# Exclusive electroproduction of mesons

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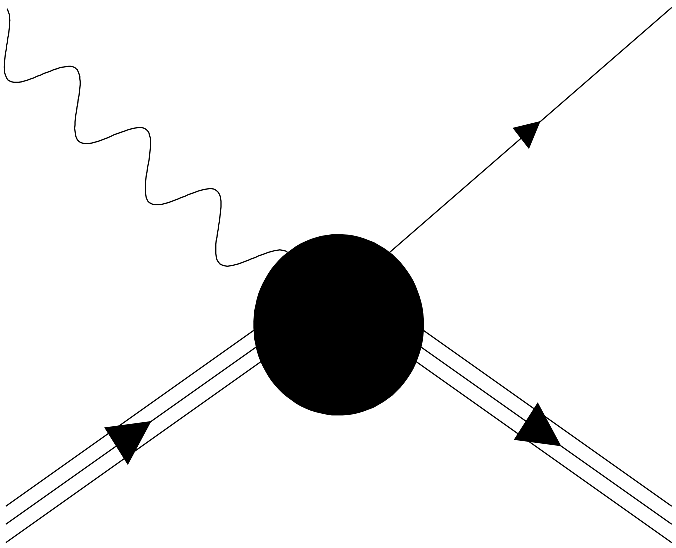
The hermes Collaboration

Exclusive reaction: selected final state (e.g. proton target returns to ground state)

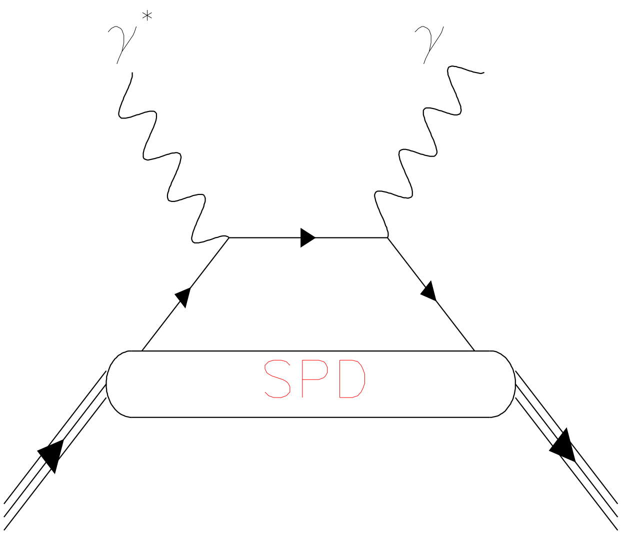


$\Delta E = \frac{M_X^2 - M^2}{2M}$ $(= 0)$ $\qquad t = (q - p_M)^2$

# SPDs

Recent development: exclusive reactions described in terms of Skewed Parton Distributions (SPD)

DVCS:

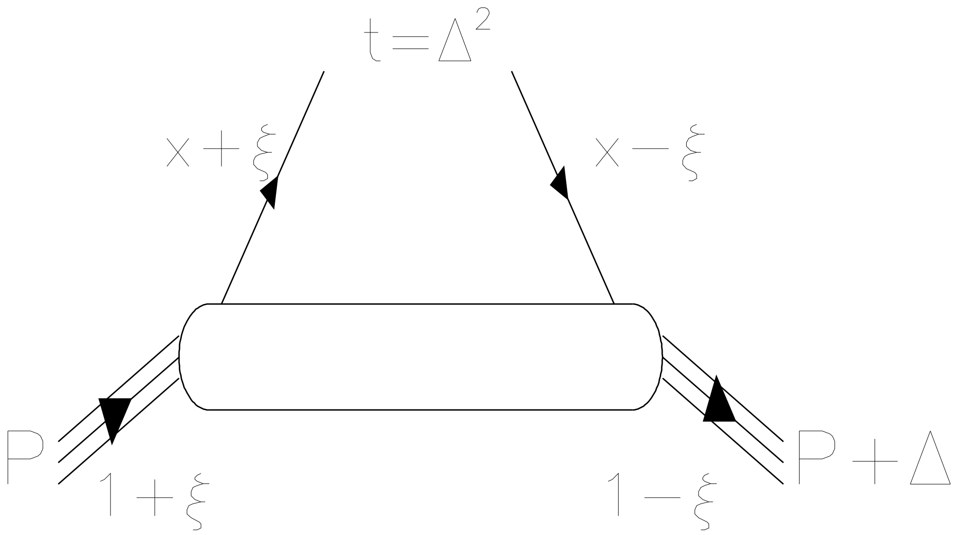



Requires factorization. Meson production $\rightarrow$ proven for longitudinal photons

