Exclusive Vector Meson Production at HERMES

Symmetries and Spin 2005, Prague, Czech Republic.

Jeroen Dreschler

on behalf of the HERMES collaboration

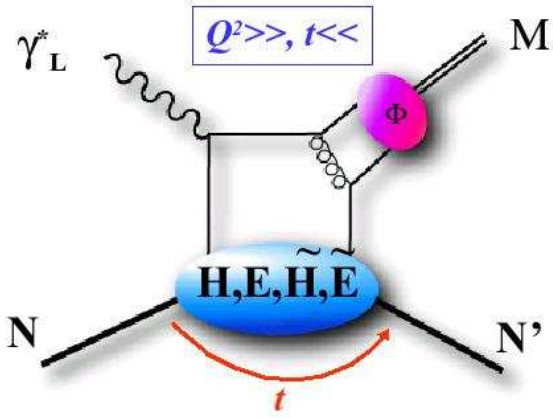
Nationaal Instituut voor Kernfysica en Hoge-Energiefysica (NIKHEF)

Outline

- Introduction
- $\sigma_L - \sigma_T$ separation
- Measured cross sections
- Transverse target spin asymmetry in exclusive ρ^0 production
- Conclusion

GPDs & Exclusive Meson Production

- Factorization of LO amplitudes
  - For meson production only proven for γ_L^*
  - GPDs parametrize lower non pertubative part



GPDs & Exclusive Meson Production

- Factorization of LO amplitudes
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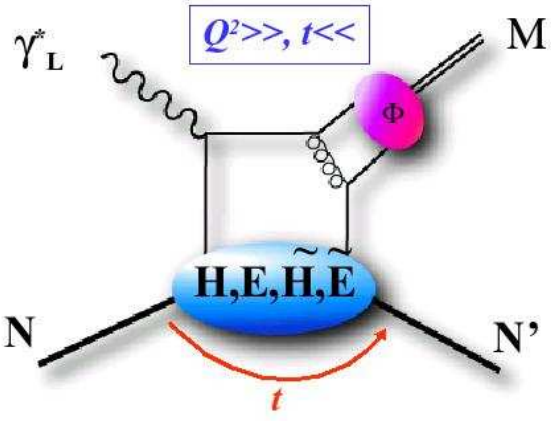
  - GPDs parametrize lower non pertubative part
- Leading twist Generalized Parton Distributions
  - For each quark flavour q: $H^q, E^q, \tilde{H}^q, \tilde{E}^q$
  - Vector mesons production $\Rightarrow$ H^q, E^q
  - Pseudoscalar meson production $\Rightarrow$ $\tilde{H}^q, \tilde{E}^q$



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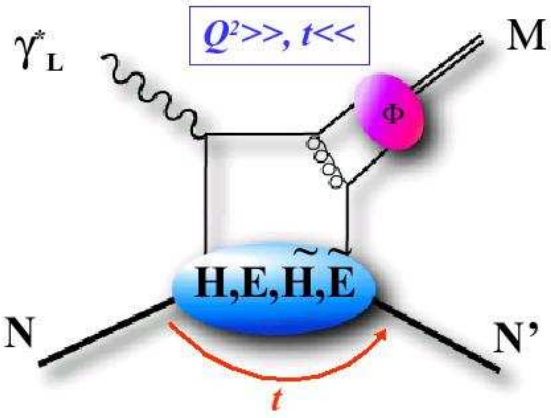
- New information about quark structure in nucleon
  - Quark (orbital) angular momentum:

$$J^q = \frac{1}{2} \lim_{t \to 0} \int_{-1}^{1} x[H^q + E^q] dx$$

$$L^q = J^q - \frac{1}{2}\Delta\Sigma$$

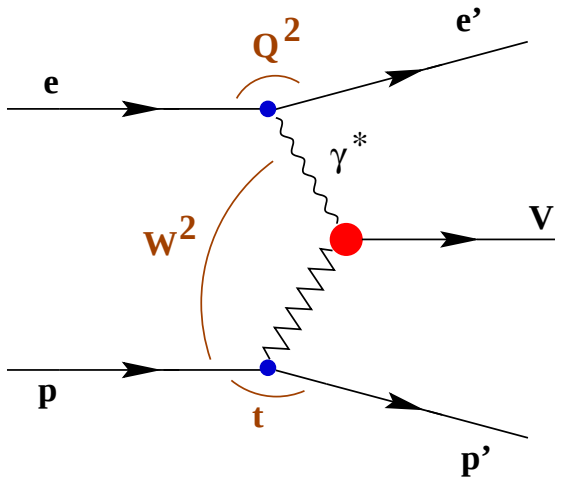


Extraction of Exclusive VM Sample

- Detected in HERMES spectrometer
  - Scattered lepton
  - Vector meson decay products

$$M_{2h} = \sqrt{(P_{h^+} + P_{h^-})^2}$$

V	$\rightarrow$	h^+h^-
ρ^0	$\rightarrow$	$\pi^+\pi^-$
φ	$\rightarrow$	K^+K^-



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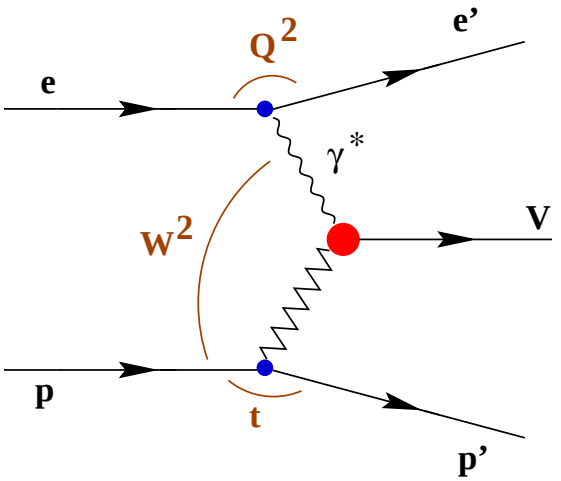

