Hard Exclusive pion production at HERMES

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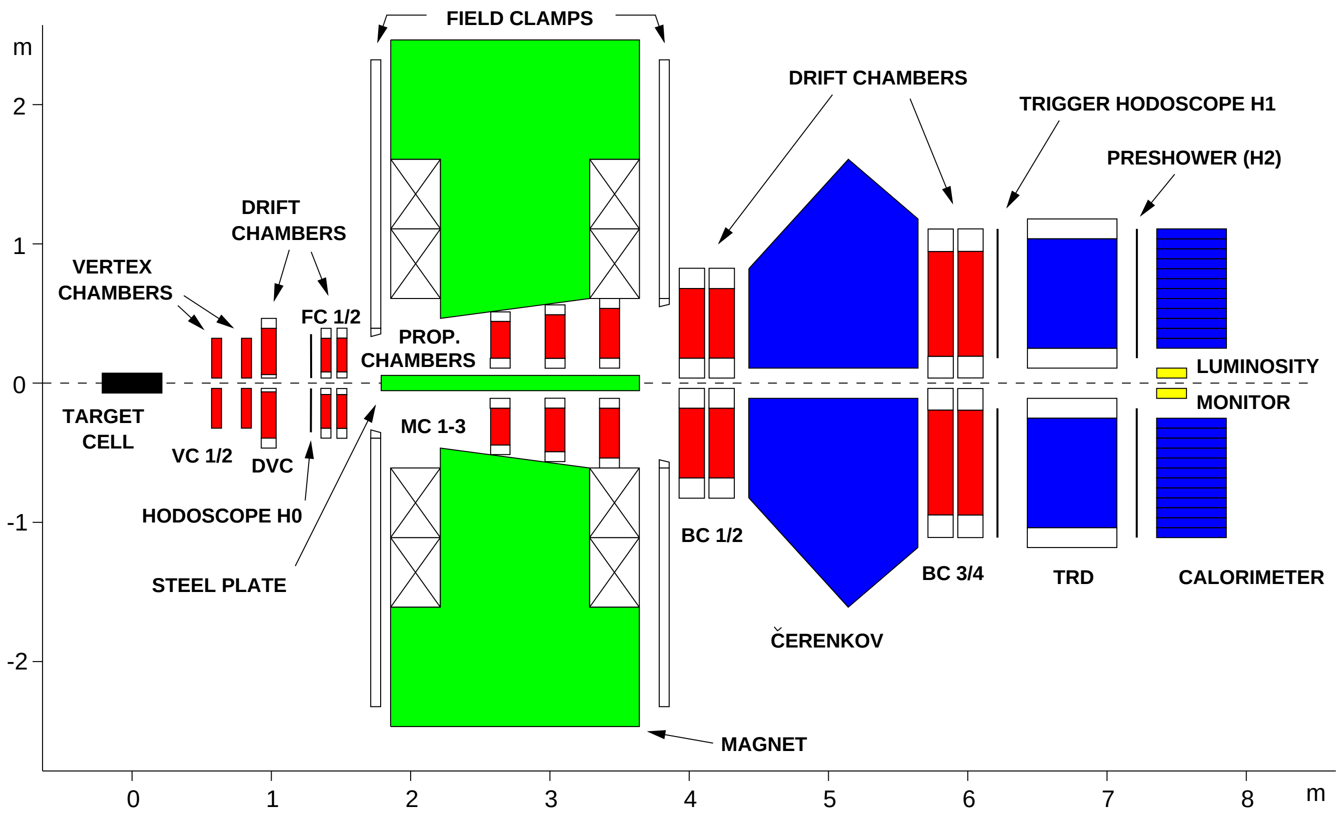
On behalf of HERMES collaboration

- The HERMES Experiment
- Exclusive π^+ production.
- Single spin asymmetries.
- Summary-outlook

The HERMES Experiment (in 97)



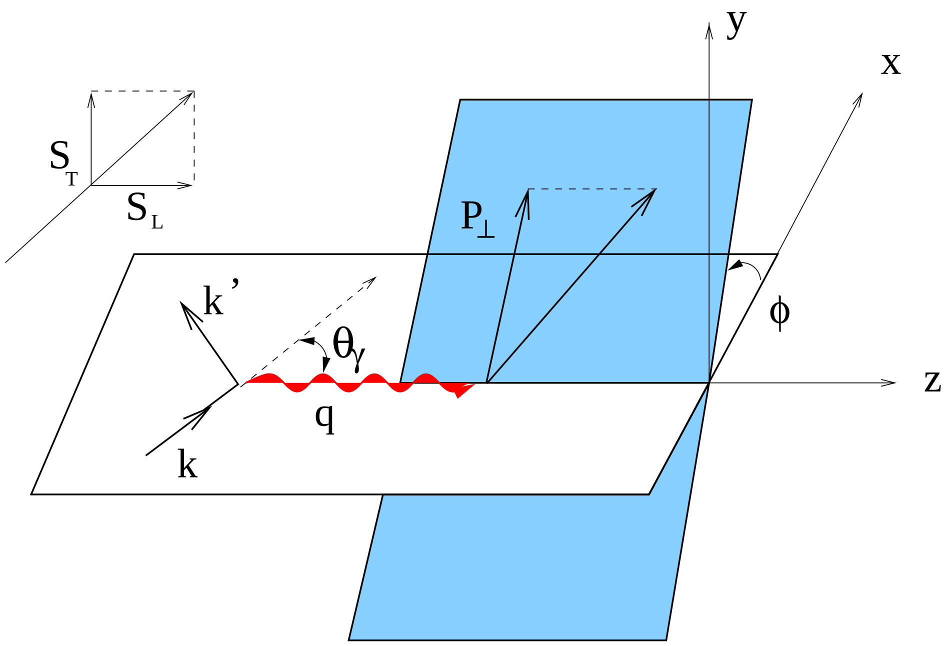
- **Beam** 27.5 GeV HERA e^+ beam
- **Target**: Internal storage cell gas target $P_{\vec{H}} \approx 86\%$
- **kinematic:** $0.02 < x < 0.8$ for $Q^2 > 1$ and $W^2 > 4$
- **Tracking**: 57 tracking planes, $\delta P/P = (0.7 - 1.3)\%$, $\delta\theta < 0.6$ mrad
- **Particle identification**: Čerenkov (RICH98), TRD, Preshower, Calorimeter.