SPDs: $H, E$, $\tilde{H}, \tilde{E}$
Vectormesons, pseudoscalar mesons

# More on SPDs

$H(x, \xi, t)$




$H^q(x, 0, 0) = q(x)$ $\qquad$ $\int_{-1}^{+1} H^q(x, \xi, t)dx = F_1^q(t)$

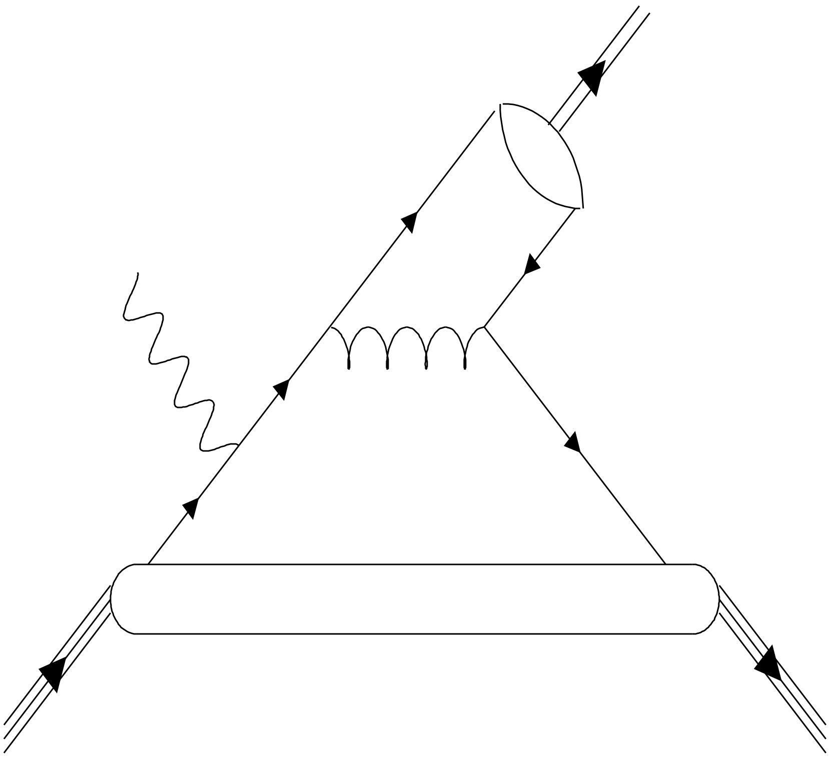
$\tilde{H}^q(x, 0, 0) = \Delta q(x)$ $\qquad$ $\int_{-1}^{+1} E^q(x, \xi, t)dx = F_2^q(t)$

$$\frac{1}{2}\int_{-1}^{+1} x[H^q(x, \xi, t = 0) + E^q(x, \xi, t = 0)]dx = J_q$$

# Exclusive mesons

H1, ZEUS, NMC, E665: $W \gtrsim 10$ GeV $\Rightarrow x_{Bj} \ll 0.1$
2-gluon exchange mechanism

HERMES: $W \sim 4$ GeV $\Rightarrow x_{Bj} \sim 0.3$
quark exchange mechanism



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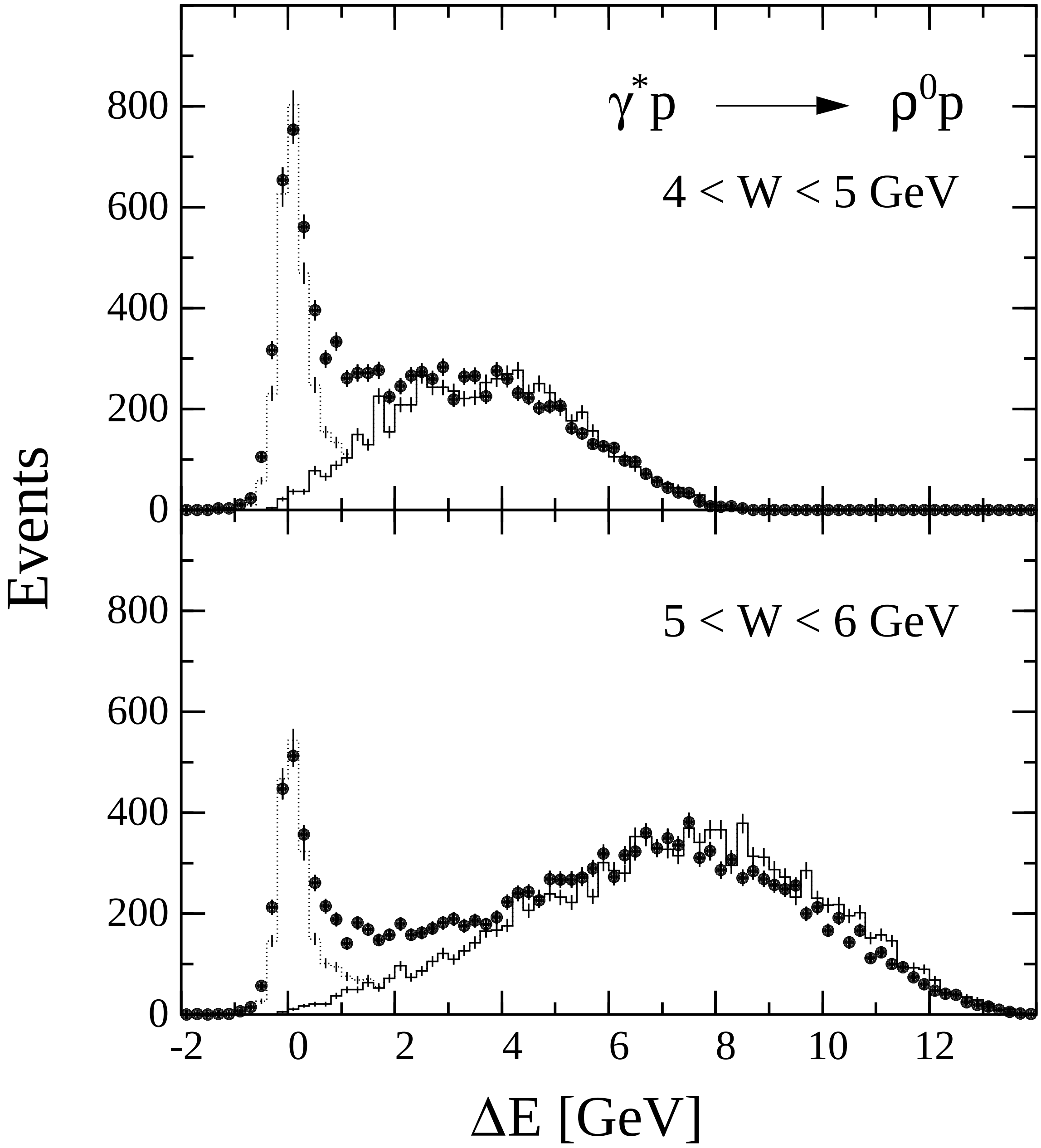
Usually: $H, \tilde{H}$ dominate
$\pi^+$ production: $\tilde{E}$ may dominate because of large contribution from pion pole at $t = m_\pi^2$

