

The status of the COMPASS experiment

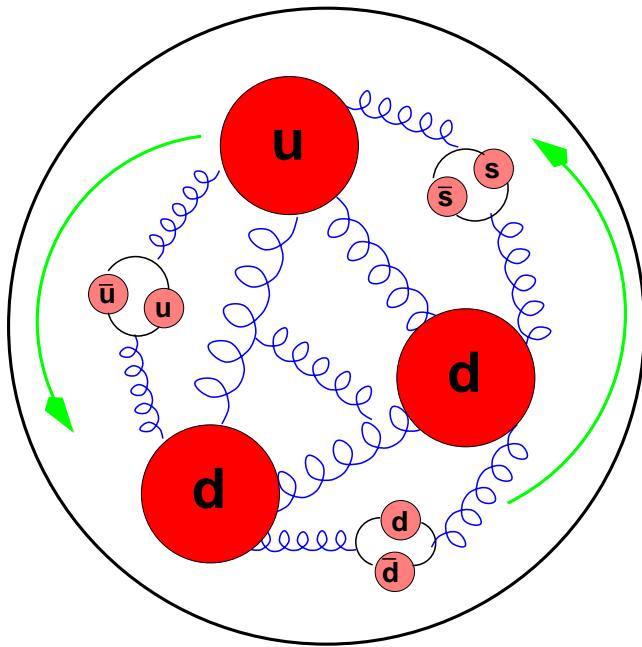


Eva-Maria Kabuß
University of Mainz

for
the COMPASS collaboration

- Motivation
- Experiment
- Data taking 2002
- First results
- Plans

PROTON SPIN PUZZLE



$$\frac{1}{2} = \frac{1}{2} \Delta\Sigma + \Delta G + L_q + L_g$$

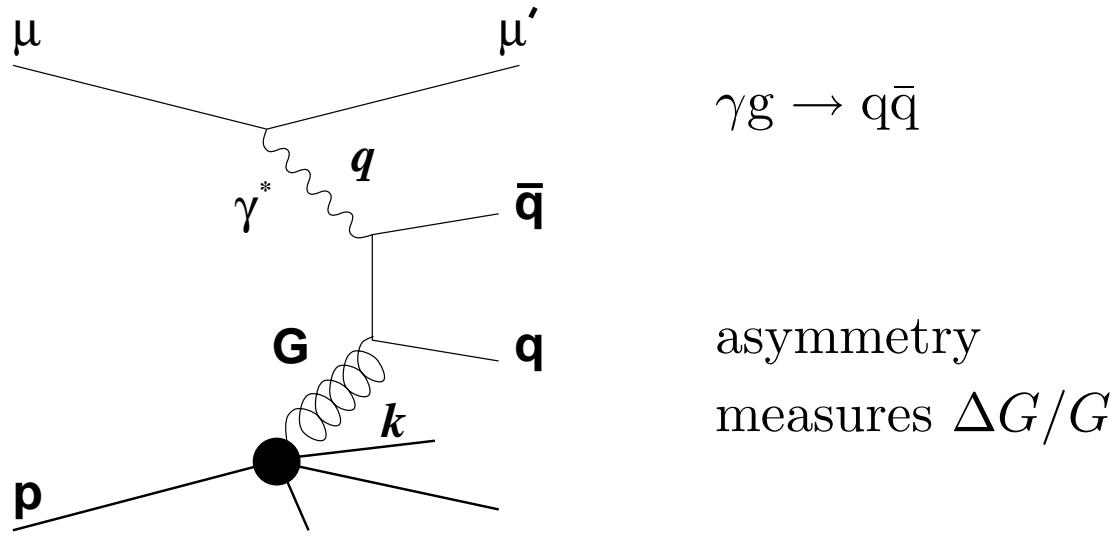
quarks	gluons	angular-momentum
antiquarks		

- naive quark model $\Delta\Sigma = 1$
QPM +SU(3) (Ellis, Jaffe (1974)) $\Delta\Sigma = 0.6$
- EMC (1985) $\Delta\Sigma \ll 1$
 $\Delta s \approx -0.1$
- SMC, SLAC, HERMES
(1988-2000) $\Delta\Sigma \approx 0.2$

Measurement of ΔG



- photon gluon fusion



- methods

- open charm production

$$\begin{aligned}\gamma g &\rightarrow c\bar{c} \\ &\rightarrow D^0 \rightarrow \pi K \quad \text{BR: 4\%}\end{aligned}$$

cleanest channel, but D^0 reconstruction needed

- high p_T hadron pairs

$$\begin{aligned}\gamma g &\rightarrow q\bar{q} \\ &\rightarrow 2 \text{ jets or } H^+H^-\end{aligned}$$

detection of 2 oppositely charged hadrons with high p_T and $\Delta\Phi \approx \pi$



CO_{MMON} M_{UON} AND P_{ROTON} A_{PPARATUS} FOR S_{TRUCTURE AND S_{PECTROSCOPY}}

Bielefeld, Bochum, Bonn, Burdwan und Calcutta, CERN,
Dubna, Erlangen, Freiburg, Heidelberg, Helsinki, Lisbon,
Mainz, Moscow, München, Nagoya, Protvino, Saclay, Tel
Aviv, Torino, Trieste, Warsaw
(27 institutes, > 200 physicists)

MUON BEAM

gluon polarisation
polarized
quark distributions
polarized
fragmentation functions
transversity
(via Collins effect)
DVCS
vector meson production

HADRON BEAM

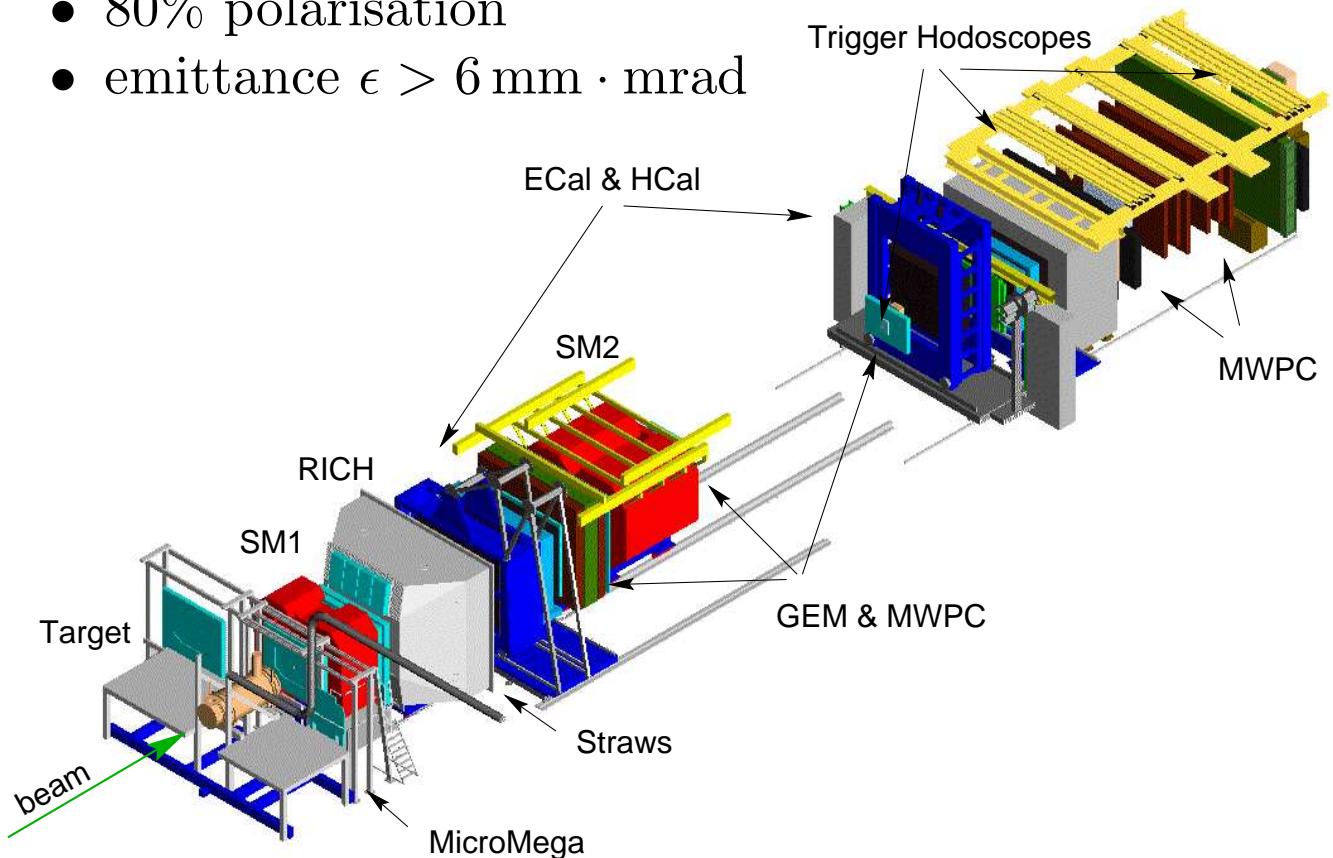
Primakoff effect
glueballs
charmed
baryons
exotic
charm states

Spectrometer



Muon beam

- 160 GeV μ^+
- $2 \cdot 10^8 \mu/\text{spill}$ (4.8 s/16.2 s)
- 80% polarisation
- emittance $\epsilon > 6 \text{ mm} \cdot \text{mrad}$

