spin 2004
16th international spin physics symposium

Transversity signals in two hadron correlations at COMPASS

Rainer Joosten, University of Bonn

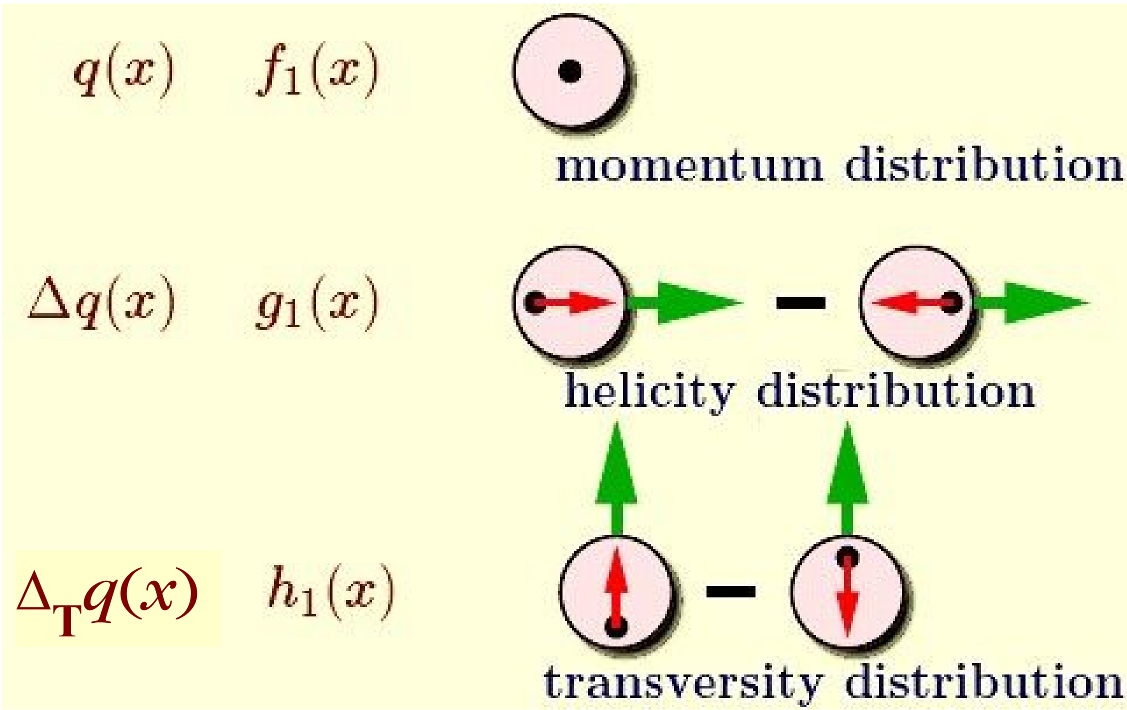
on behalf of the

COMPASS Collaboration

Trieste, October 10-16

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**

COMPASS: polarized μ^+ on a polarized ^{6}LiD target

Transverse Spin Physics

3 possible quark polarimeters suggested using SIDIS:

- Measure transverse polarization of Λ
- Azimuthal distribution of leading hadrons ← P. Pagano !
- Azimuthal dependence of the plane containing hadron pairs ← This talk !

The coordinate system

Frame where:

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

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

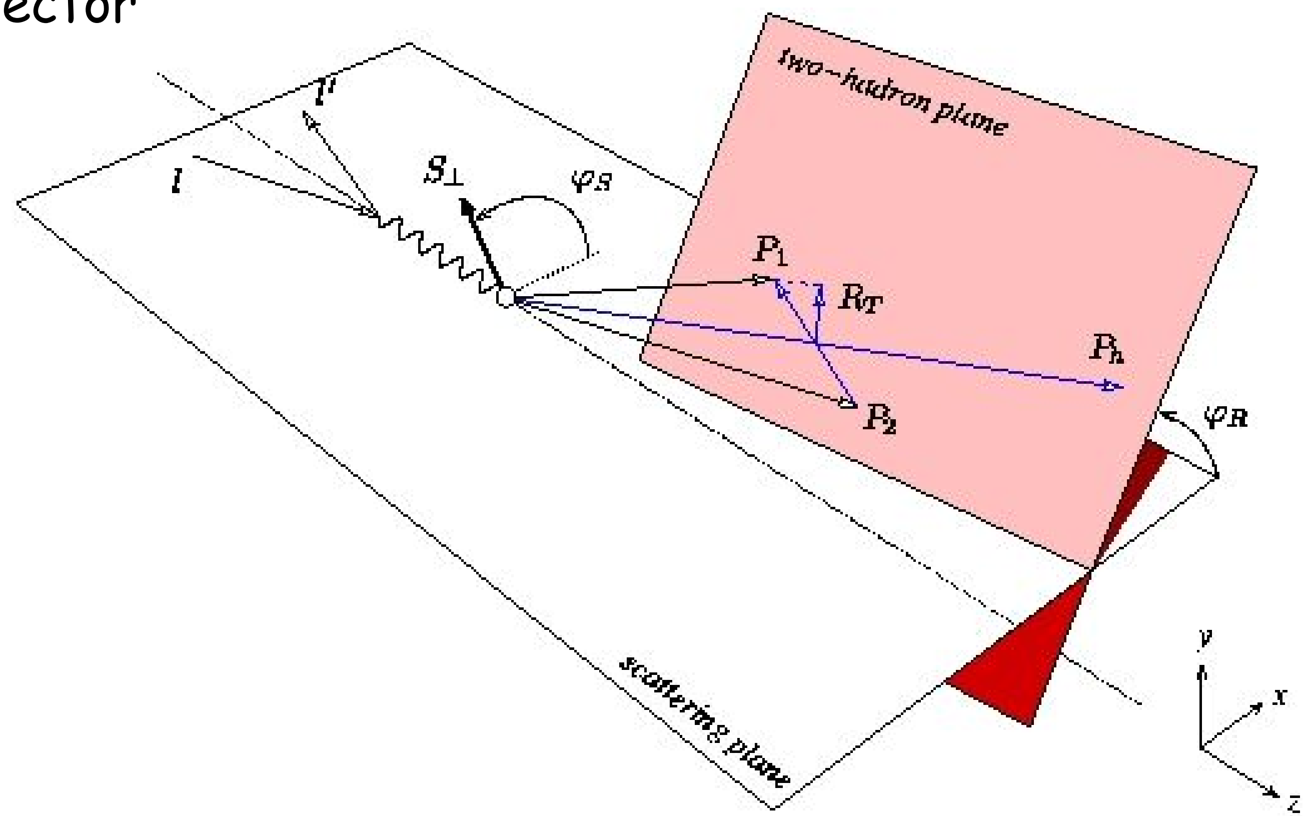
$\varphi_{S'}$ = azimuthal angle of spin vector of **fragmenting** quark with $\phi_{S'} = \pi - \phi_S$ (spin flip)