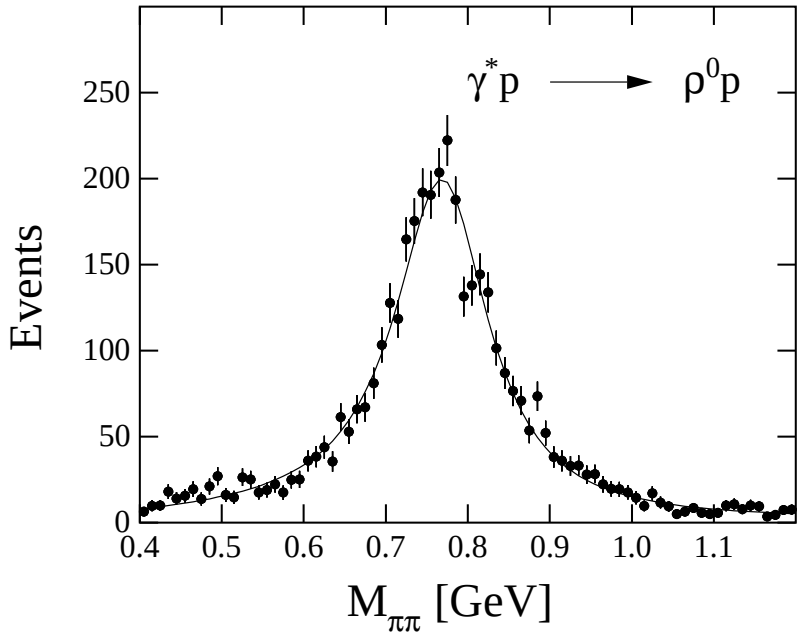

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  - Calculate missing mass M_X

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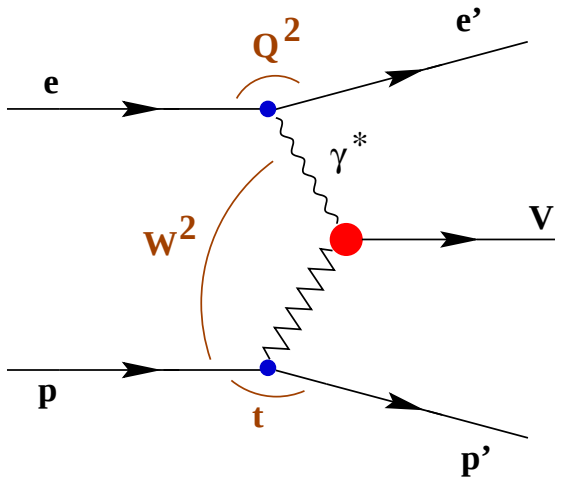