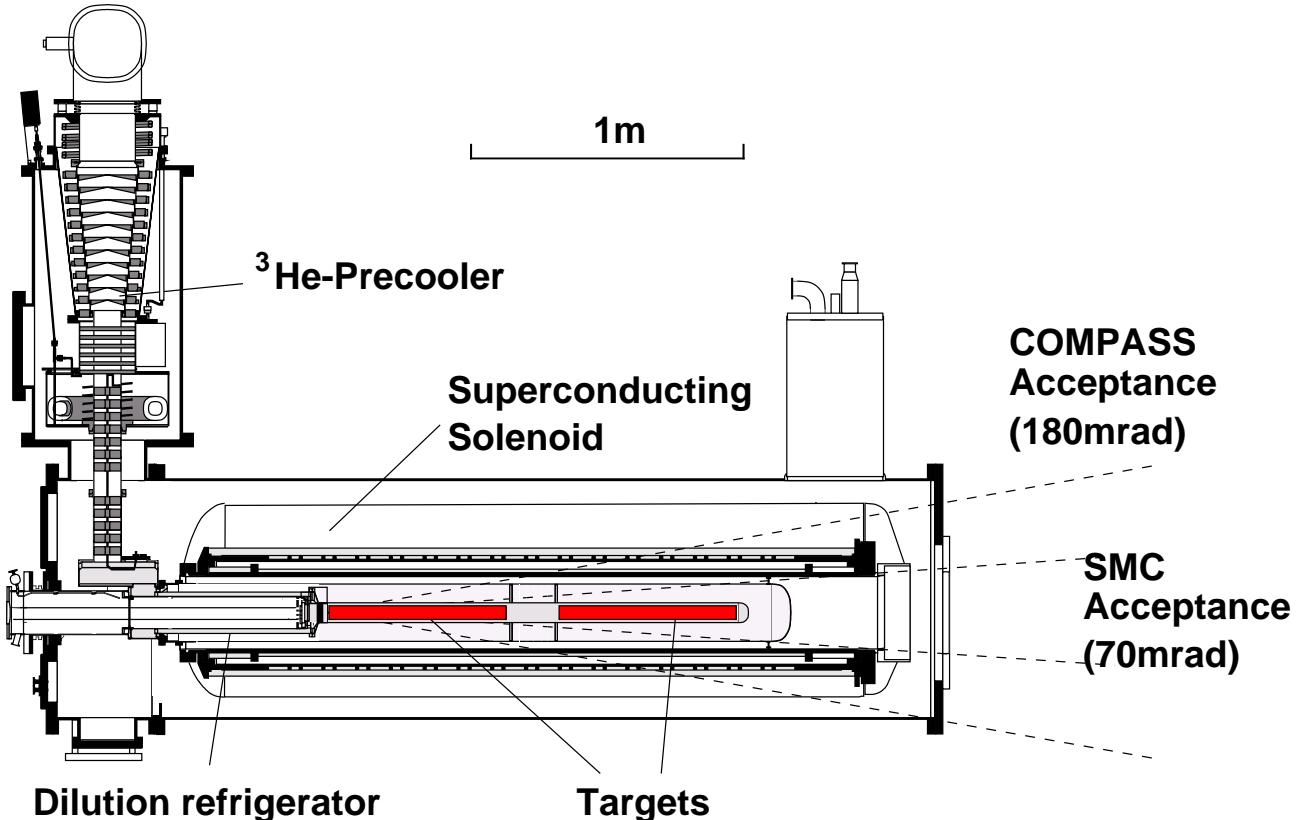


Spectrometer

- 2 stages
- detectors:
 - SciFi, Silicon, MicroMega, GEM, MWPC, drift chambers, straws, drift tubes
- PID:
 - RICH, ECAL, HCAL, μ -filter



Polarized target

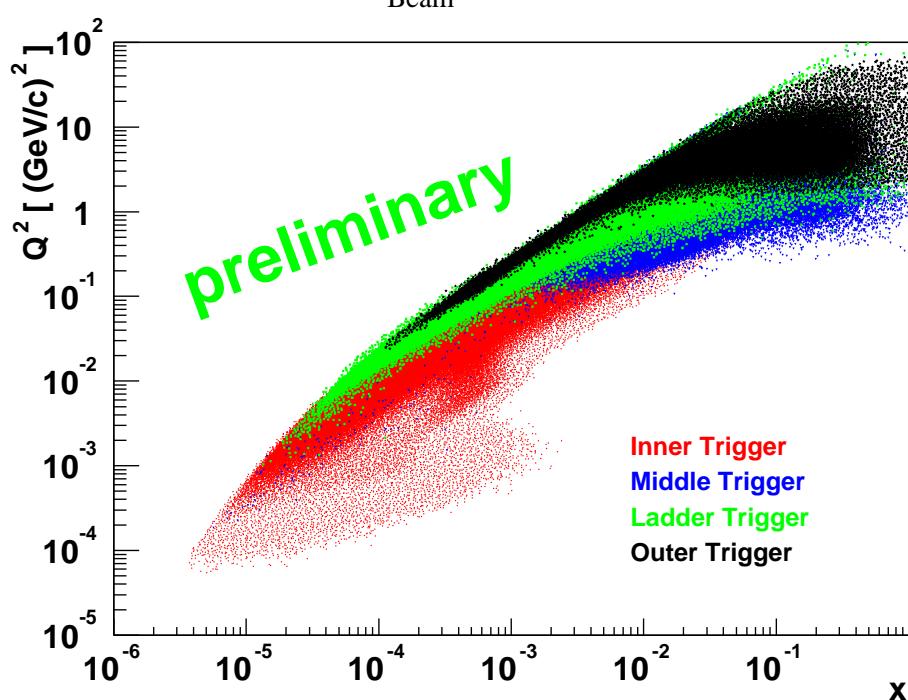
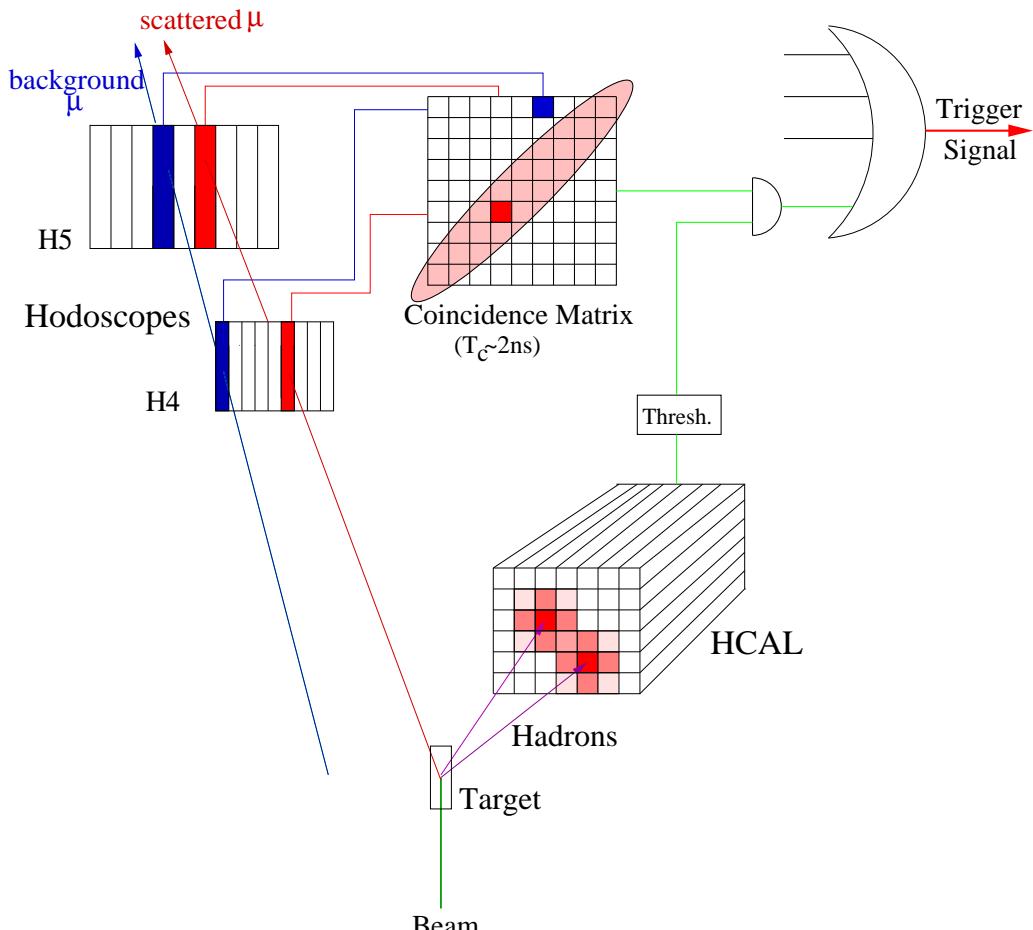


- method: Dynamic Nuclear Polarization
- SMC magnet: solenoid (**2.5 T** longitudinal)
dipole (**0.5 T** transversal)
- ³He/⁴He dilution refrigerator: **50–300 mK**
- target: two **60 cm** long cells
with opposite polarisation
- material: **⁶LiD**
max. polarisation $P = +57\%$
dilution factor ~ 0.4