φ_R = azimuthal angle of the hadron plane

We define:

$$\varphi_{RS} = \varphi_R - \varphi_{S'}$$

$$= \varphi_R + \varphi_S - \pi$$



Transverse Spin Physics

The fragmentation function of a quark q into a pair h of two hadrons h_1 and h_2 can be written as:

spin dependent part

$$D_q^h(z,p_T^h) + H_q^{\sphericalangle h}(z,p_T^h)\sin\varphi_{RS}$$

$$\varphi_{RS} = \varphi_R - \varphi_{S'}$$
$$= \varphi_R + \varphi_S - \pi$$

Causing a count rate difference:

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

From this we get:

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

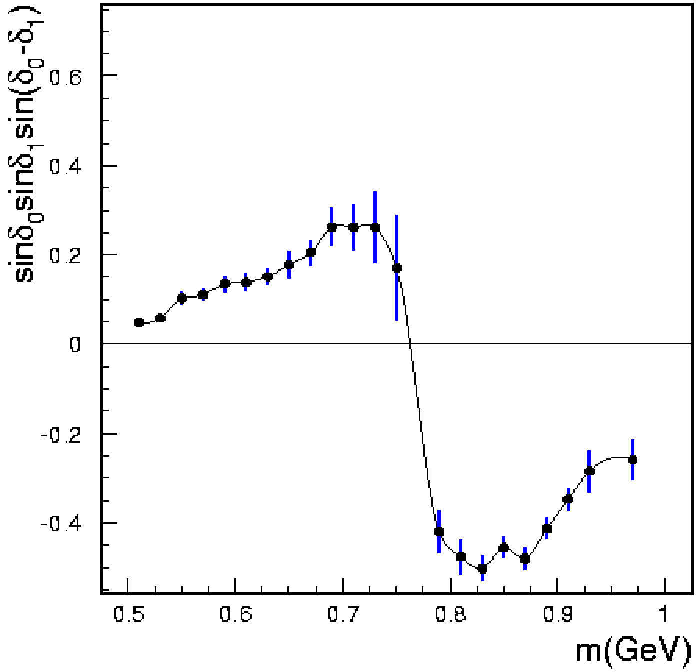
f dilution factor; P target polarization; $D_{NN} = (1-y)/(1-y-y^2/2)$ Depolarization factor

Interference fragmentation function

Example $\pi^+\pi^-$ fragmentation:

- $\pi^+\pi^-$ can be produced via the σ (I=0,L=0) and ρ (I=1,L=1) resonances
- Final state is a superposition of two resonant states with different relative phases

$$|\pi^+\pi^-,X\rangle = e^{i\delta_0}\,|\sigma,X\rangle + e^{i\delta_1}|\rho,X\rangle$$



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

leading to:

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

δ_0,δ_1 depend on $M^2_{\pi^+\pi^-}$ and can be obtained from $\pi\pi$ phase shifts

Data Sample

2002: 12+7 days of data taking (total)
with transversely polarized ^{6}LiD target
(separate analysis for both periods of data taking)

- $1.8 * 10^9$ events
- $1.3 * 10^6$ events after all cuts (preliminary)