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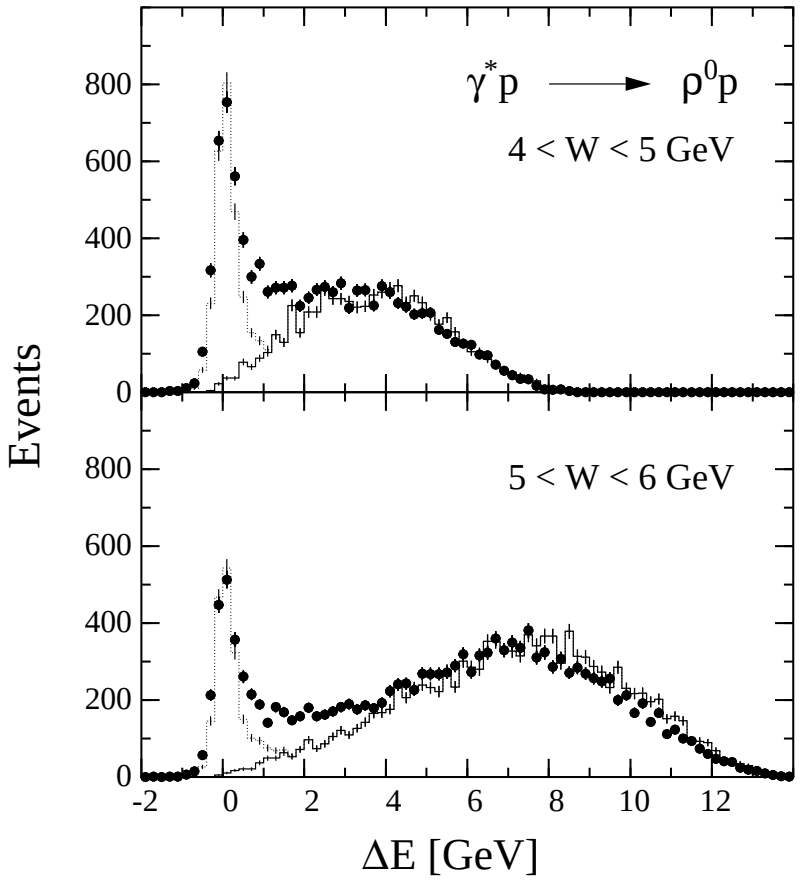
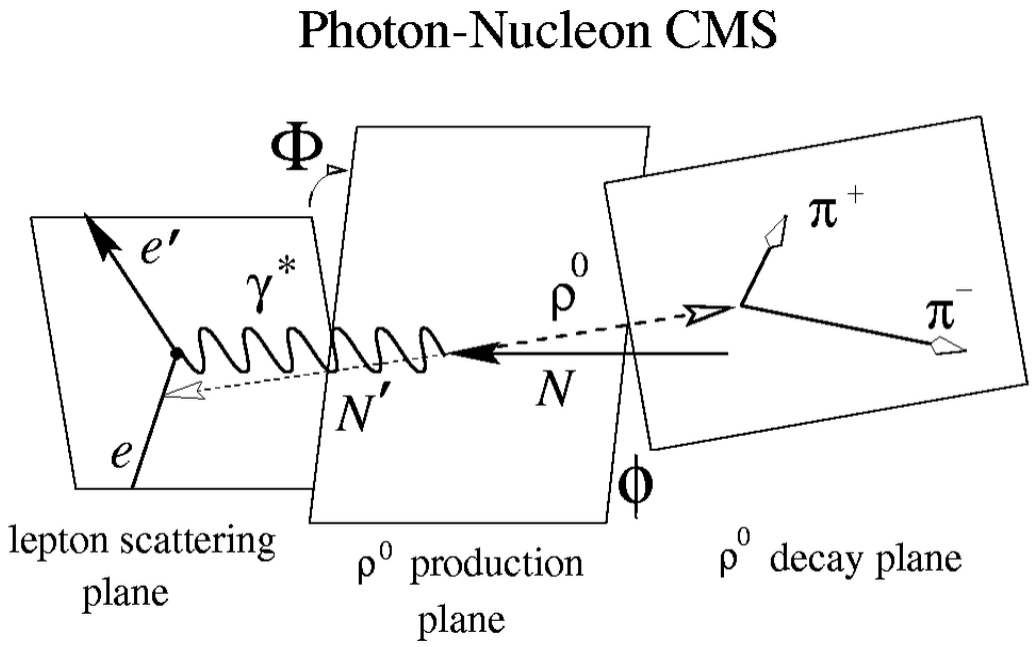
  - ΔE should be peaked around zero

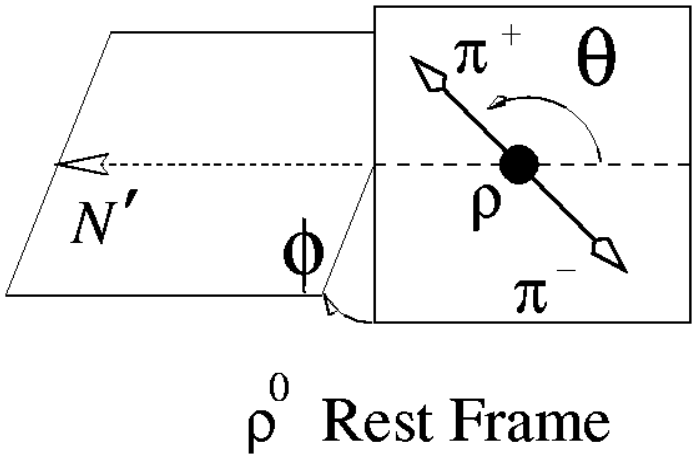
$$\Delta E = \frac{M_X^2 - M_p^2}{2M_p}$$



Angular Distributions of Decay Products

- $\sigma_L - \sigma_T$ separation possible from $W(\cos\theta, \phi, \Phi)$
  - $W(\cos\theta, \phi, \Phi)$ can be descibed in terms of 23 SDMEs
  - $r_{00}^{04} \quad \Rightarrow \quad W(\cos\theta)$





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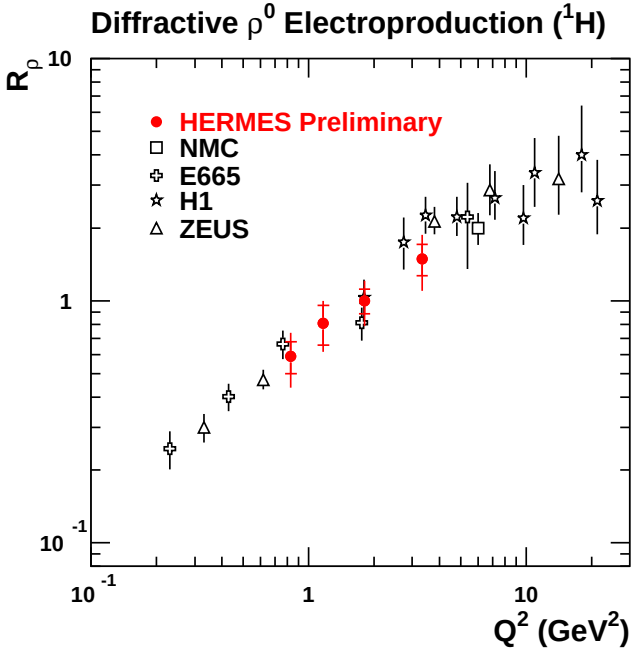