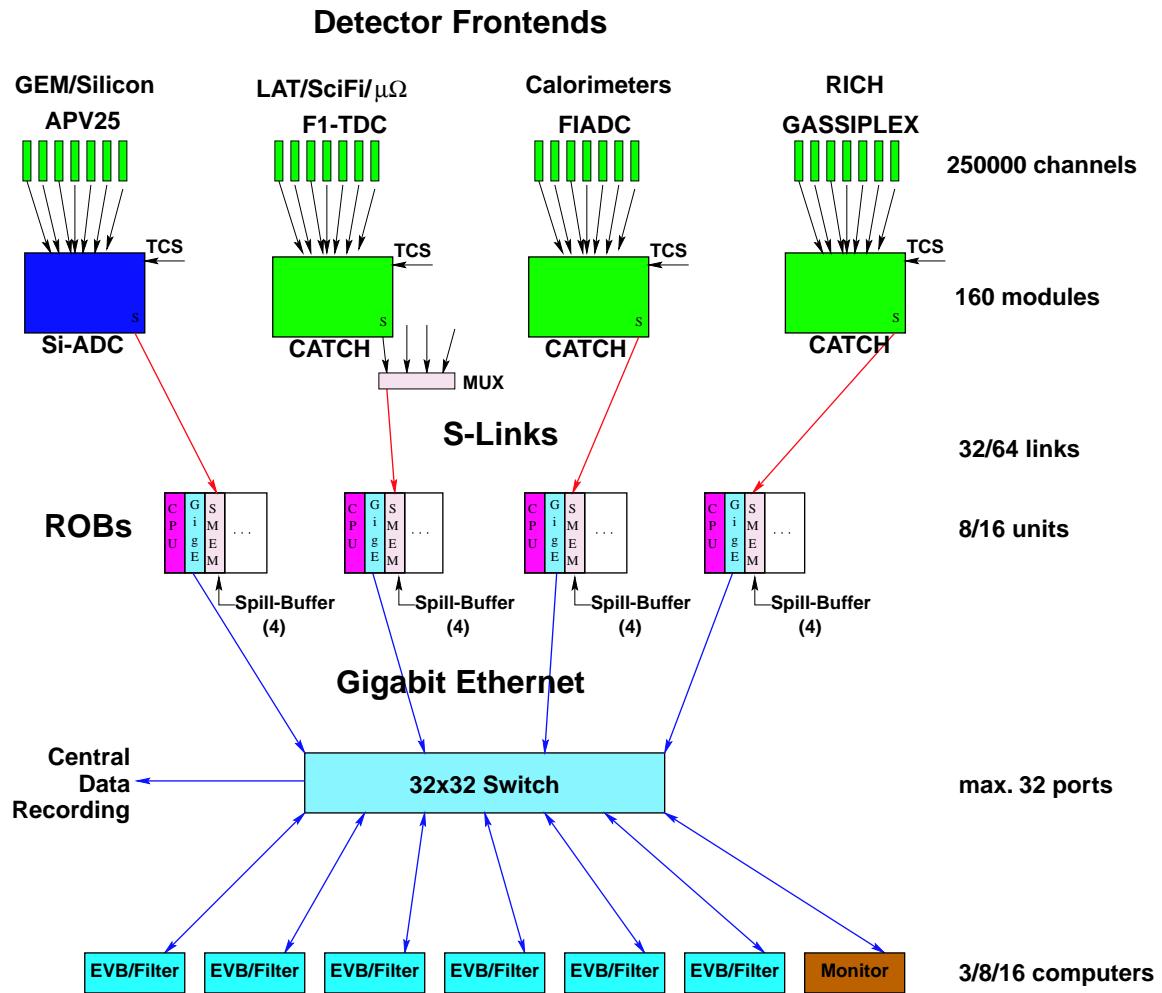
COMPASS trigger



Trigger: $(H4 * H5) * (HCAL1 \vee HCAL2)$



Data Acquisition



features

- pipelined readout architecture
- data transfer via S-Link
- buffering of bursts (SPS duty cycle $\approx 20\%$)
- network eventbuilding

performance

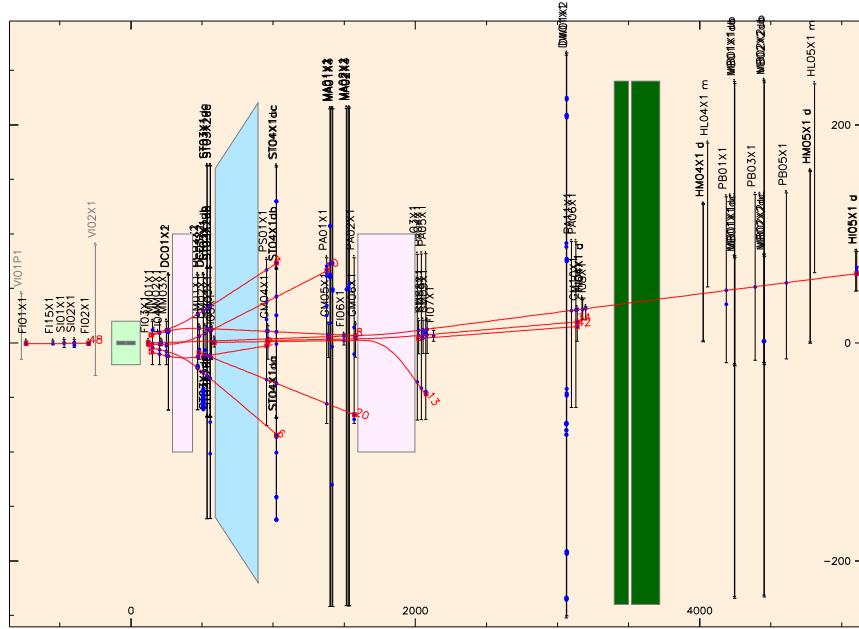
- total number of channels 250k
- trigger rates 5 – 50 kHz
- event size ≈ 30 kB
- data rates 0.6 – 6 GB/SPS spill

Performance 2002



Projection 0.0 deg.

Run 22385 Event 84939982 (81, 5326) Trigger(s) 0 Nhits 910

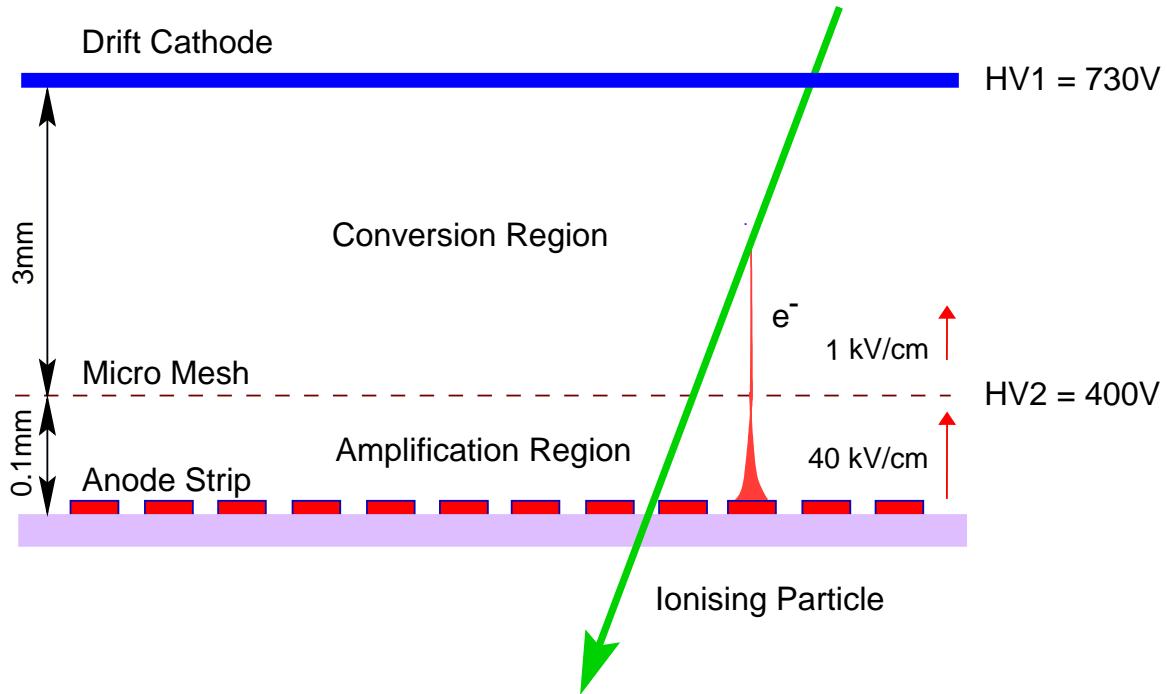


TRAFFIC (version 1.71) event display

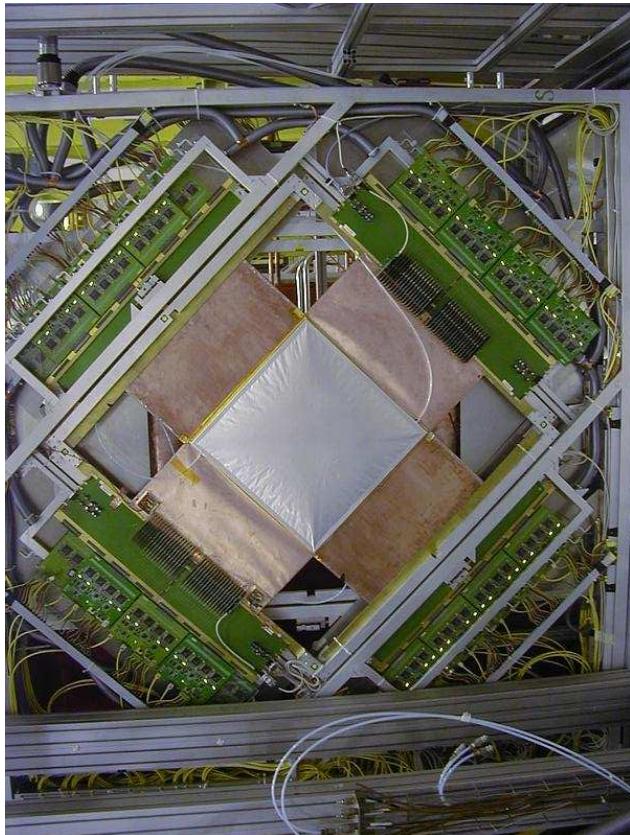
(060)

detector	coord	efficiency	resolution
scint. fibers	21	94%	130 μm 0.45 ns
microMegas	12	95–98%	70 μm 8 ns
drift chambers	24	94–97%	170 μm
straw tubes	18	>90%	\sim 270 μm
GEM	40	95–98%	50 μm 12 ns
MWPC	32	97–99%	600 μm