2003: 14 days of data taking
with transversely polarized ^{6}LiD target

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

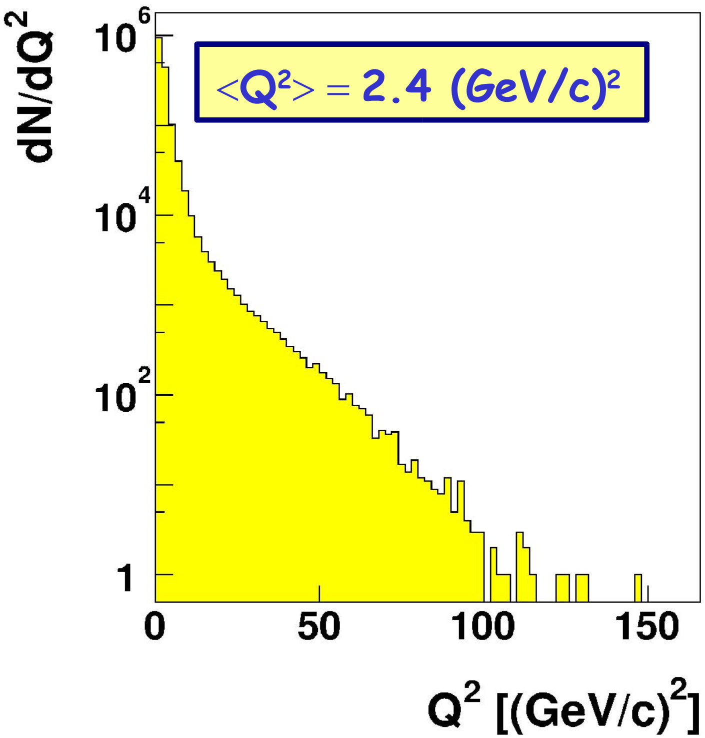
- ~ 2002+2003 data doubled

Event selection (1)

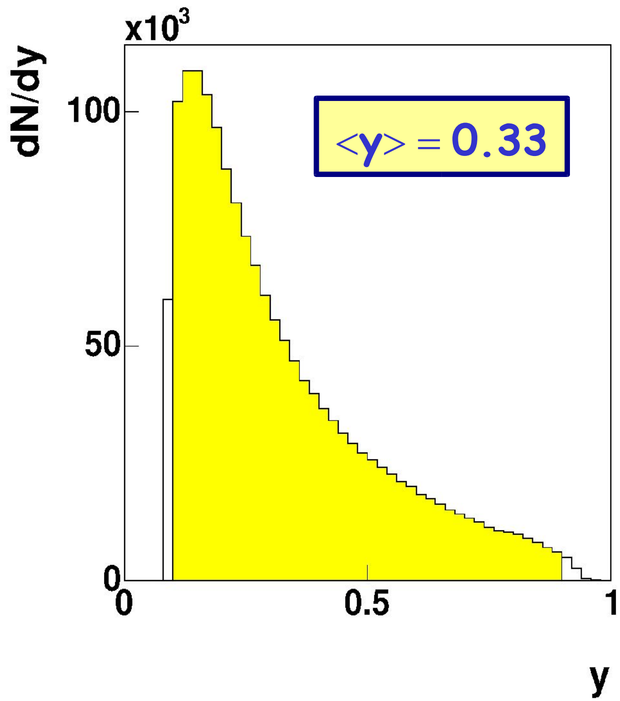
- Primary vertex with identified μ, μ'

Kinematical cuts:

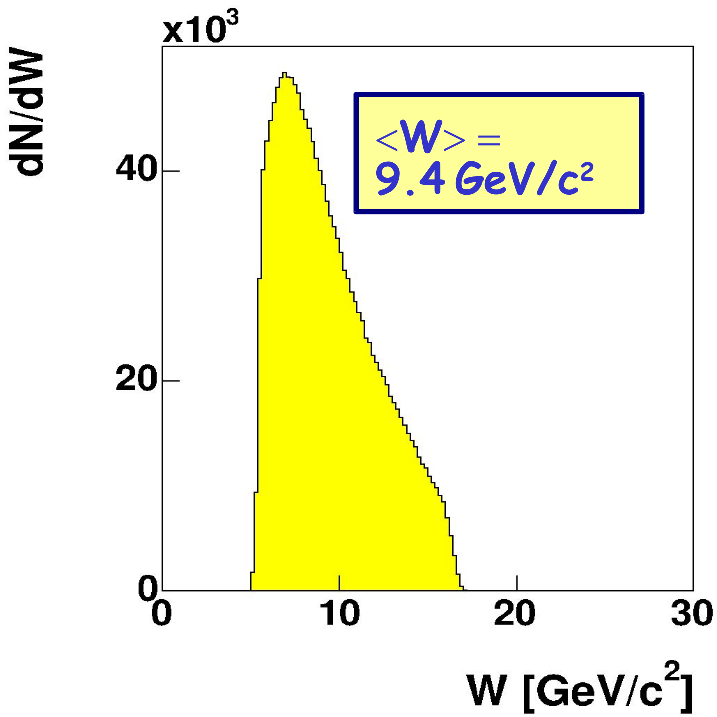
- $Q^2 > 1\ (GeV/c)^2$



- $0.1 < y < 0.9$



- $W > 5\ GeV/c^2$



Event selection (2)

Selection of hadron pairs:

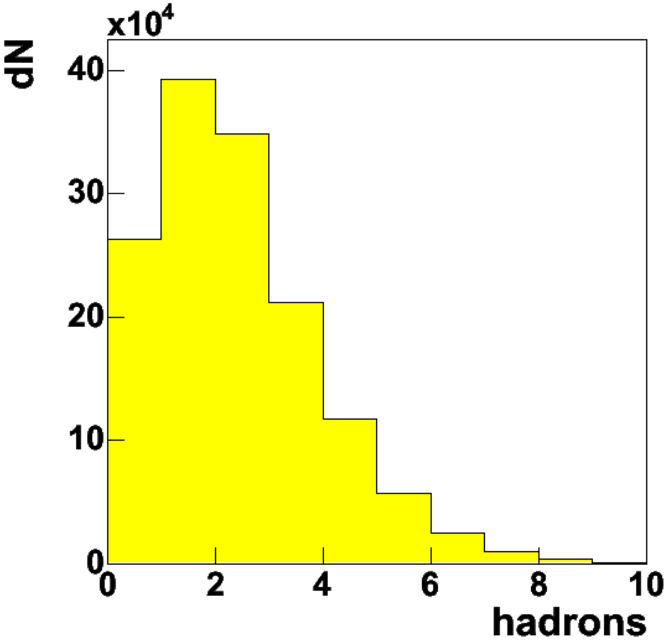
➔ leading (lh) and next to leading hadron (nlh) with

