Exclusive Meson Production at HERMES

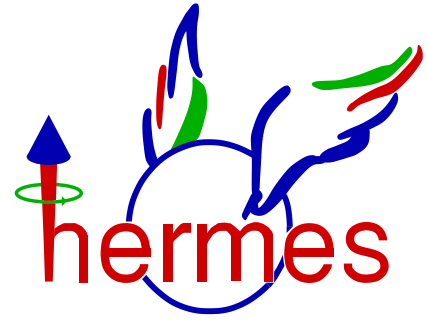
Jefferson Lab, VA, USA, May 2007

Armine Rostomyan

(on behalf of the HERMES collaboration)

(DESY)

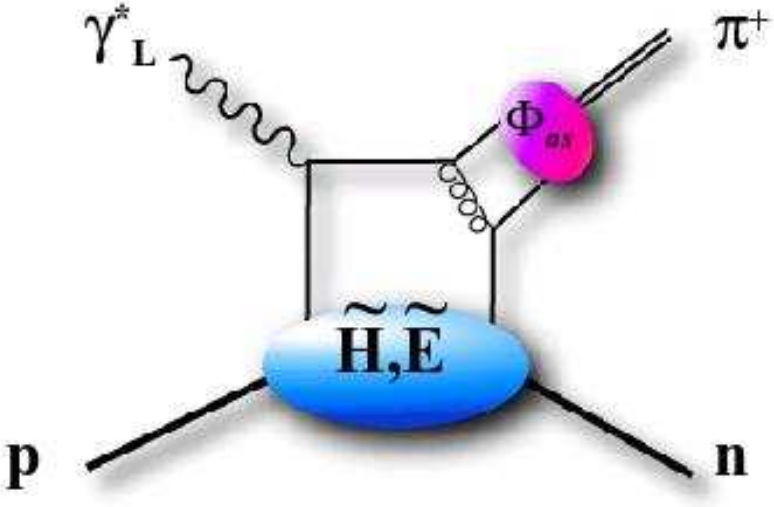
- Exclusive π^+ production
- Exclusive ρ^0, ϕ production



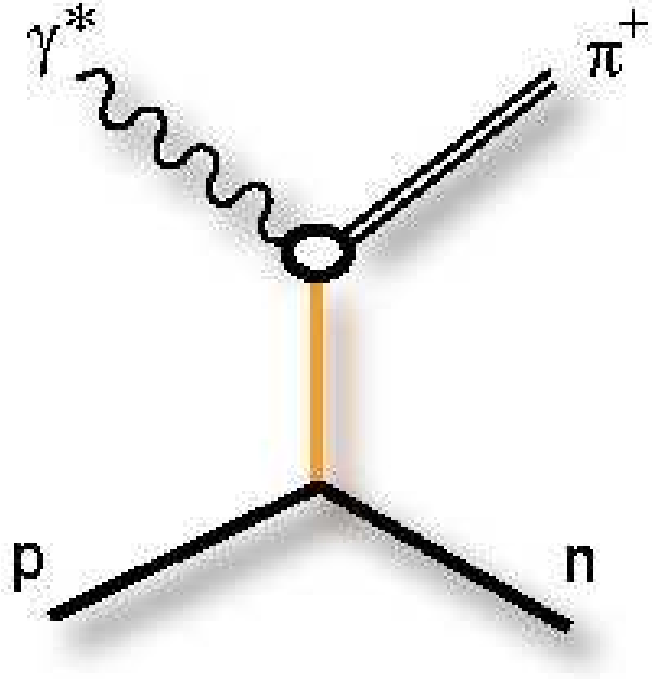
Exclusive π^+ Production

$ep \rightarrow e\pi^+ n$

GPD model



Regge model



- information about partonic structure of the nucleon

Exclusivity for $ep \rightarrow e'\pi^+(n)$

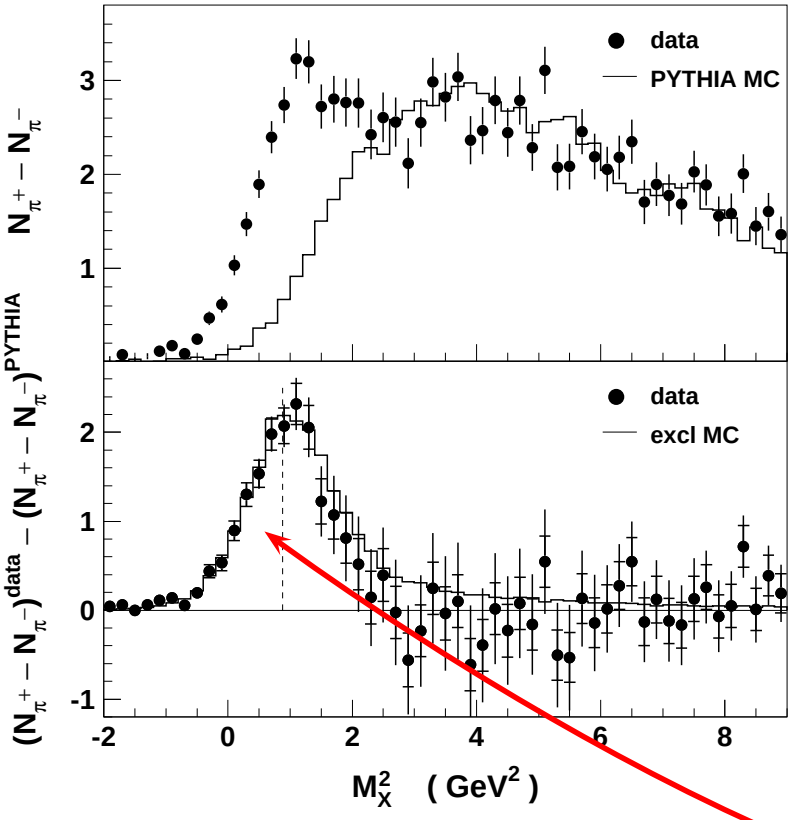
- for analyzed data no recoil nucleon detection yet
- select exclusive π^+ reaction through the missing mass technique:

$$M_x^2 = (P_e + P_p - P_{e'} - P_{\pi^+})^2$$

Exclusivity for $ep \rightarrow e'\pi^+(n)$

$$M_x^2 = (P_e + P_p - P_{e'} - P_{\pi^+})^2$$

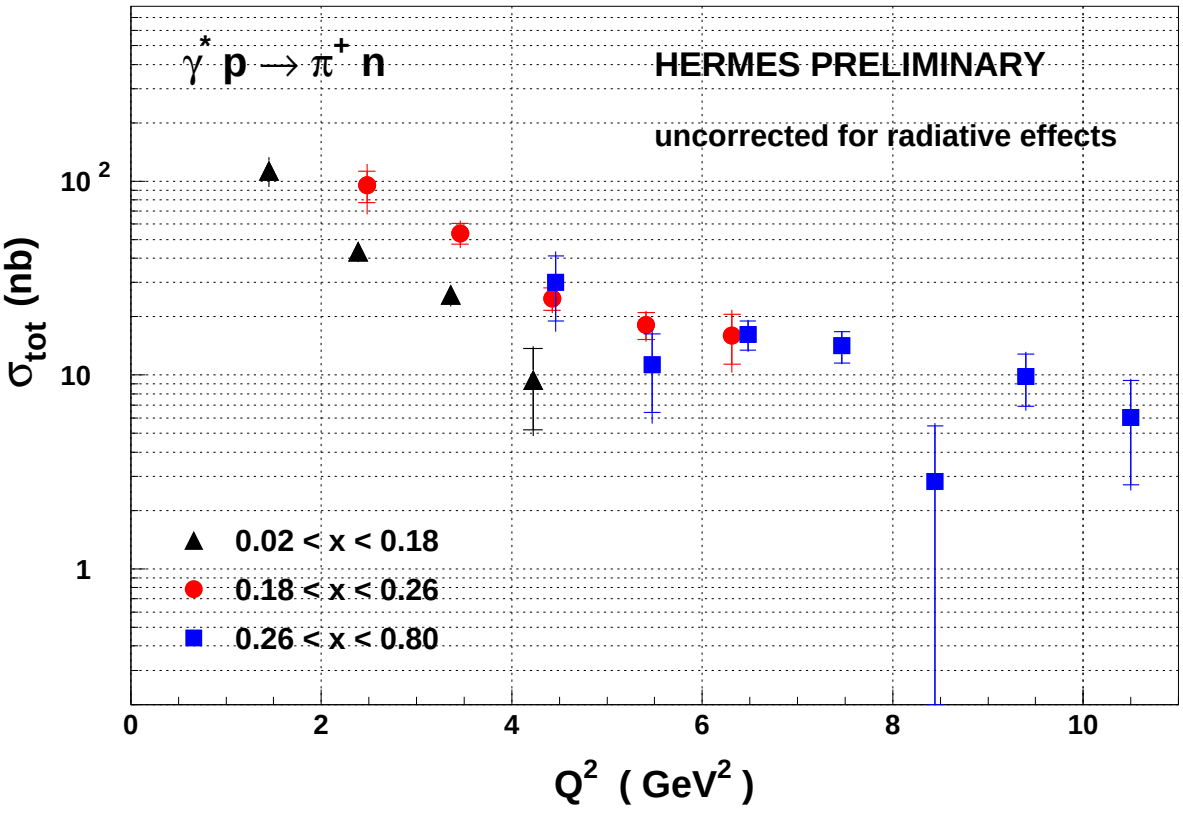
π^+	exclusive π^+	VM_{π^+}	SIDIS
π^-		VM_{π^-}	SIDIS



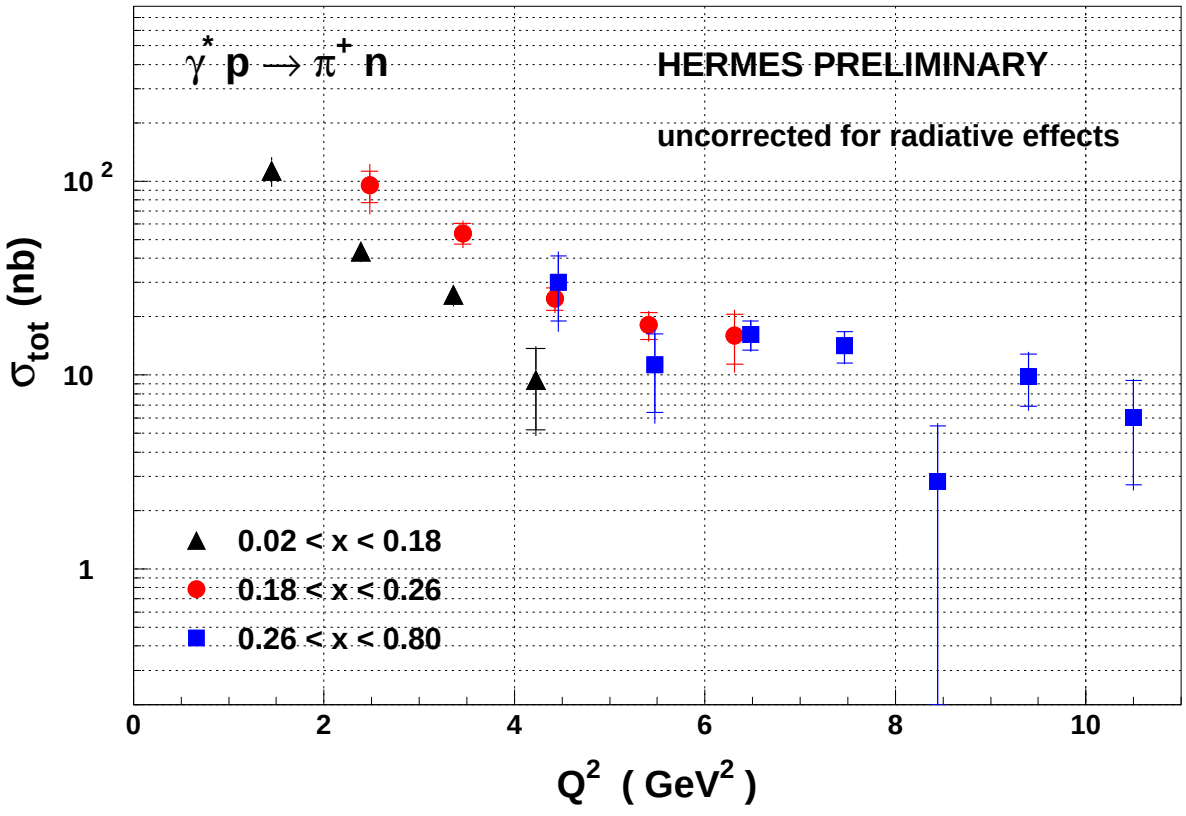
$$N^{excl} = (\pi^+ - \pi^-)^{data} - (\pi^+ - \pi^-)^{MC}$$

- $\pi^+ - \pi^-$ yield difference was used to subtract the non exclusive background
- exclusive peak centered at the nucleon mass
- exclusive MC based on GPD model