MicroMegas

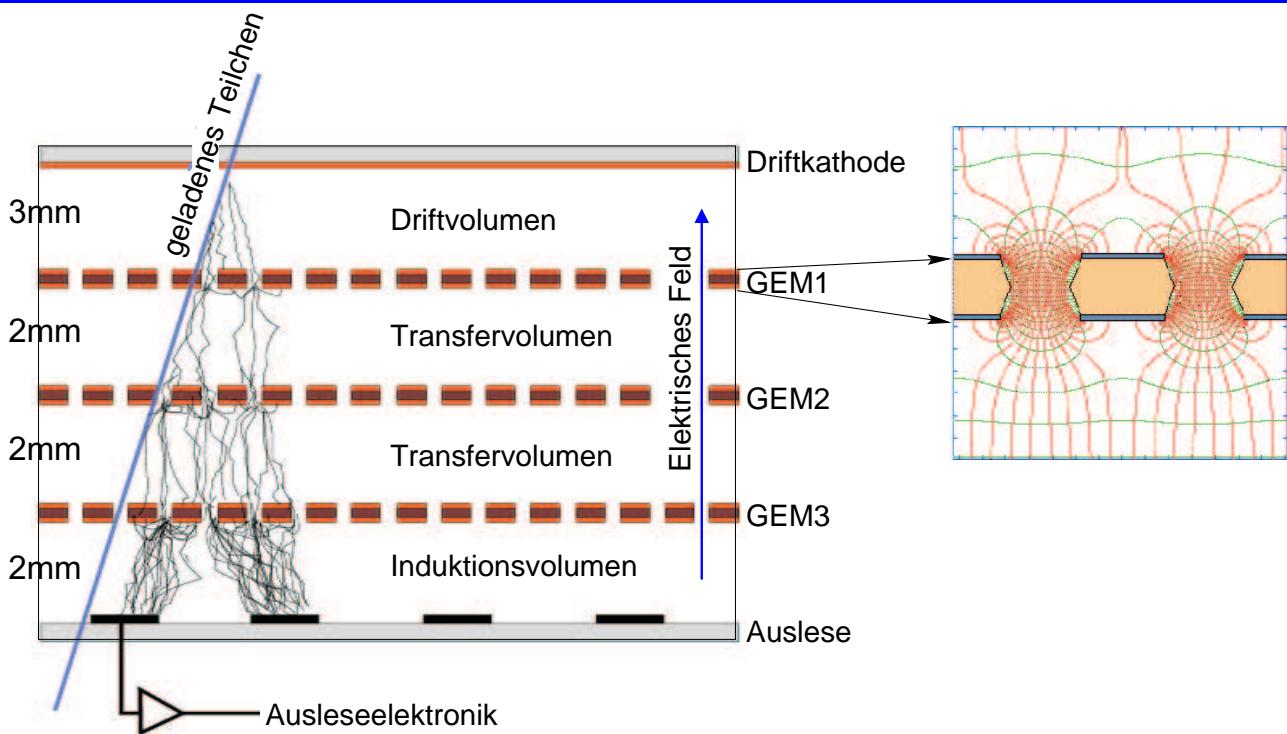


Micro-Mesh-Gas-Detektor

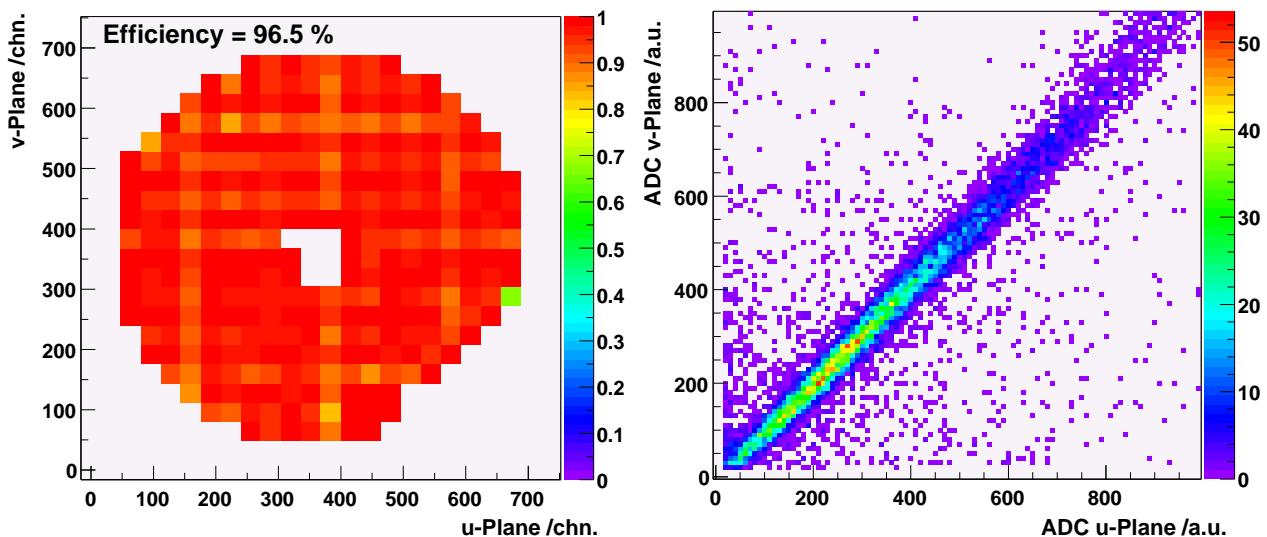


- 12 planes
- active area: $40\text{ cm} \times 40\text{ cm}$
- high flux: 300 kHz/stripe
- spatial res. $\sim 70\mu\text{m}$
- time resolution $\sim 8\text{ ns}$
- dead regions: 5 cm diameter
- efficiency $\sim 96\text{--}97\%$

GEM detectors



- 40 planes, $30\text{ cm} \times 30\text{ cm}$, 2-dimensional readout
- 3 GEM foils, capton with $50\text{ }\mu\text{m Cu}$
- spatial resolution $\sim 50\text{ }\mu\text{m}$, time res. $\sim 12\text{ ns}$
- efficiency $\sim 96 - 97\%$



2002 Data Sample



Statistics

- **2002** initial phase completed
- **long. data** $3.8 \cdot 10^9$ events (57 Tage)
- **trans. data** $1.2 \cdot 10^9$ events (19 Tage)

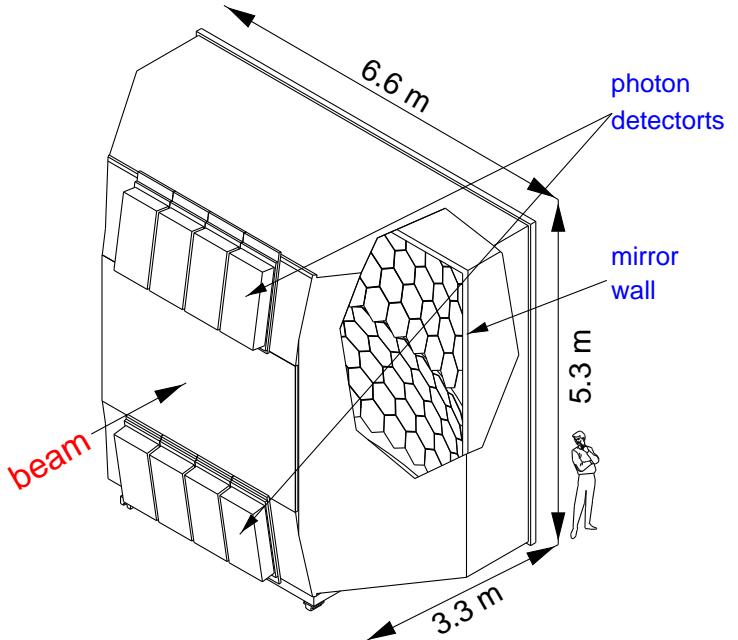
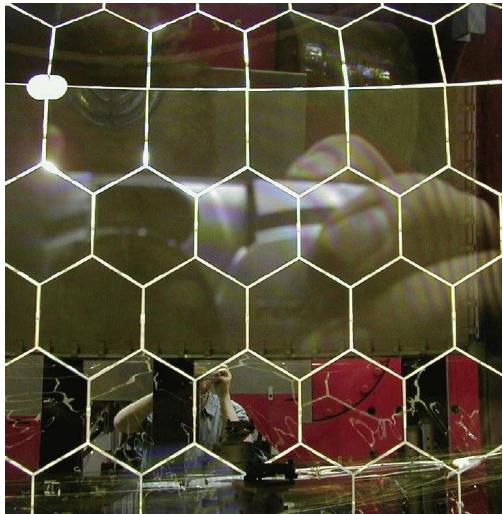
Analysis