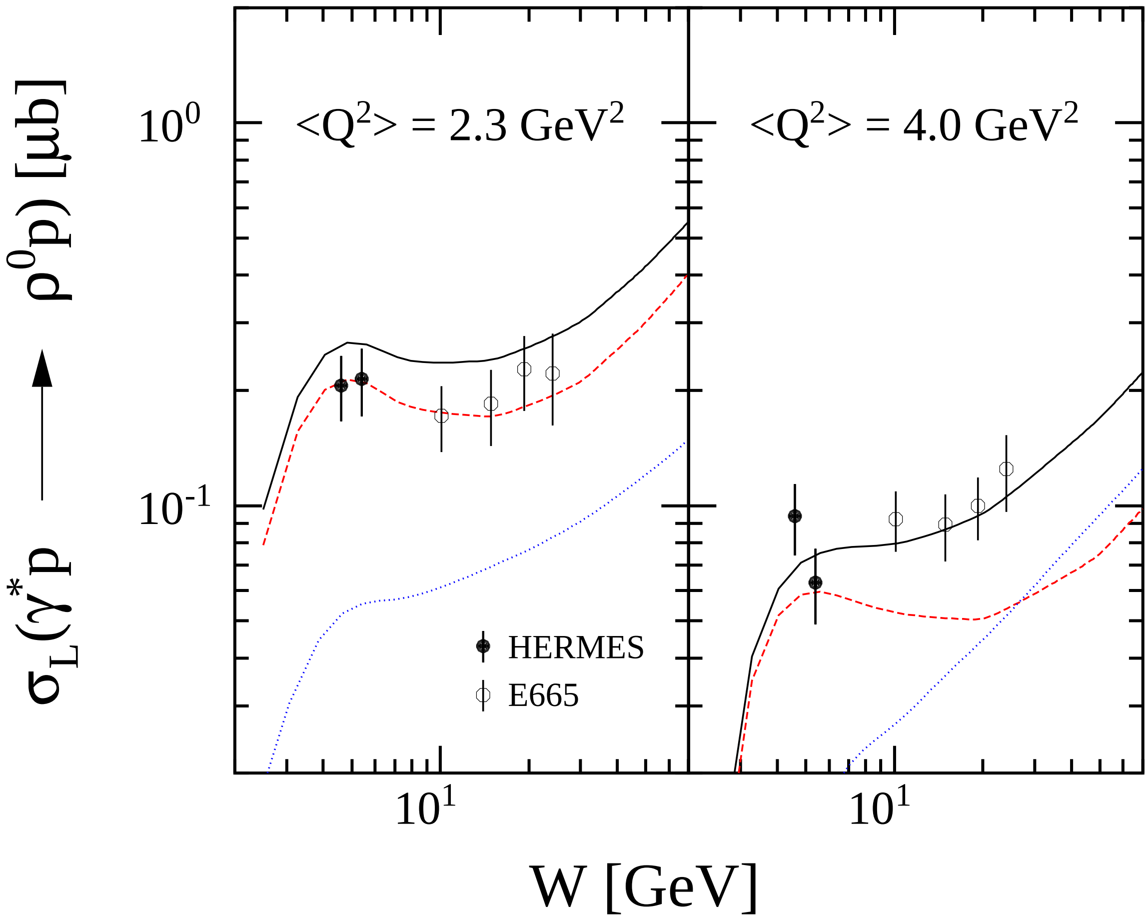
# Exclusive $\rho^0$'s




- Good energy resolution
- Small non-diffractive background; well described by DIS Monte Carlo

# Exclusive $\rho^0$'s

$\Rightarrow$ Deduce longitudinal cross section: possible from decay angular distributions