- Penetration $< 10\ X_0$
- Track quality $\chi^2_{red} < 10$

Presently no π / K / p separation by RICH

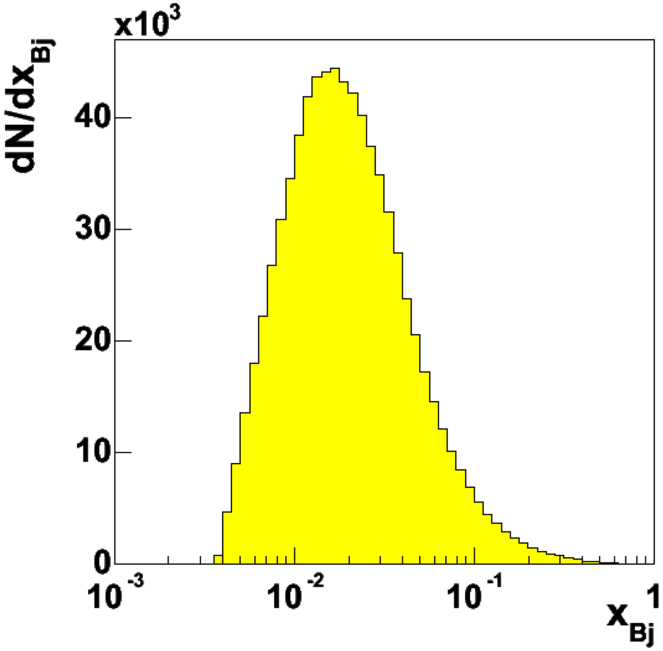
- Cut on lh based on kinematics: $z > 0.25$

