Exclusive ρ^0 and ϕ meson production from COMPASS.

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on behalf of the
COMPASS collaboration

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Outline of the talk

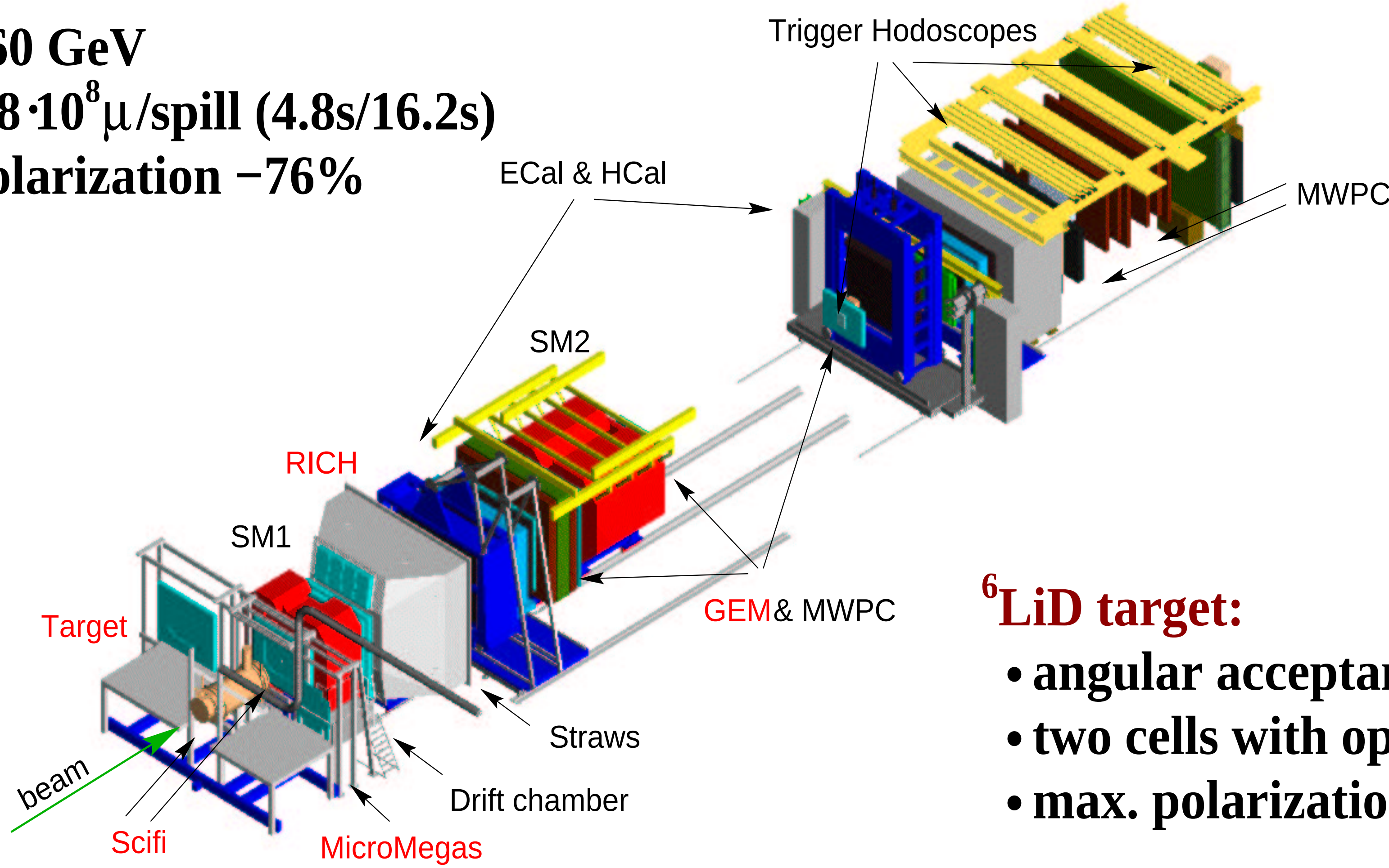
- COMPASS potentials for exclusive VM study.
- Experimental set-up.
- First preliminary results
  - Sample selection criteria.
  - Skewing of ρ^0 invariant mass distribution (Söding model).
  - Angular distributions.
- Outlook.

