Measurement of transversity signals in two hadron production at COMPASS

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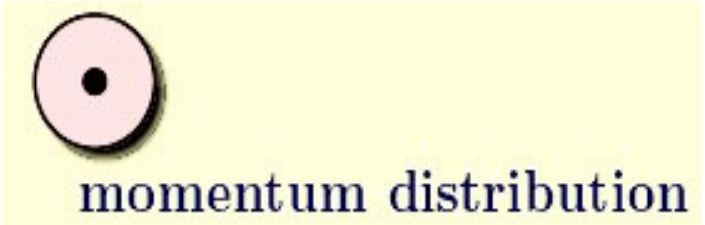
on behalf of the COMPASS-Collaboration

universitätbonn

RHEINISCHE FRIEDRICH-WILHELMS-UNIVERSITÄT

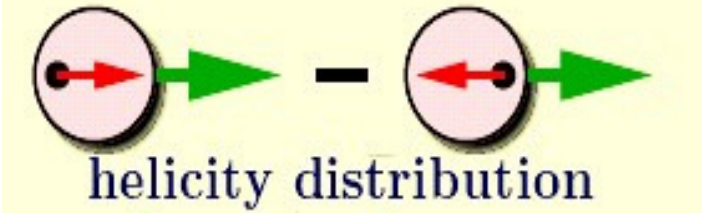
parton distribution functions

$q(x)$



=> well known - unpolarized DIS

$\Delta q(x)$



=> known - polarized DIS

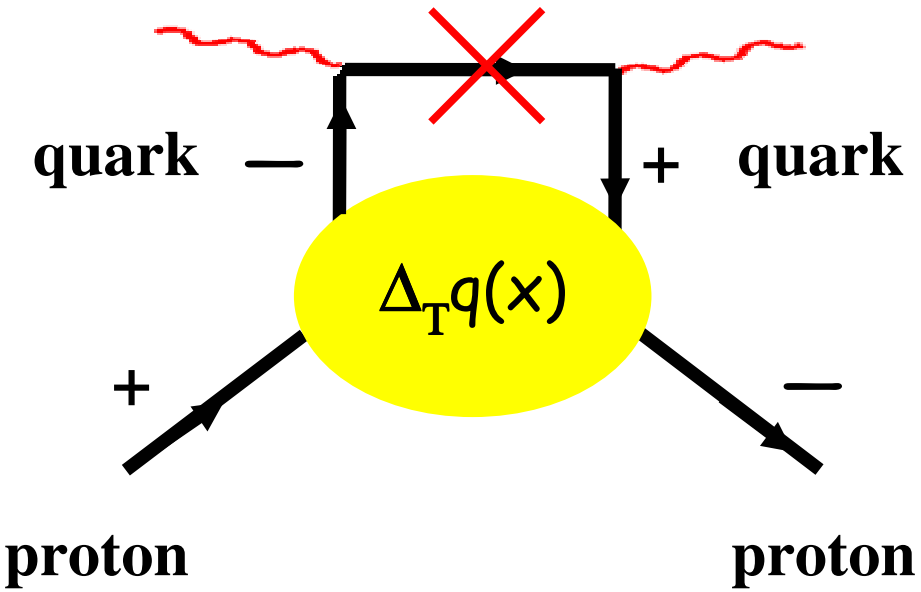
$\Delta_T q(x)$

=> still unknown

decouples from inclusive DIS because quark-spin must flip; => SIDIS;

measuring transversity

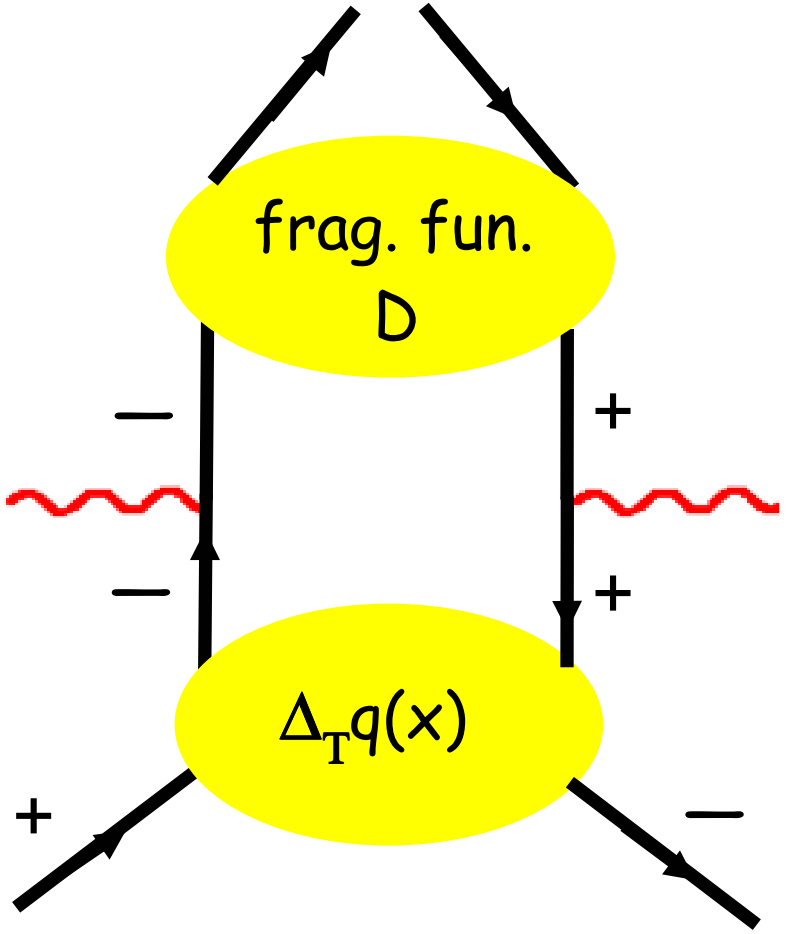
DIS



another chiral odd function is needed !

measuring transversity

SIDIS

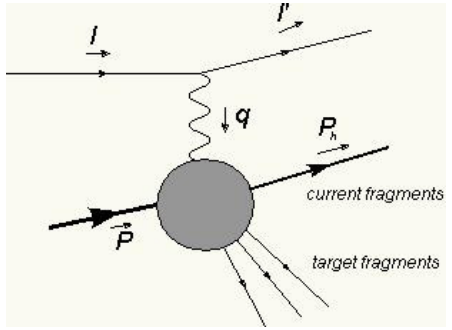


$$l + p \rightarrow l' + \pi + X$$

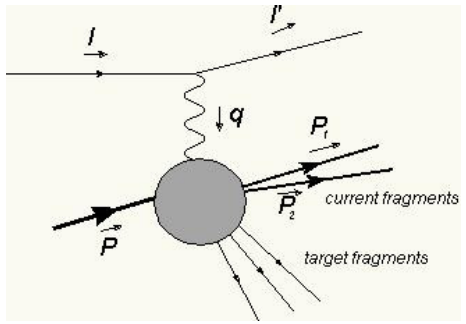
how to access transversity function ?

possible quark polarimeters:

- azimuthal distribution of single hadrons
  Collins fragmentation function (FF)

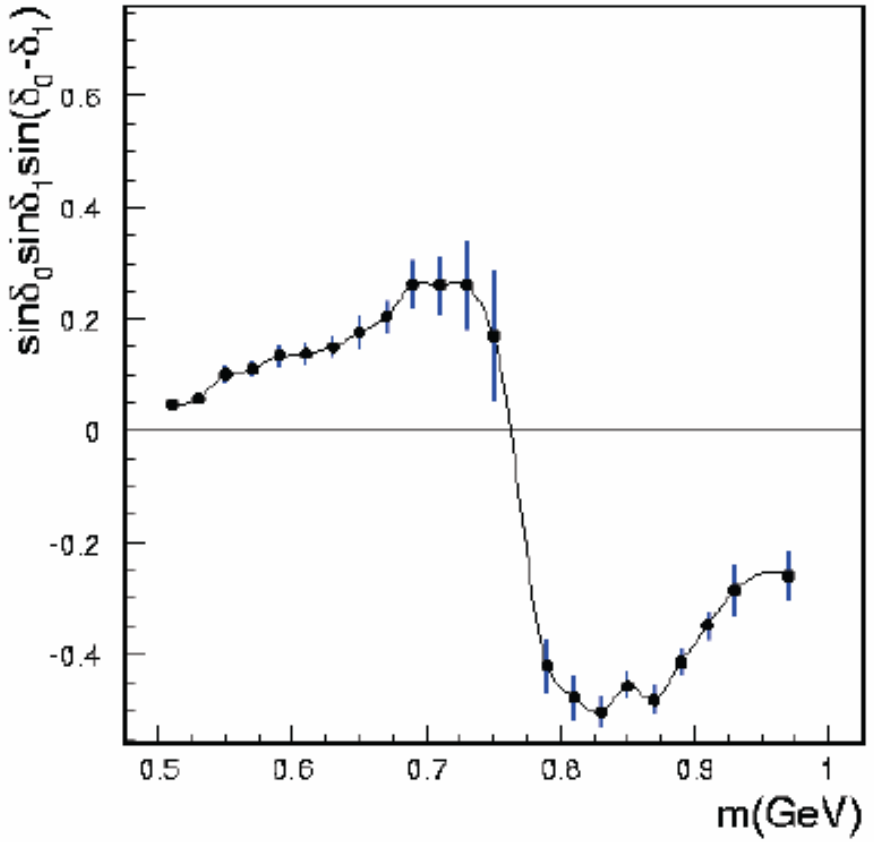


- azimuthal dependence of the plane containing the hadron pair
  2-hadron interference FF



