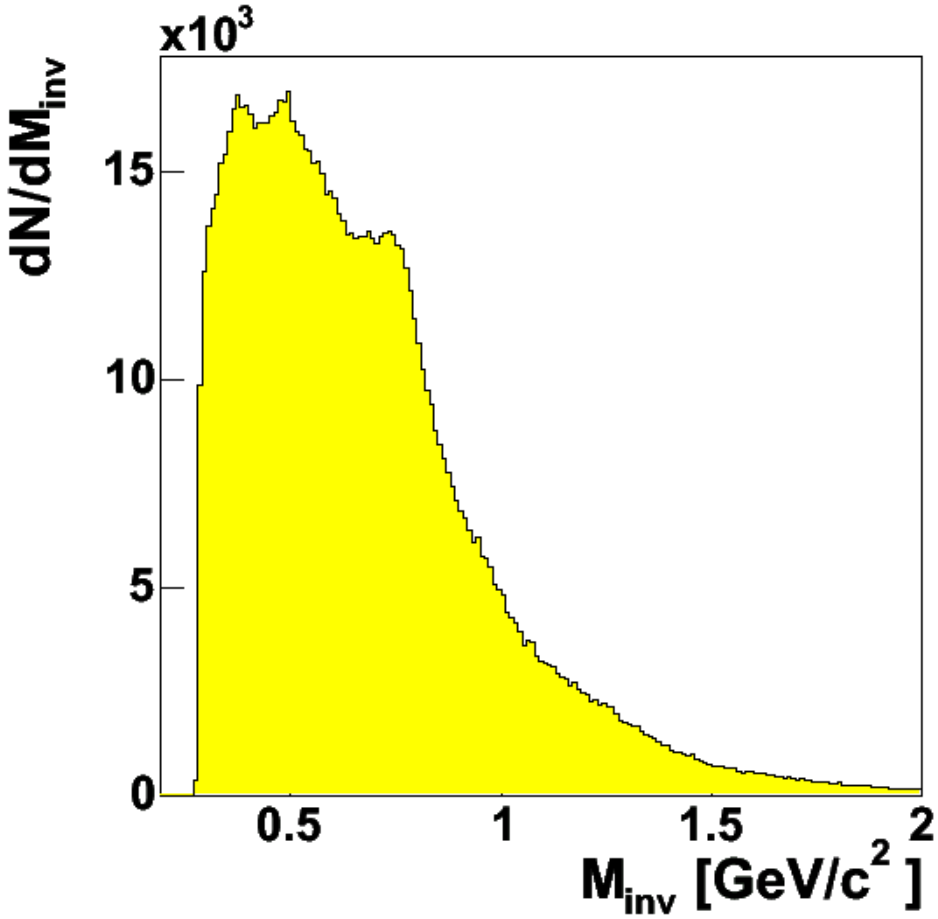
- $z_1 > 0.1$ & $z_2 > 0.1$ and $x_{f1} > 0.1$ & $x_{f2} > 0.1$
- $z = z_1 + z_2 < 0.9$



Presently no π / K / p separation by RICH

Final Sample





2002-2004:

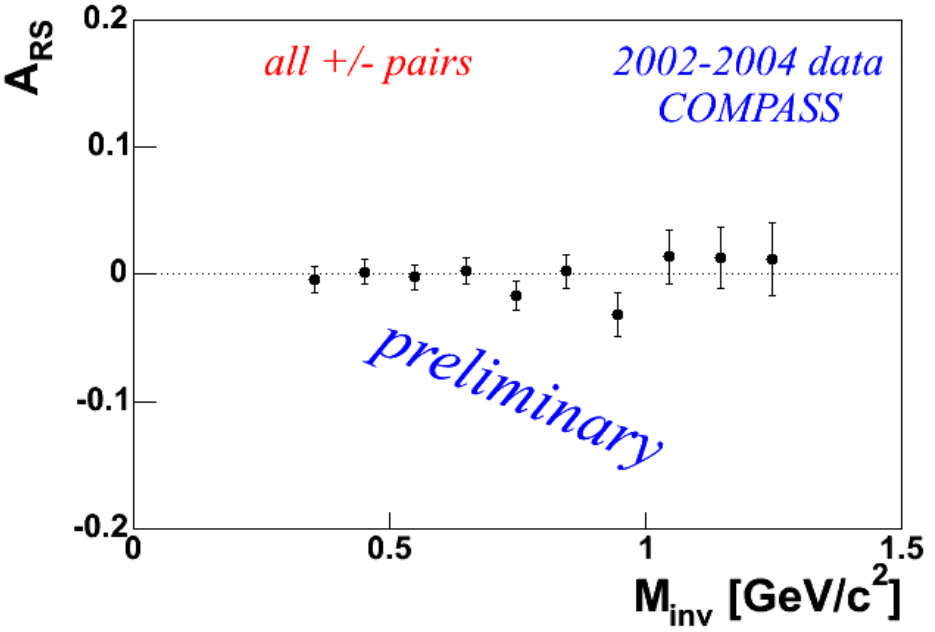
6.1 10^6 combinations

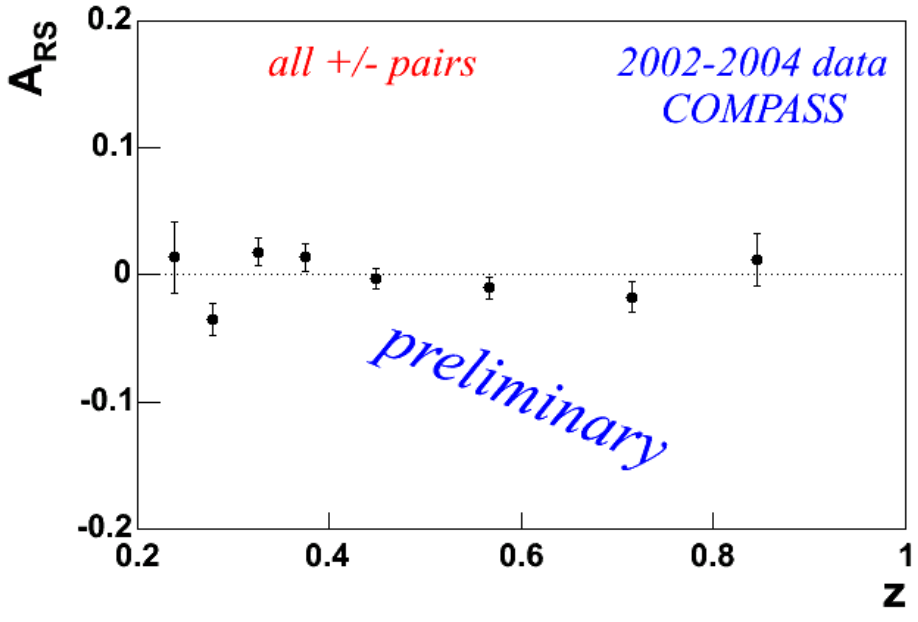
Presently no π / K / p separation by RICH