COMPASS potentials for exclusive VM study

- COMPASS initially designed for semi-inclusive asymmetry study.
- Trigger perfectly adopt exclusive reactions which are in addition
  - are easier from reconstruction point of view (3 tracks in final state)
  - better satisfy geometrical acceptance conditions due to the forward property of diffractive reactions
- Trigger allow the measurement in wide Q^2 region from soft diffraction $Q^2 > 10^{-3}$ (GeV/c)^2 to pQCD $Q^2 < 20$ (GeV/c)^2.
- High luminosity results to the large statistics.

μ^+ beam:

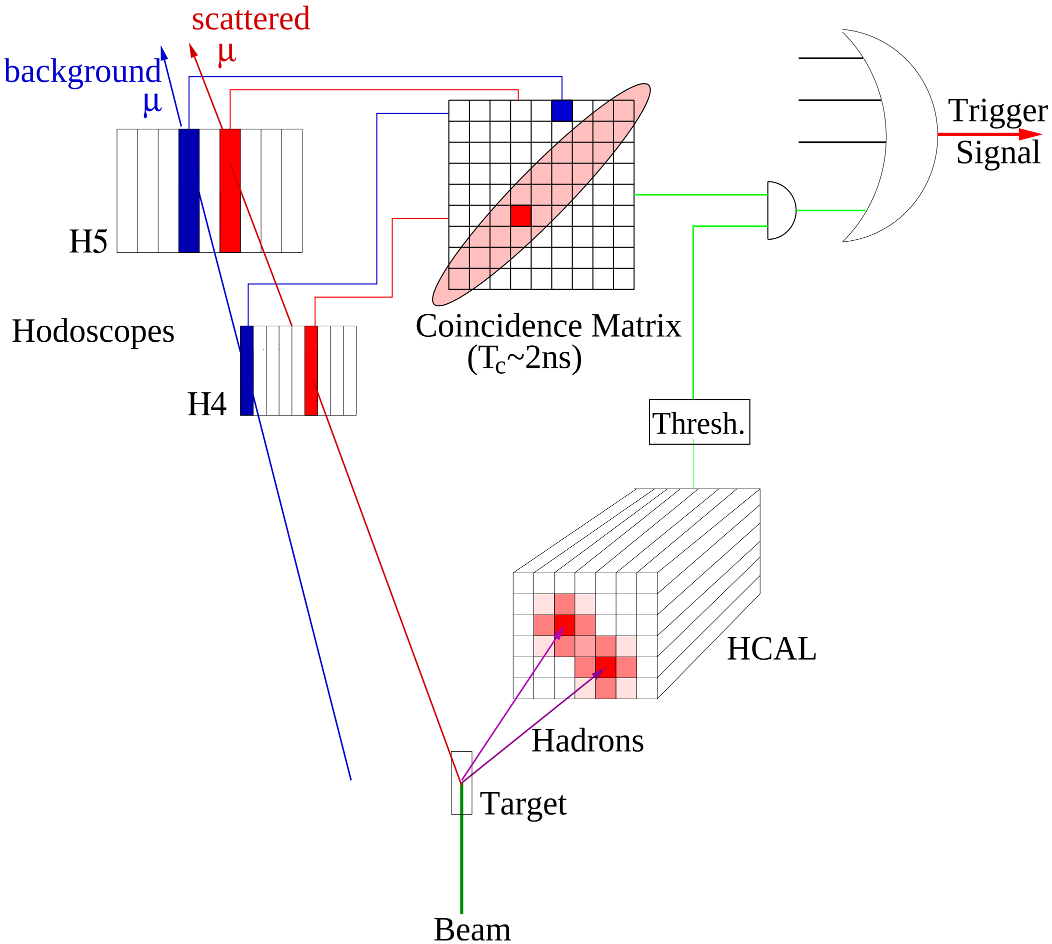
- 160 GeV
- $2.8 \cdot 10^8 \mu$/spill (4.8s/16.2s)
- polarization −76%