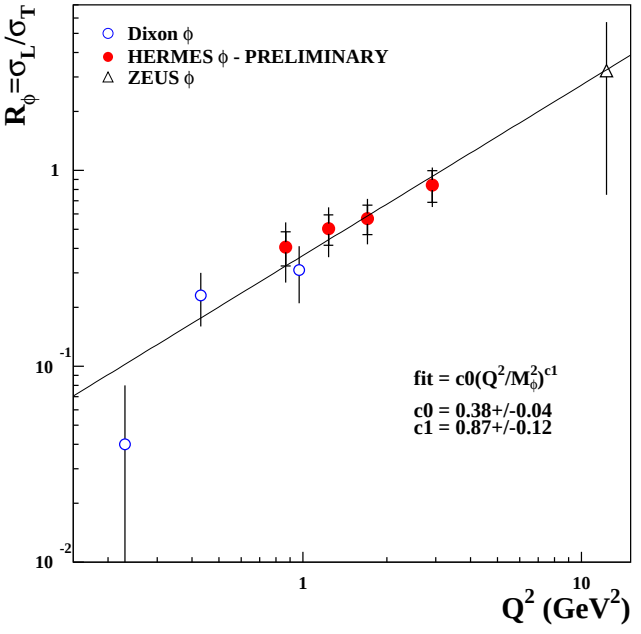

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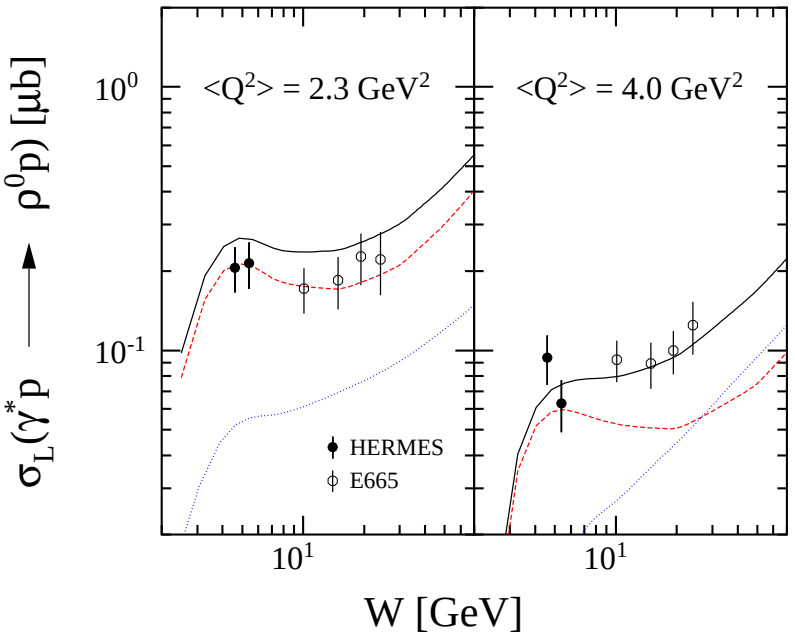
- $\sigma_L - \sigma_T$ separation possible
  - $\sigma_L = \frac{R}{1+\epsilon R}\sigma_{\gamma^* p \to V p}$
  - Allows comparison with GPD based models

Cross Section Measurements

- Is exclusive ρ^0 production dominated by quark exchange?



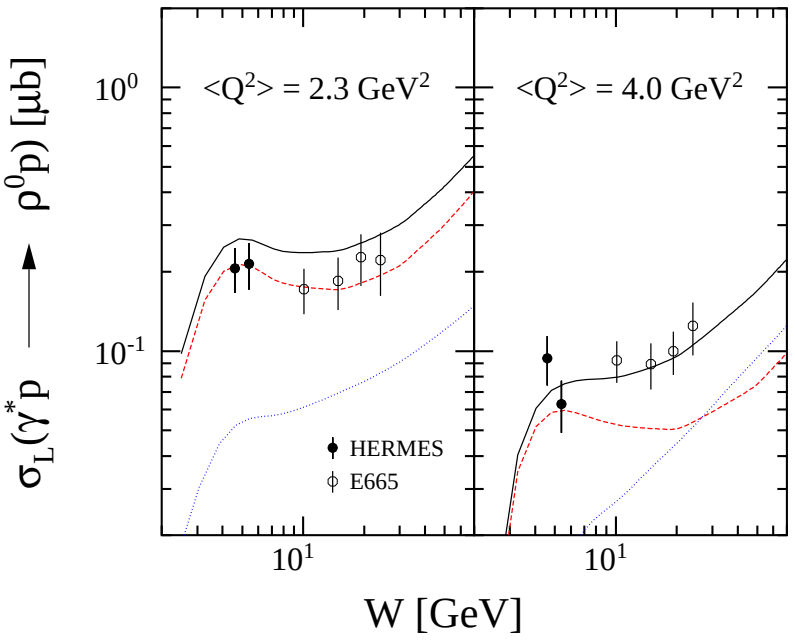
— *VGG calculations*

— *VGG, two-quark exchange*

— *VGG, two-gluon exchange*

Cross Section Measurements

- Is exclusive ρ^0 production dominated by quark exchange?
- Exclusive ϕ meson produced via gluon exchange