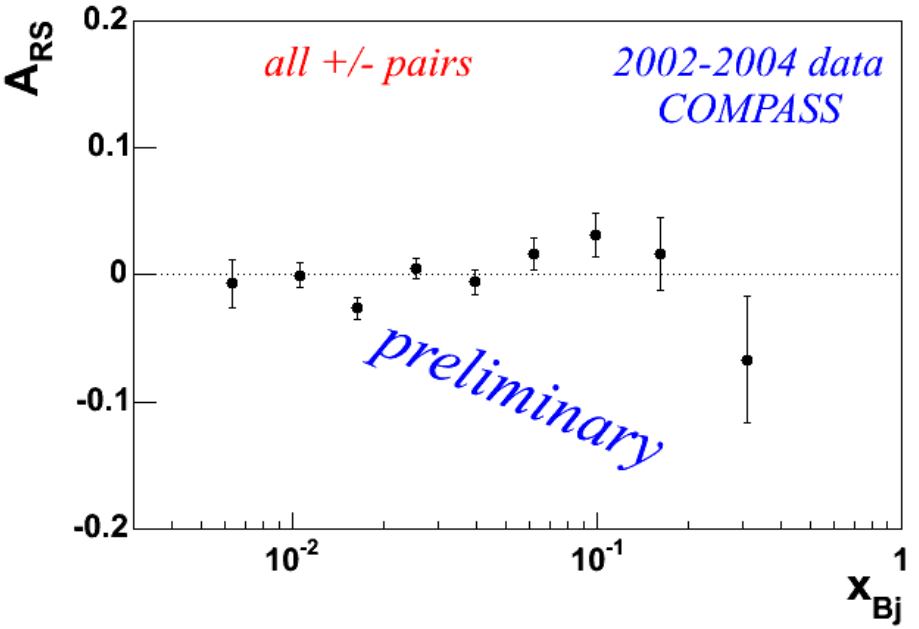
2-Hadron Asymmetry all +/- pairs

2002-2004 data

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



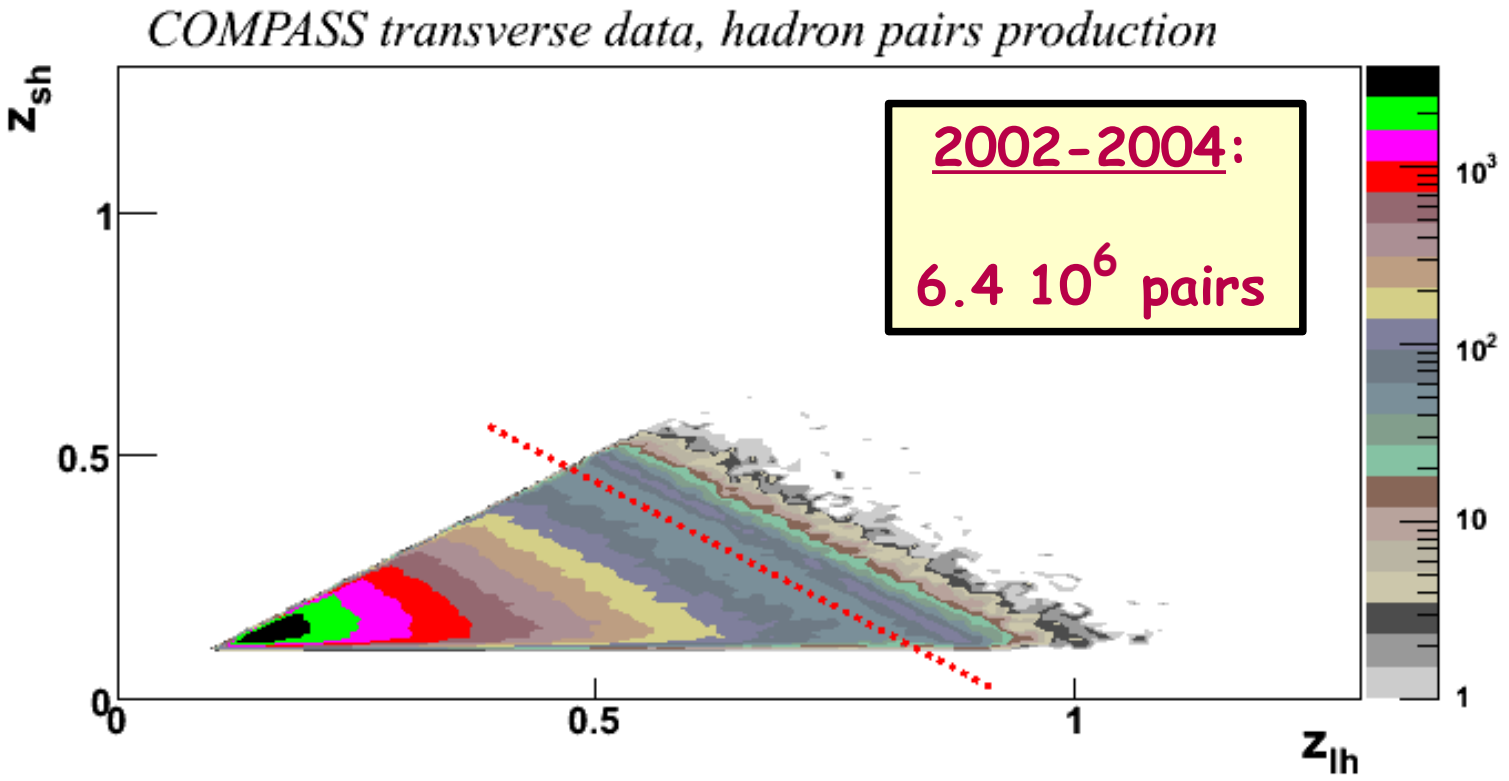




2-Hadron Asymmetries (z ordered pairs)