- measurement of transverse polarization of Λ-baryons
  FF q→ Λ

interference fragmentation function

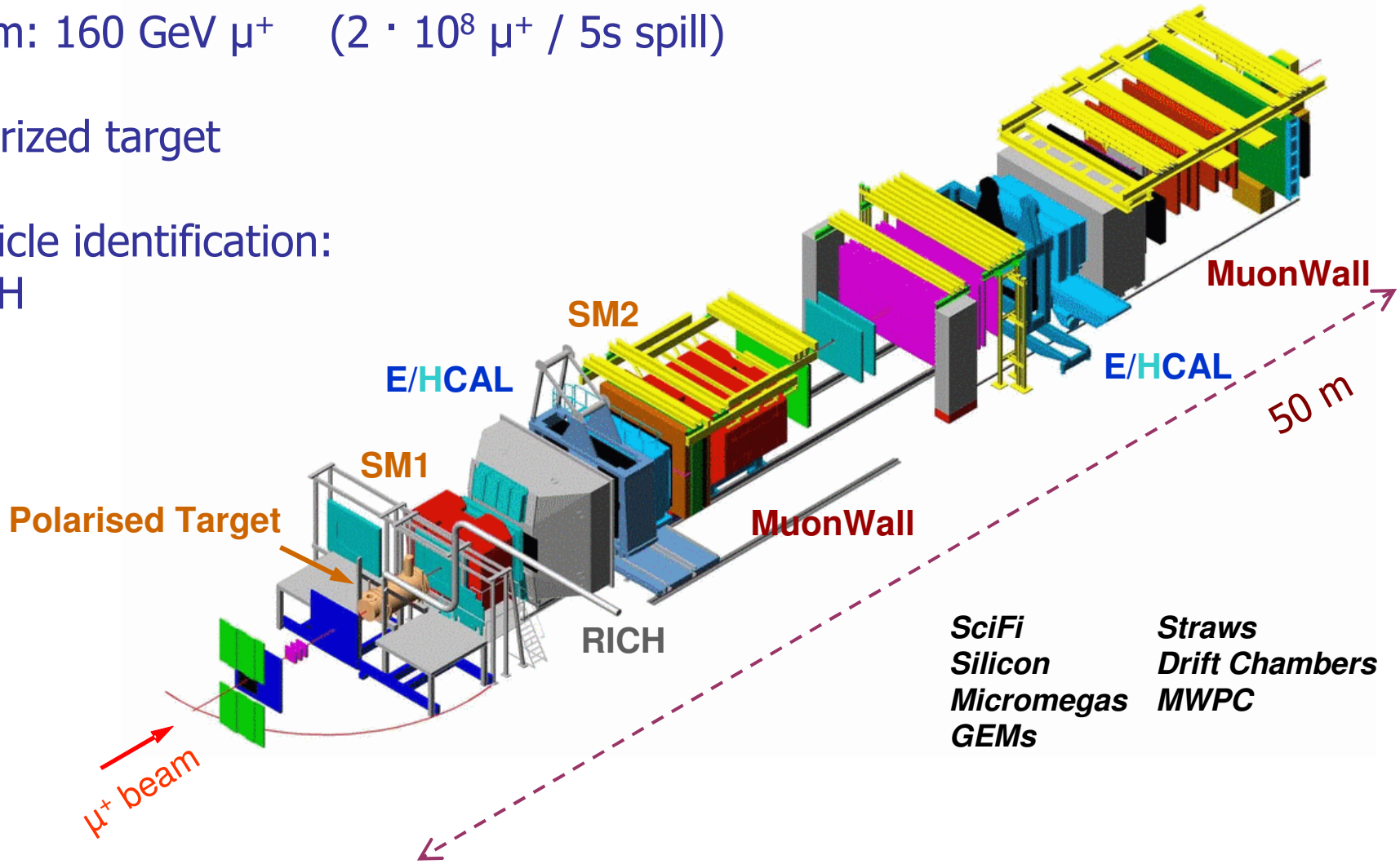


R. L. Jaffe, X. Jin and J. Tang,
Phys. Rev. Lett. 80, 1166 (1998)

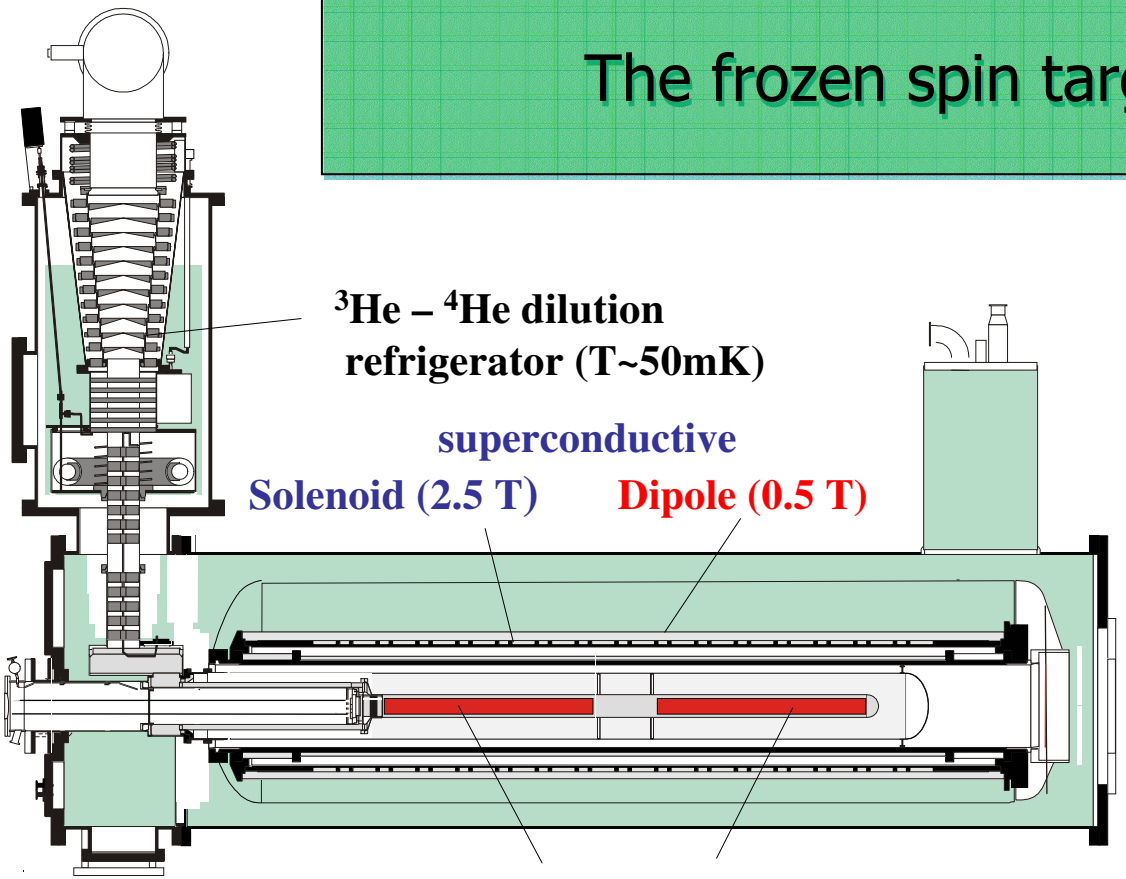
$$H^{\sphericalangle}(z,M^2_{\pi^+\pi^-}) \sim \sin\delta_0 \sin\delta_1 \sin(\delta_0-\delta_1)\hat{H}^{\sphericalangle}(z,M^2_{\pi^+\pi^-})$$

The COMPASS-spectrometer

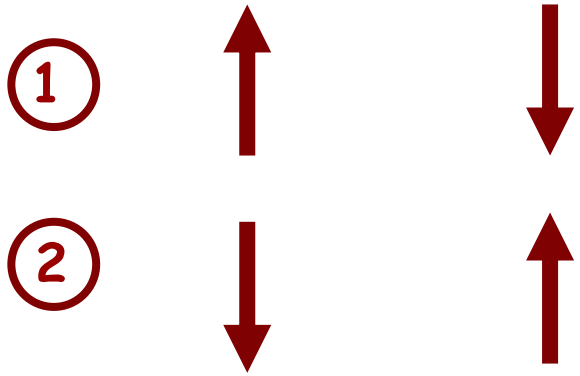
- beam: 160 GeV μ^+ ($2 \cdot 10^8$ μ^+ / 5s spill)
- polarized target
- particle identification:
  RICH