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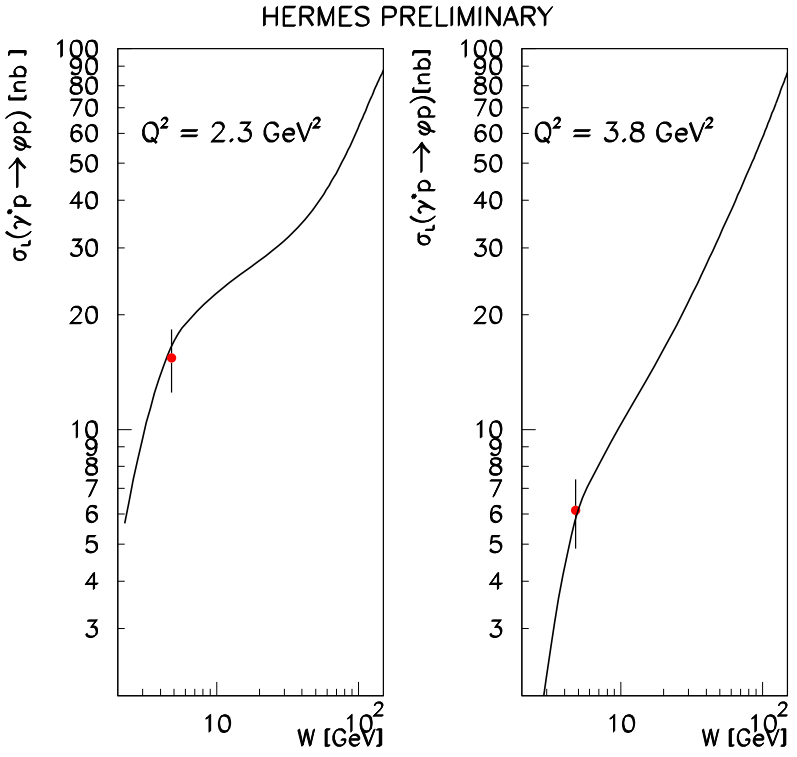

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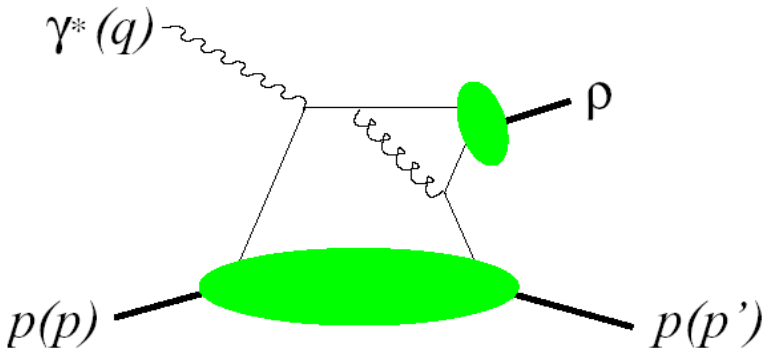
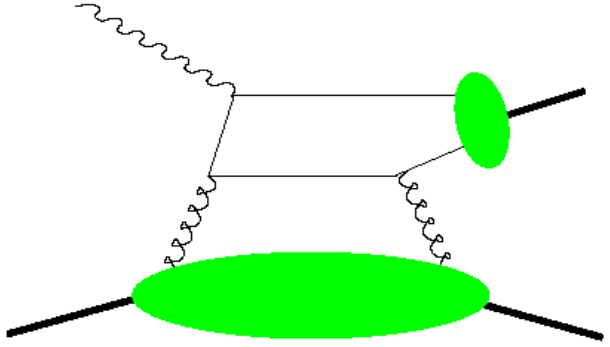
Cross Section ratio $\sigma_\phi / \sigma_{\rho^0}$

- Estimate contributions quark / gluon exchange for exclusive ρ^0 production





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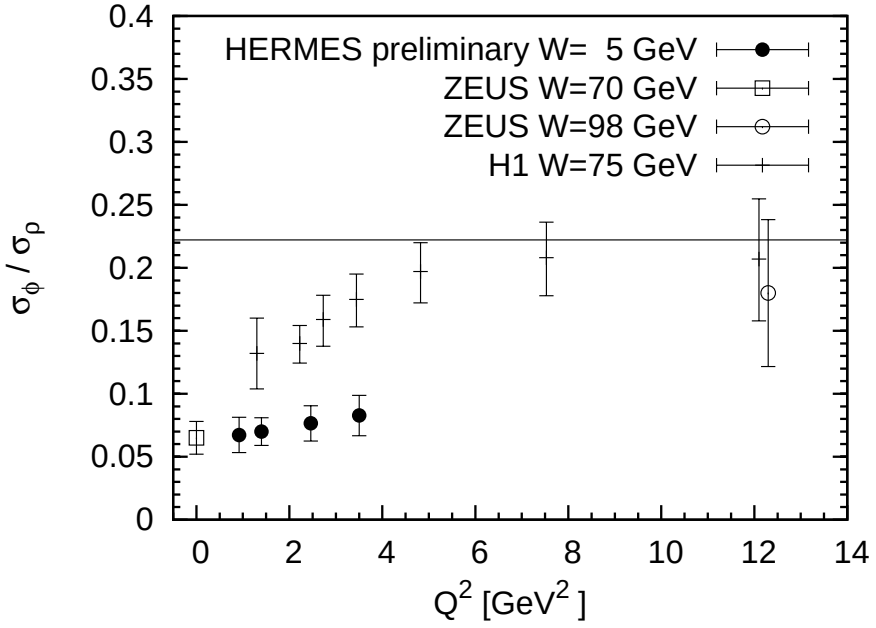