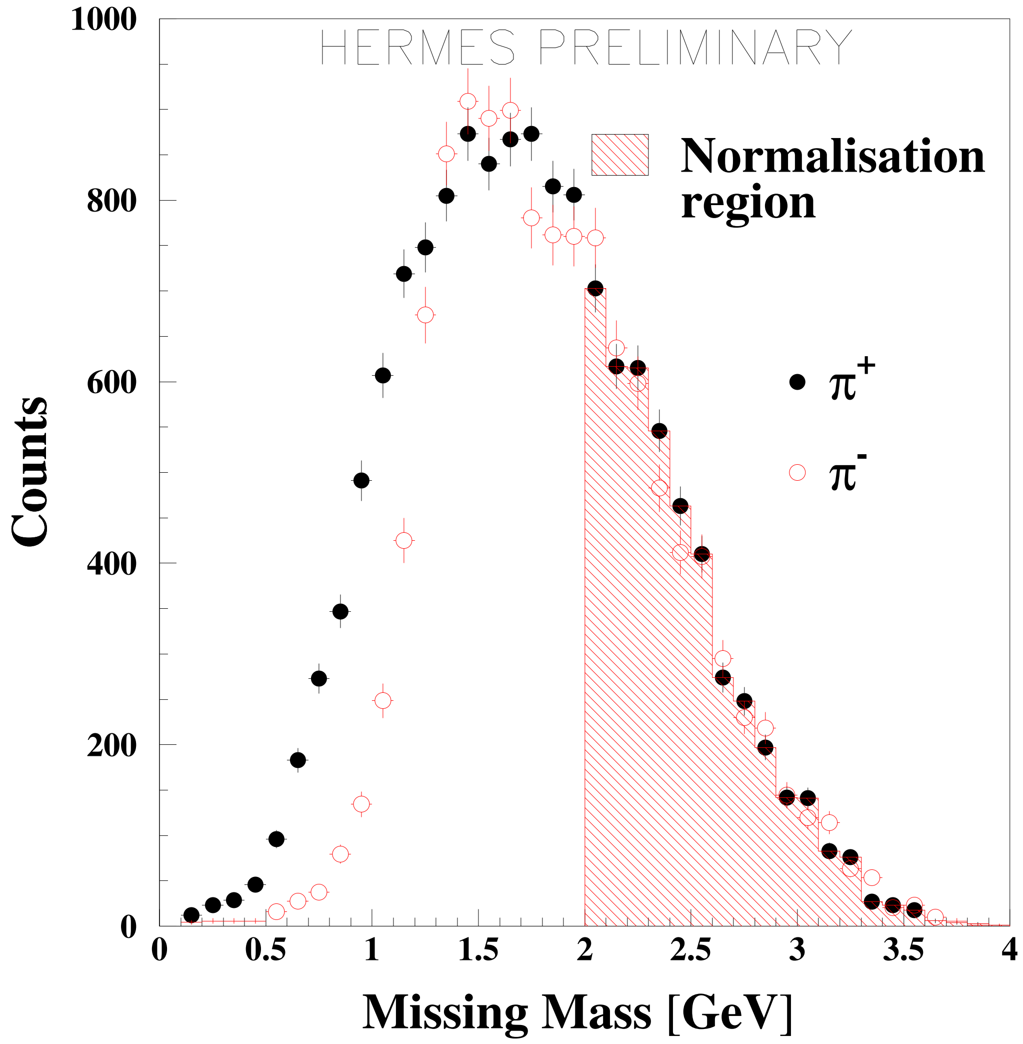



Compared to SPD calculations (Vanderhaeghen et al. PRD60(1999)094017)

- 2-gluon exchange mechanism
- quark exchange mechanism

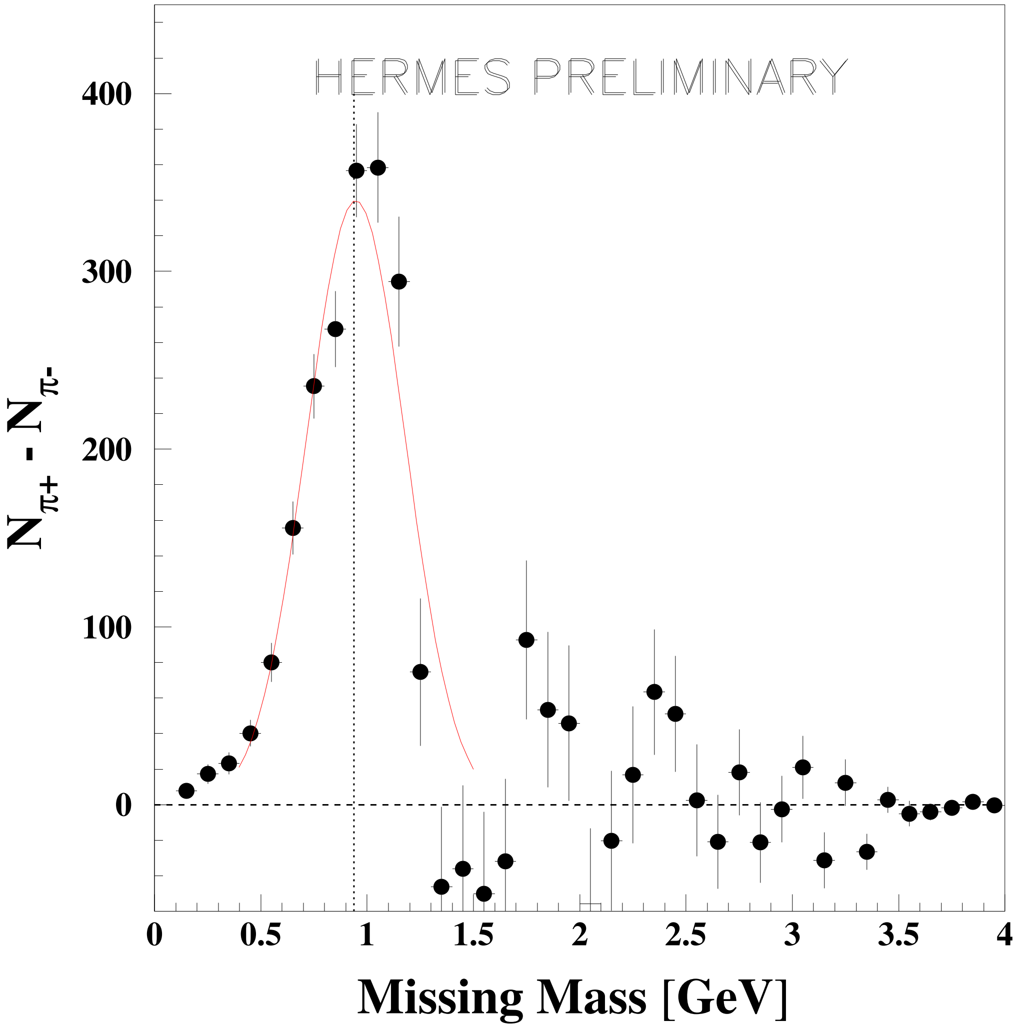
$\Rightarrow$ At small $W$ (larger $x_{Bj}$) quark exchange dominates.