- calibration of trackers, alignment done
- RICH calibration in progress
- first analysis pass for 16% of long. data, 66% of trans. data

First analysis results

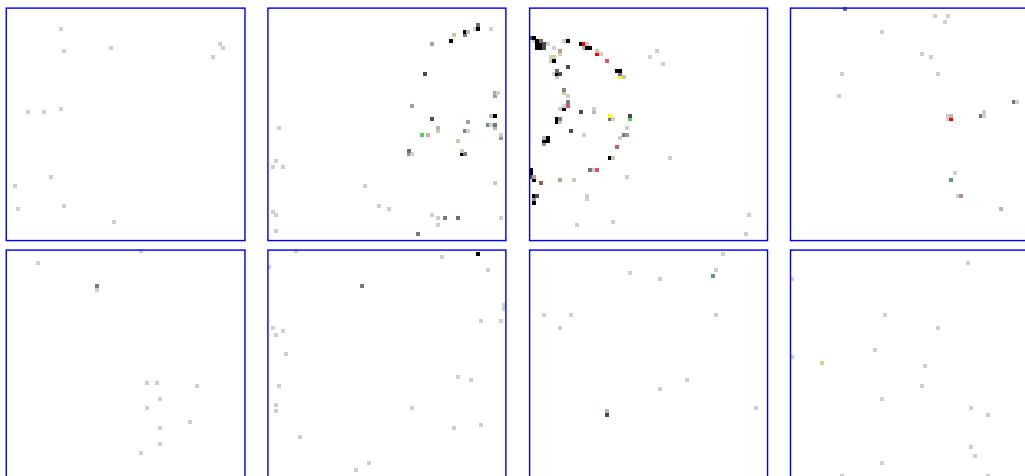
- Λ and $\bar{\Lambda}$ production
- vector meson production ρ , Φ and J/ψ)
- $\Delta G/G$ from high p_T hadron pairs
- flavour decomposition of pPDF
- transversity from Collins asymmetry

Ring Imaging Cherenkov



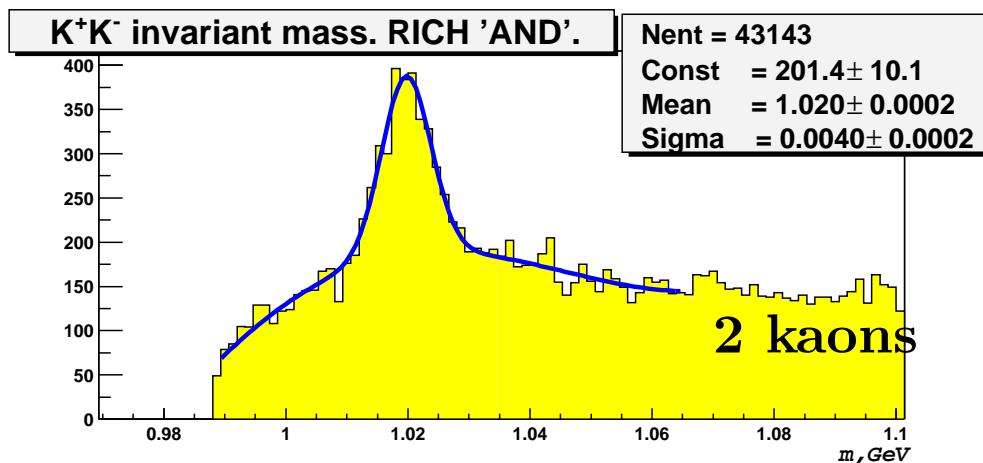
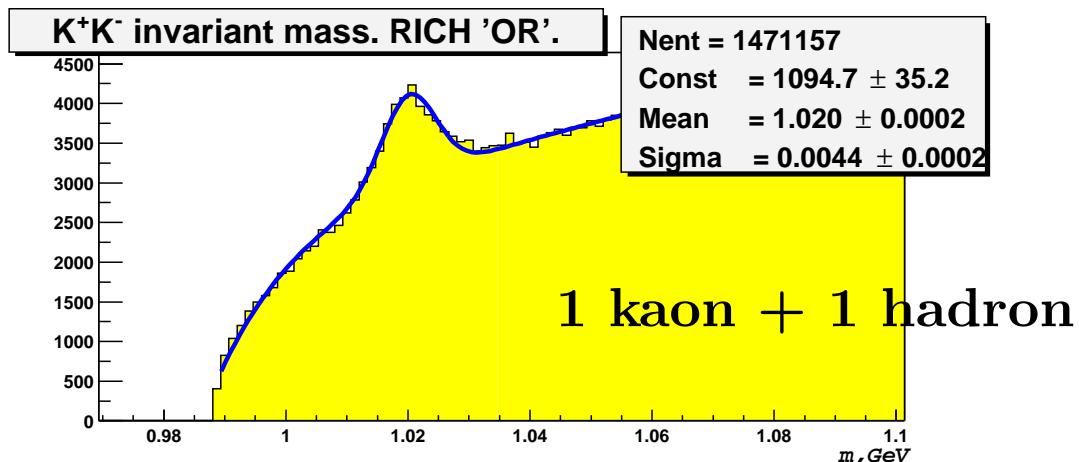
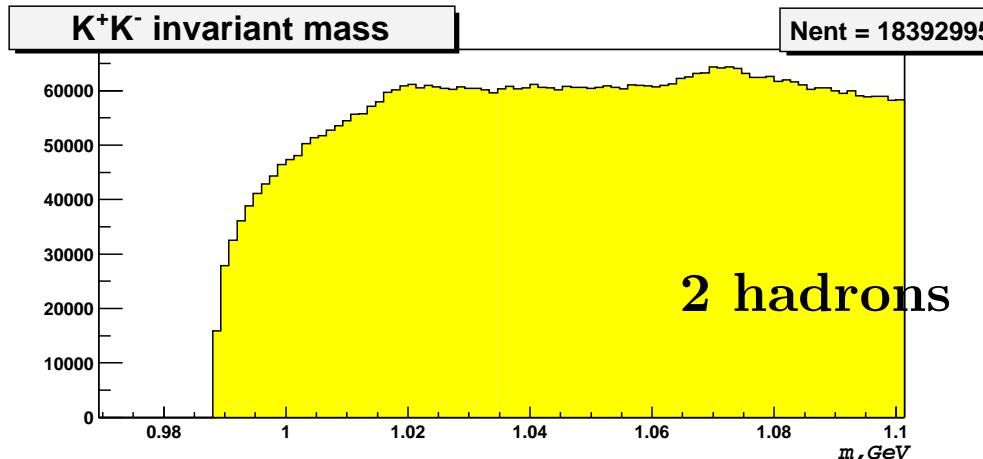
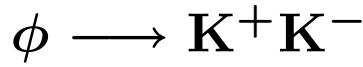
- π/K separation up to 50 GeV/c
- $80 \text{ m}^3 \text{ C}_4\text{F}_{10}$, $n=1.00153$
- 116 VUV spherical mirrors (21 m^3)
- MWPCs with CsI cathodes, granularity $8 \times 8 \text{ mm}^2$