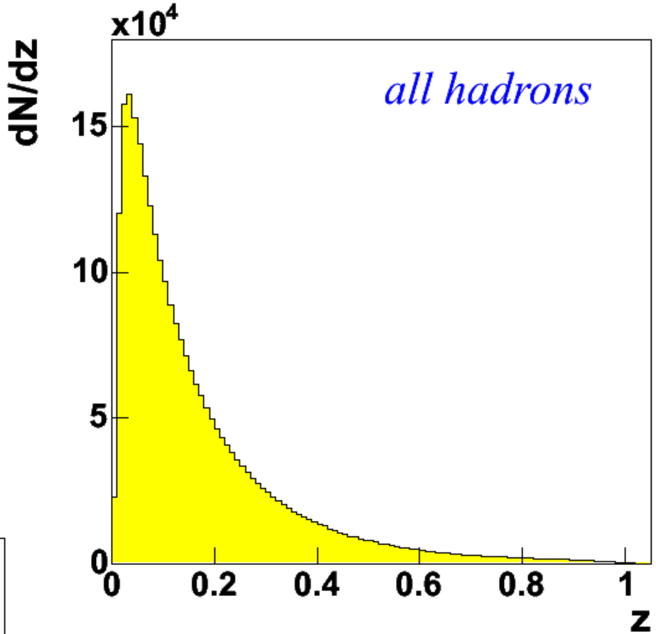
Hadron sample



$<N> = 1.9$

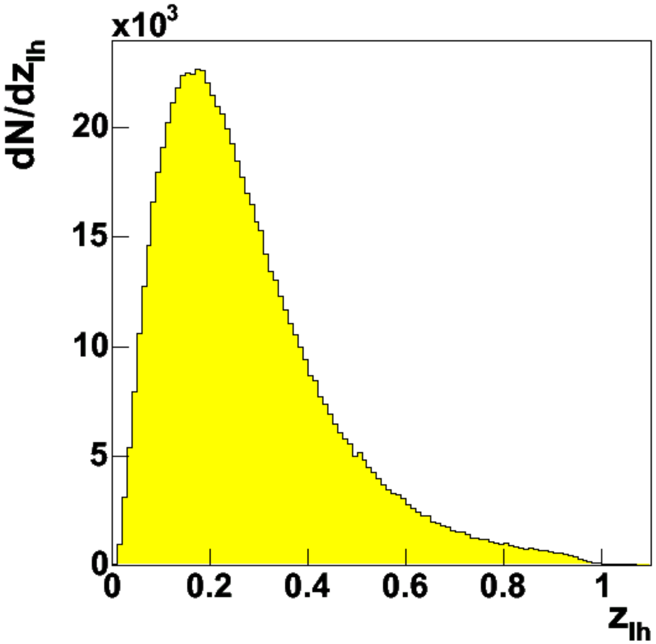
$<x_{Bj}> = 0.031$





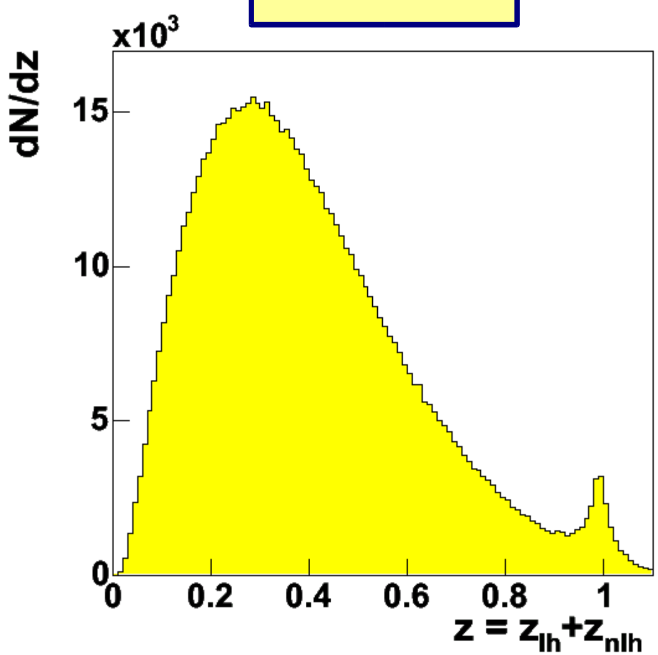
$<z> = 0.17$

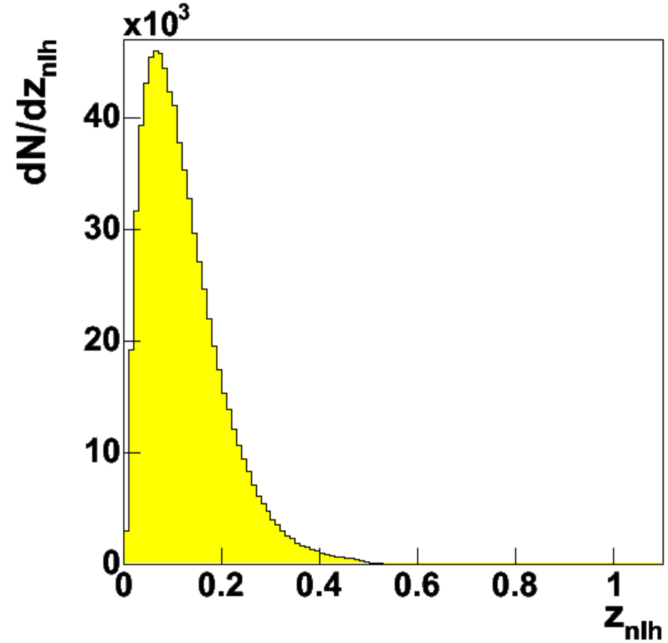
Hadron sample



$<z_{lh}> = 0.28$