The frozen spin target



for transversity measurements the polarization was reversed once a week from 1 to 2



two 60 cm long target cells with opposite polarization

relaxation time > 2000 hrs

2002,2003,2004:	^{6}LiD
achieved polarization:	~50%
dilution factor:	~0.38

event selection for all plus-minus pairs

kinematic variables:

$Q^2 = -q^2 = 4EE'\sin\theta/2$

$x_{Bj} = Q^2/2M(E_k - E_{k'})$

$y = (E_k - E_{k'})/E_k$

$z = E_h/(E_k - E_{k'})$

- DIS cuts:

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

  $0.1 < y < 0.9$

- all uniden. +/- pairs
- all π+ π- pairs
- all π+ K- pairs
- all K+ π- pairs
- all K+ K- pairs

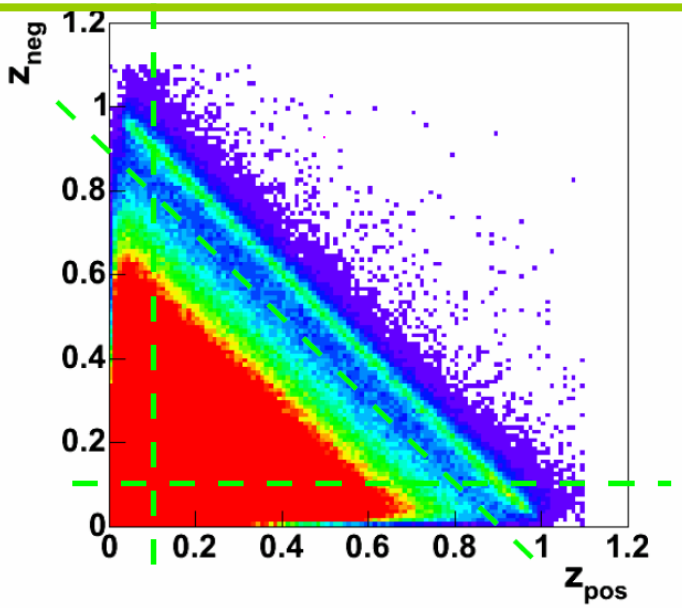
- current fragmentation

  $x_{fh1,h2} > 0.1$

  $z_{h1,h2} > 0.1$

- non exclusive ρ events

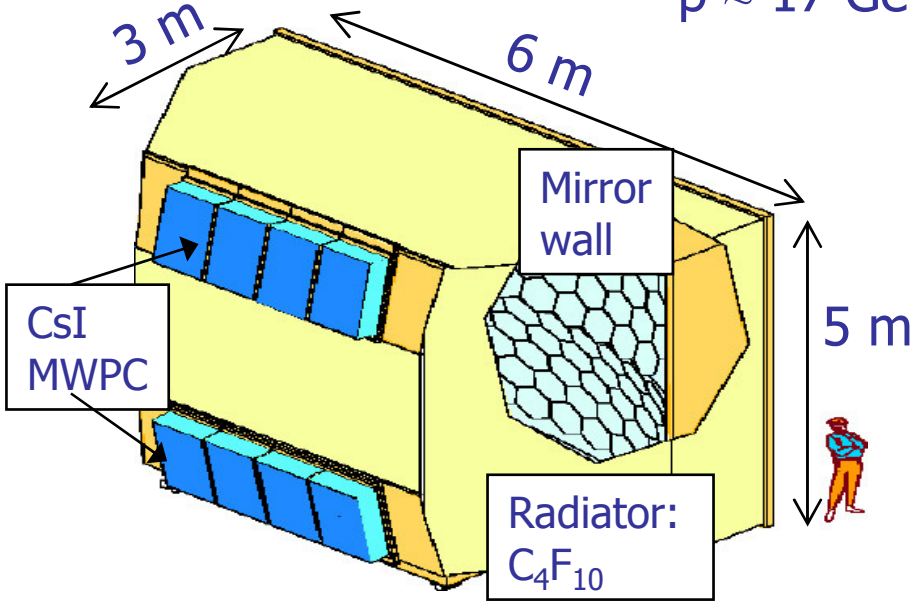
  $(z_{h1}+z_{h2}) < 0.9$

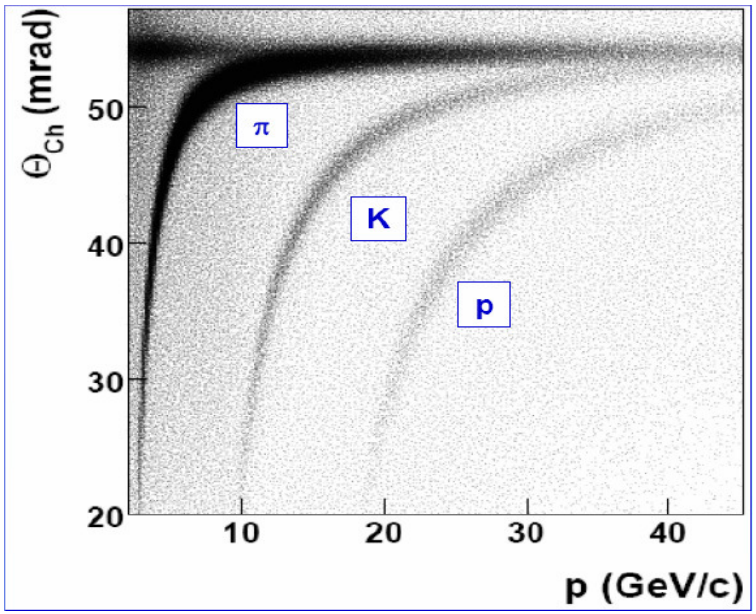


particle identification with Compass RICH

identification of π, K and protons
Cherenkov thresholds: $\pi \approx 3$ GeV/c
$K \approx 9$ GeV/c
$p \approx 17$ GeV/c

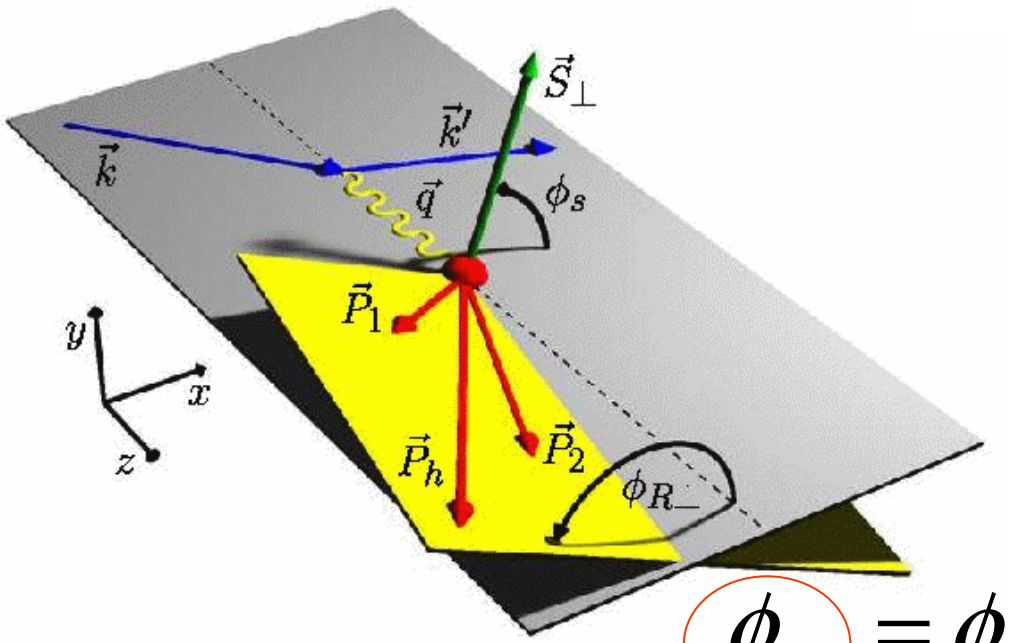
2σ π/K separation at 43 GeV/c





	without PID	π+ π-	π+ K-	K+ π-	K+ K-
total	$5.3*10^6$	$3.7*10^6$	$2.4*10^5$	$3.0*10^5$	$8.7*10^4$

two hadron production



kinematic variables:

$Q^2 = -q^2 = 4EE'\sin\theta/2$

$x_{Bj} = Q^2/2M(E_k - E_{k'})$

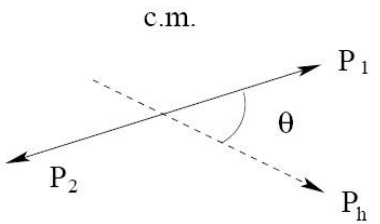
$y = (E_k - E_{k'})/E_k$

$z = E_h/(E_k - E_{k'})$

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

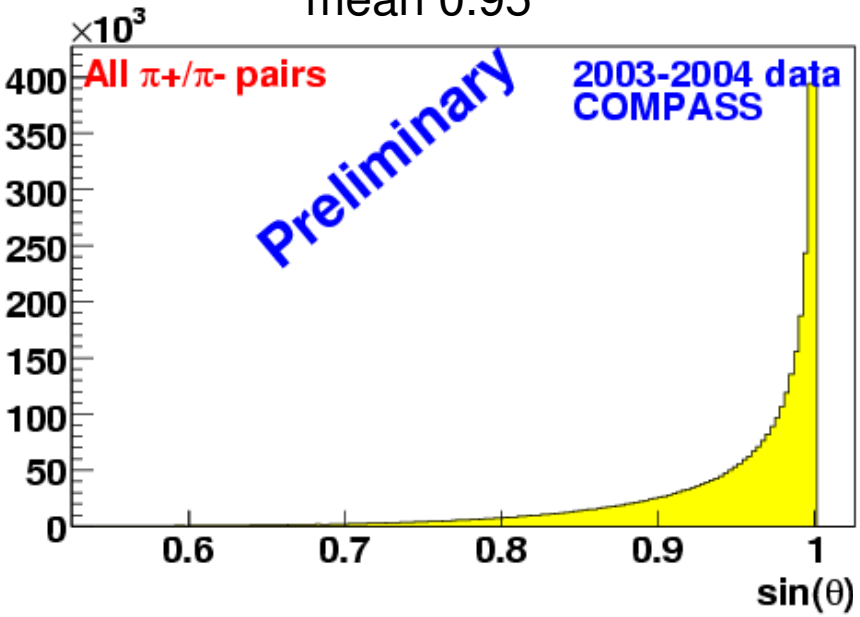
$$\Rightarrow \quad \sigma \propto \sigma_0 + \sin(\phi_{RS})\Delta_T q(x) H_1^{\sphericalangle}(z, M_h^2)$$

$$H_1^{\sphericalangle}(z, M_h^2) = H_{1,sp}^{\sphericalangle}(z, M_h^2) + \cos\theta H_{1,pp}^{\sphericalangle}(z, M_h^2)$$



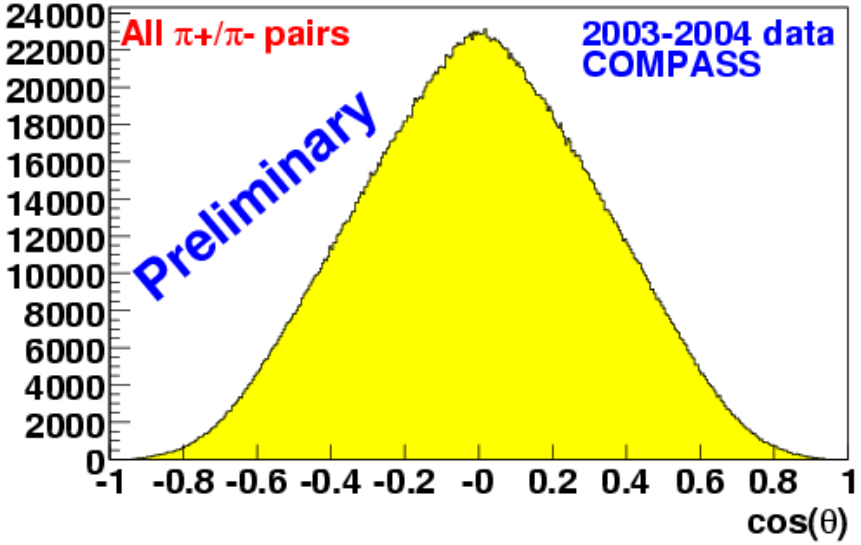
sin(θ) and cos(θ)

mean 0.95



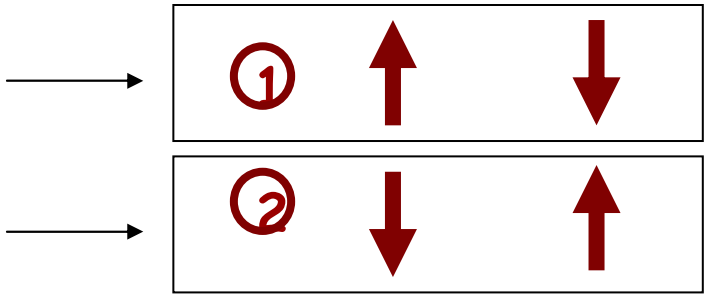
<= sin(θ) distribution for all π+ π- pairs

cos(θ) distribution for all π+ π- pairs =>



asymmetry extraction

target-cell configurations for the two weeks:



16 bins for ϕ_{RS} => $$D(\phi) = \frac{N_u^+(\phi_{RS}) * N_d^+(\phi_{RS})}{N_u^-(\phi_{RS}) * N_d^-(\phi_{RS})}$$

=> fitting function: $F(\phi_{RS}) = A_{2h0}(1 + 4A_{2h1}\sin(\phi_{RS}))$

A_{2h1} corresponds to the raw-asymmetry

=> relevant-Asymmetry: $$A_{\phi_{RS}} = \frac{A_{2h1}}{D_{NN} f P}$$

with dilution-factor: $f \approx 0.4$,target polarisation: $P \approx 0.5$ and $D_{NN} = \frac{1-y}{1-y+y^2/2}$

asymmetry extraction

$z=z_1+z_2$

$$A_{RS}(x,z,M_h^2)=\frac{\sum_q e_q^2\,\Delta_T q(x)\,H_q^{\angle h}(z,M_h^2)}{\sum_q e_q^2\,q(x)\,D_q^h(z)}$$

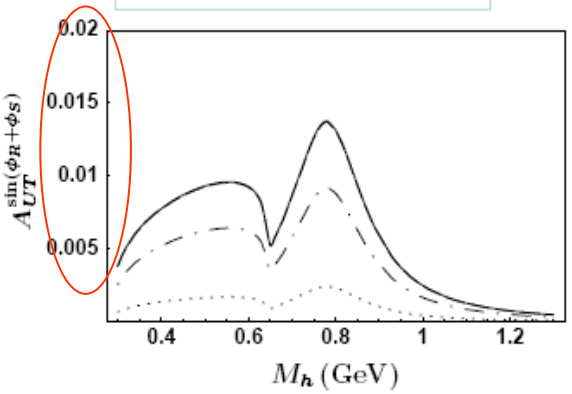
$H_q^{\angle h}(z,M_h^2)$ presently unknown
can be measured
in e^+e^- (BELLE)

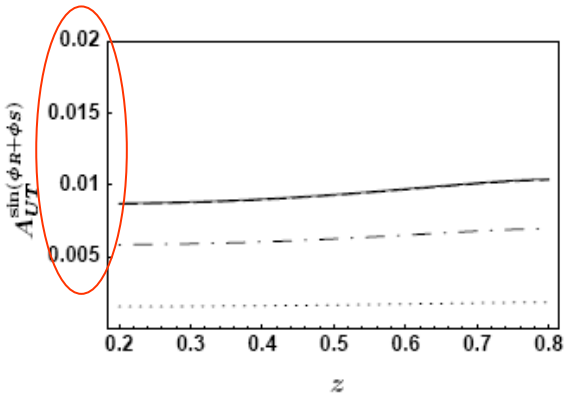
↓

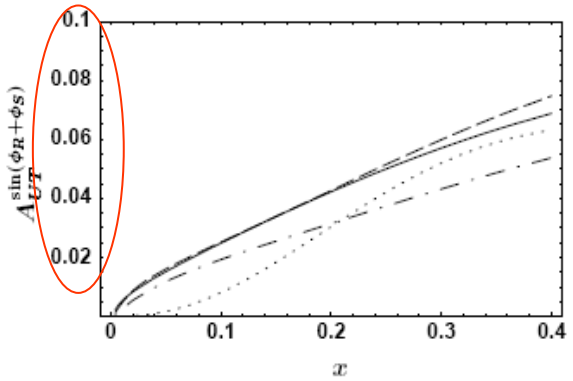
expected to depend on the hadron
pair invariant mass

predictions for resulting asymmetries for $\pi^+ \pi^-$ at COMPASS

deuteron-target

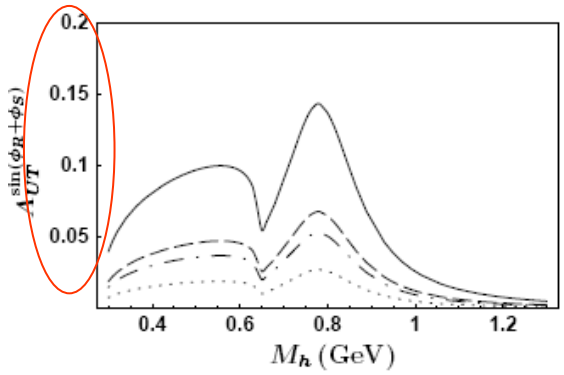


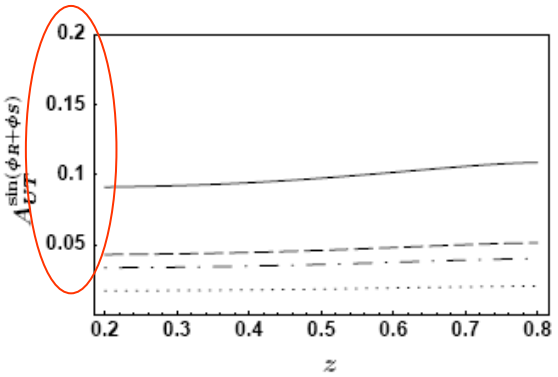


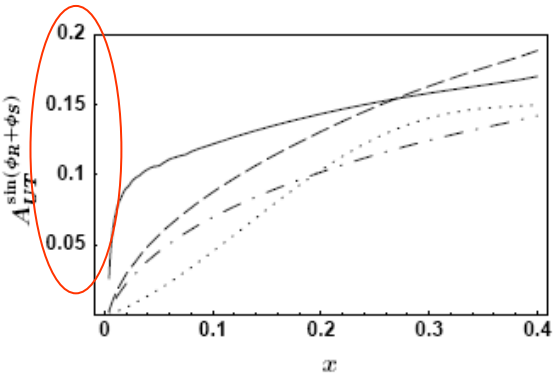


scale !!