^{6}LiD target:

- angular acceptance 70 mrad
- two cells with opposite polariza
- max. polarization 57%

Trigger concept



Inclusive triggers ($Q^2 > 0.5$ (GeV/c)^2)

- geometric property of scattered μ

Semi−inclusive triggers ($Q^2 < 5$ (GeV/c)^2)

- geometric property of scattered μ
- minimal energy deposition in hadron calorimeter

$\rho^0 \to \pi^+\pi^-$

$\phi \to K^+K^-$

☺

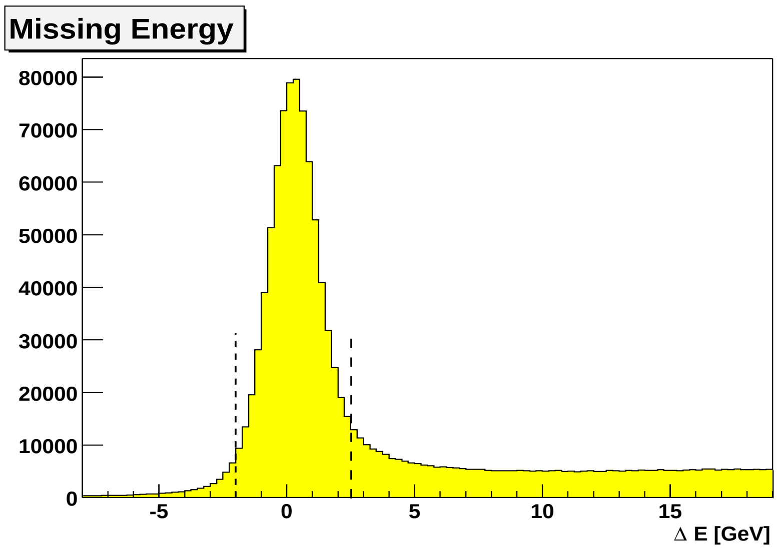
$J/\psi \to \mu^+\mu^-$ suppressed

Selection criteria

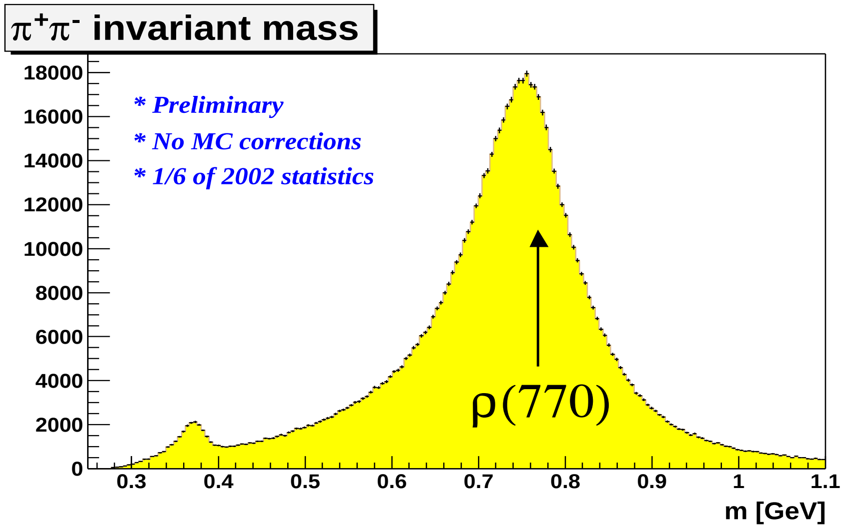
- Four tracks in the primary vertex $\{\mu,\, \mu',\, h^+,\, h^-\}$
- To minimize distortions due to inefficiency for soft tracks: $\nu > 30$ GeV
- To reduce contamination due to triggering by muons from decays of final state hadrons: $E_{\mu'} > 20$ GeV
- To reduce the contribution from non-exclusive background: $|t'| < 0.5$ (GeV/c)^2
- Cut on missing energy to suppress non-exclusive events which exhibit the same topology: $-2 < \Delta E < 2.5$ GeV