$$4.5 \text{ GeV} < P_{\pi^\pm} < 13.5 \text{ GeV}$$

$$3 \text{ GeV} < P_{\pi^0} < 18 \text{ GeV}$$

Kinematic

$$e\, P \rightarrow e'\, N\, \pi$$

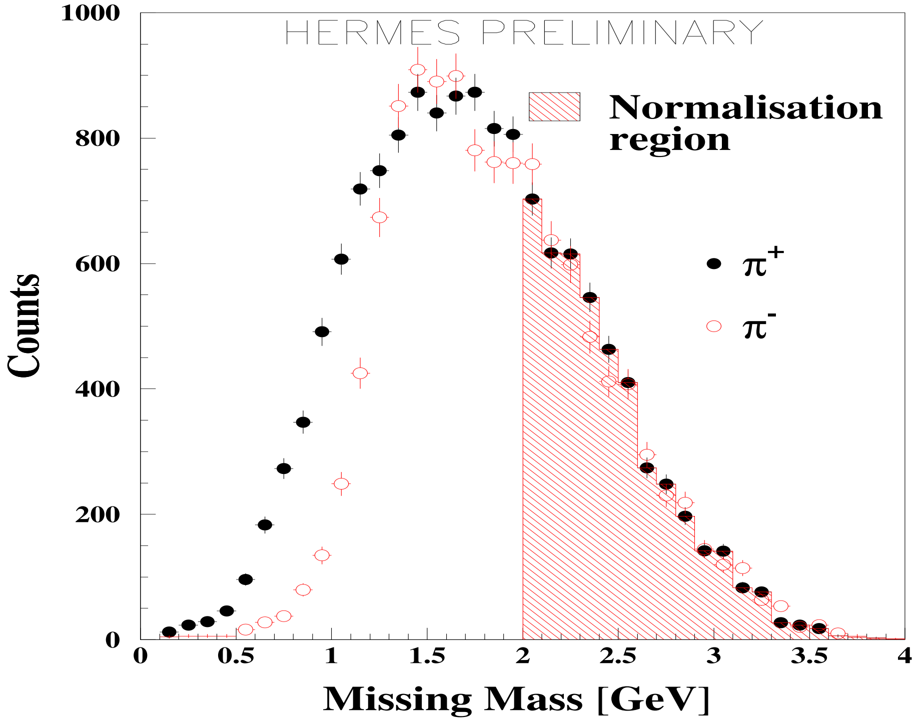


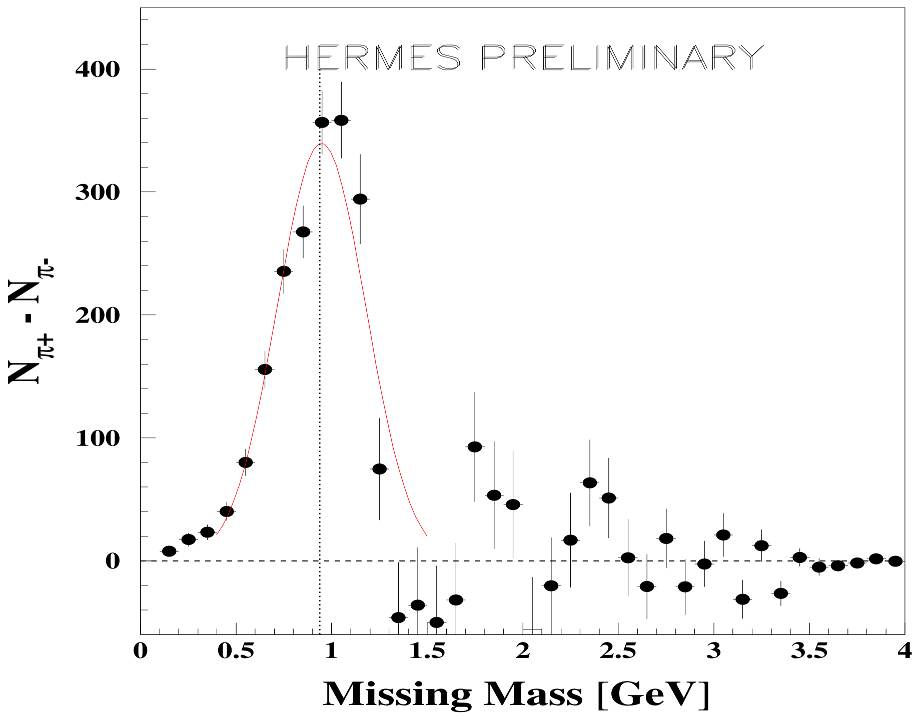
e' and π detected

$$\begin{aligned} t &= (q - p_\pi)^2 = (P - N)^2 \\ &= \text{squared 4-momentum transfered to the nucl.} \\ M^2 &= (P + q - p_\pi)^2 \\ &= \text{Squared Missing Mass} \\ \phi &= \text{Azimuthal angle of } \pi \text{ around } \gamma^* \text{ momentum} \end{aligned}$$