Exclusive π^+ Production Cross Section



Exclusive π^+ Production Cross Section

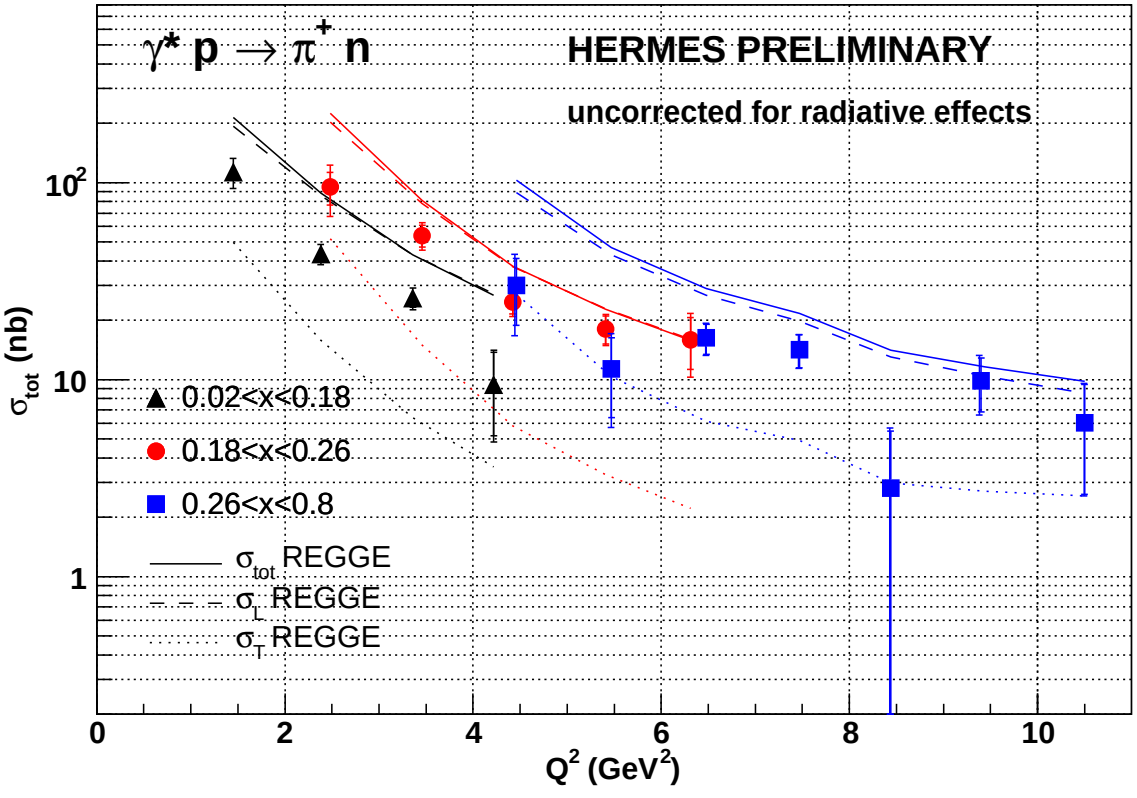


$\sigma_{tot} = \sigma_T + \epsilon\sigma_L$

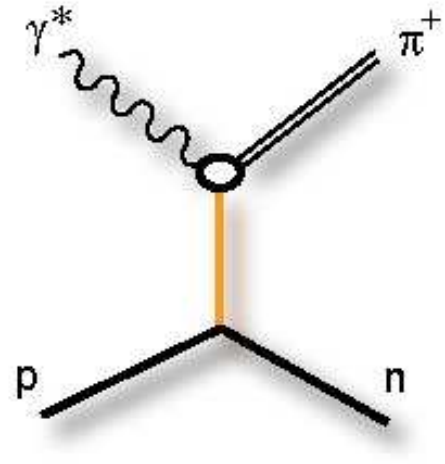
- L/T separation not possible
- HERMES kinematics: $0.80 < \epsilon < 0.96$
- σ_T suppressed by $1/Q^2$

σ_L dominates at large Q^2

Regge Model



$$\sigma_{tot} = \sigma_T + \epsilon\sigma_L$$

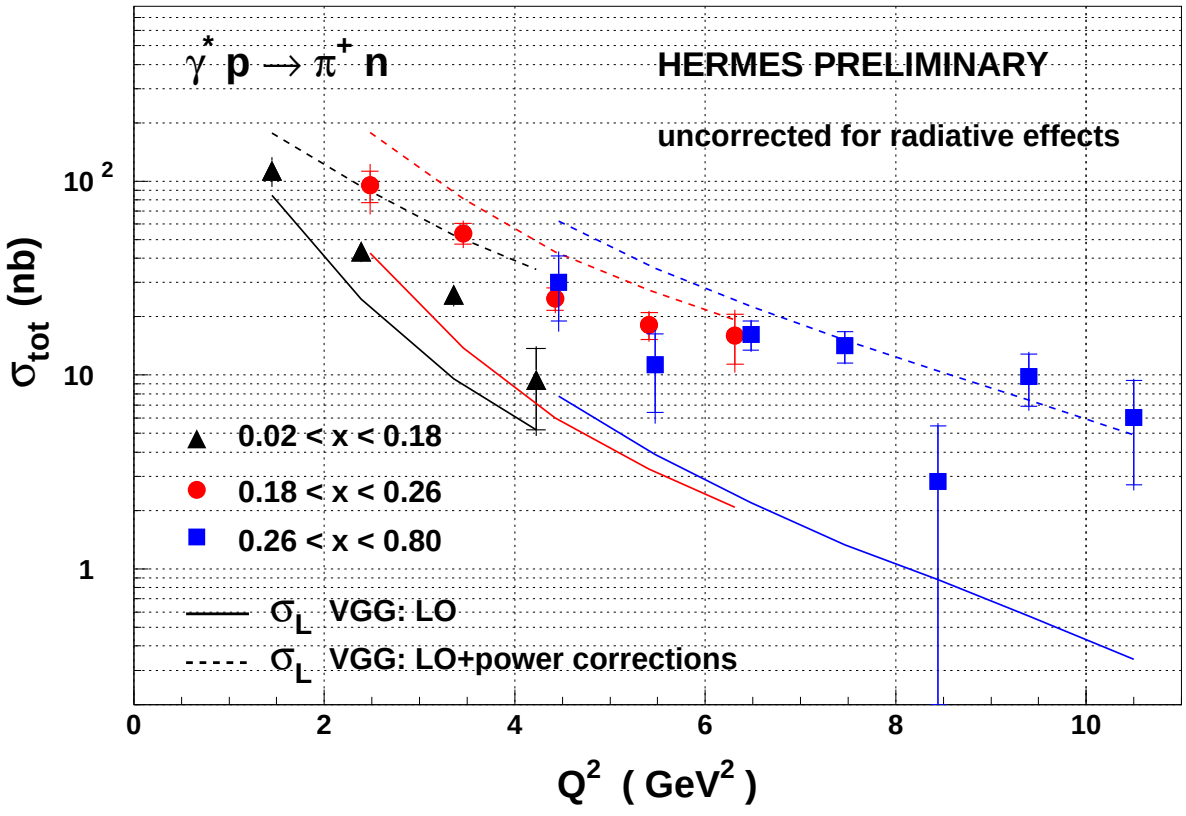


-J.M. Laget (2004)-

Model predicts

- small contribution from σ_T
- $\sigma_L \approx \sigma_{tot}$

GPD model

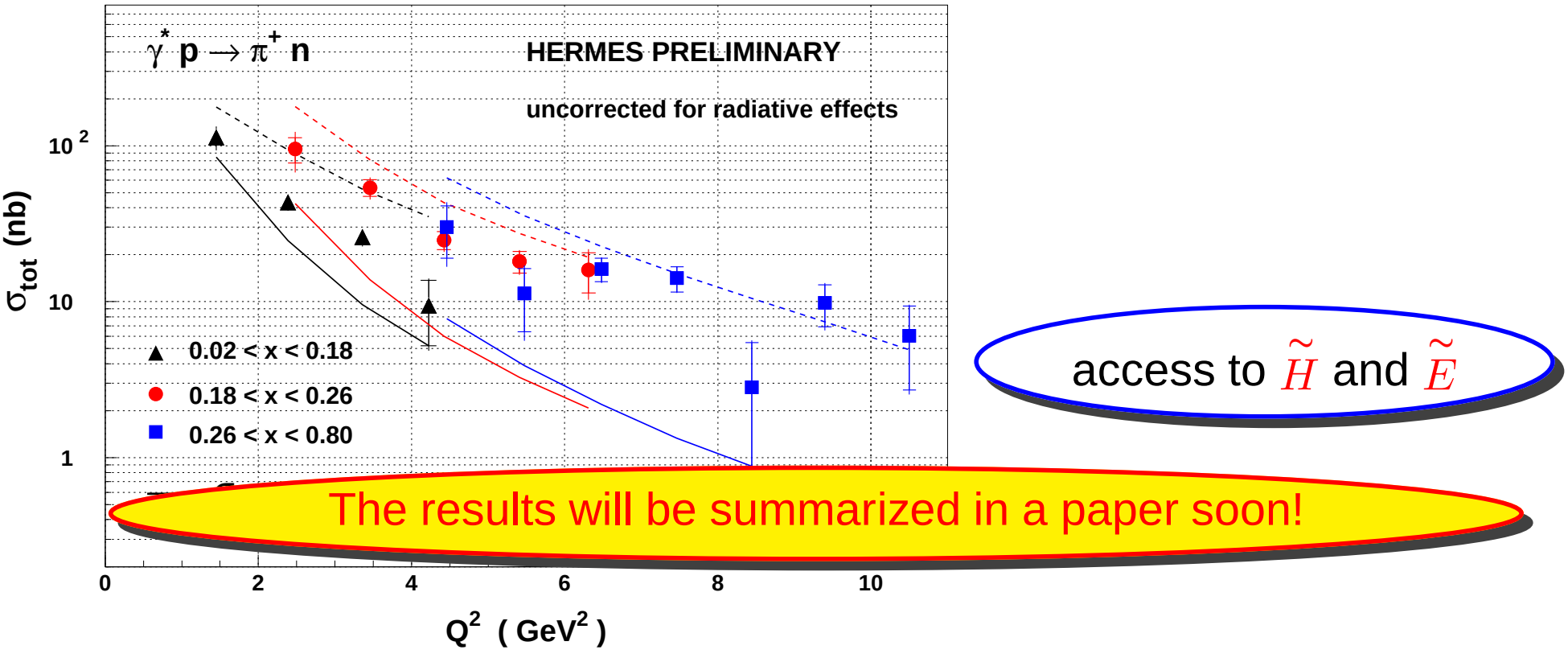


access to $\widetilde{H}$ and $\widetilde{E}$

-Vanderhaeghen,Guichon,Guidal (1999)-

- LO calculations underestimate the data
- Evaluation of the power correction ($k_\perp$ and soft overlap) appears too large

GPD model



access to $\widetilde{H}$ and $\widetilde{E}$

The results will be summarized in a paper soon!