$<z> = 0.40$

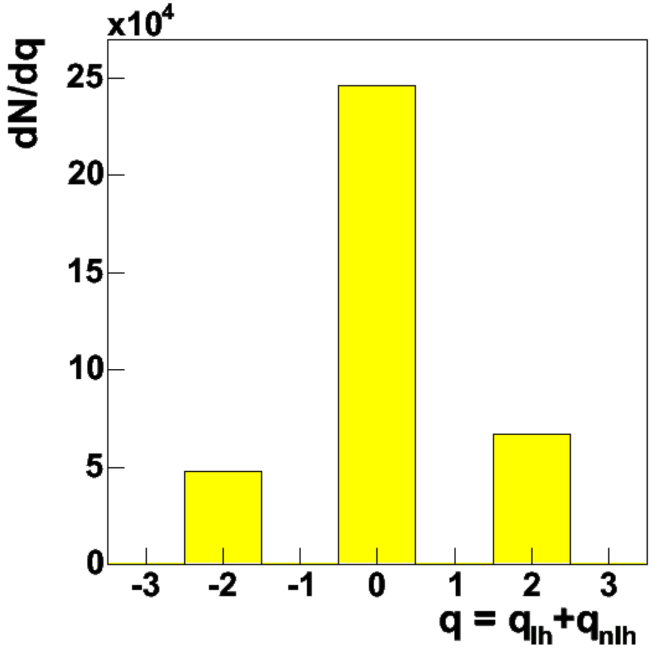


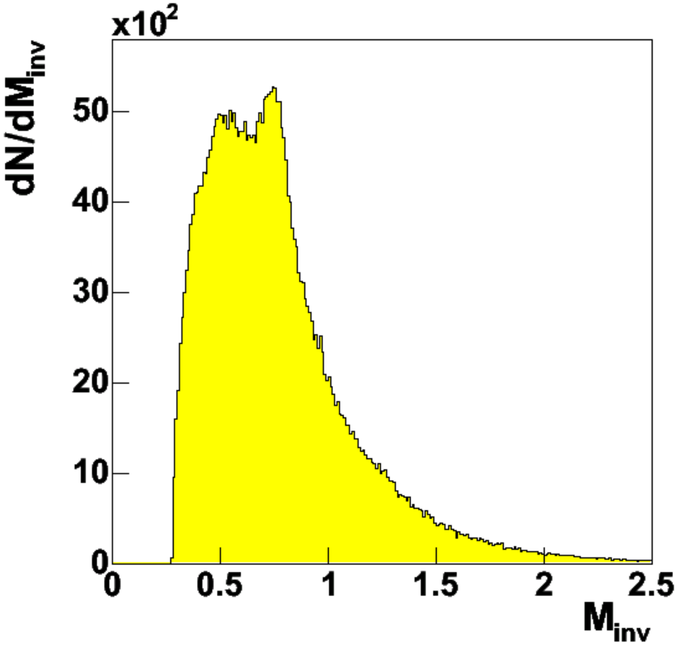


$<z_{nlh}> = 0.12$

Final sample

$z_{lh} > 0.25$

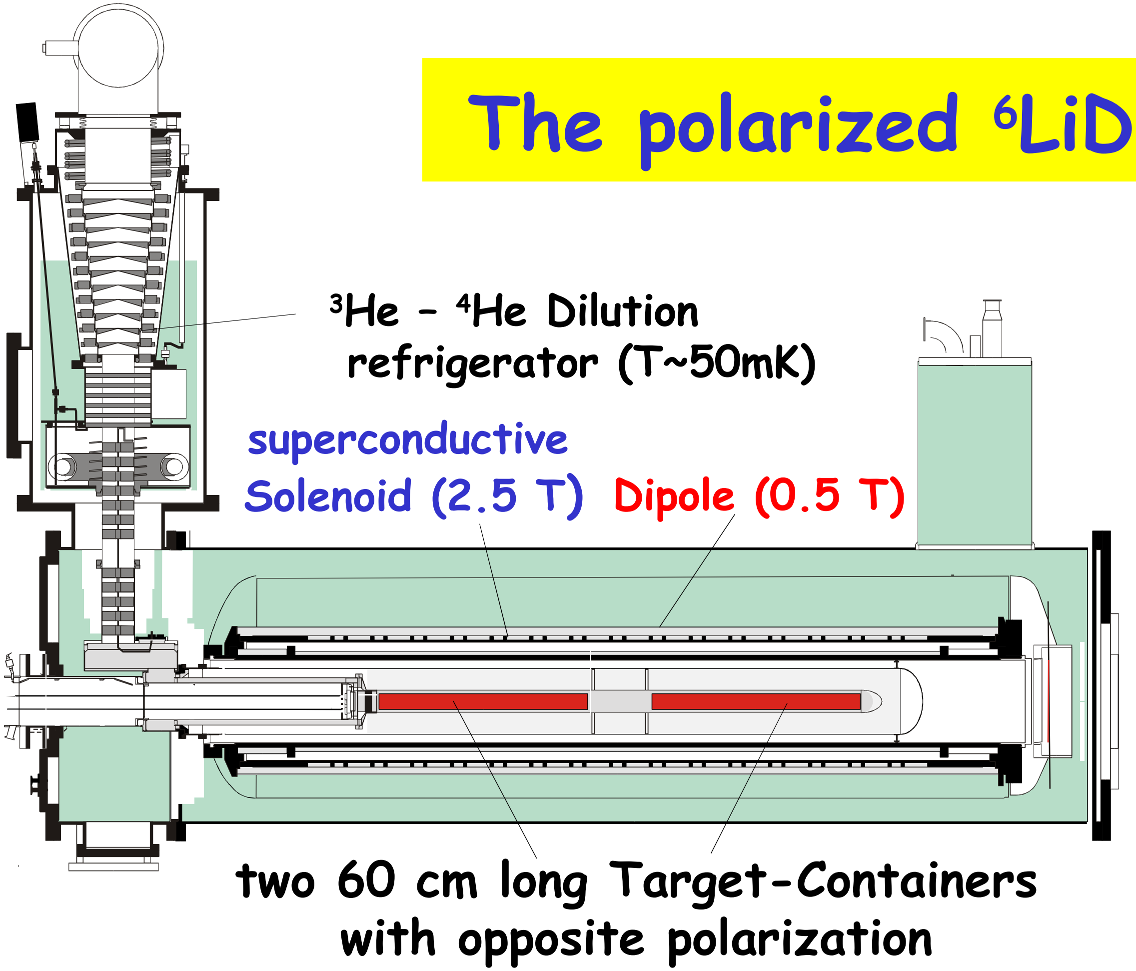




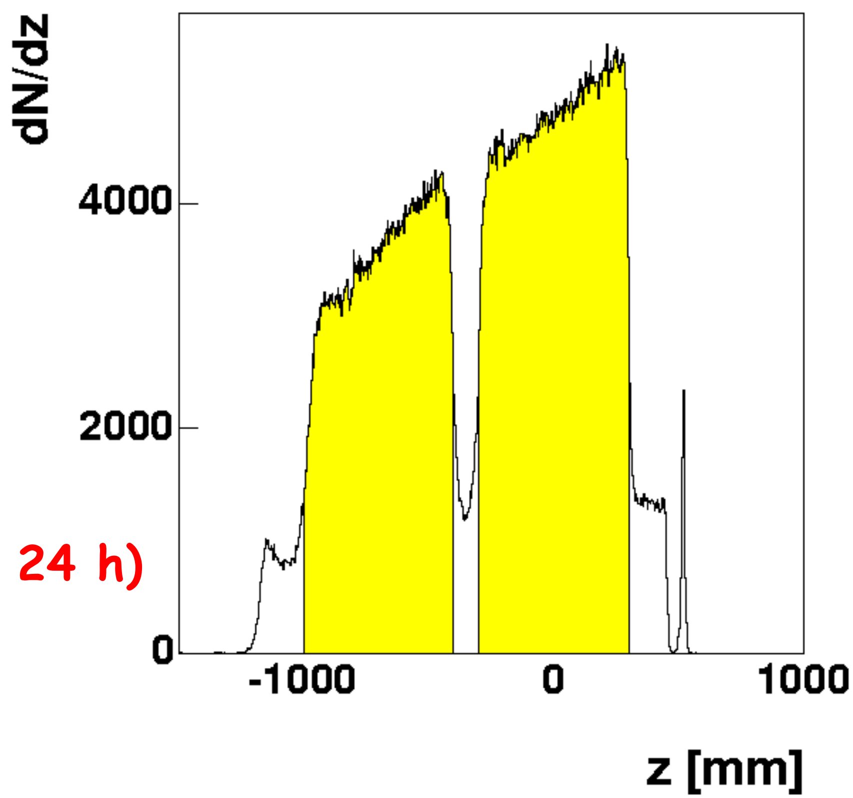
Final 2002 data statistics:

	1st period		2nd period	
	1st orientation	2nd orientation	1st orientation	2nd orientation
cell1	137k	141k	72k	123k
cell2	224k	231k	117k	195k

The polarized ^{6}LiD-Target



Polarization: 50%
Dilution factor: 0.38



During data taking for transversity:

dipole field always on and ↑

polarization changed by microwave reversal(~ 24 h)

Relaxation time:
transversal running > 2000 hrs

Asymmetry calculation

For each polarization and target cell we measure:

$$N(\varphi_{RS}) = N_0\{1 + A_{UT}^{\sin\varphi_{RS}} \cdot \sin\varphi_{RS}\} \cdot F_{acc}(\varphi_{RS})$$

To cancel out the acceptance function F_{acc} we additionally measure with opposite spins and subtract the normalized data-sets.

The counting rate asymmetry is then calculated for φ_{RS} bins by:

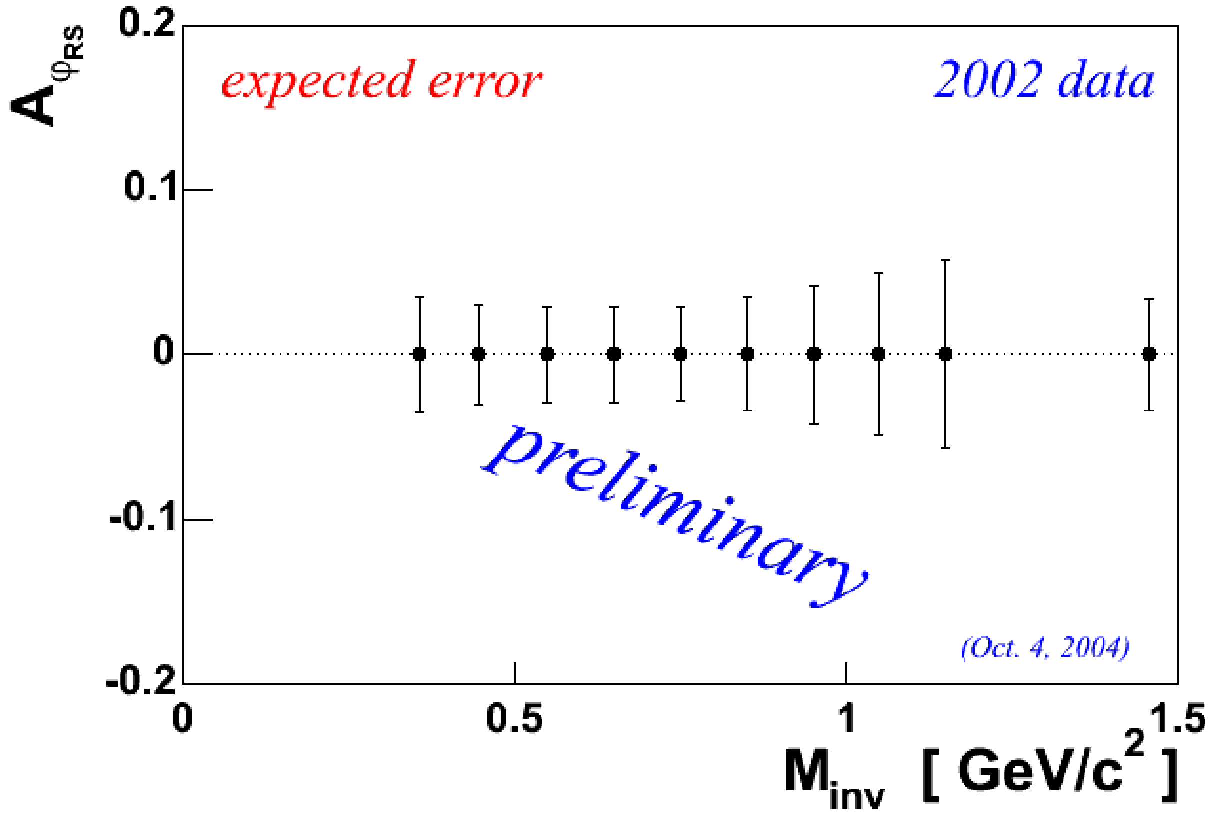
$$A_N(\varphi_{RS}) = \frac{N^+(\varphi_{RS}) - R \cdot N^-(\varphi_{RS})}{N^+(\varphi_{RS}) + R \cdot N^-(\varphi_{RS})} \qquad \text{where} \qquad R = \frac{N^+_{tot}}{N^-_{tot}}$$

The result is then fitted by: $A_0 + A_{UT}^{\sin\varphi_{RS}} \cdot \sin\varphi_{RS}$

So that we get: $$A_{\varphi_{RS}} = \frac{A_{UT}^{\sin\varphi_{RS}}}{D_{NN} \cdot f \cdot P}$$