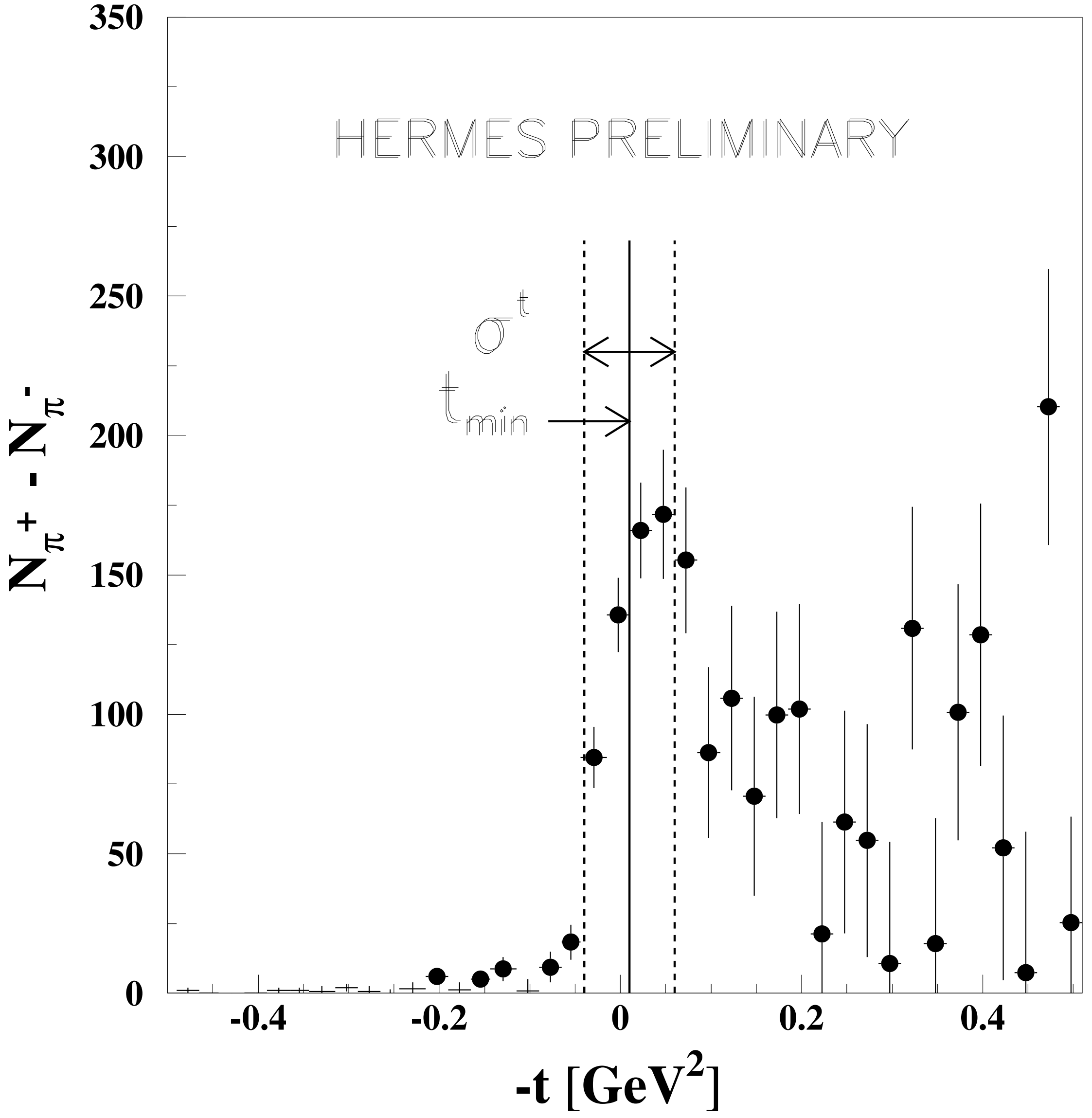
Missing Mass

$$e\,P \rightarrow e'\,\pi^{\pm}\,X$$



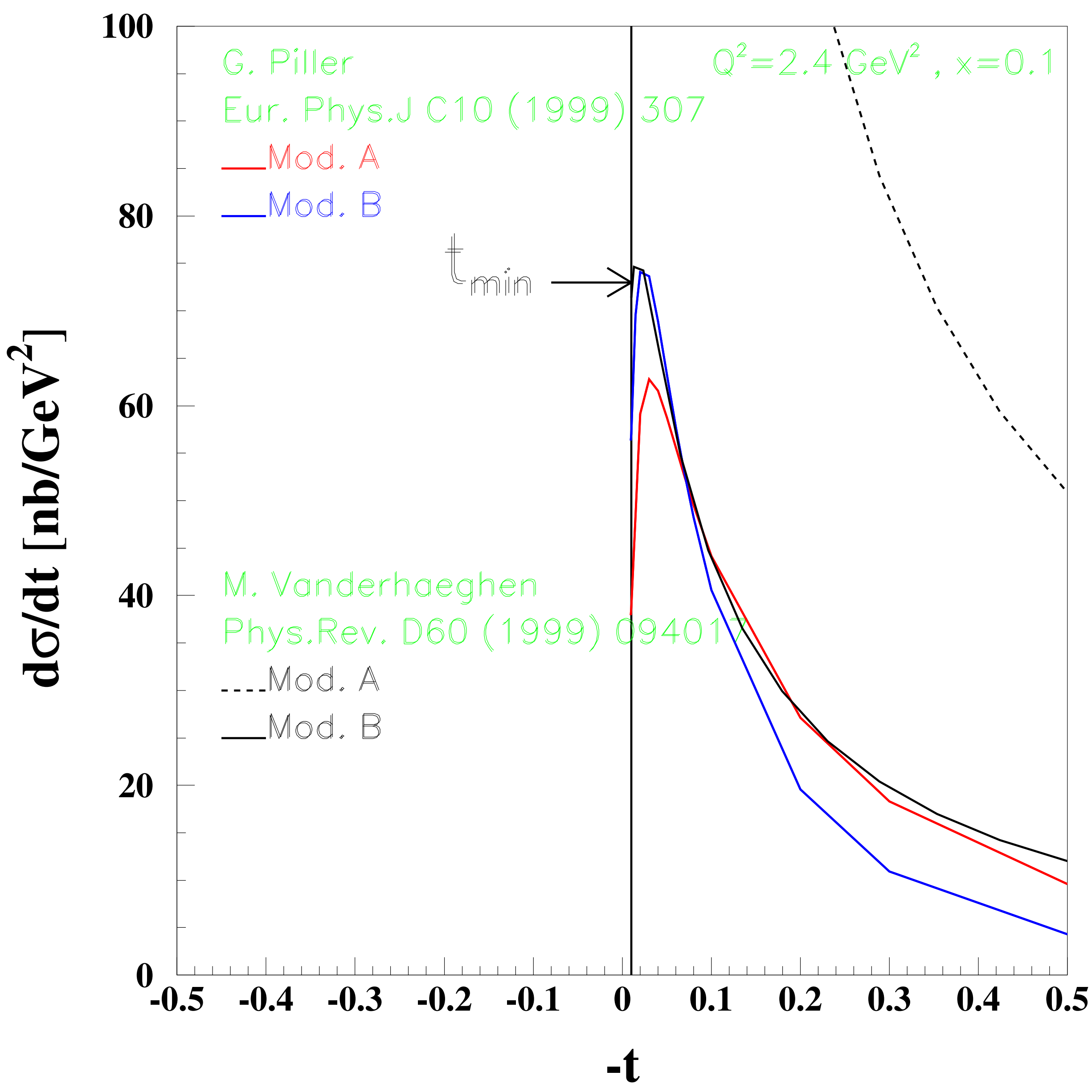


t-distribution