proton target

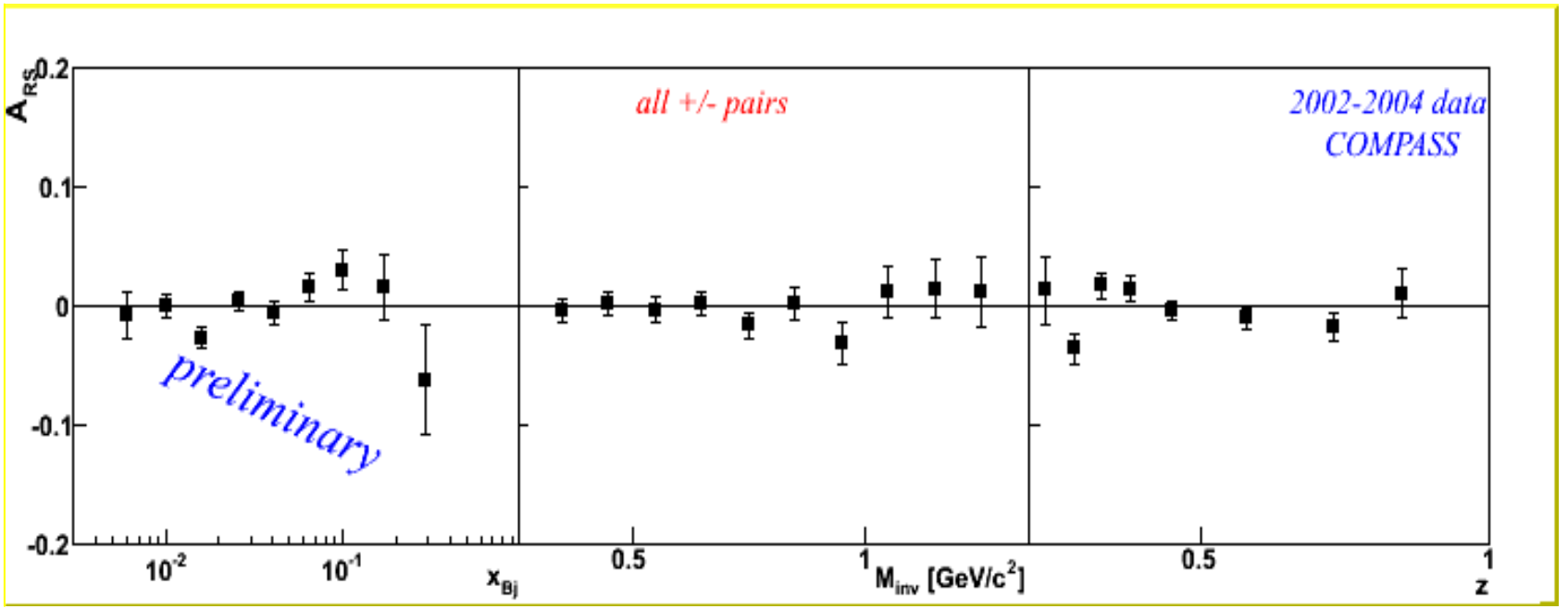




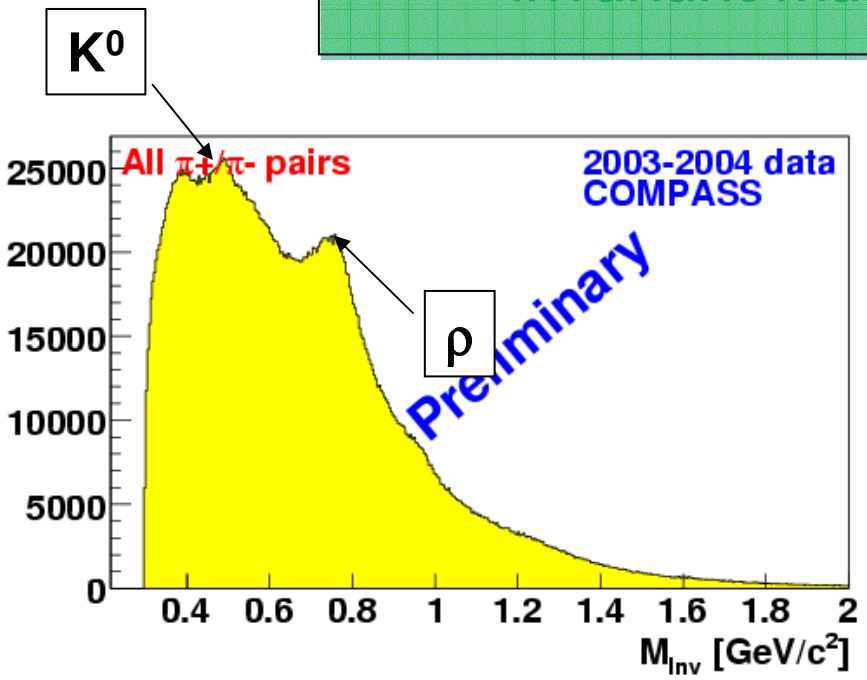


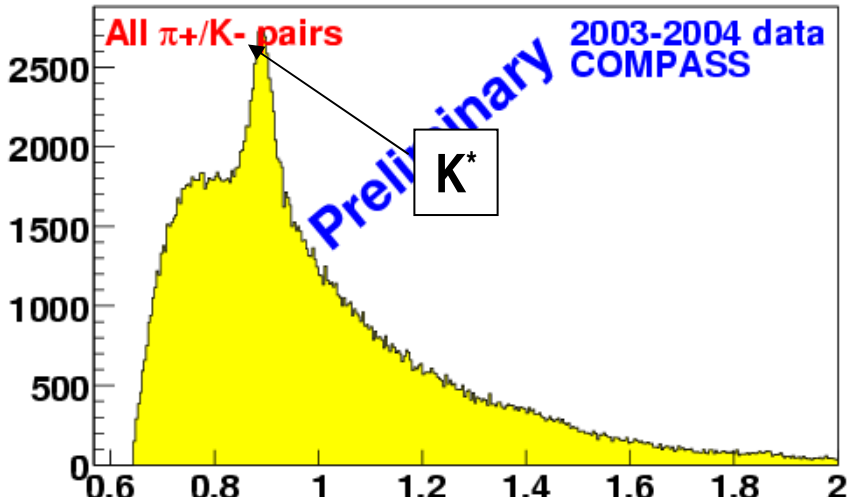
Bacchetta, Radici hep-ph/0608037

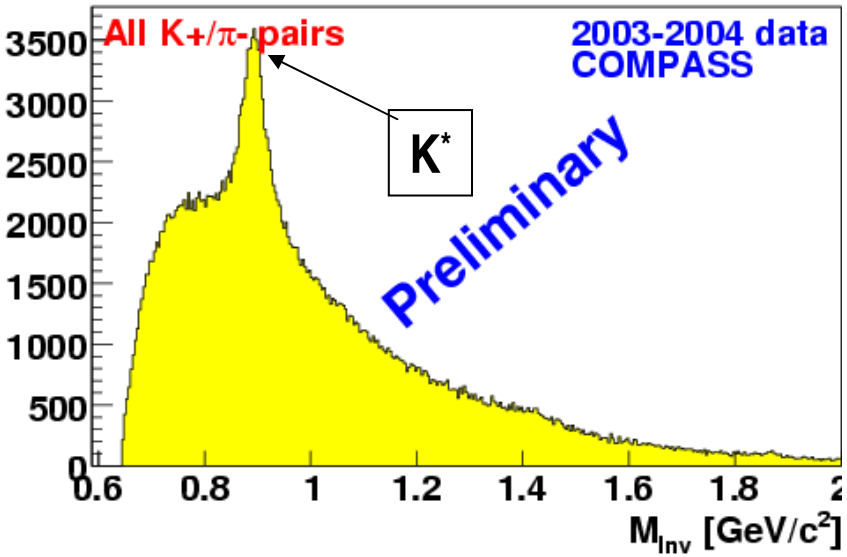
results for unidentified +/- pairs

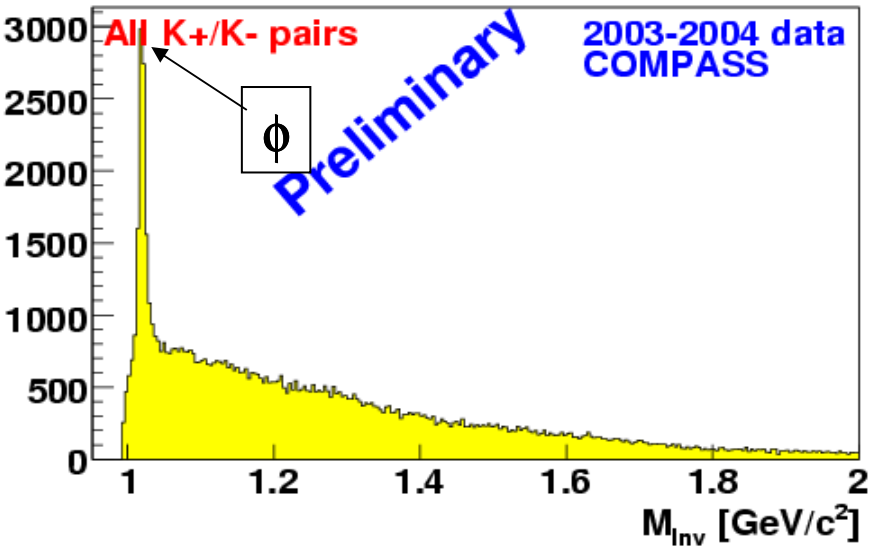


invariant mass distributions

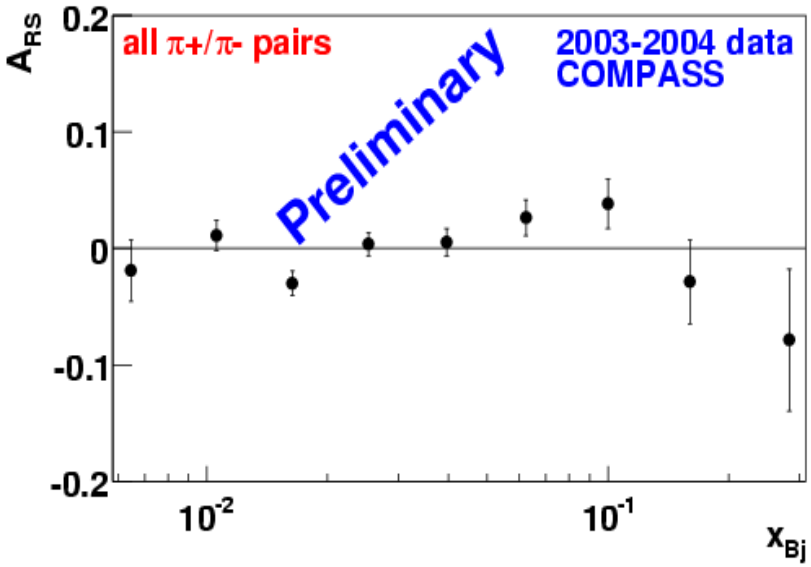


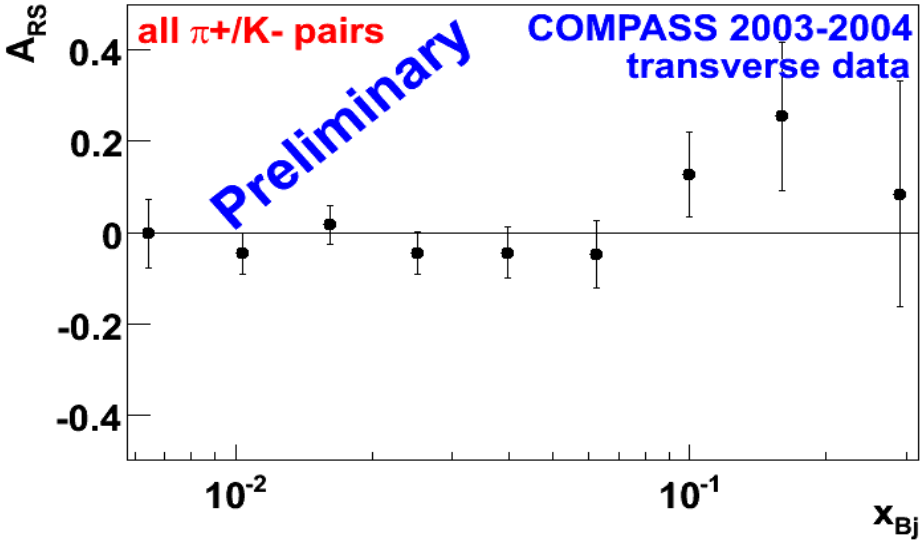


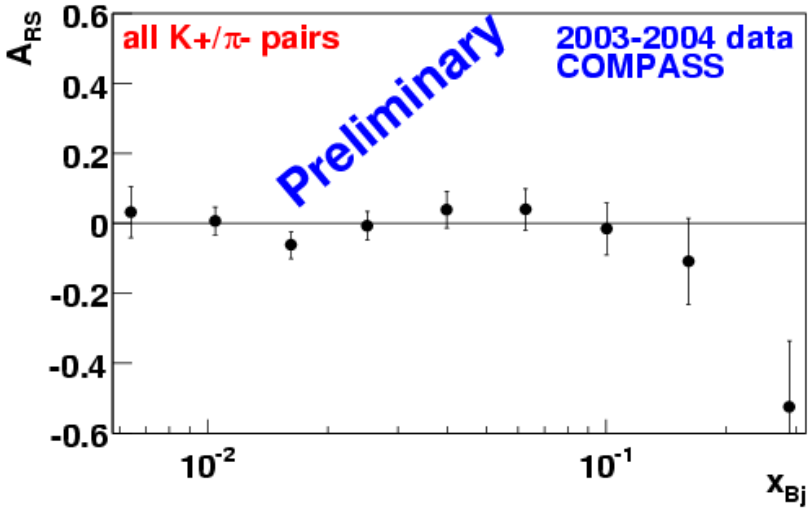


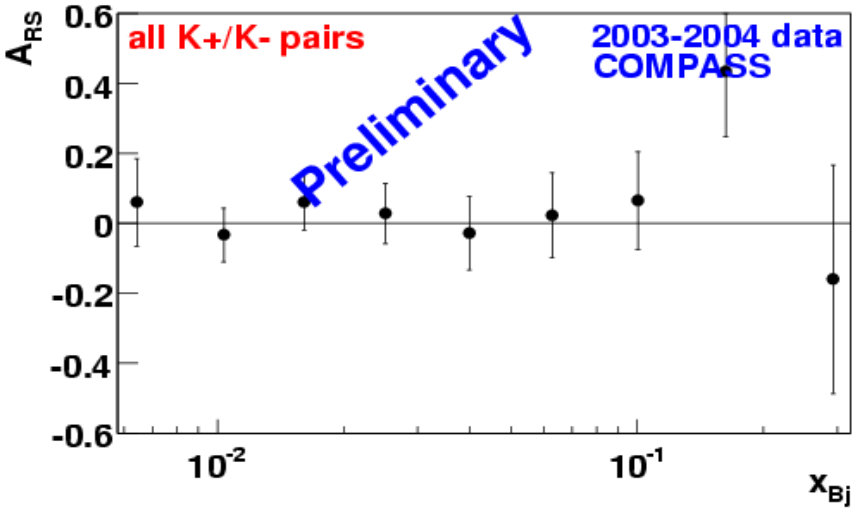