-Vanderhaeghen,Guichon,Guidal (1999)-

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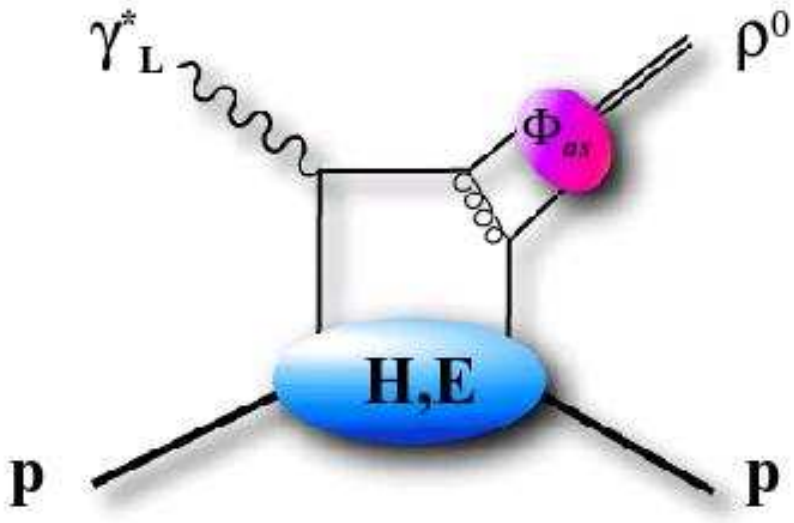
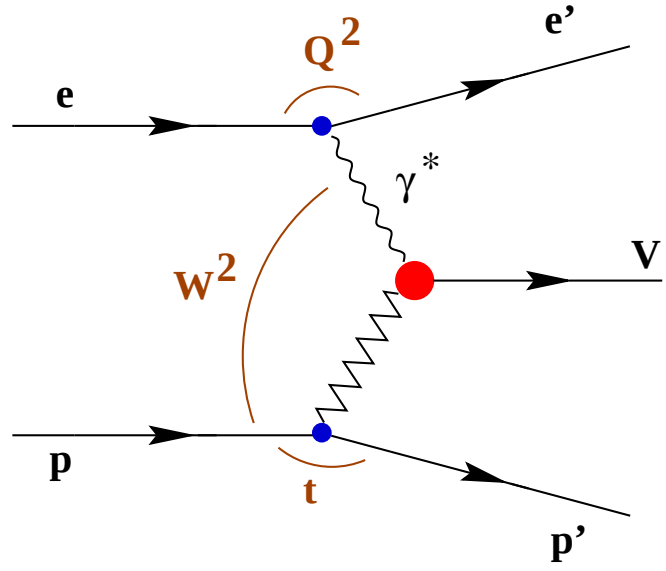
Exclusive Vector Meson Production

$$ep \rightarrow eVp$$

GPD model



VMD model



- ρ^0: probe the quark and gluonic structure of the nucleon
- ϕ: probe the gluonic structure of the nucleon

- describe the vector meson production and decay

Exclusive Vector Meson Selection

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

$\phi \rightarrow K^+K^-$

- no recoil nucleon detection for the analyzed data set
- exclusive ρ^0 and ϕ reactions through the energy and momentum transfer:

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

$t' = t - t_0$

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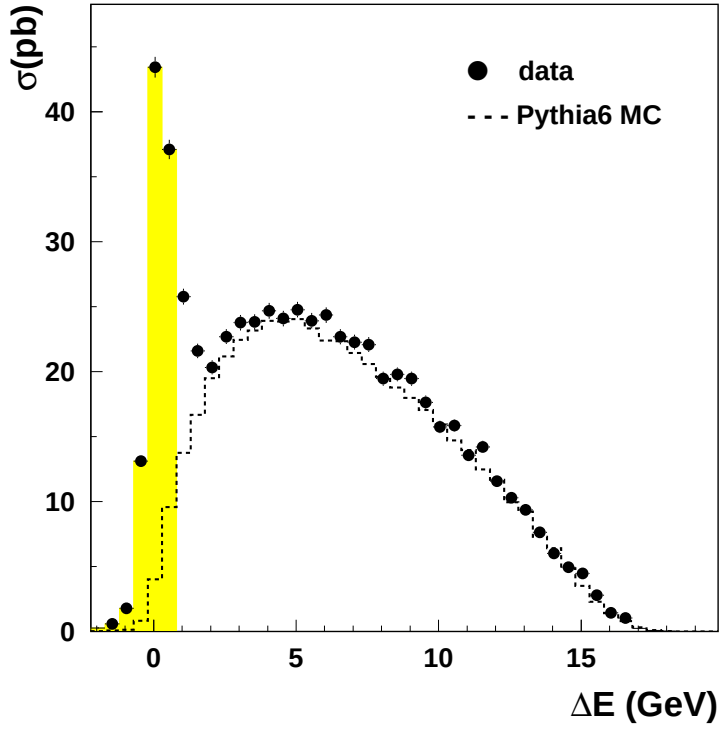
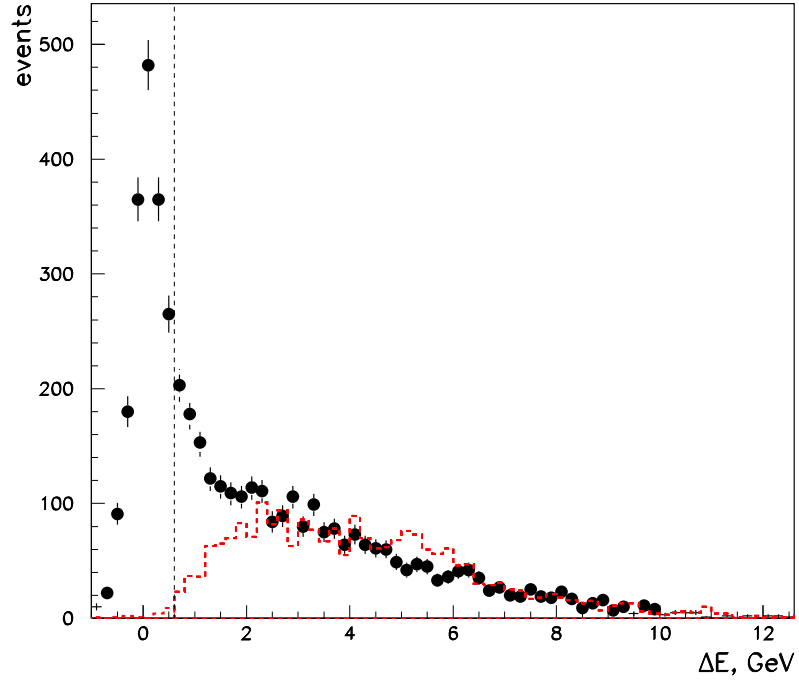
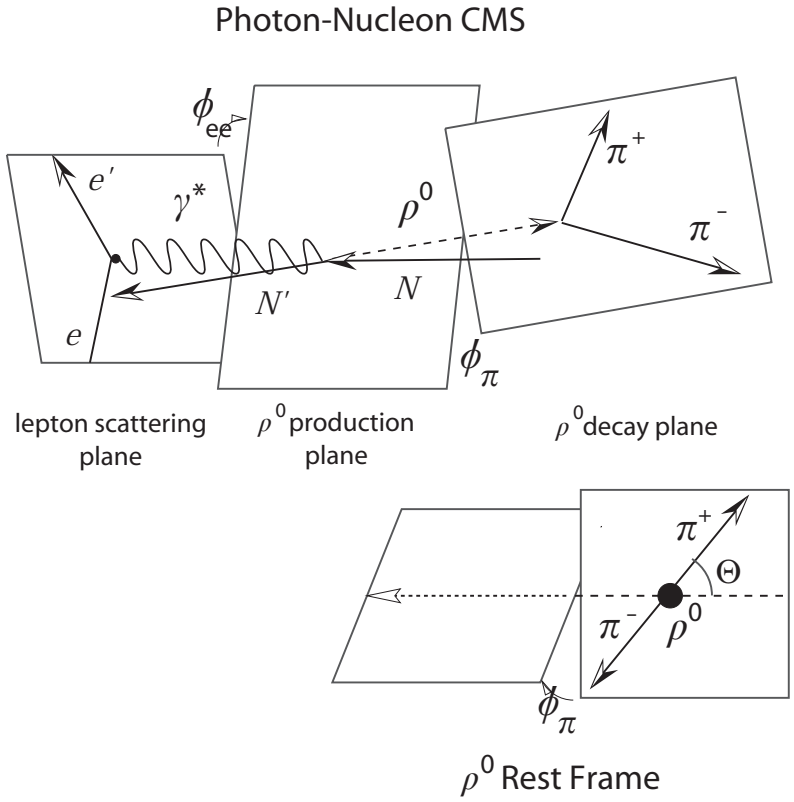