Online Event Display



$\langle n \rangle = 15$ photons

RICH efficiency



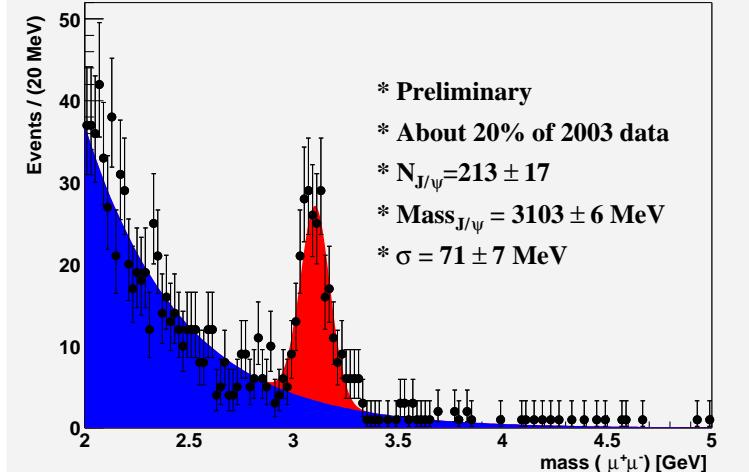
present result: $\varepsilon \sim 35\%$

Invariant mass spectra

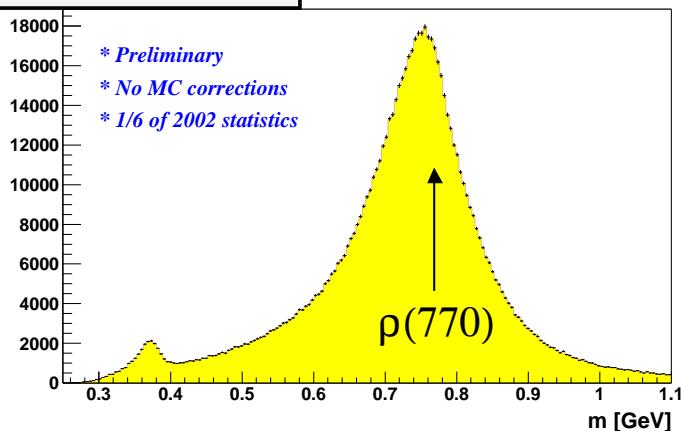


$$J/\psi \rightarrow \mu^+ \mu^-$$

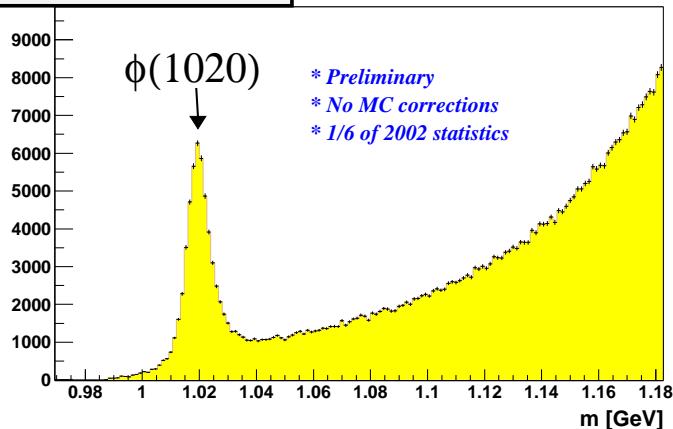
- events with
2 μ + one track
- mainly elastic



$\pi^+ \pi^-$ invariant mass



$K^+ K^-$ invariant mass.



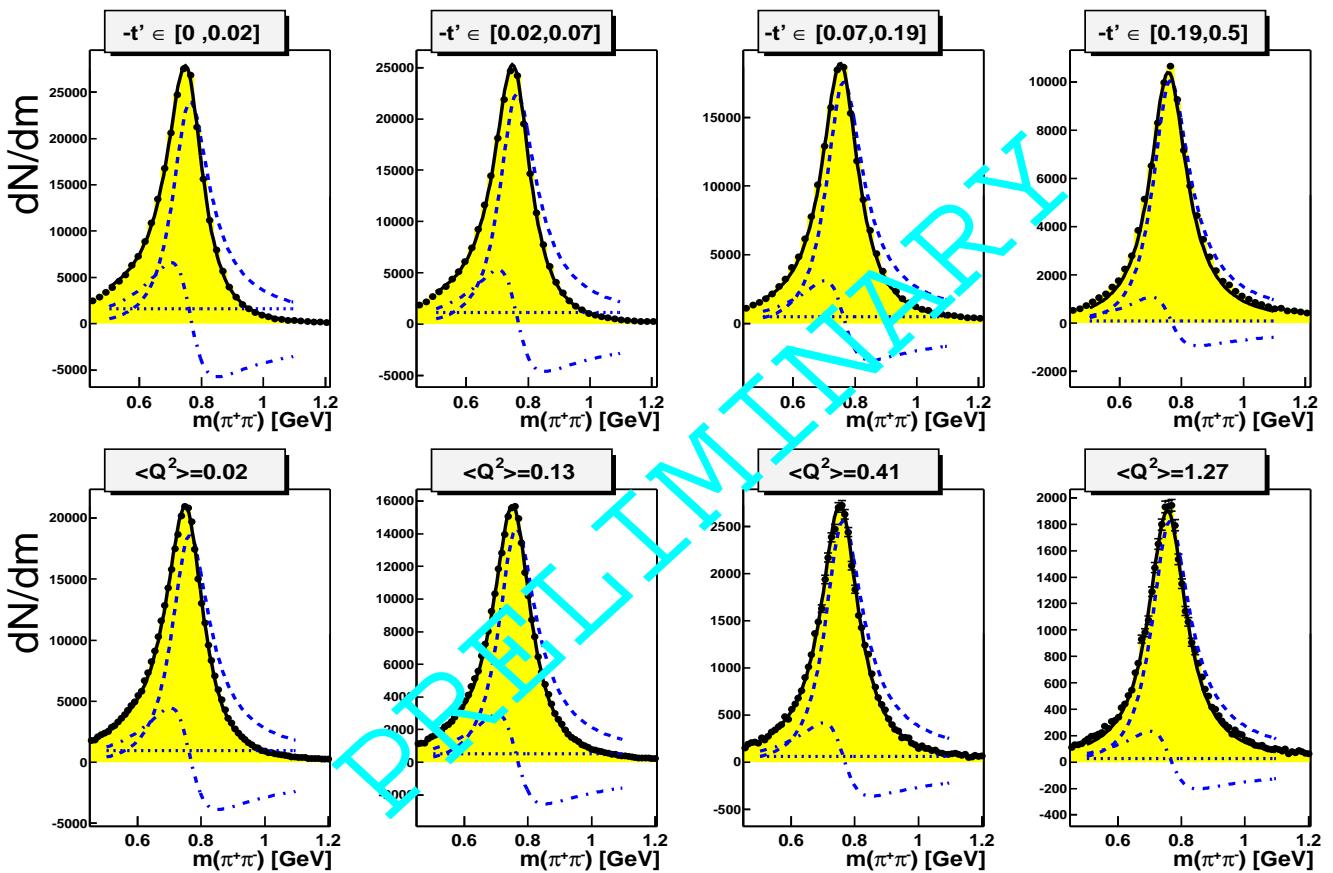
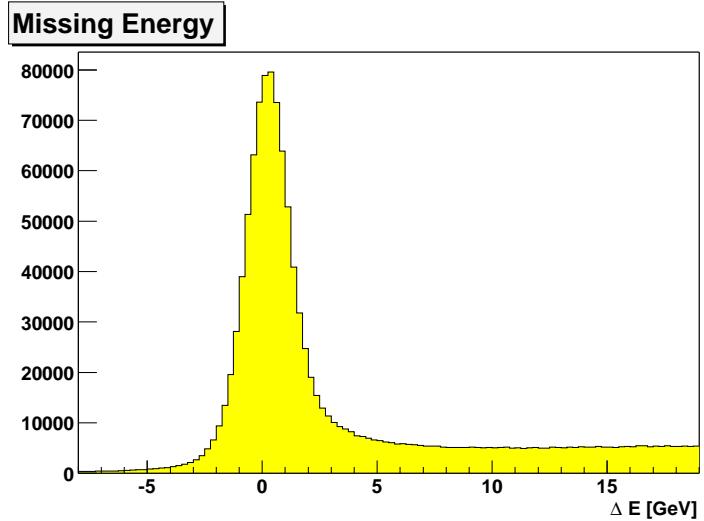
- 4 charged tracks:
 μ, μ', h^+, h^-
- cuts on $\nu, E', W, \Delta E, |t'|$

- $0.5 < m_{\pi^+ \pi^-} < 1 \text{ GeV}: 1.4 \cdot 10^6 \rho^0$
- $|m_{KK} - m_\Phi| < 9 \text{ MeV}: 42 \cdot 10^3 \Phi$

Exclusive ρ production

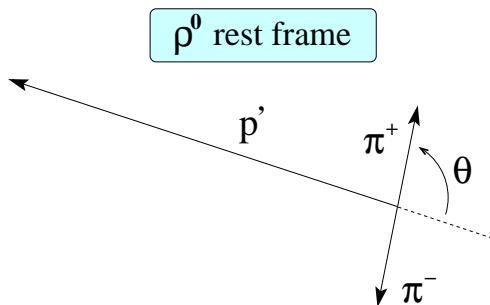
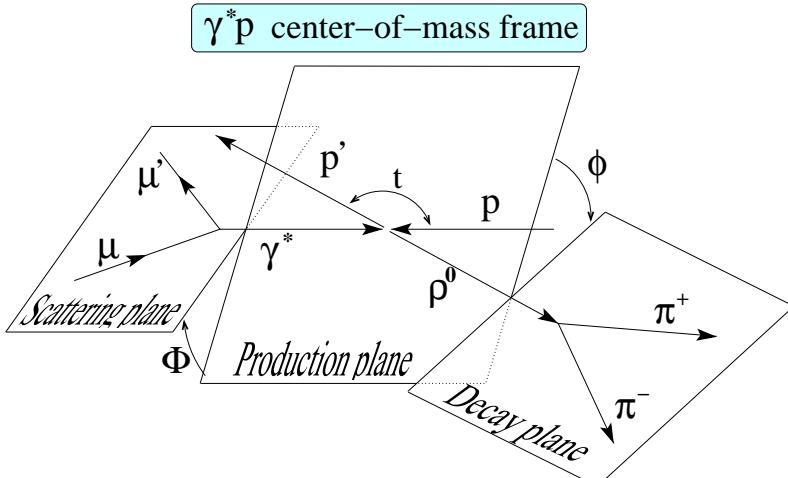