Diehl, Vinnikov, 2005

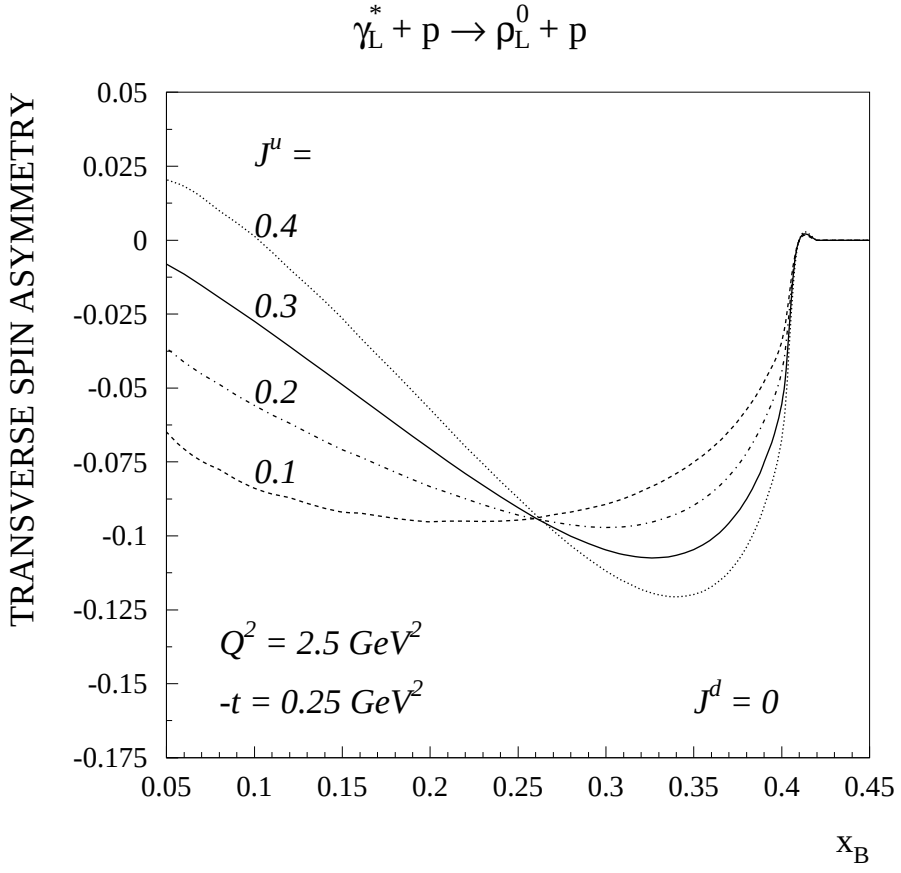
$$\frac{\sigma_\phi}{\sigma_{\rho^0}} \approx \frac{2}{9}\frac{|g_{\rho^0}|^2}{|g_{\rho^0}|^2 + 2|q_{\rho^0}||g_{\rho^0}|\cos\alpha + |q_{\rho^0}|^2} \quad \Rightarrow \quad 0.38 \leq |q_{\rho^0}/g_{\rho^0}| \leq 1.5$$

Cross Section ratio $\sigma_\phi / \sigma_{\rho^0}$

- Estimate contributions quark / gluon exchange for exclusive ρ^0 production
- Possibly substantial contribution from gluon exchange
- New GPD model based predictions
  - 15-20% pure quark exchange contribution to cross section

Transverse Target Spin Asymmetry

- Transverse target spin azimuthal asymmetry
  - $\mathcal{A}_{theory} \propto EH$
  - Sensitivity to J^q
- Measurements of A_{UT} in exclusive ρ^0 production
  - $\mathcal{A}_{theory} = -\frac{2}{\pi} A_{UT}^{\sin(\phi-\phi_s)}$