Spin Density Matrix Elements



classical VMD model: *- Wolf Schilling -*

$$W(\cos\theta,\phi,\Phi) = W^{unpol}(\cos\theta,\phi,\Phi) + P_{beam}W^{pol}(\cos\theta,\phi,\Phi)$$

$\Downarrow$ $\qquad$ $\Downarrow$

$15\ \ SDMEs$ $\qquad$ $7\ \ SDMEs$

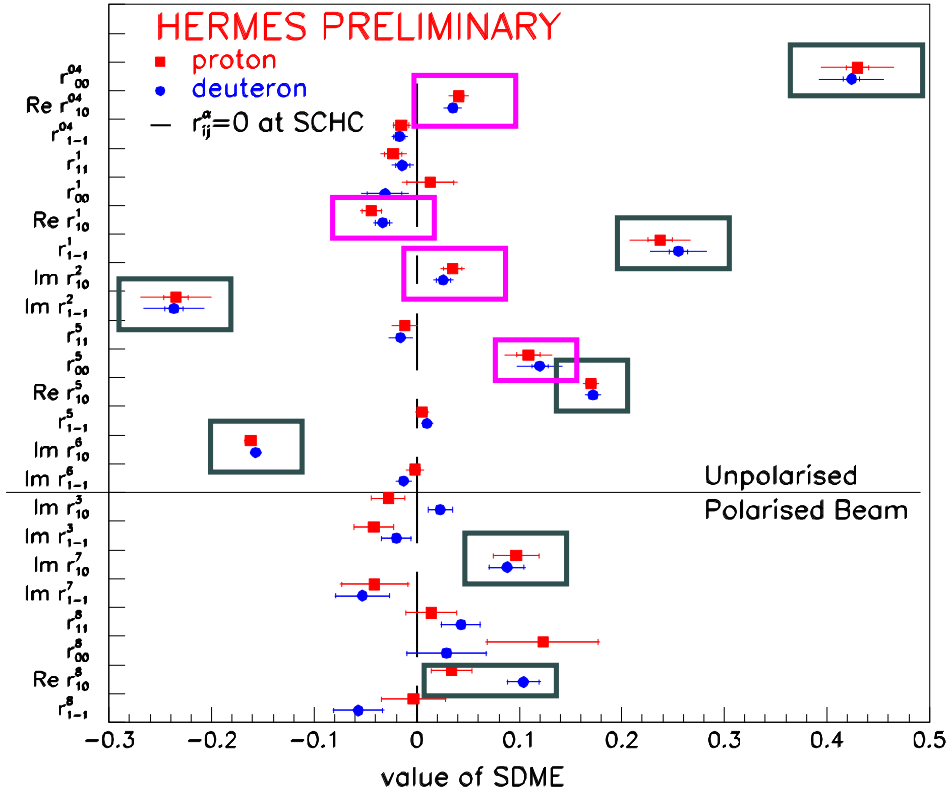
relation to GPDs: *- Goloskokov, Kroll (2005) -*

- Diehl (2007) -

- describe the helicity transfer from virtual photon to the vector meson
  s-channel helicity conservation (SCHC)?
- describe the parity of the exchanged particle
  natural parity exchange ($J^P = 0^+, 1^-, 2^+$) (NPE)?
  unnatural parity exchange ($J^P = 0^-, 1^+, 2^-$) (UPE)?

SCHC

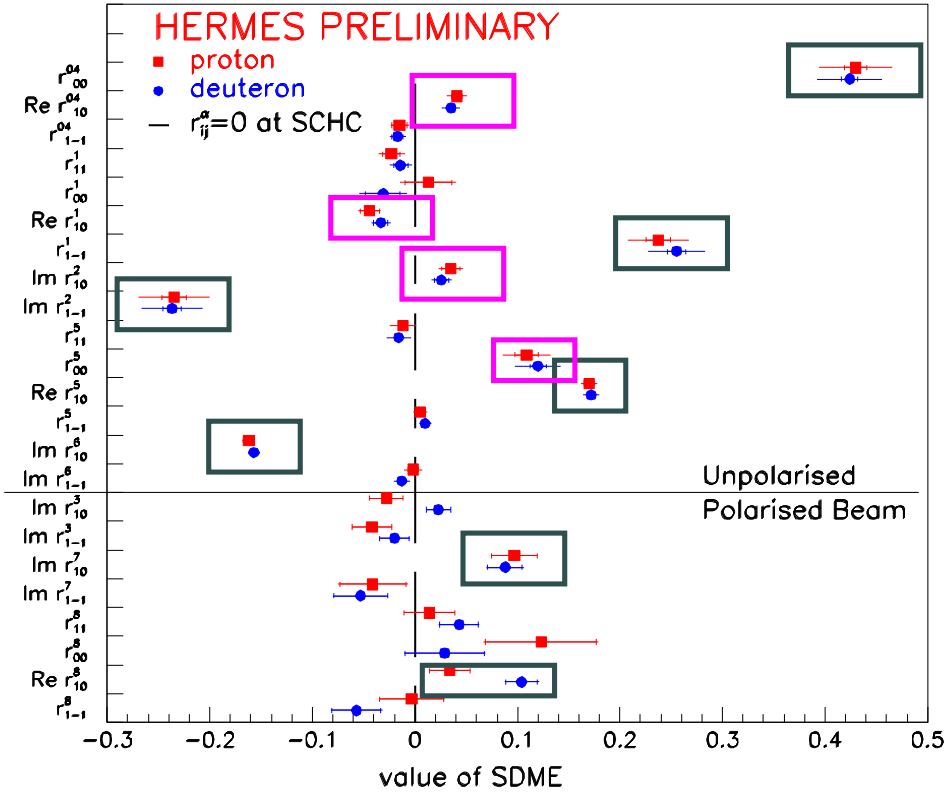
- 7 non-zero SDMEs if $\gamma_L^* \to V_L$ and $\gamma_T^* \to V_T$