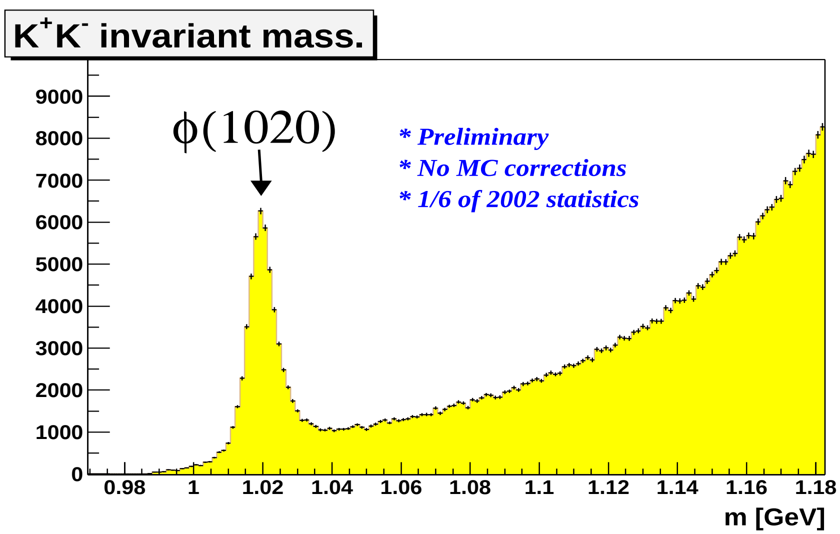
$$\Delta E = \frac{M_x^2 - M_{targ}^2}{2M_{targ}}$$

$$M_x = \sqrt{(p + q - p_V)^2}$$



Events after selection





- Skewing of ρ^0 invariant mass due to the interference with non-resonant background
- The small peak below 0.4 GeV is due to assignment of the pion mass to the kaons from ϕ decay.
- Clear ϕ peak on the reflection of the ρ^0 tail.

Statistics and kinematic interval

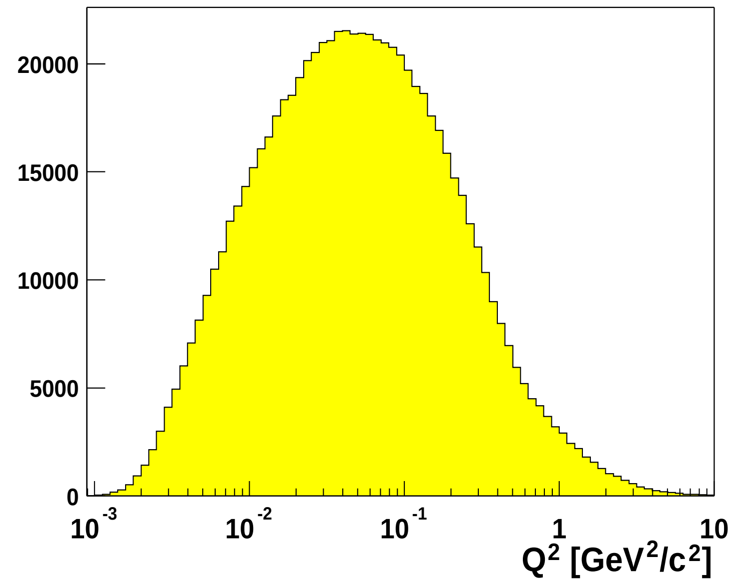
meson	mass cut	statistics (1/6 of 2002)
ρ^0	$0.5 < m_{\pi\pi} < 1$ GeV	$1.3 \cdot 10^6$
ϕ	$\lvert m_{KK} - m_\phi \rvert < 9$ MeV	$42 \cdot 10^3$

$$7.5 < W < 16 \text{ GeV}$$

$$10^{-3} < Q^2 < 10 \ (\text{GeV/c})^2$$

$$30 < \nu < 160 \text{ GeV}$$

$$|t'| < 0.5 \ (\text{GeV/c})^2$$



Interference between ρ^0 production and "Drell mechanism"