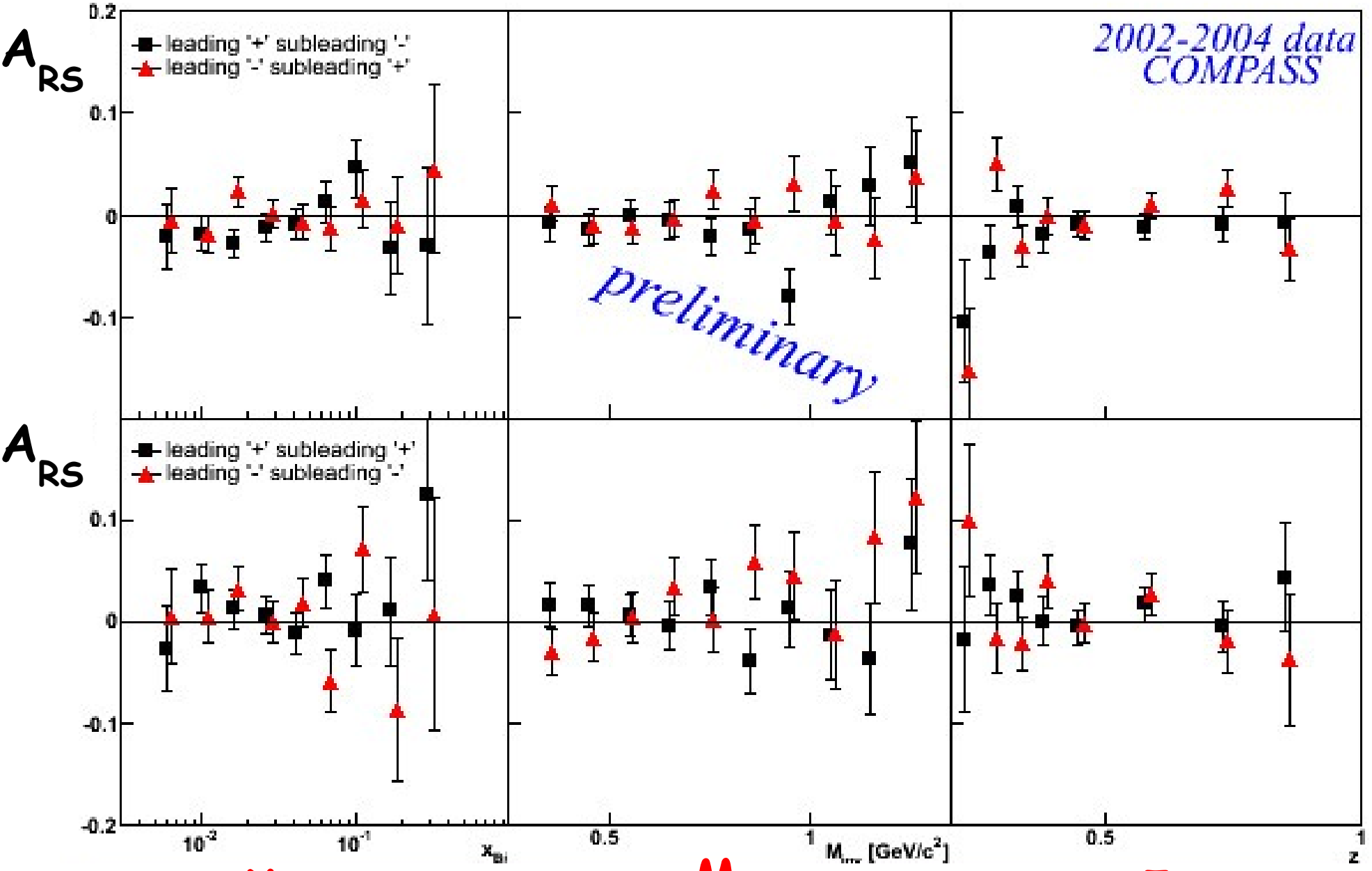
Select the combinations of leading (h_1) and next to leading (h_2) hadrons with:

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



+/+	19.2 %	+/-	34.2 %
-/-	14.3 %	-/+	32.2 %

2-Hadron Asymmetries (z ordered pairs)



x_{Bj} M_{inv} z

Conclusion

- 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

- RICH identification of the hadrons will be included

- <u>COMPASS in 2007:</u>

  → complementary measurements with proton target planned.