results for x_{Bj} binning

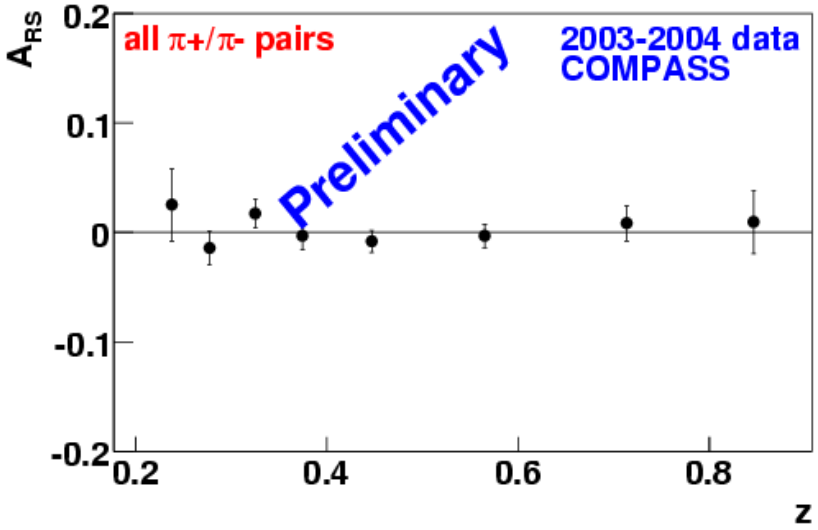


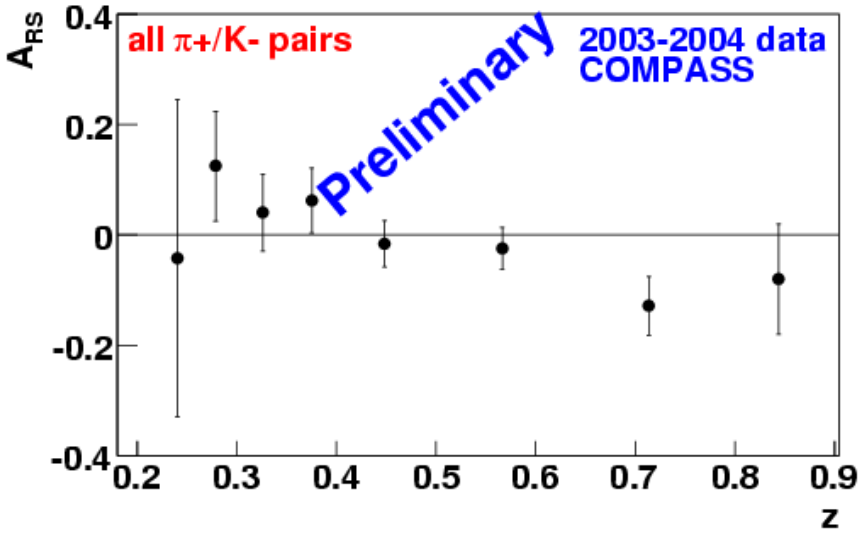


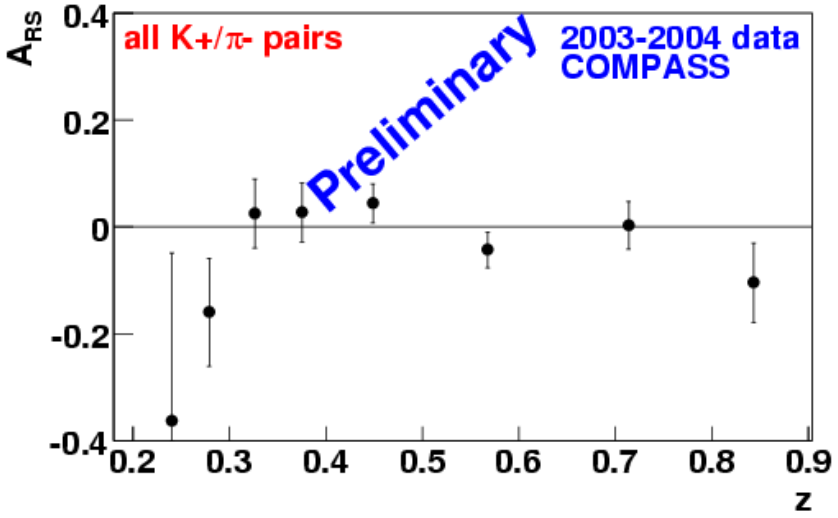


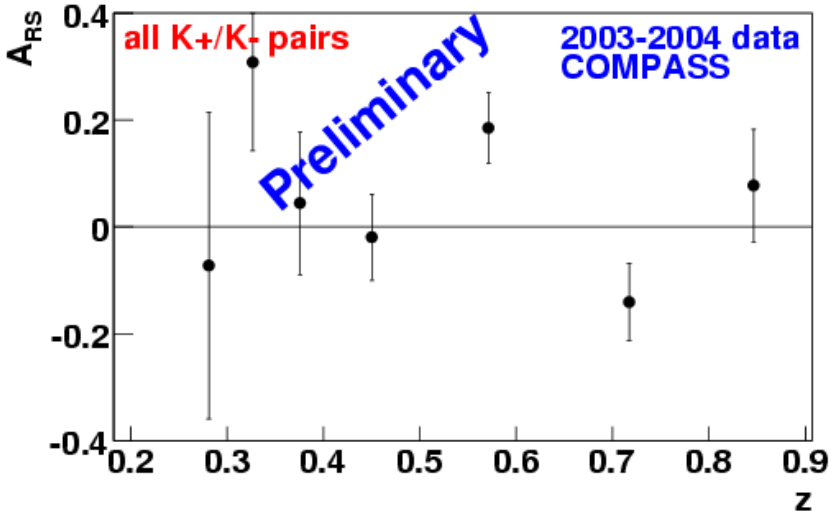


results for z binning

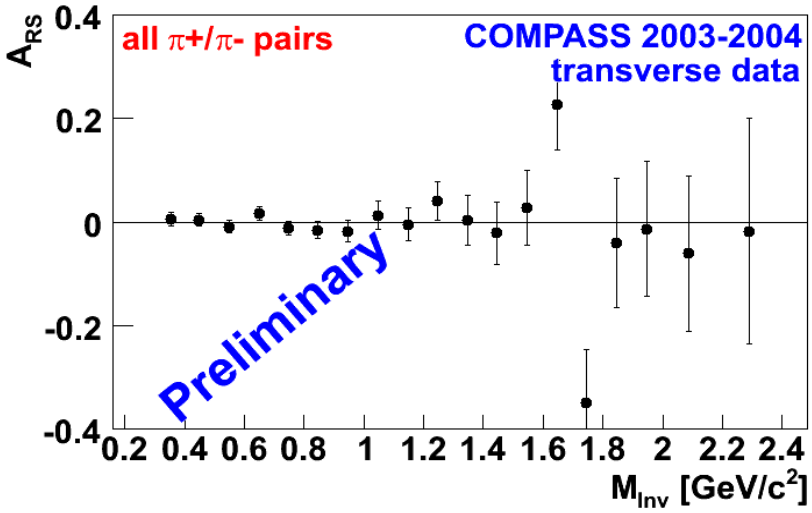


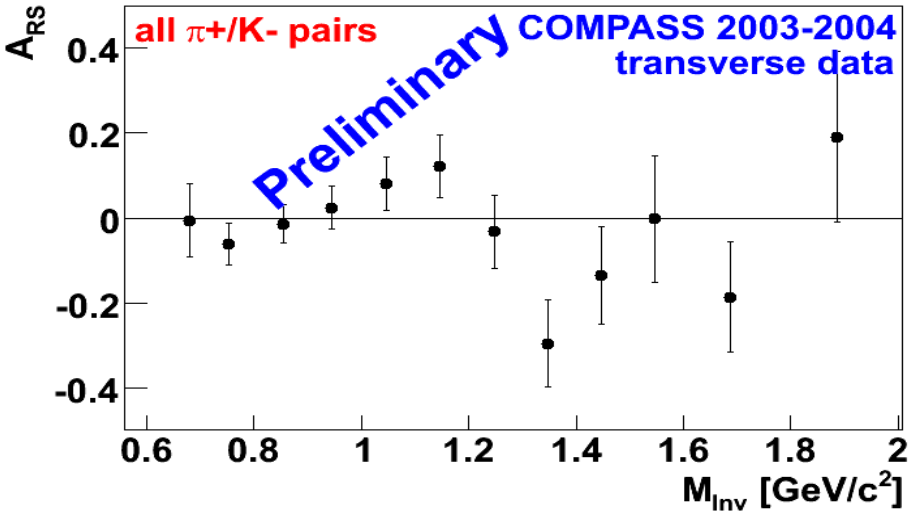


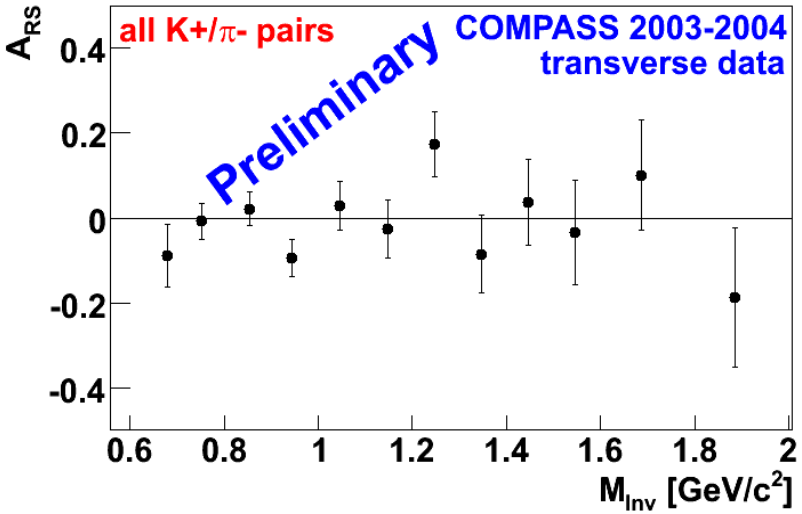


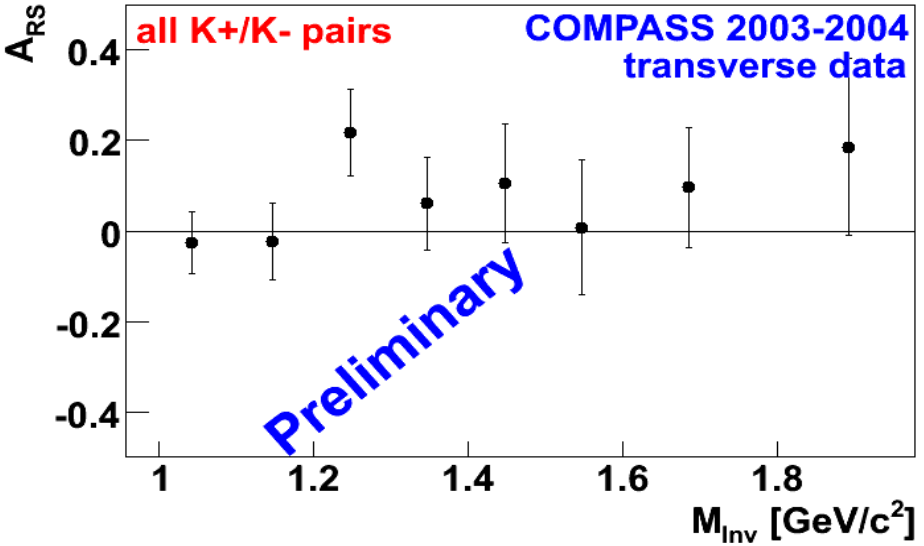


results for M_{Inv} binning









event selection for z-ordered +/- pairs

motivation

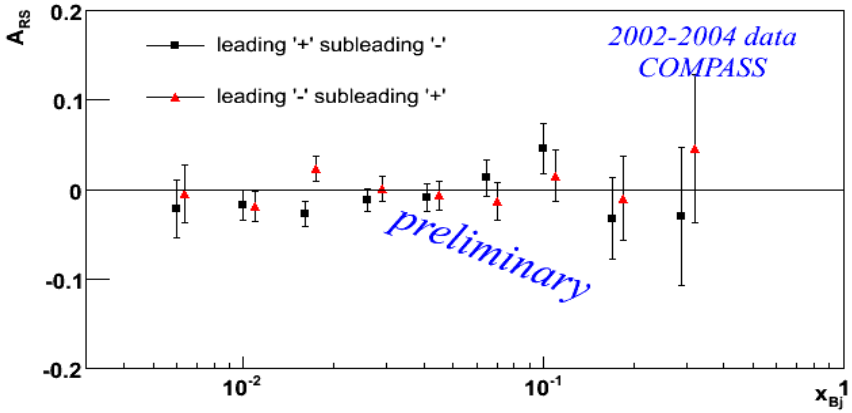