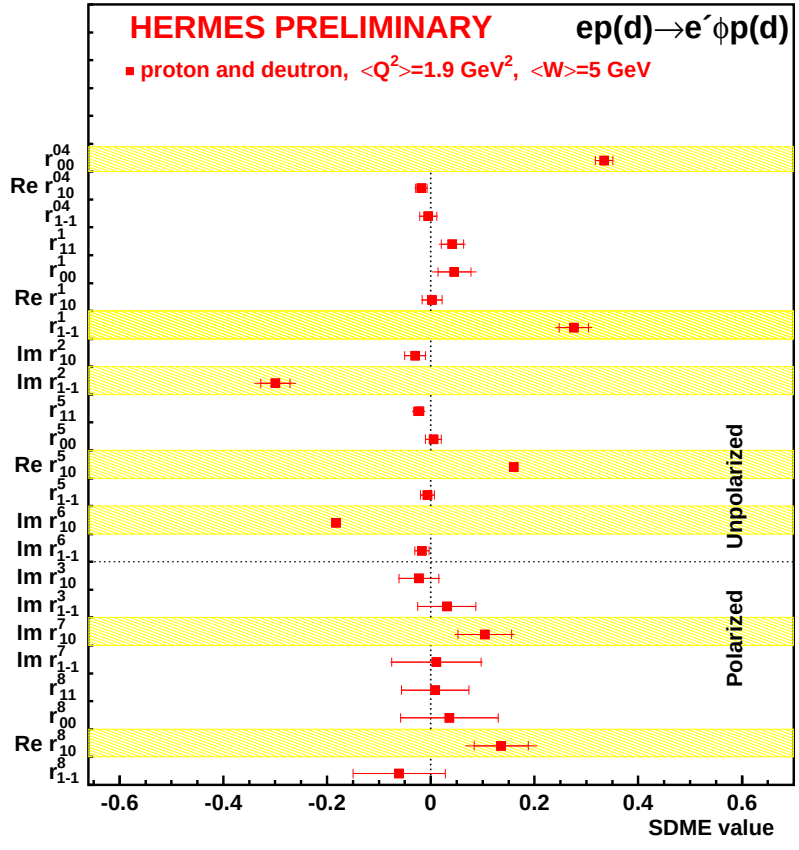


- s-channel helicity violation: $Re\{r^5_{00}\}$, $Re\{r^1_{10}\}$, $Re\{r^2_{10}\}$, $Re\{r^{04}_{10}\}$

SCHC

- 7 non-zero SDMEs if $\gamma_L^* \to V_L$ and $\gamma_T^* \to V_T$



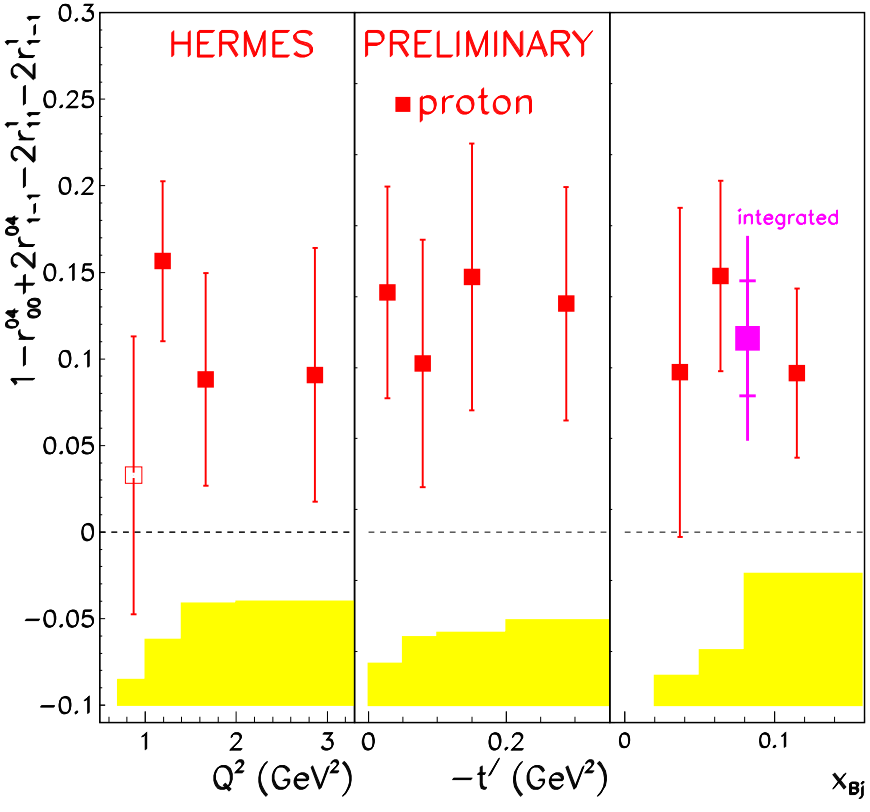


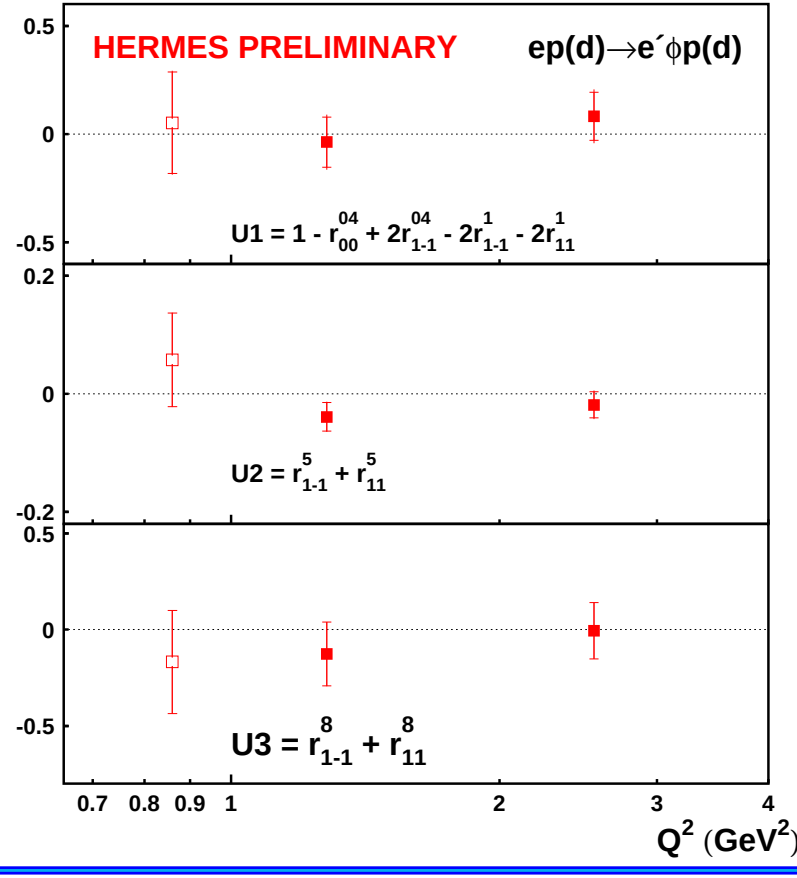
- s-channel helicity violation: $Re\{r_{00}^5\}$, $Re\{r_{10}^1\}$, $Re\{r_{10}^2\}$, $Re\{r_{10}^{04}\}$
- no s-channel helicity violation

NPE

- if the reaction is dominated by exchange of particles with natural parity ($J^P = 0^+, 1^-, 2^+$) $\Rightarrow$ non-zero 5 SDMEs
- probe the NPE:

$$U_1 = 1 - r^{00}_{04} + 2r^{1-1}_{04} - 2r^{11}_1 - 2r^{1-1}_1 = 0$$





σ_L/σ_T separation

- GPD calculations only for longitudinal component of cross section (σ_L)