Data (of comparable statistics) will be collected on a transversely polarized proton target (NH_3) and will allow for flavor separation.

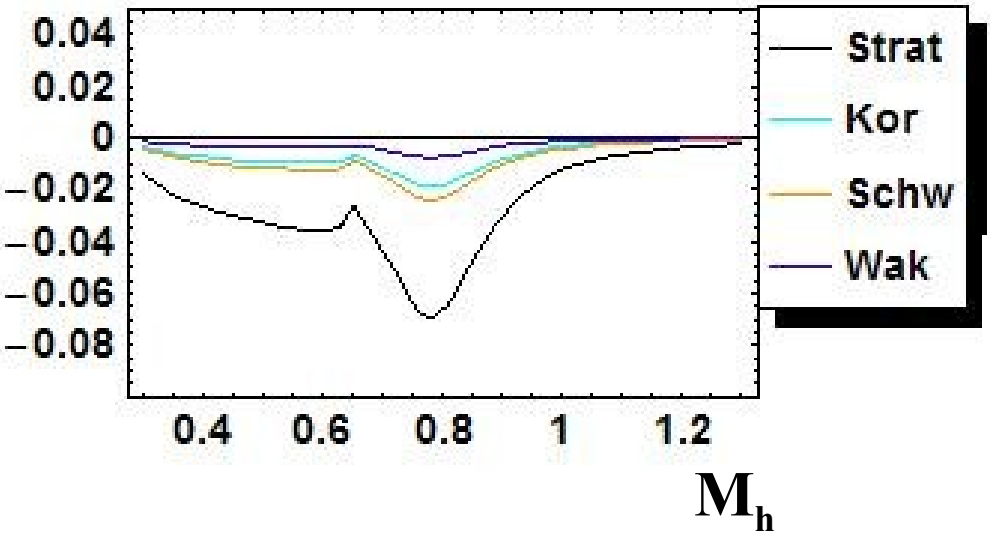
Outlook

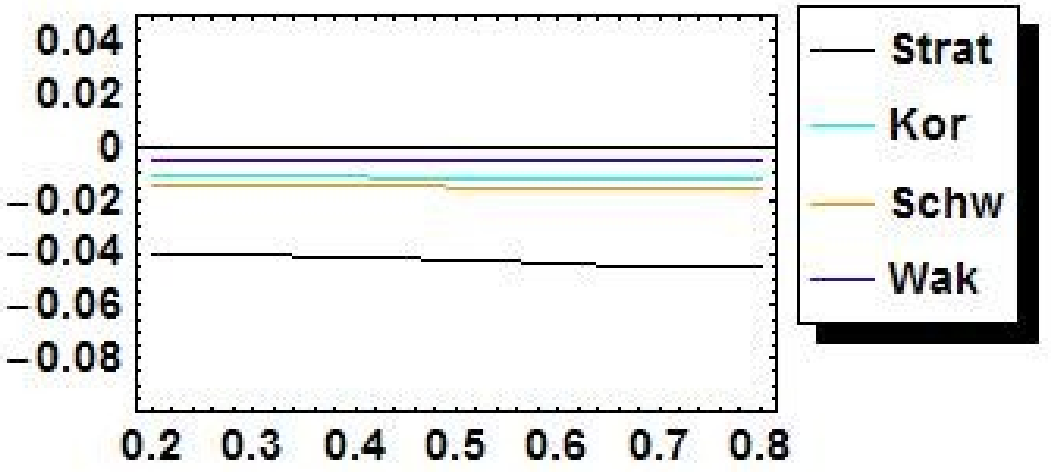
- Prediction for proton target:

Radici (QCD N'06):

spin asymmetry @ COMPASS

$0.004<x<0.4$; $0.1<y<0.9$
$Q^2>1\ GeV^2$





Thank you