# Exclusive $\pi$'s




Much larger non-exclusive background in $\pi^+$ sample.
$\Rightarrow$ Use $\pi^-$ data to determine this background.

# Exclusive $\pi$'s

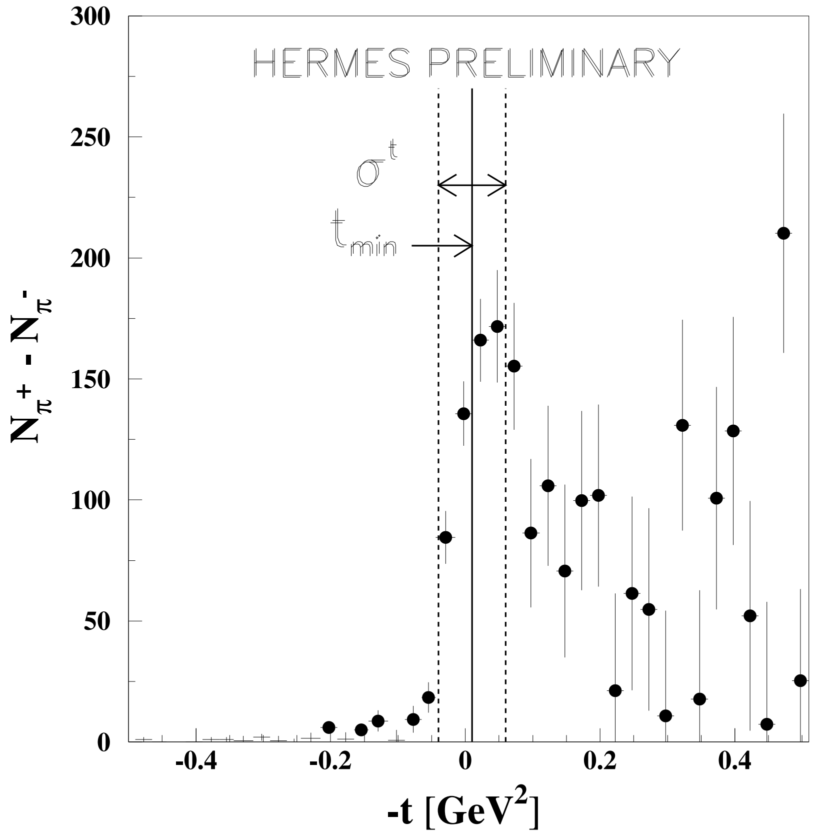


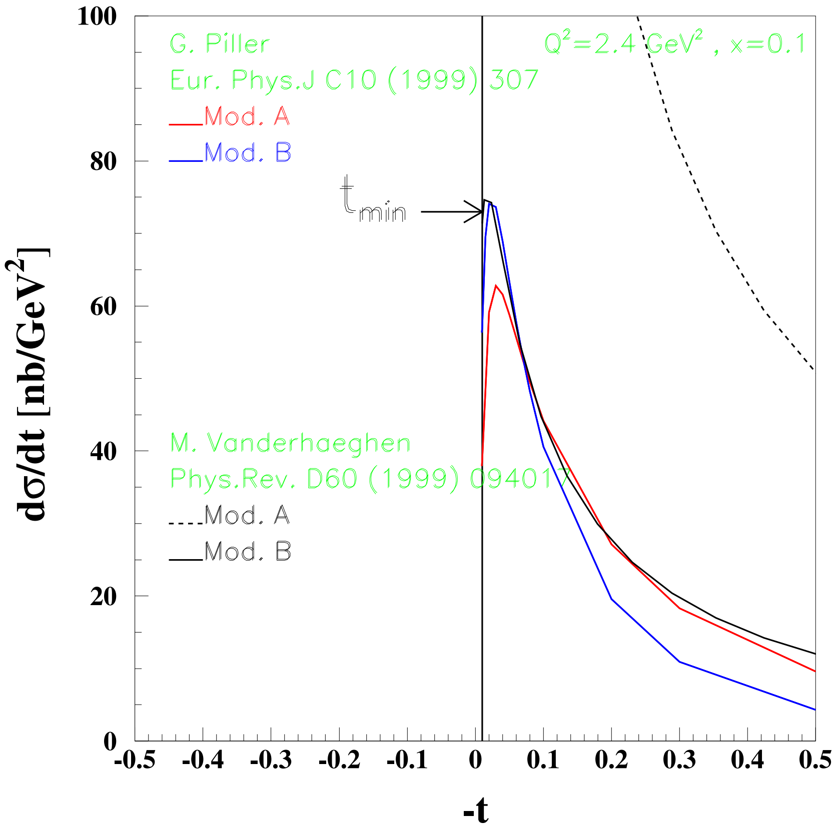

- $\sim$ 1700 exclusive $\pi^+$ in sample
- Missing mass resolution $\approx$ 0.25 GeV (in agreement with simulation)

$\star$ Need data at lower $E$ for Rosenbluth separation.