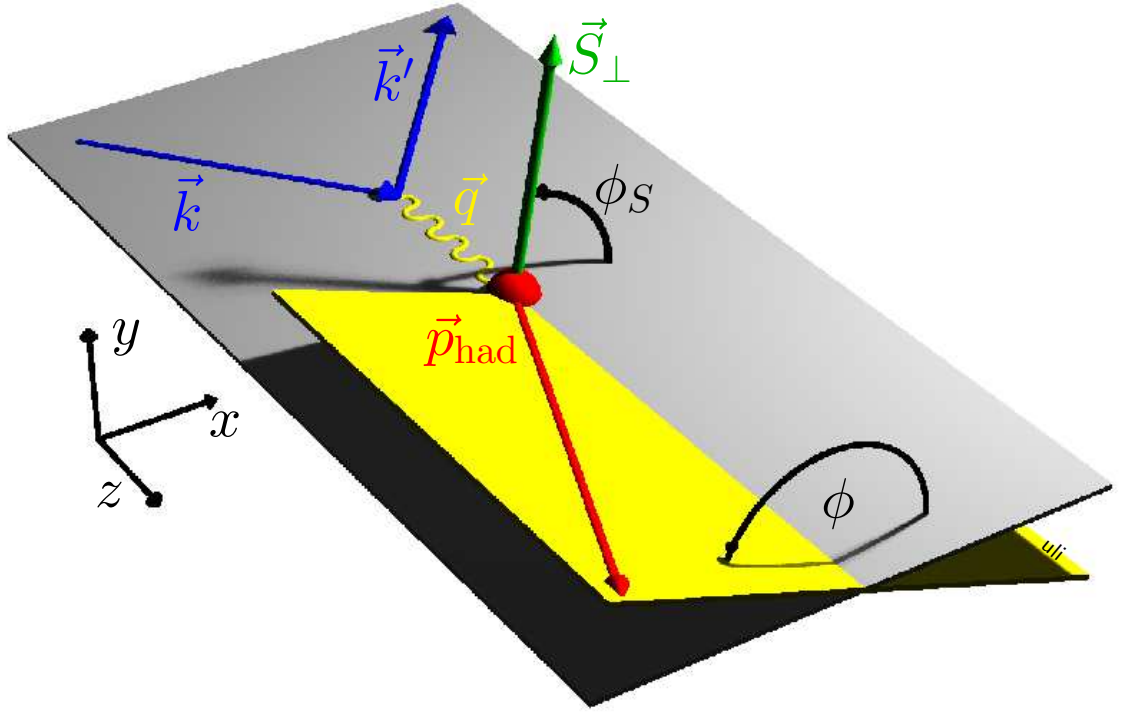


Goeke, Polyakov, Vanderhaeghen, 1999

Transverse Target Spin Asymmetry

- Experimentally:

$$A_{UT}(\phi,\phi_S) = \frac{1}{|P_t|}\frac{N^{\uparrow}(\phi,\phi_S) - N^{\downarrow}(\phi,\phi_S)}{N^{\uparrow}(\phi,\phi_S) + N^{\downarrow}(\phi,\phi_S)}$$



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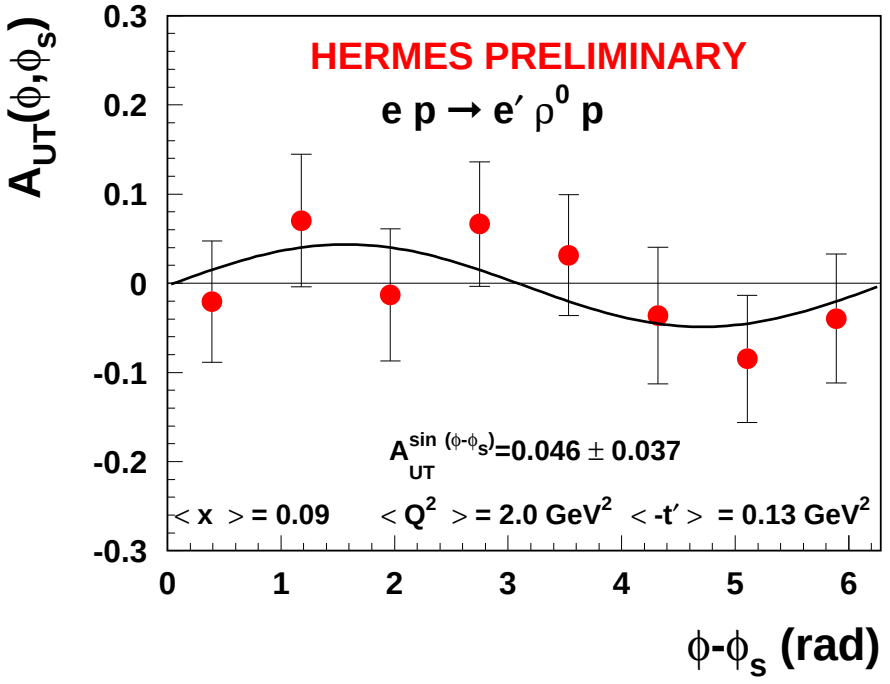
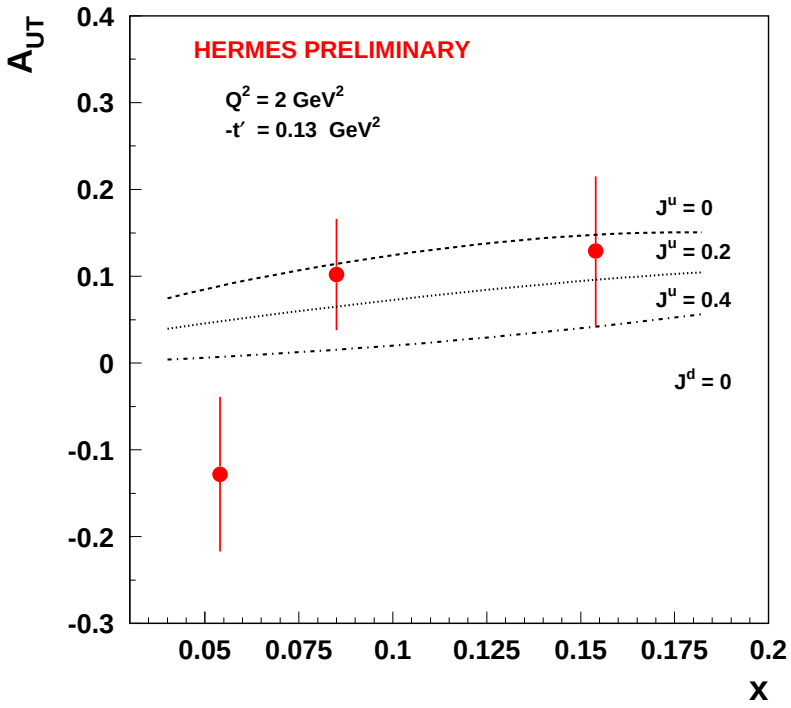
- $A_{UT}(\phi-\phi_s) = A_{UT}^{\sin(\phi-\phi_s)}\sin(\phi-\phi_s)$