- $\nu > 30 \text{ GeV}$
- $E' > 20 \text{ GeV}$
- $|t'| < 0.5 \text{ GeV}^2$

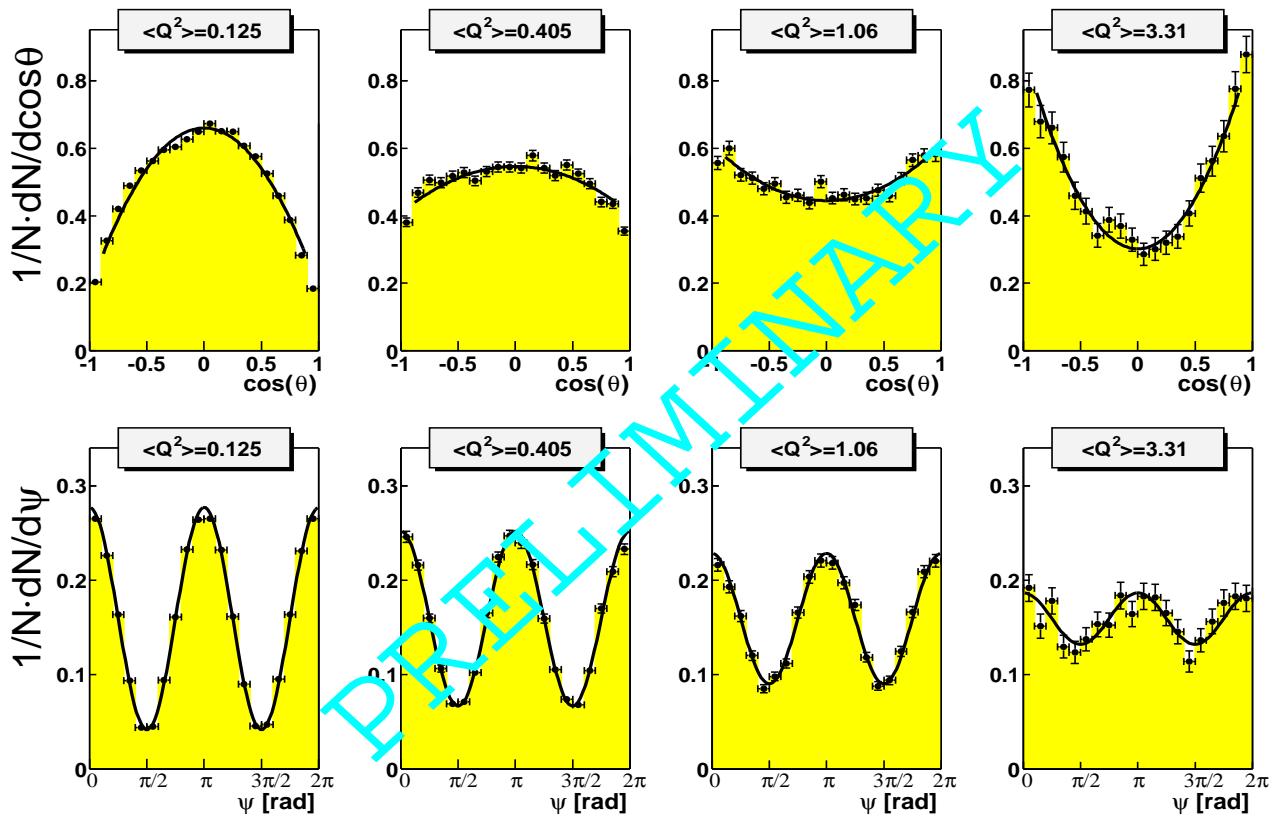


- interference of ρ and $\pi\pi$: Söding parametrisation
- no acceptance correction

Angular distributions



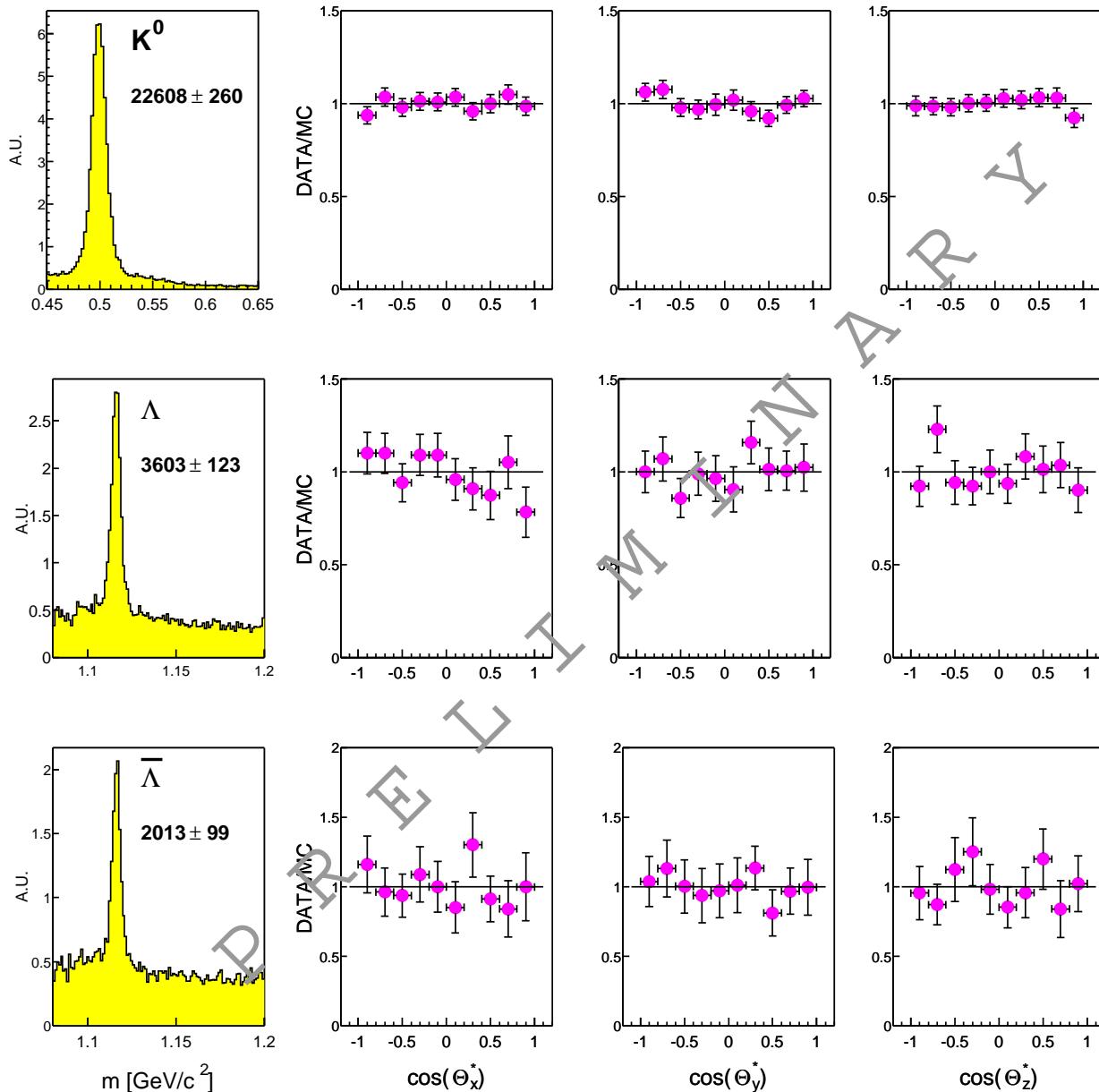
- SCHC:
 $\psi = \phi - \Phi$
- $p_T > 0.15$ GeV
- $Q^2 > 0.05$ GeV 2
- $\Delta E < 2.5$ GeV



Λ polarisation



- secondary vertex outside target, 1/6 of 2002 statistics
- $Q^2 > 1 \text{ GeV}^2$, $0.2 < y < 0.9$
- $dN \sim 0.5(1 + \alpha P_i \cos \Theta_i)$