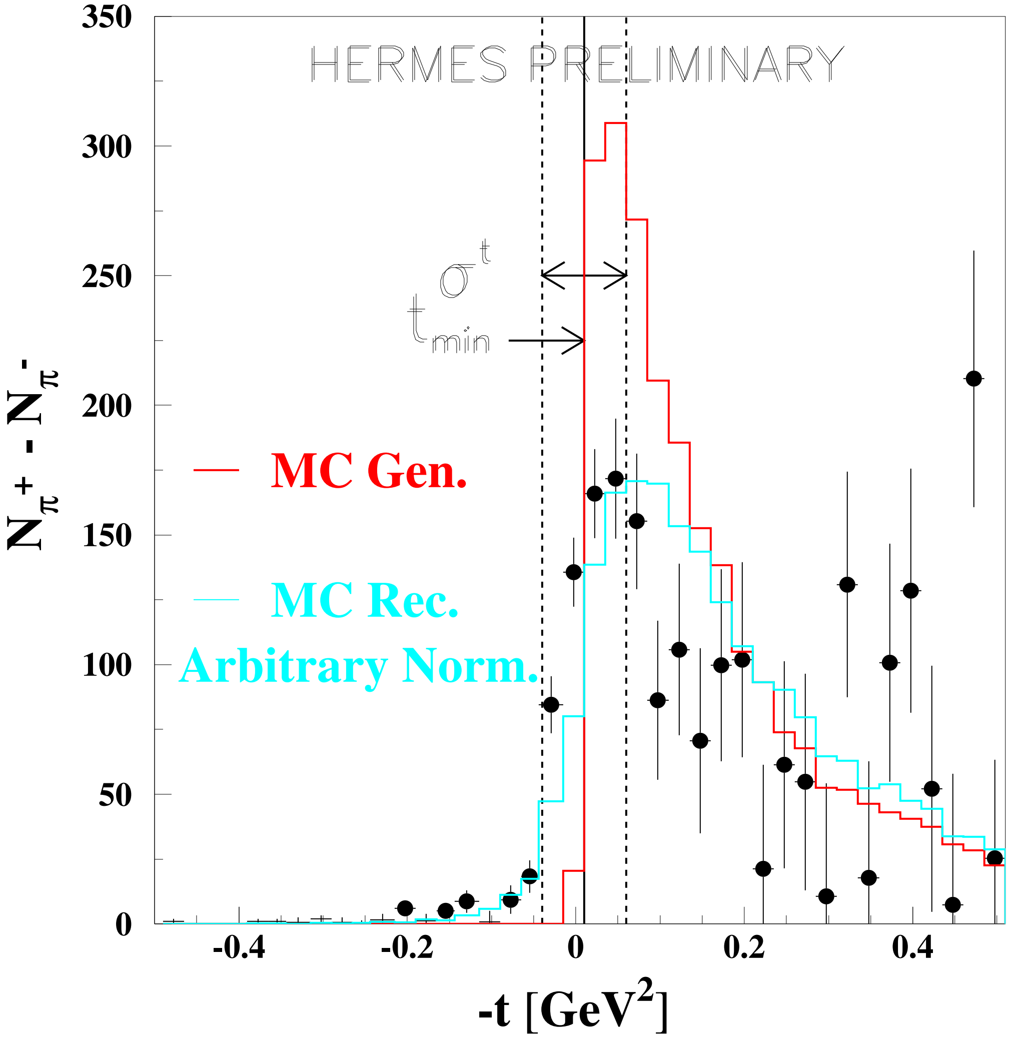
# $\pi^+ : -t$-distribution

Expected to reflect the influence of $\pi$-pole term in $\tilde{E}$

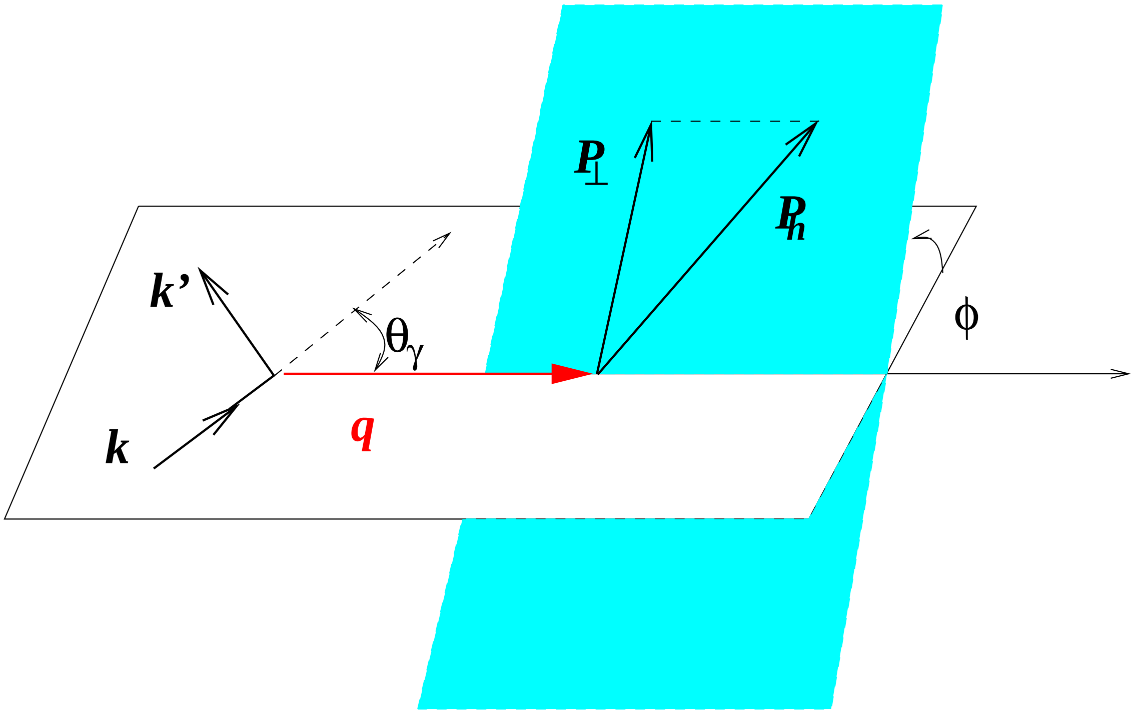


# $\pi^+ : -t$-distribution



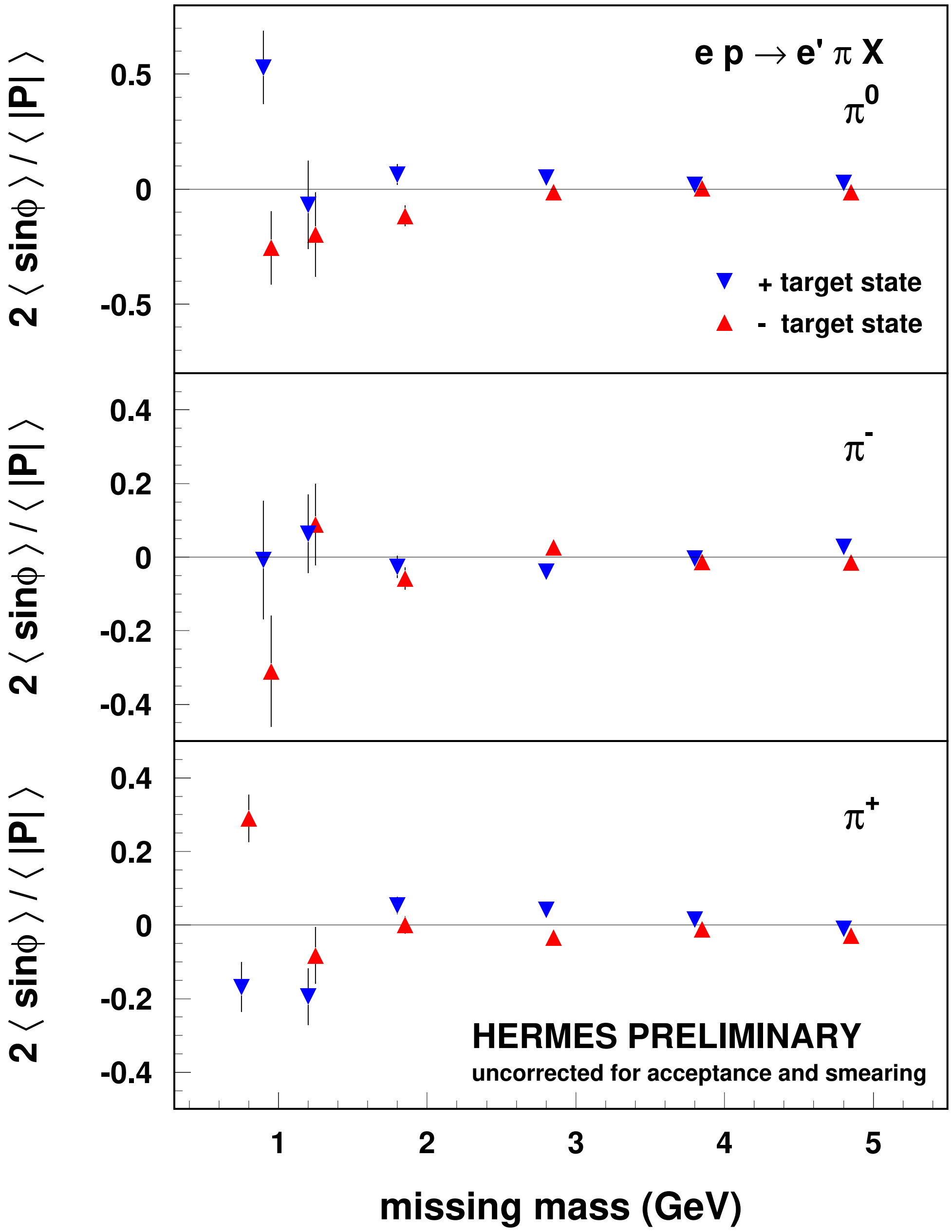
# Azimuthal asymmetries



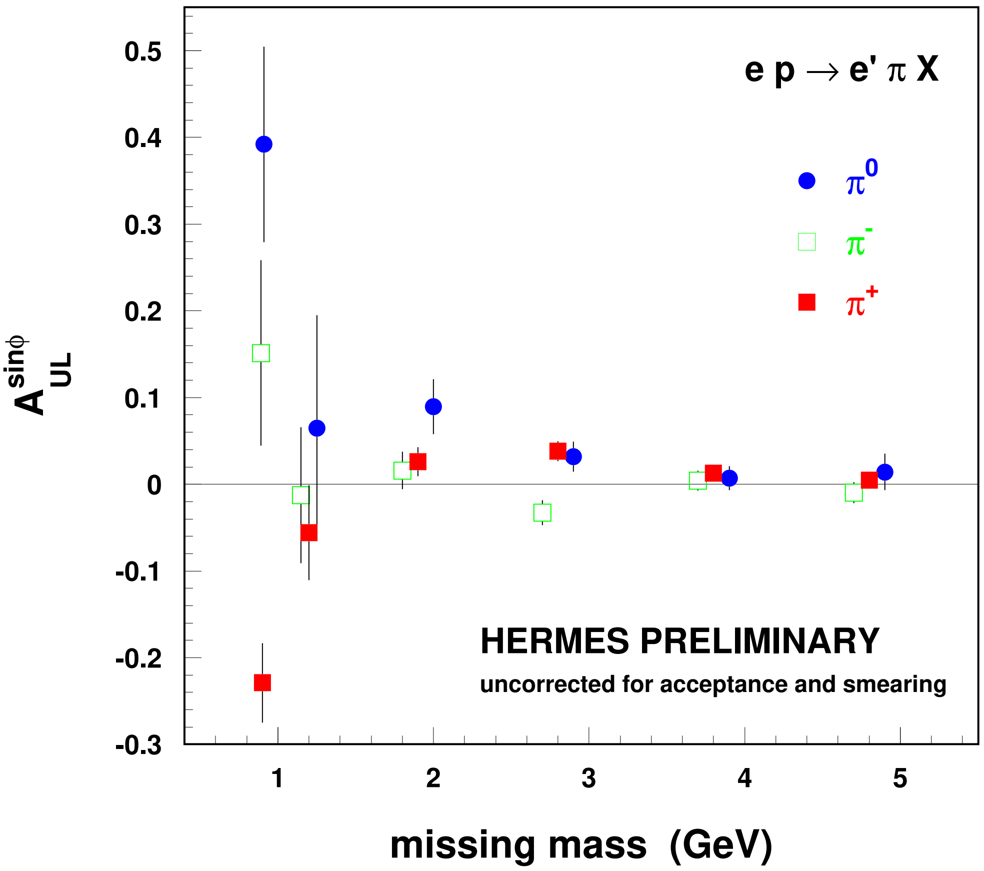

$$A_{UL}^{\sin\phi} = \frac{1}{P}\frac{\int_0^{2\pi}\sin\phi \mathrm{d}N_+ - \int_0^{2\pi}\sin\phi \mathrm{d}N_-}{\frac{1}{2}[\int_0^{2\pi}\mathrm{d}N_+ + \int_0^{2\pi}\mathrm{d}N_-]}$$
$$= 2 < \sin\phi >$$

Should display "precocious scaling", earlier than X-sections. (Frankfurt et al., PRL 84(2000)2589; for transverse target)

# $\pi$ asymmetries



# $\pi$ asymmetries




⇒ Large asymmetries for $\pi^+$ and $\pi^0$.

→ opposite sign to semi-inclusive region

→ no calculations (yet) for longitudinal target

# Summary & Outlook

- Exclusive $\rho^0$'s: $\sigma_L$ in agreement with SPD-estimates

- Exclusive $\pi^+$'s:

  $\Rightarrow$ Exclusive peak seen
  $\Rightarrow$ $t$-distribution $\rightarrow$ SPD-estimates
  $\Rightarrow$ Large azimuthal asymmetries

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- more data coming:

  $\Rightarrow$ $Q^2$-distributions (scaling laws)
  $\Rightarrow$ improved detector simulations

- HERMES working on recoil detector to improve exclusivity of data sample

- HERMES-II run starting summer 2001: will yield large data sample with transverse target