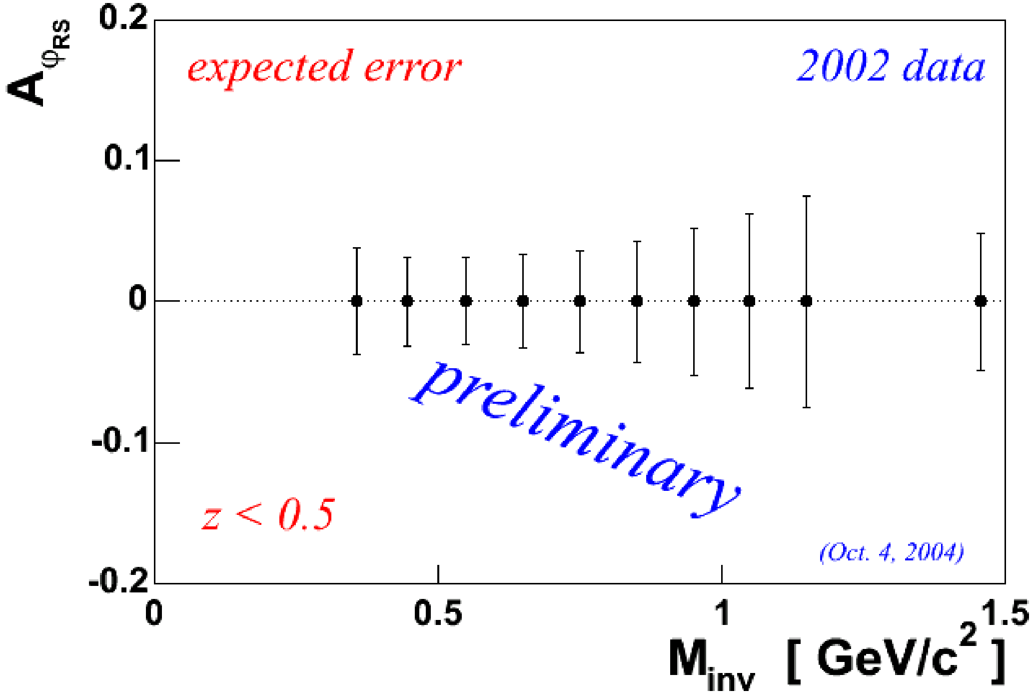
Expected asymmetry error (2002 data)

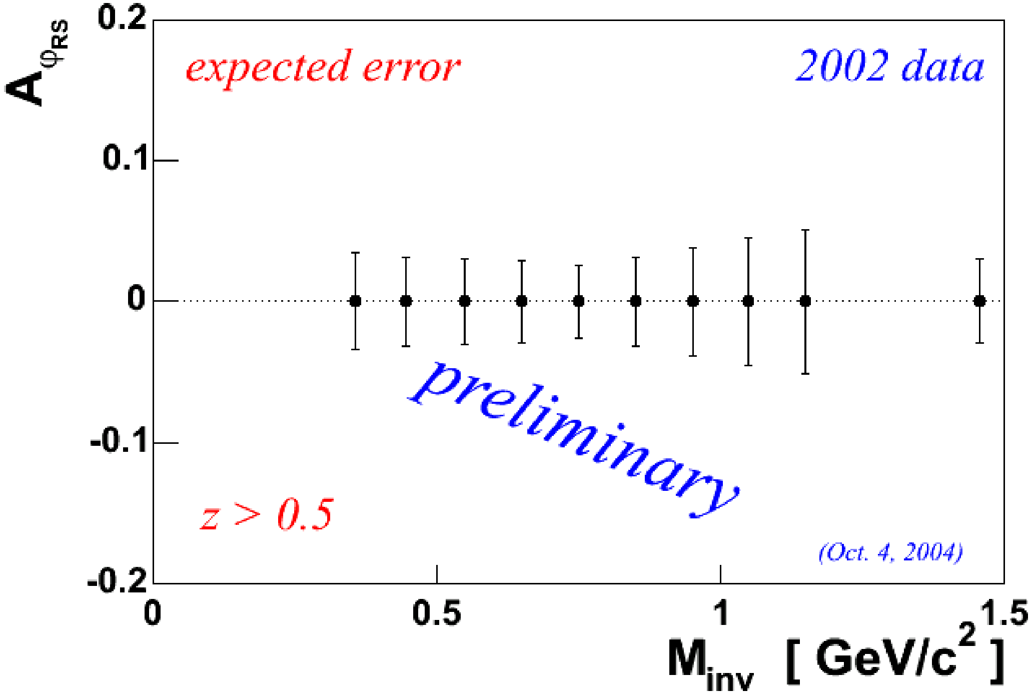
$$\Delta A_{\varphi_{RS}} = \frac{\Delta A_{UT}^{\sin\varphi_{RS}}}{D_{NN} \cdot f \cdot P} \longleftarrow \sim 1/6$$



Expected asymmetry error (2002 data)

$$z = z_{lh} + z_{nlh}$$





Conclusion & Outlook

- The analysis of our transverse target data concerning two hadron asymmetry signals started.

- The gathered statistics and estimated errors from the 2002 data are promising.

- Including 2003 & 2004 data
  → sensitivity improvement by factor ~ 2 expected

- The analysis is ongoing, and:

First results on two hadron correlations on a transversely polarised target can be expected in spring 2005

END of talk