L-T Separation of Transverse Target Spin Asymmetry In Exclusive Rho Production

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Introduction

The measurement of the Transverse Target Spin Asymmetry (TTSA) A_{UT} in the exclusive production of longitudinally polarized ρ^0 mesons on hydrogen, is a good tool to access the generalized parton distribution (GPD) function E. Moreover, it might give us some insight in the GPDs of the gluons, because the production amplitude involves exchange processes of quarks and gluons simultaneously.

In this work we contribute releasing the moment $A_{UT}^{sin(\phi-\phi_s)}$ for the process $\gamma^\star p^\uparrow \rightarrow \rho^0 p$, separated over ρ^0_L and ρ^0_T, using the latest data produced by HERMES.

Data Selection

- 2005 running period
- hydrogen polarized gas target

- More than two trajectories from vertex (target region $-18 < Z < 18$)
- 2 oppositely-charged hadrons
- It was also checked that the tracks were not kaons from a ϕ

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The relevant 4-momenta are:

- Incident electron: k, scattered electron: k'
- Photon: $q \equiv k - k'$
- Struck nucleon: P
- Detected hadrons: P_{h^+} and P_{h^-}

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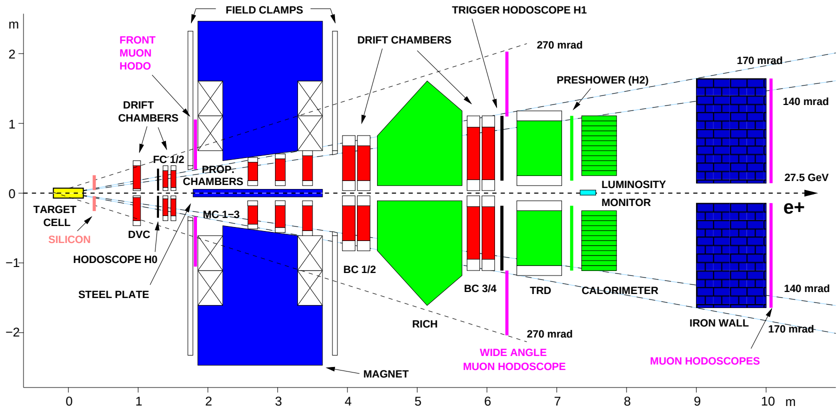
HERMES Apparatus



Cuts

General cuts

- **Data quality cuts**. Properly working detector components and reasonable beam-target polarization (official burst list was used with DQ pattern 401ffffd")
- **Vertex cut**
- **Particle identification and exclusive cuts**.

Particular cuts

- **T-prime cut**. 4 bins with same statistics.
- **Target bit cut**. Spin up, down.
- **$\cos\theta$ cut** Further application in analysis

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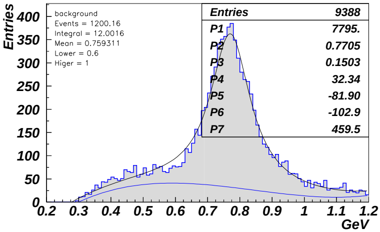
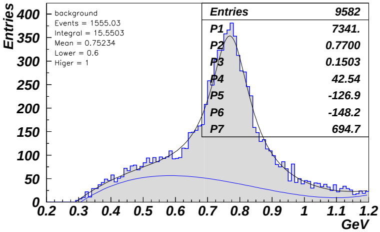
ρ^0 Reconstruction



TMC1: 1st version of transverse magnet correction (TMC)



TMC2: 2nd version of transverse magnet correction (TMC)

Method Description

We use the decay angle θ of the π^+ to get information about the longitudinal polarization of the ρ^0 meson. Assuming that the helicity of the virtual photon is transferred completely to the produced ρ^0 meson.

$$W(\theta) = \frac{3}{4}(1.0 - r_{00}^{04} + (3.0 r_{00}^{04} - 1)\cos^2(\theta))$$

r_{00}^{04}: Longitudinal polarization of the ρ^0

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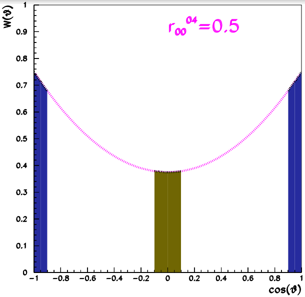
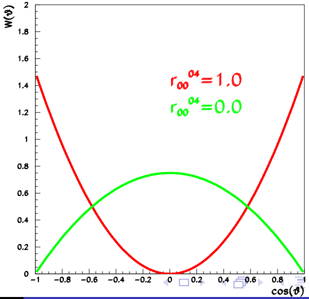
In principle, with unlimited statistics when we determine the asymmetry A_{UT} for events with $\cos(\theta) = 0$, we have selected the process $\gamma^\star p^\uparrow \longrightarrow \rho^0_T p$. For events satisfying $|\cos(\theta)| = 1$, the process $\gamma^\star p^\uparrow \longrightarrow \rho^0_L p$ is selected.