- The contribution from resonant and non-resonant terms are added coherently on the level of amplitudes

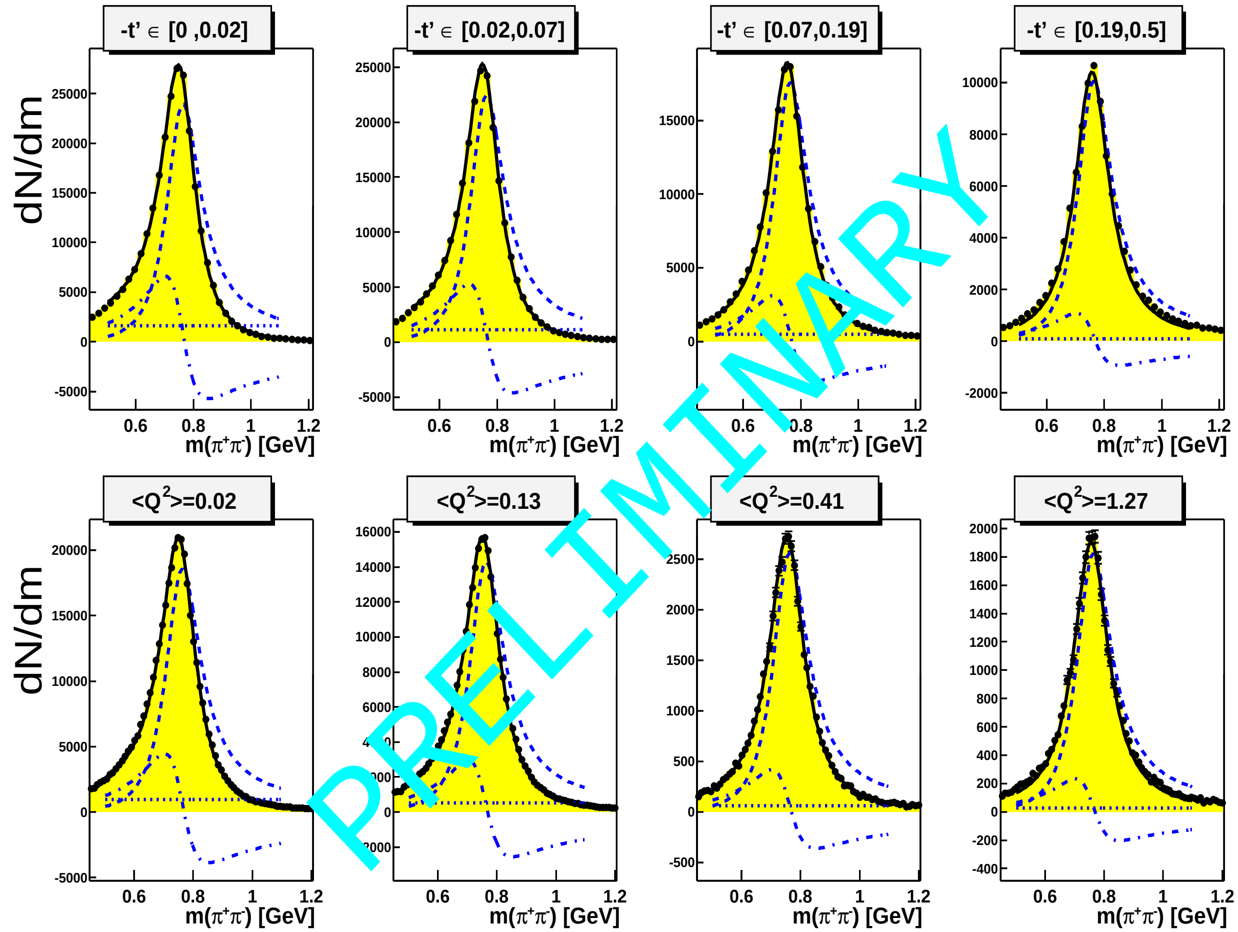
$$\frac{dN}{dm_{\pi\pi}} = \left| A \cdot \frac{\sqrt{m_{\pi\pi} m_\rho \Gamma(m_{\pi\pi})}}{m_{\pi\pi}^2 - m_\rho^2 + i\, m_\rho \Gamma(m_{\pi\pi})} \; + \; B \right|^2 \; + \; f_{PS} \; ,$$

where

$$\Gamma(m_{\pi\pi}) = \Gamma_\rho \left(\frac{q}{q_0}\right)^3 \frac{m_\rho}{m_{\pi\pi}}$$