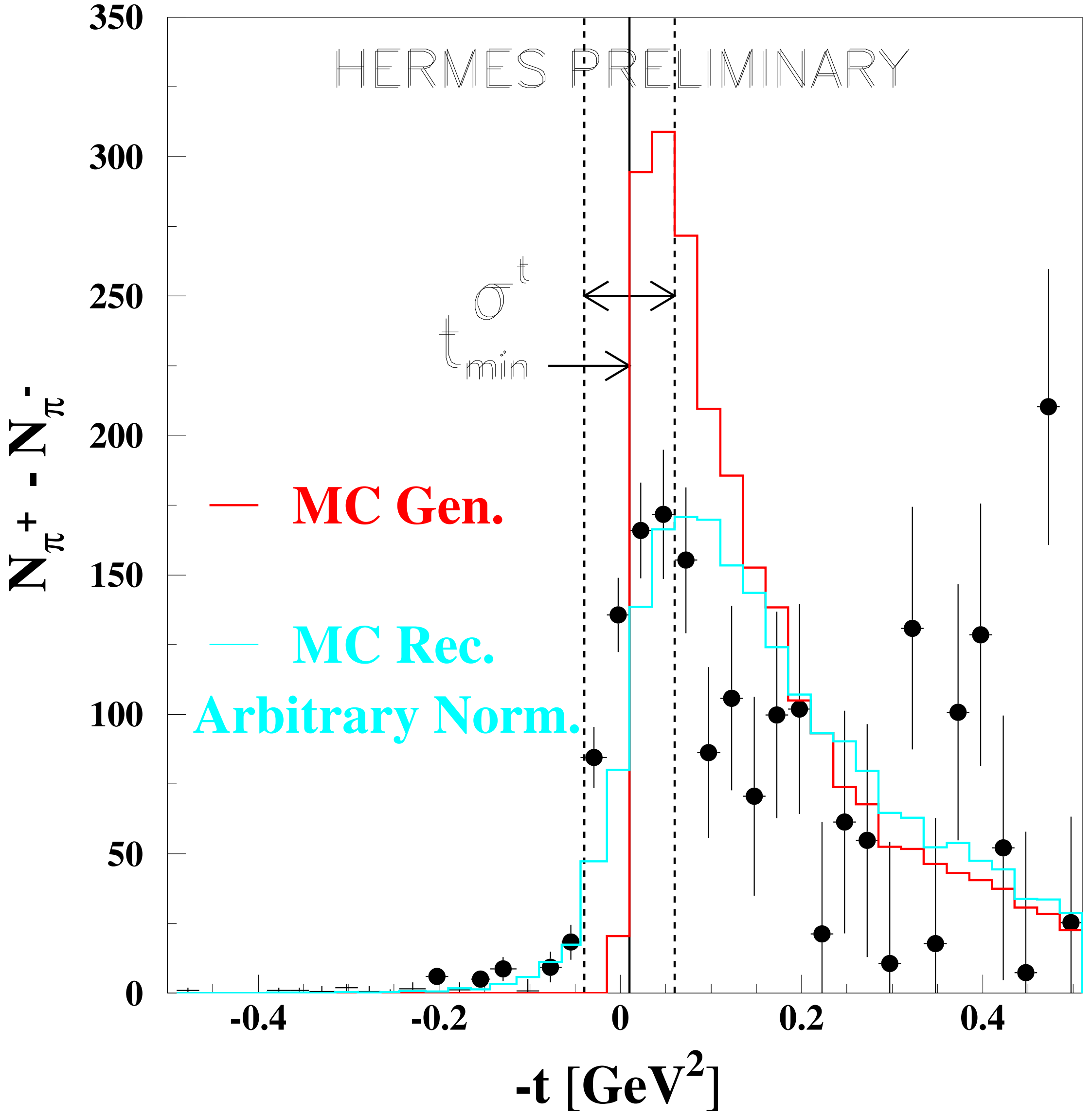


Monte Carlo simulation

Theoretical predictions for HERMES kinematic
at **fixed** $Q^2 = 2.4\text{GeV}$ and $x = 0.1$