$$\longleftarrow \quad W(\theta, r^{04}_{00})$$

$$r^{04}_{00} \rightarrow 0 \;\; W(\theta)^{T} \longrightarrow$$

$$r^{04}_{00} \rightarrow 1 \;\; W(\theta)^{L} \longrightarrow$$



$$A_{UT}^{inner} = \beta_1 A_{UT}^{T} + (1 - \beta_1) A_{UT}^{L}$$

$$A_{UT}^{outer} = \beta_2 A_{UT}^{L} + (1 - \beta_2) A_{UT}^{T}$$

$$\downarrow$$

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$$A_{UT}^{L} = \frac{A_{UT}^{outer}\beta_1 + A_{UT}^{inner}(\beta_2 - 1)}{\beta_1 + \beta_2 - 1}$$

$$A_{UT}^{T} = \frac{A_{UT}^{inner}\beta_2 + A_{UT}^{outer}(\beta_1 - 1)}{\beta_1 + \beta_2 - 1}$$

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$$A_{UT}^{T} = \frac{A_{UT}^{inner}\beta_2 + A_{UT}^{outer}(\beta_1 - 1)}{\beta_1 + \beta_2 - 1}$$

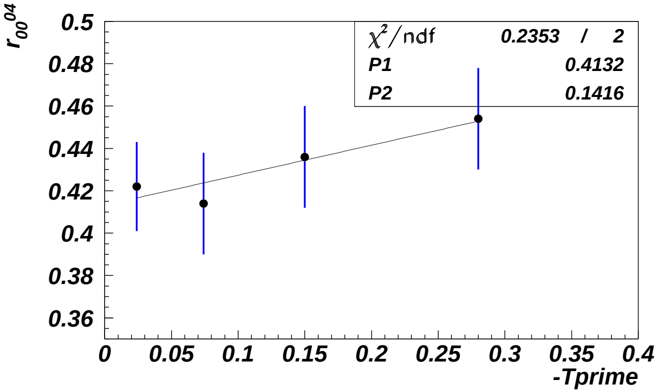
Determination of β_1 and β_2

$$\beta_1 = \frac{\int_{-0.5}^{0.5} (1 - X) W(\theta)^T d\theta}{\int_{-0.5}^{0.5} (XW(\theta)^L + (1 - X) W(\theta)^T) d\theta}$$

$$\beta_2 = \frac{\int_{-1}^{-0.5} XW(\theta)^L d\theta}{\int_{-1}^{-0.5} (XW(\theta)^L + (1 - X) W(\theta)^T) d\theta}$$

$$X = r_{00}^{04}$$

Assuming that r^{04}_{00} is the same for polarized target as for unpolarized target...



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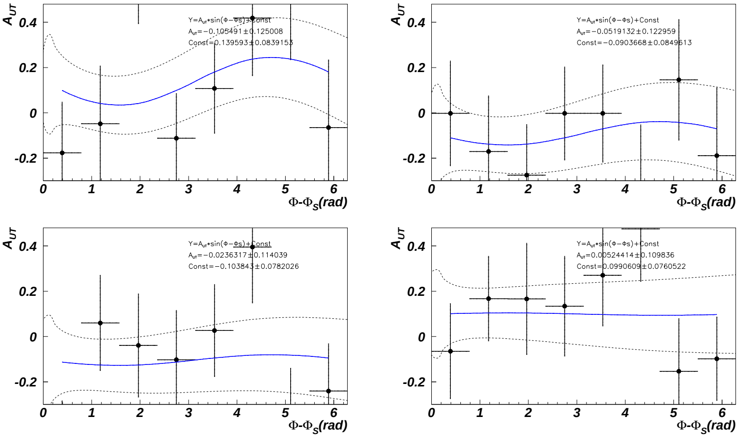
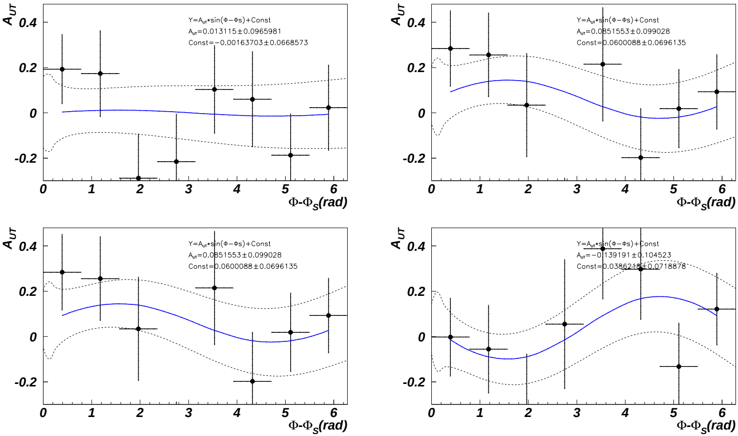
TMC1				
	Bin 1	Bin 2	Bin 3	Bin 4
Tprime	0.02141	0.07620	0.1581	0.2898
r_{00}^{04}	0.41623	0.42399	0.43558	0.45423
β_1	0.88524	0.88196	0.87695	0.86856
β_2	0.66626	0.67331	0.68362	0.69973