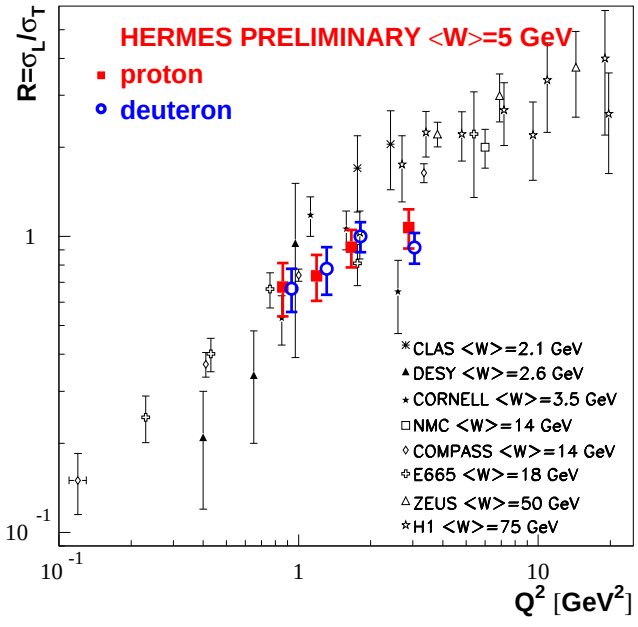
$$\sigma_L = \frac{R}{1+\epsilon R}\sigma_{\gamma^* p \to V p}$$

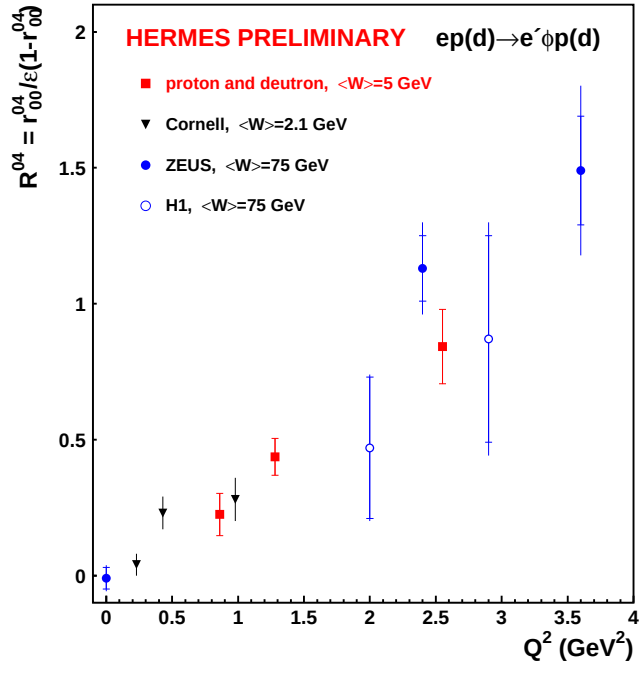
$$R = \frac{\sigma_L}{\sigma_T}$$

- assuming SCHC

$$R = \frac{1}{\epsilon}\frac{r_{00}^{04}}{1-r_{00}^{04}}$$

$$r_{00}^{04} \to W(cos\theta)$$





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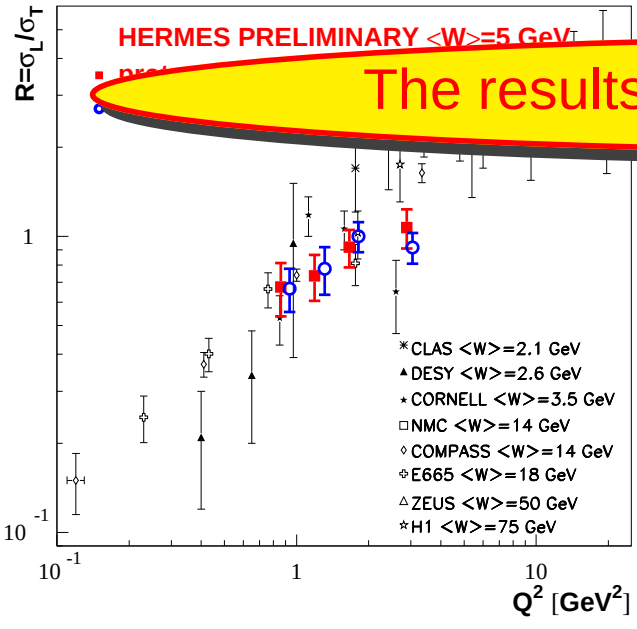
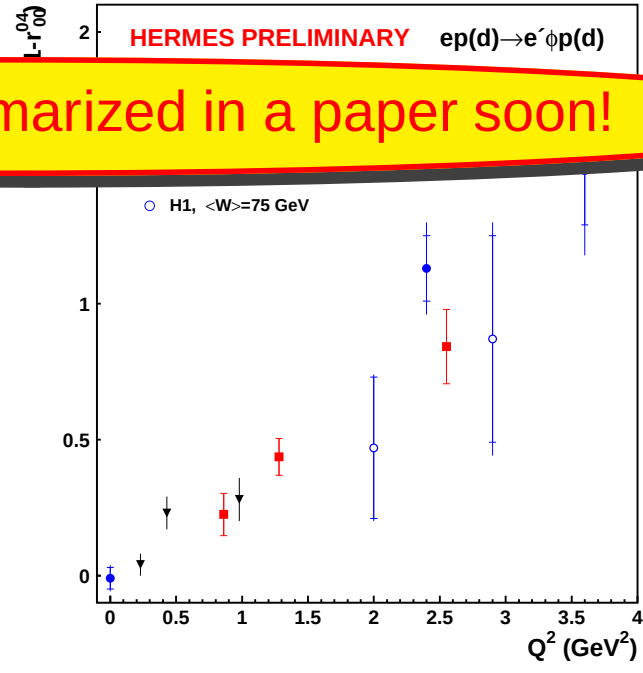
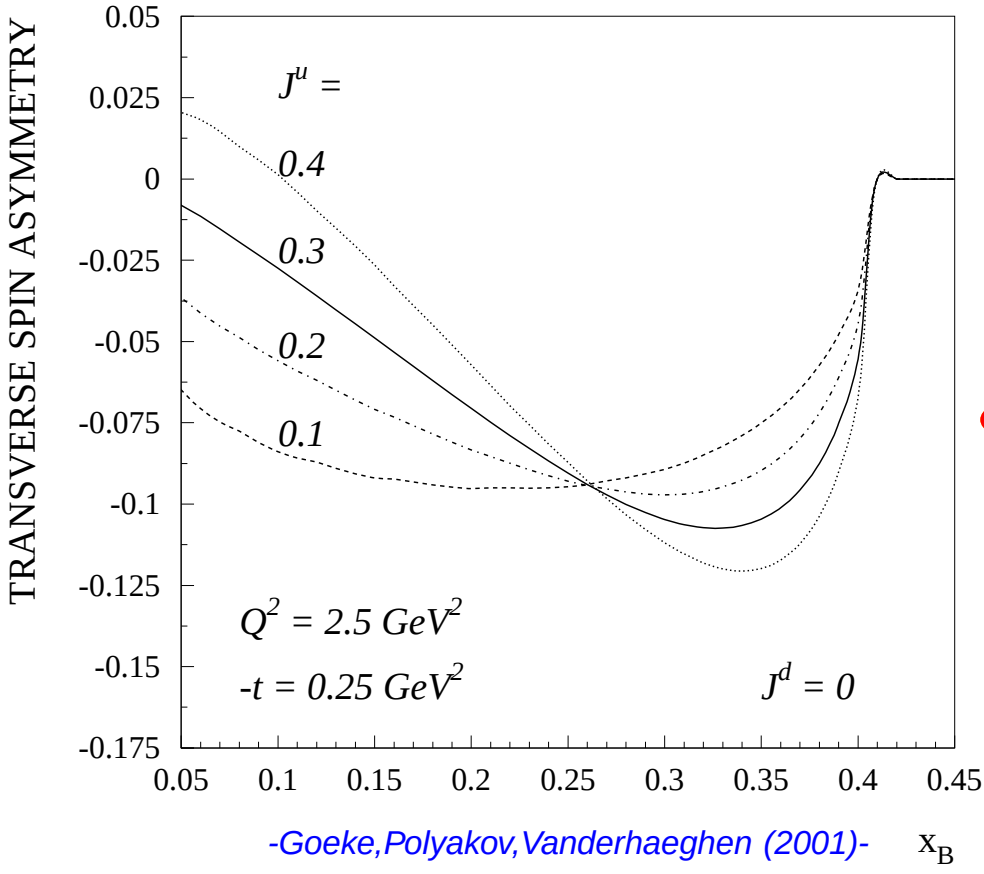