by M. Vanderhaeghen - G. Piller & Co.

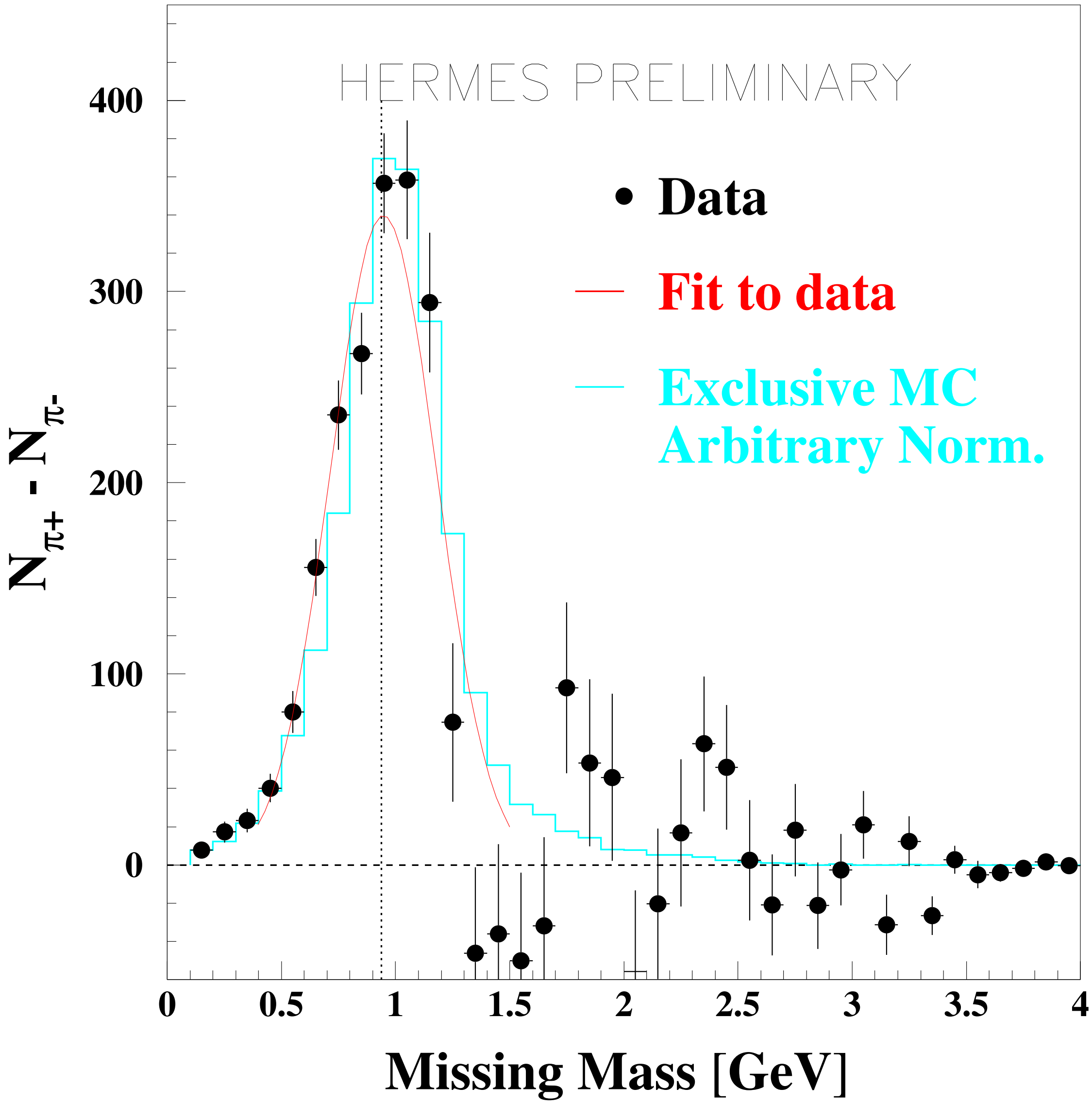


t-distribution



- Rough agreement between data and exclusive MC
  - ▷ MC studies: Q^2 , ν dependence.