TMC2				
	Bin 1	Bin 2	Bin 3	Bin 4
Tprime	0.02063	0.07515	0.1560	0.2867
r_{00}^{04}	0.41612	0.42384	0.43528	0.453796
β_1	0.88528	0.88202	0.87708	0.86876
β_2	0.66616	0.67317	0.68336	0.69936

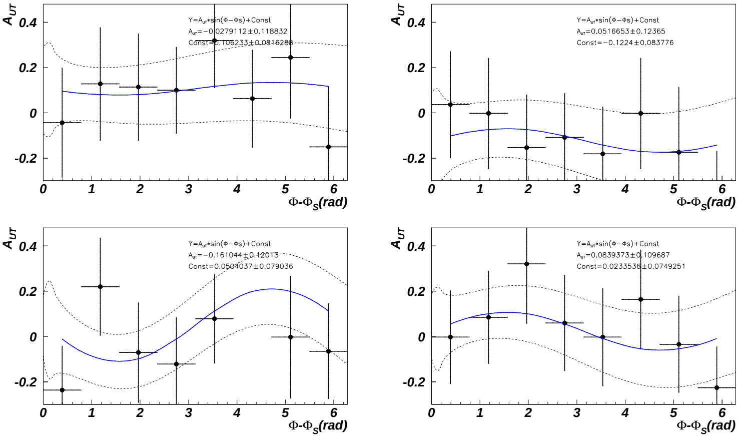
TMC1 A_{UT}^{inner}



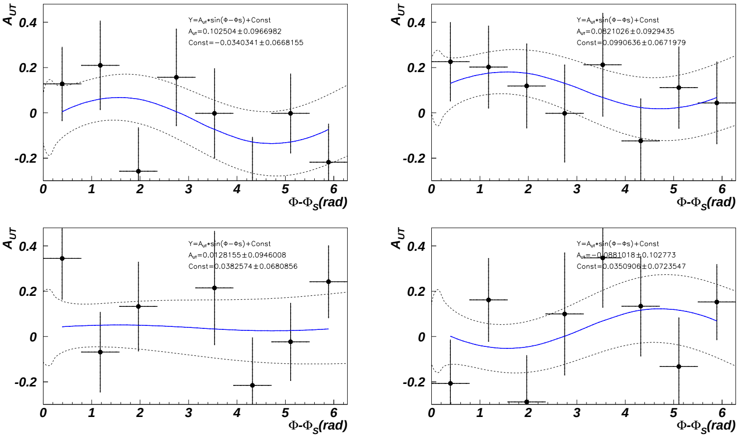
TMC1 A_{UT}^{outer}



TMC2 A_{UT}^{inner}



TMC2 A_{UT}^{outer}



Results

$$A_{UT}^{L} = \frac{A_{UT}^{outer}\beta_1 + A_{UT}^{inner}(\beta_2 - 1)}{\beta_1 + \beta_2 - 1}$$

$$A_{UT}^{T} = \frac{A_{UT}^{inner}\beta_2 + A_{UT}^{outer}(\beta_1 - 1)}{\beta_1 + \beta_2 - 1}$$

TMC1				
	Bin 1	Bin 2	Bin 3	Bin 4
A_{UT}^{outer}	0.013115± 0.09659	-0.0231192±0.09559	0.0851553±0.0696	-0.139191±0.1045
A_{UT}^{inner}	-0.105491±0.125	-0.0519132±0.1229	-0.0236317±0.1140	0.00524414±0.1098
A_{UT}^{L}	0.0848868±0.1725	-0.00617872±0.168	0.146551±0.12649	-0.215505±1699
A_{UT}^{T}	-0.130171±0.1523	-0.058034±0.1504	-0.0475108±0.1399	0.0386484±0.137