- hadrons with higher relative energy carry more information about the fragmenting quark polarization
- for leading hadron pairs signal enhancement is predicted

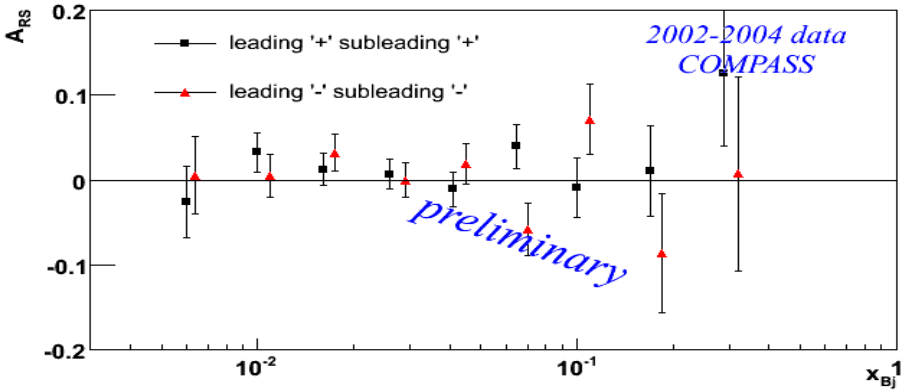
- same cuts as for all hadron +/- pairs
- charge selection:
  leading+/2nd leading-
  leading-/2nd leading+
  leading-/2nd leading-
  leading+/2nd leading+

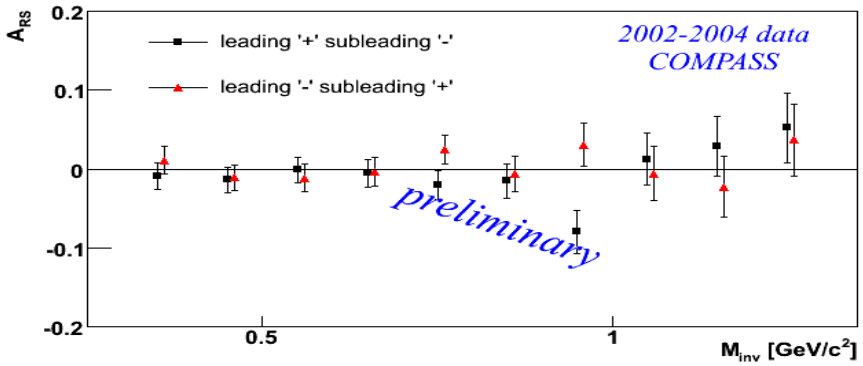
additional cuts:

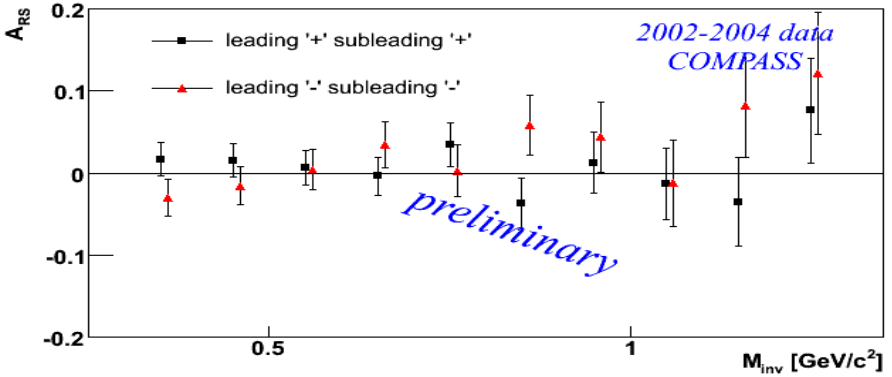
- if one leading hadron is cutted, event is dropped