Missing mass distribution



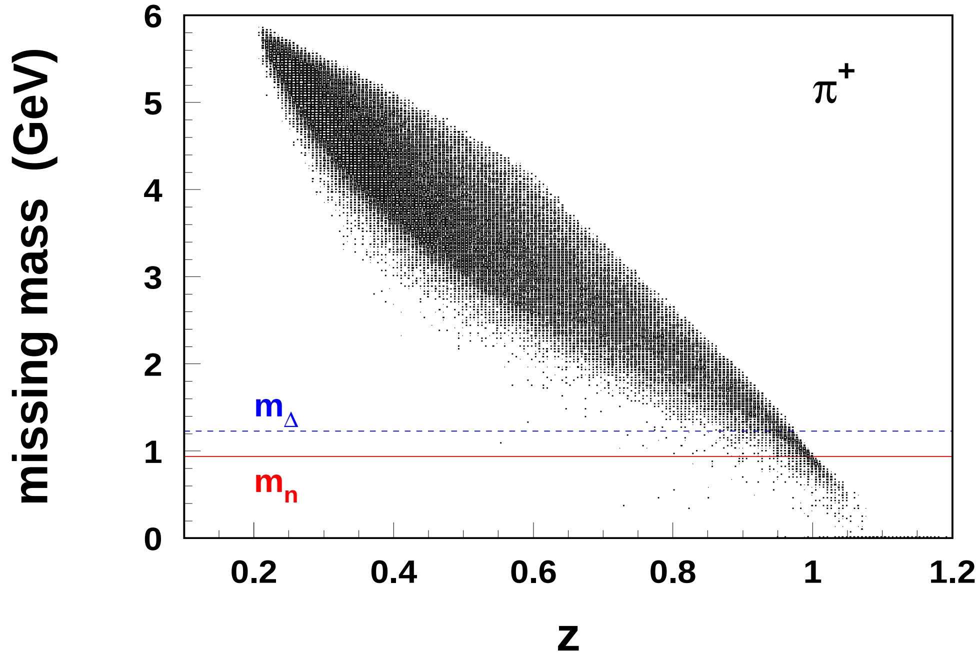
- ~ 1.7 k exclusive π^+ for 96+97 data.
- Agreement between data and MC.
- Missing mass resolution ≈ 0.25 GeV.

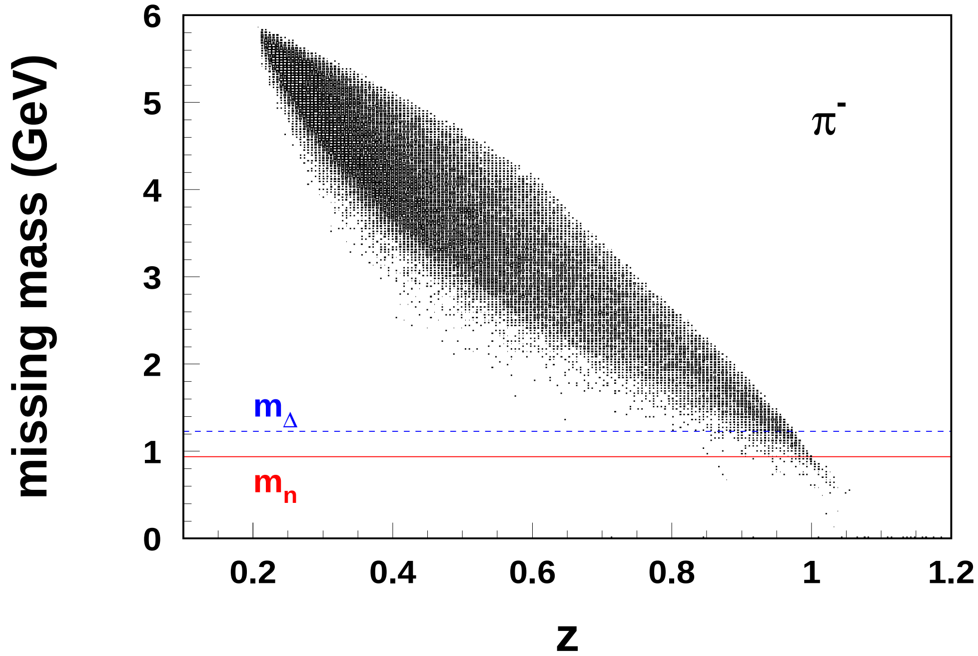
Single Spin Asymmetries (SSA).

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

P = target polarisation $\qquad \pm$ = target polarisation state

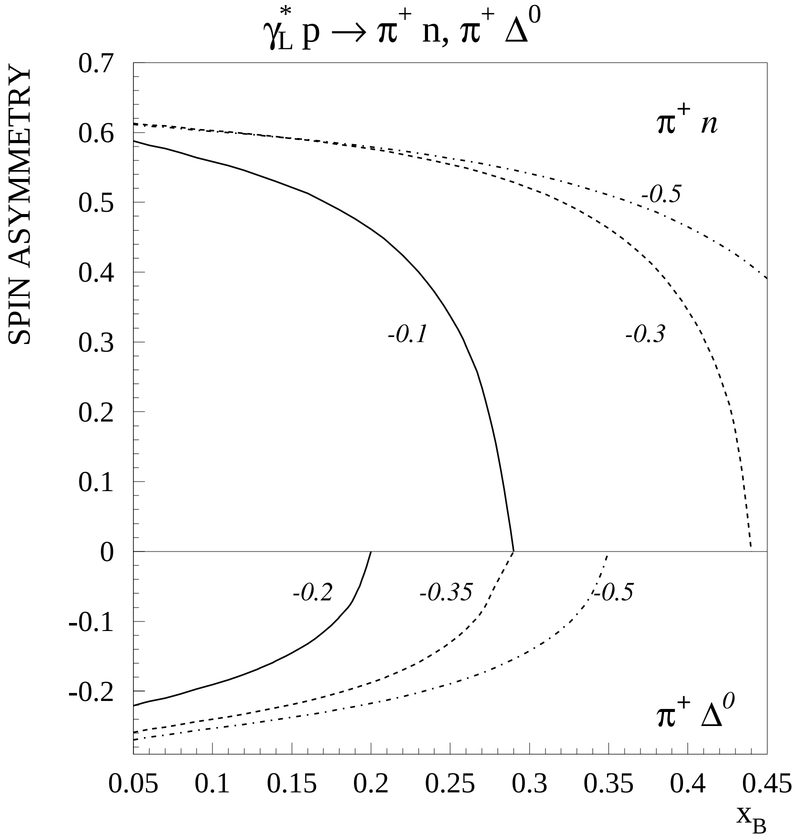
Kinematic plane





lines indicate: nucleon mass $(m_n) \sim z = 0.98$
delta mass $(m_\Delta) \sim z = 0.94$