TMC2				
	Bin 1	Bin 2	Bin 3	Bin 4
A_{UT}^{outer}	0.102504±0.09669	0.0821026±0.0929	0.0128155±0.0946	-0.0881018±0.1027
A_{UT}^{inner}	-0.0279112±0.1188	0.0516653±0.1236	-0.161044±0.120	0.0839373±0.1096
A_{UT}^{L}	0.181454±0.171	0.10002±0.164	0.111041±0.1628	-0.179139± 0.1675
A_{UT}^{T}	-0.0550403±0.1449	0.0451979±0.1512	-0.199175±0.1479	0.123677±0.137

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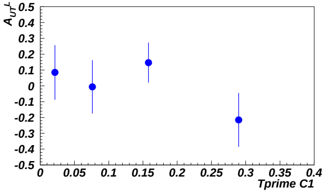
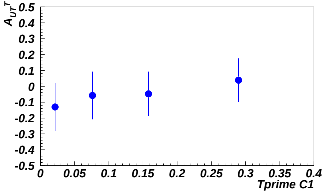
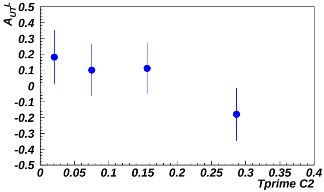


A_{UT}^{L}



A_{UT}^{T}

TMC2



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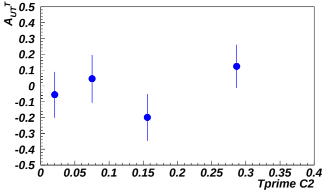
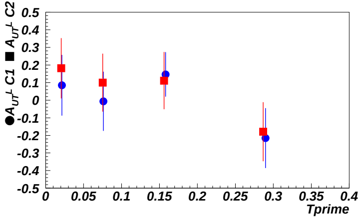
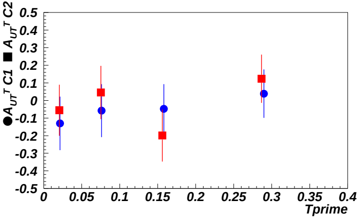


A_{UT}^{T}

Comparisons Among TMC1 and TMC2

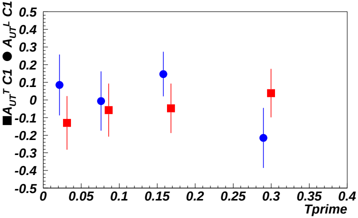


A^L_{UT}, blue: TMC1, red: TMC2

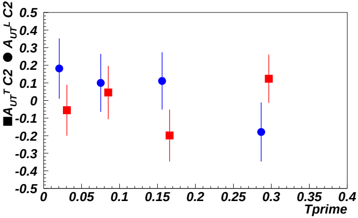


A^T_{UT}, blue: TMC1, red: TMC2

Comparisons Among A_{UT}^{L} and A_{UT}^{T}

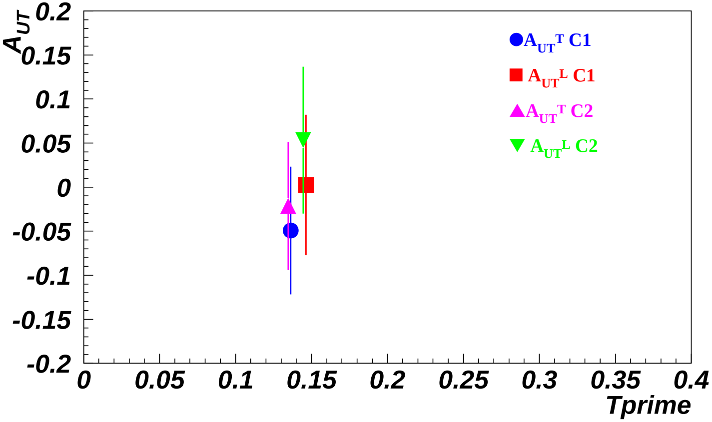


TMC1, blue: A_{UT}^{L}, red: A_{UT}^{T}



TMC2, blue: A_{UT}^{L}, red: A_{UT}^{T}

general averages



Conclusions

We separate the transversal and longitudinal components of Transverse Spin Asymmetry in exclusive ρ^0 production, using a method based on the cosine of the decay angle of the π^+ in the ρ^0 center of mass, verifying that all the calculation process in correct we obtain a result of this measurement as follows:

	A_{UT}^{L}	A_{UT}^{T}
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GRACIAS...!