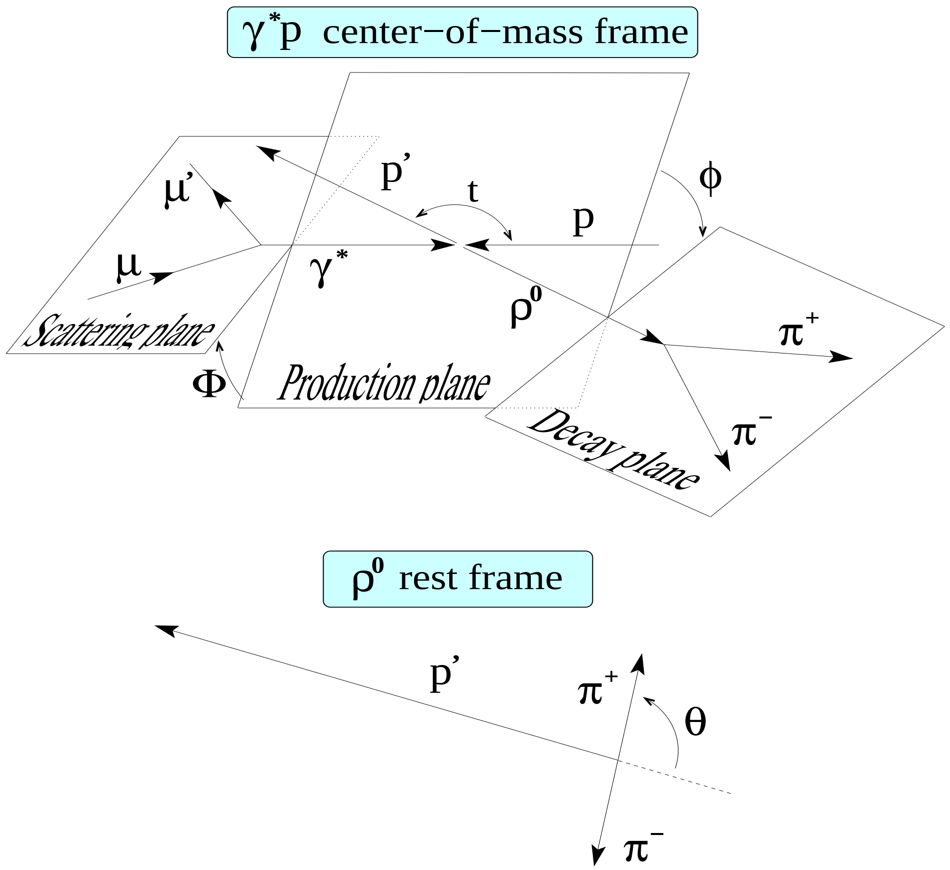
- The fist term is the relativistic p-wave Breit-Wigner resonant amplitude
- The second term is the non-resonant amplitude which is assumed to be real and constant
- The third term is contribution from non-exclusive background

Fit with Söding parametrization



- No acceptance corrections
- Non-exclusive contribution is subtracted
- Non-resonant contribution decreases with increase of $|t'|$ or increase of Q^2

Angular distributions



- The spin state of ρ^0 and ϕ will be reflected in angular distributions $W(\cos\theta, \phi, \Phi)$ of decay products
- Integrating over ϕ and Φ we get