Transverse polarised target



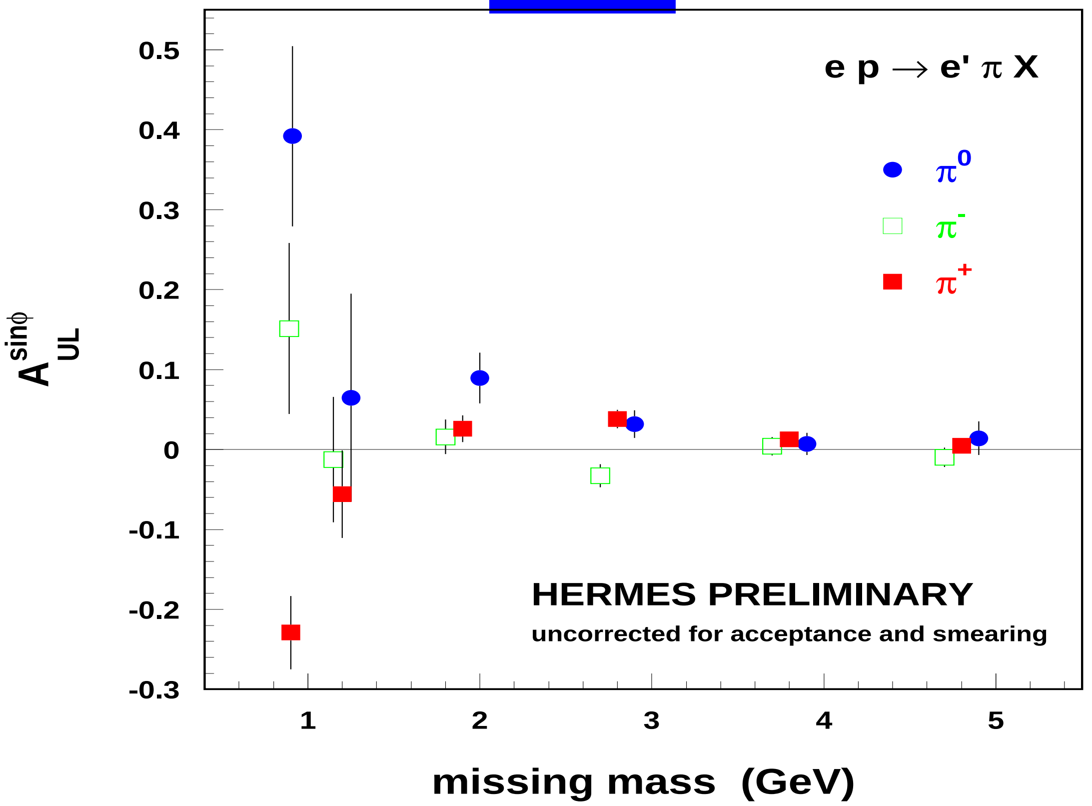
L. L. Frankfurt, M. V. Polyakov, M. Strikman, M. Vanderhaeghen; Phys.Rev.Lett. 84 (2000) 2589-2592

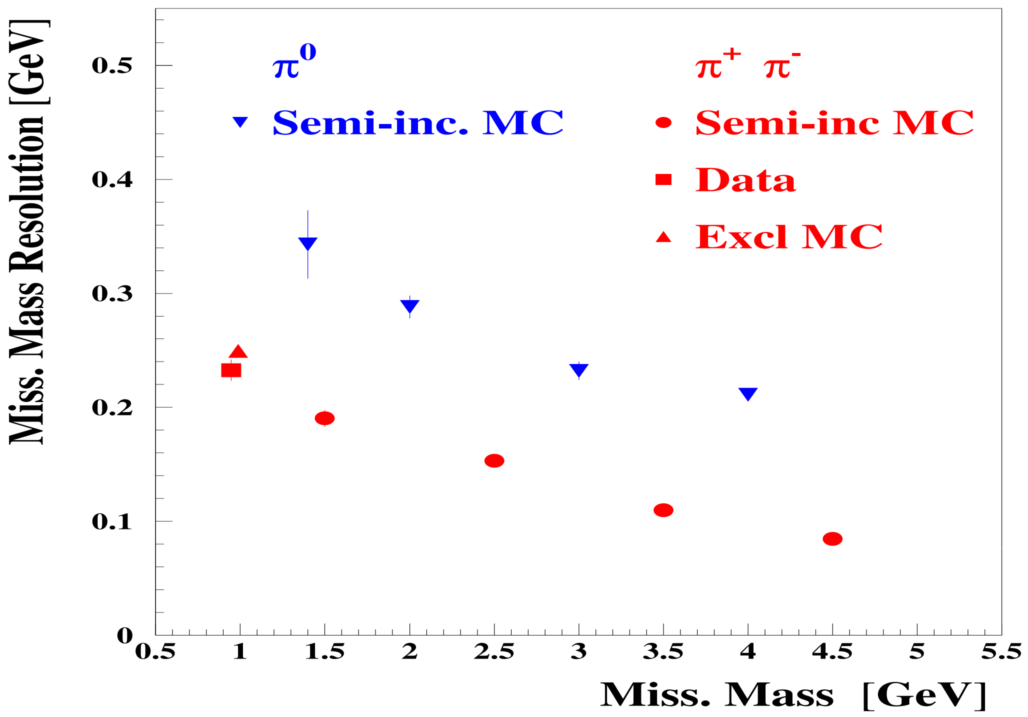
- No predictions for **longitudinally** polarised target.