Transverse Target Spin Asymmetry

$\gamma_L^* + p \rightarrow \rho_L^0 + p$

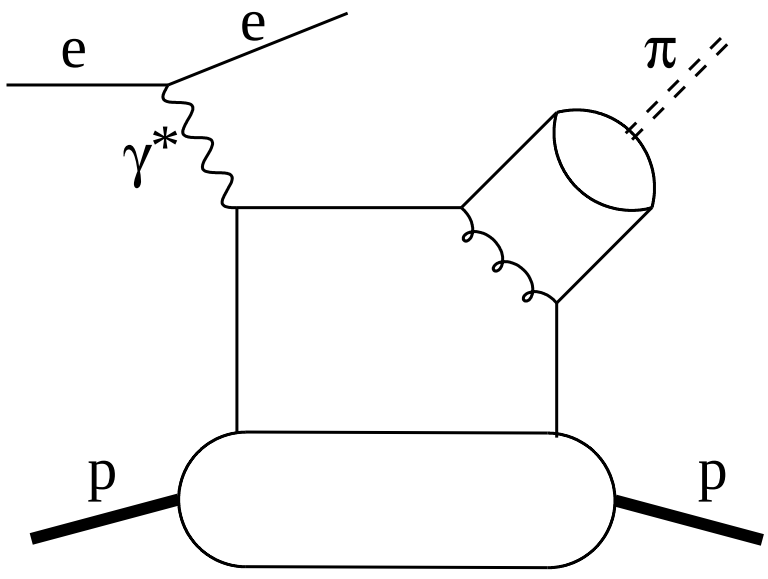


-Goeke,Polyakov,Vanderhaeghen (2001)-

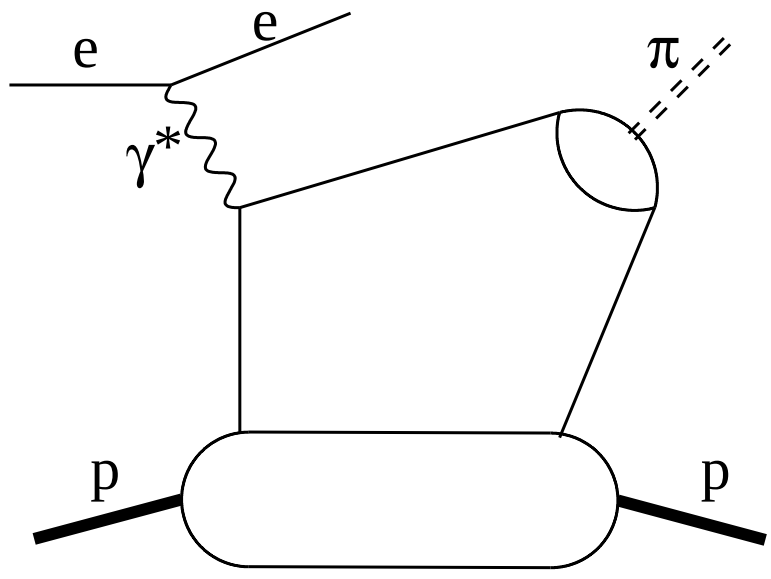
See A. Airapetian's talk

$$\sigma : |S_T| sin(\phi - \phi_s) EH$$

Backup



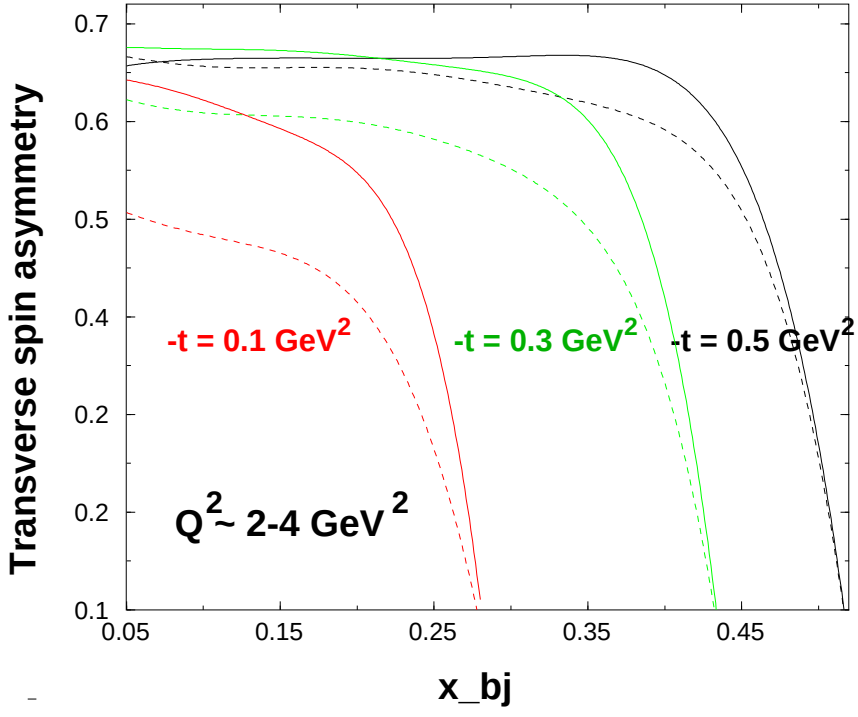
a)

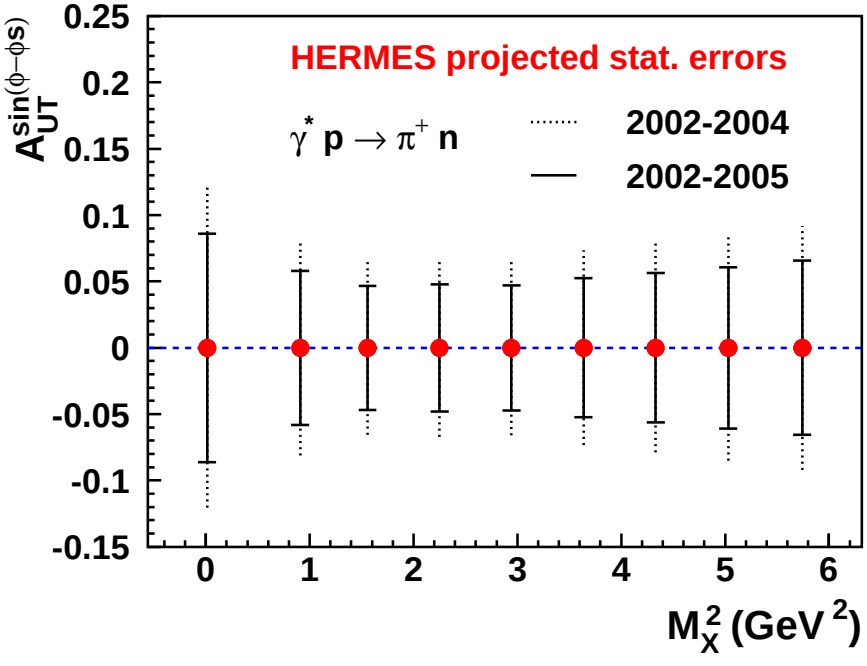


b)

BACKUP: Transverse Target Spin Asym

$$ep \rightarrow e\pi^+ n$$





-Frankfurt,Polyakov,Strikman,Vanderhaeghen (2000)-

$$\sigma : |S_T| sin(\phi - \phi_s) \tilde{E} \tilde{H}$$

BACKUP: Q^2 dependence of SDMEs