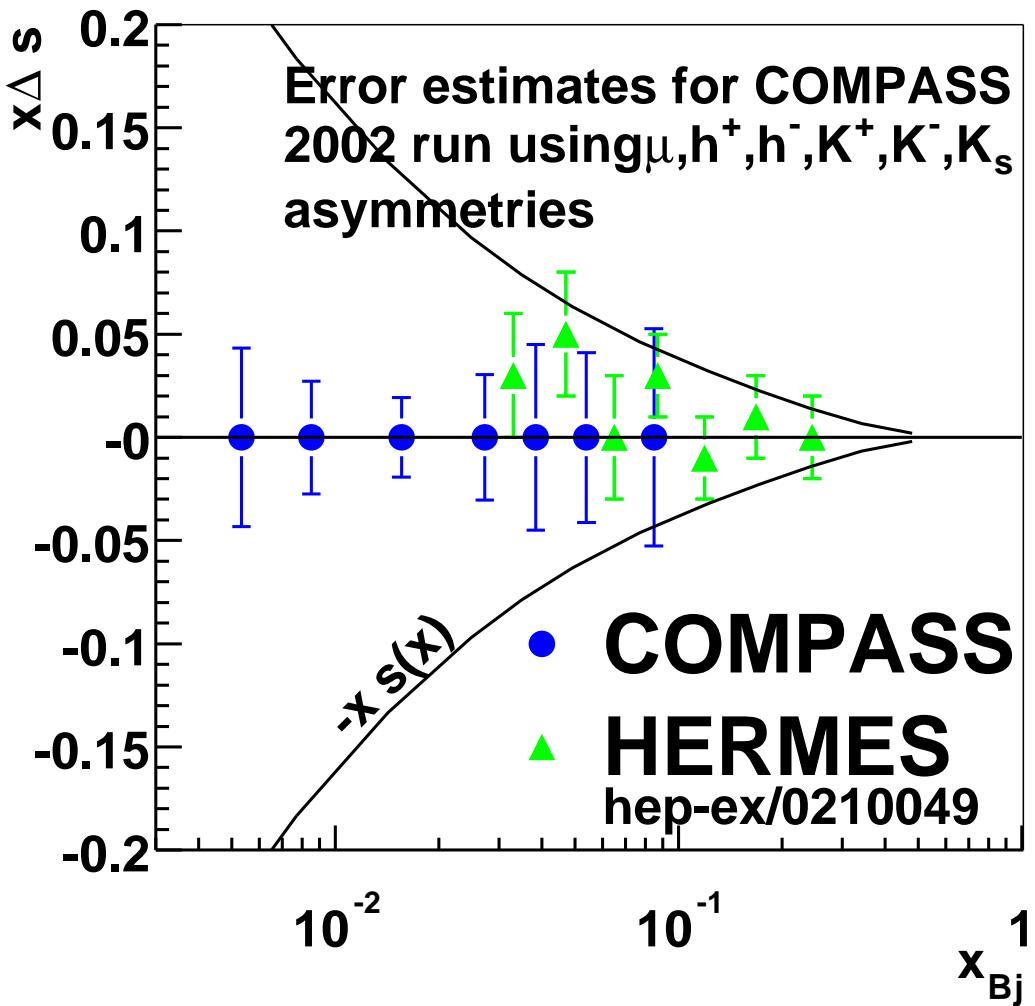


Flavour separation



Extraction from semi-inclusive asymmetries

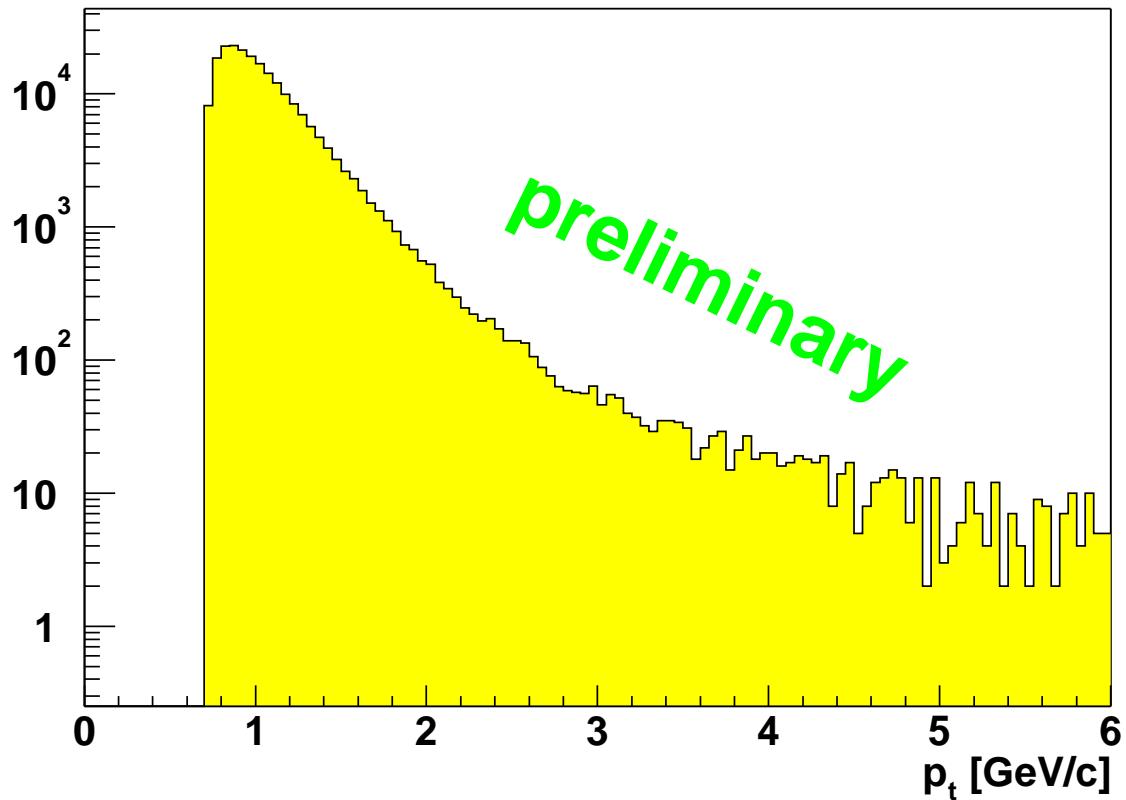
- $Q^2 > 1 \text{ GeV}^2$
- COMPASS d and SMC p data
- K identified in RICH



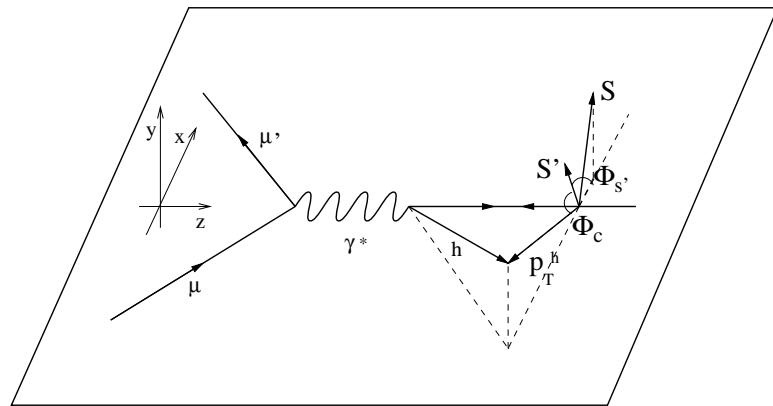
High p_T hadron pairs



- $\mu, \mu' + 2$ hadrons with $p_T > 0.7$ GeV
- $0.4 < y < 0.9, x_F > 0.1$
- $p_{T,1}^2 + p_{T,2}^2 > 2.5$ GeV 2
- large statistics
- theoretical uncertainties large for $Q^2 < 1$ GeV 2
(resolved photon contribution)
- expectation for $Q^2 > 1$ GeV 2 : 17k events
 $\delta \langle \frac{\Delta G}{G} \rangle \sim 0.31$
- all Q^2 : 160k events

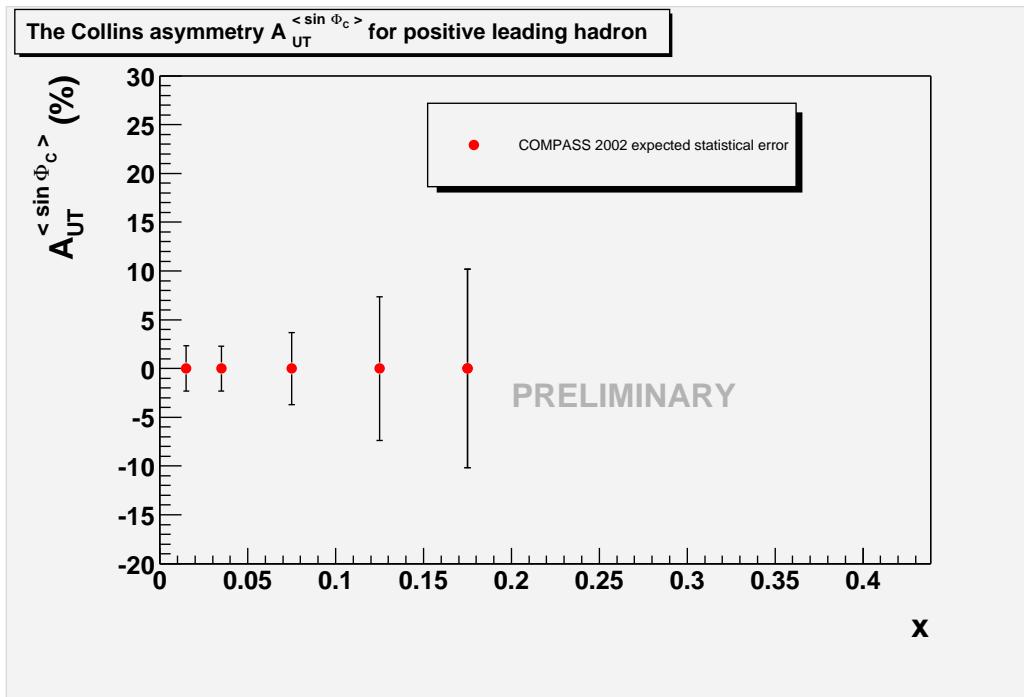


Collins asymmetry



$$\Phi_C = \Phi_h - (\pi - \Phi_S)$$

- $\sim 10^6$ DIS events with transverse polarisation
- **cuts:** $Q^2 > 1 \text{ GeV}^2$, $0.1 < y < 0.9$
 $z^h > 0.25$, $p_T^h > 0.1 \text{ GeV}$



Plans



- initial setup fully operational
- 2002 run successful
 1.2 fb^{-1} longitudinal, 0.3 fb^{-1} transversal
- reconstruction in progress, needs still fine tuning
- 2003/2004 data taking with muon beam
- improvement of RICH1 efficiency
(photon detectors, radiator gas)
- pilot hadron run in 2004 for Primakoff effect
- completion of spectrometer for 2005 – 2010
- prospects for new topics (DVCS, GPD) studied