HERMES, Longitudinally polarized target:

$S_T << S_L$

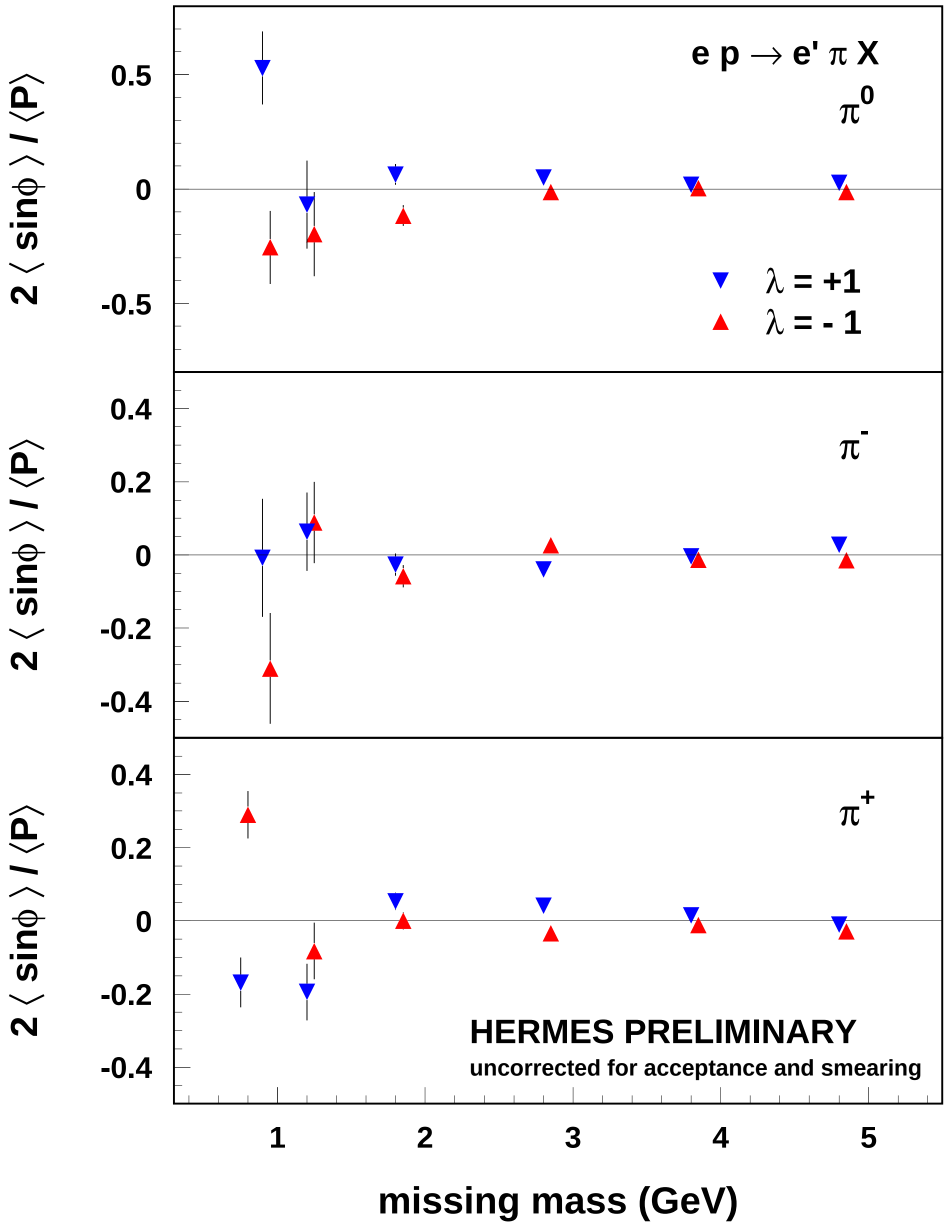
$\mathcal{A}_{UL}^{\sin\phi}$





In exclusive region the sign is opposite to predictions for transverse target.

Flip target polarisation



Effect comes from target polarisation only!

Summary and outlook

- **First and preliminary results about exclusive π production and SSA in the exclusive channels.**
- $\sim$ **2K exclusive π^+ in 1996/1997 data**
- **Large SSA in the exclusive region.**
  - ▷ π^0 $\mathcal{A}_{UL}^{sin\phi} > 0$ **for all** M_x
  - ▷ π^+ $\mathcal{A}_{UL}^{sin\phi} < 0$ **for** $M_x \approx M_N$
    $\mathcal{A}_{UL}^{sin\phi} > 0$ **for** $M_x \gg M_N$
  - ▷ π^- $\mathcal{A}_{UL}^{sin\phi} \approx 0$ **for** $M_x \gg M_N$
    $\rightarrow$ **more stat for** $M_x \approx M_\Delta$**.**

- **Improvement in statistics 97-97 $\rightarrow$ 96-06**
- **Improvement in non-exclusive event rejection:**
  partial front track analysis
  Λ-wheel detector under installation
  (Θ_{max} 0.14 -0.17 $\rightarrow$ 0.3 rad)
- **Improvement in exclusive event identification:**
  Silicon recoil detector project.