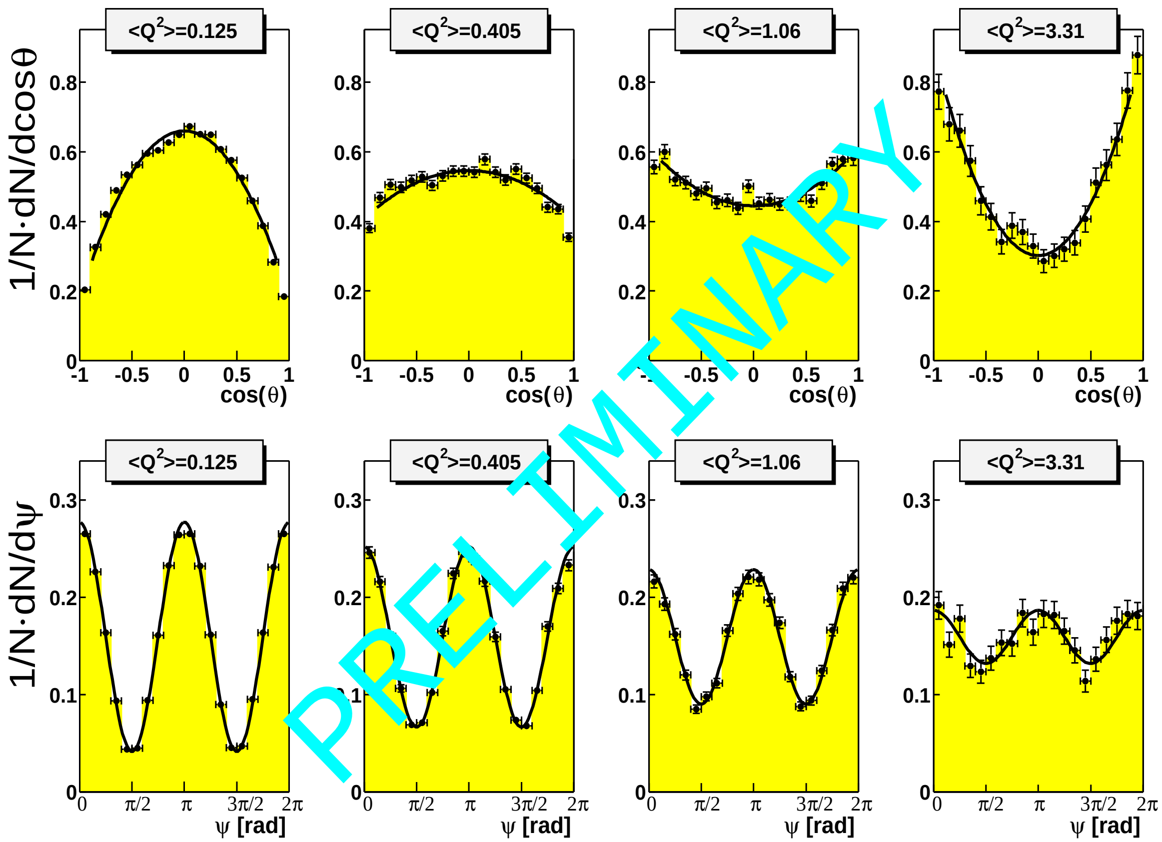
$$W(cos\ \theta) = \frac{3}{4}[(1-r^{04}_{00})+(3r^{04}_{00}-1)\cos^2\theta]\ ,$$

where r^{04}_{00} represents the probability that VM was longitudinally polarized (helicity 0)

- Assuming the validity of SCHC the angular dependence on ϕ and Φ reduces to ψ dependence ($\psi = \phi - \Phi$). Integration over θ leads then to

$$W(\psi) = \frac{1}{2\pi}[1 + 2\epsilon\ r^1_{1-1}\cos 2\psi].$$

Angular distributions



- No acceptance and smearing corrections
- To decrease angular smearing effect $p_t > 0.15$ GeV/c
- For current analysis $Q^2 > 0.05$ (GeV/c)^2

Outlook

- High luminosity allows to collect large statistics sample.
- Trigger conditions allow the measurement in transition region from soft diffraction to pQCD.
- Possibility to measure double spin asymmetries with high accuracy.
- Spin transfer mechanism can be studied (violation of SCHC).
- Study of GPD at large Q^2.