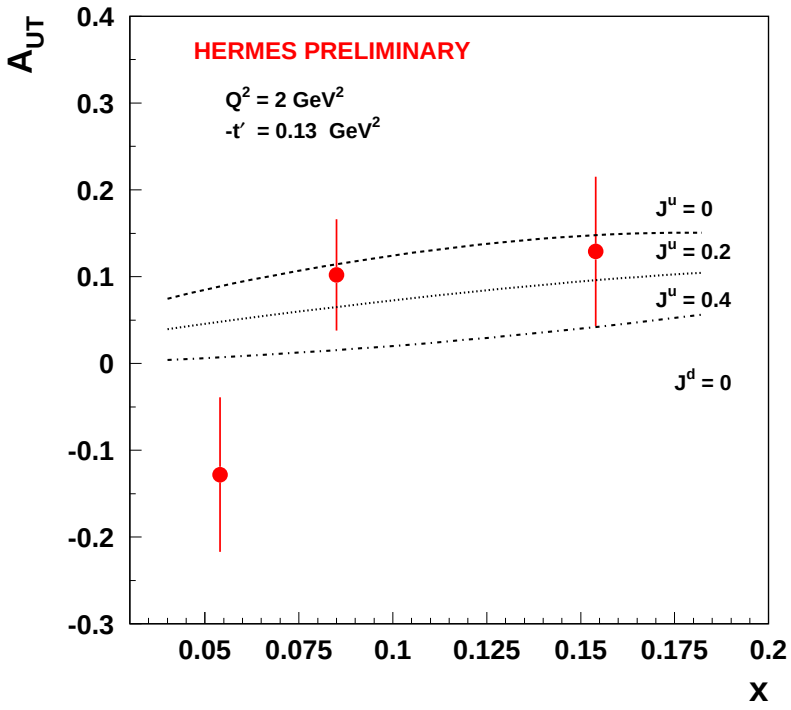
Transverse Target Spin Asymmetry

- Kinematic dependence of $A_{UT}^{\sin(\phi-\phi_s)}$



Transverse Target Spin Asymmetry

- Kinematic dependence of $A_{UT}^{\sin(\phi-\phi_s)}$
  - Results in agreement with theoretical predictions



Transverse Target Spin Asymmetry

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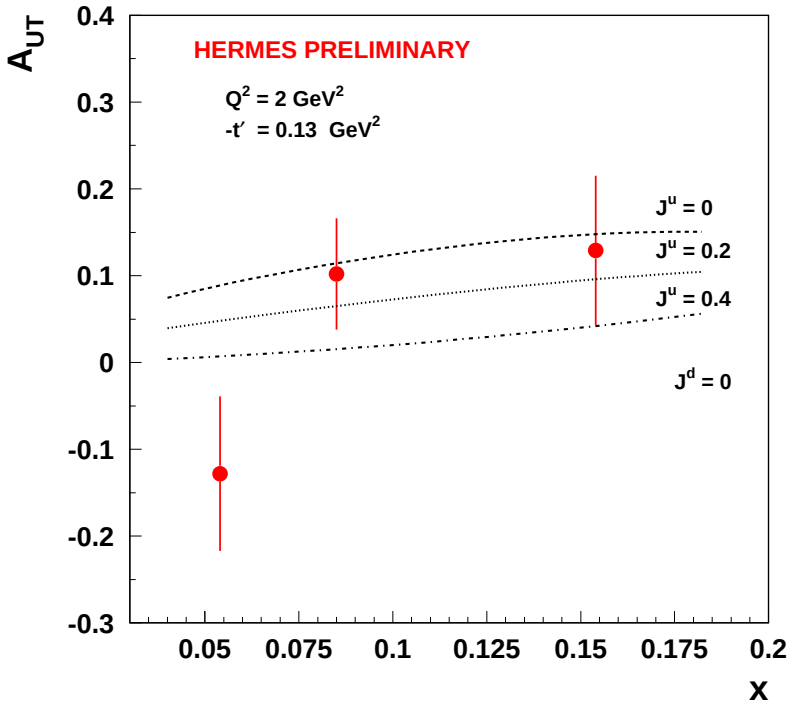
  - Results in agreement with theoretical predictions
- To be done:
  - Include 2005 data (statistics increase factor 2)



Conclusion

- Summary
  - Cross sections have been measured and compared to GPD based predictions
  - First (preliminary) results shown for A_{UT} in exclusive ρ^0 production
- Outlook
  - More data for exclusive ϕ and ρ^0 production to be analysed
  - New data with a transversely polarized target to come
  - $\sigma_L - \sigma_T$ separation for A_{UT} in exclusive ρ^0 production ...