- No neutral cluster in Calorimeter with $E_{Cl} - 2Err_{Cl} > E_{(2nd\ leading)}$
- Missing $z < z_{2nd\ leading}$

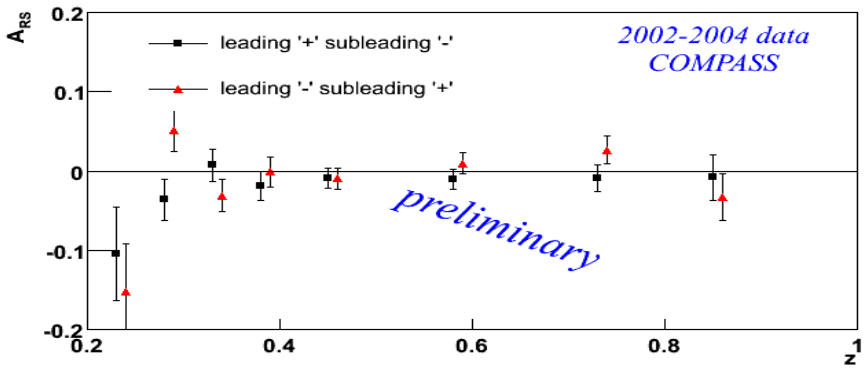
results for z-ordering (unidentified)

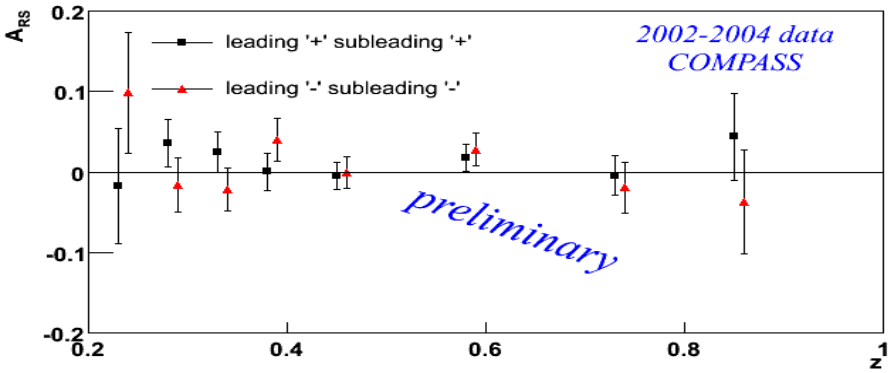












summary and outlook

- all asymmetries are compatible with 0
- asymmetries in z-ordering with PID have also been measured and are compatible with 0
- switch to proton target in 2007 beam-time.
  => detection of a non-zero asymmetry is expected