Exclusive electroproduction of the ρ^+ on the proton at CLAS

AHMED FRADI
(CLAS collaboration)

Institut de Physique Nucléaire d'Orsay (France)

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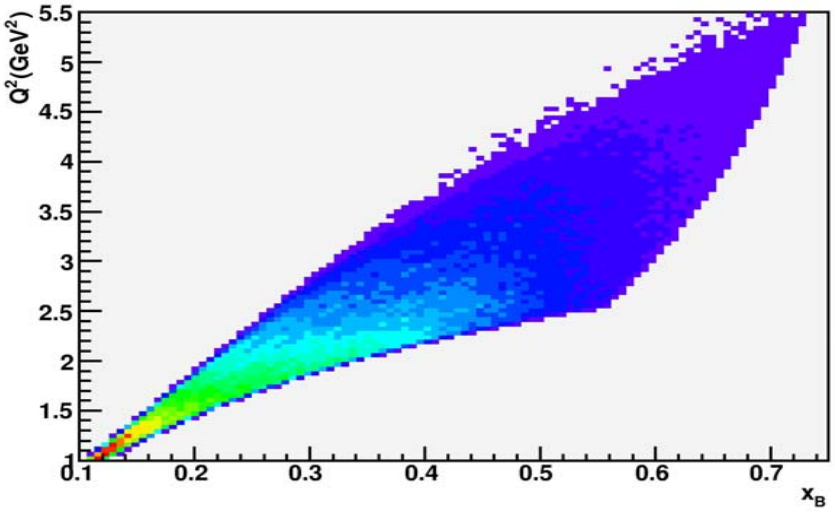
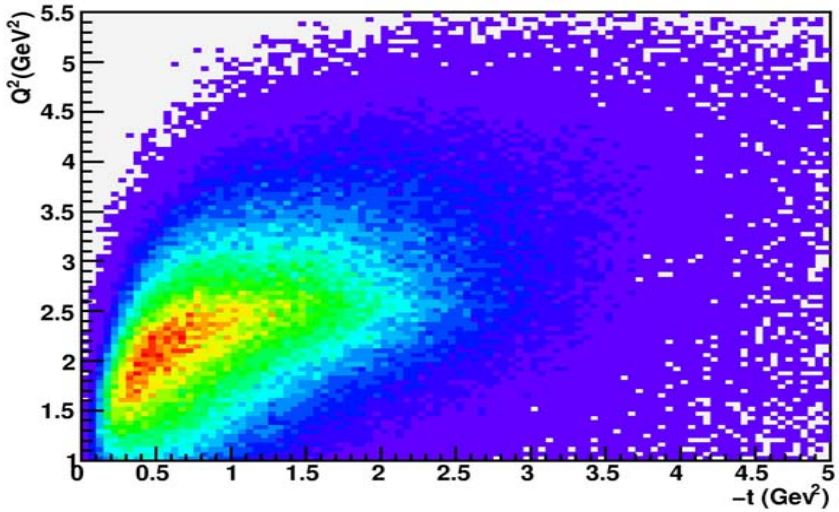
Outline:

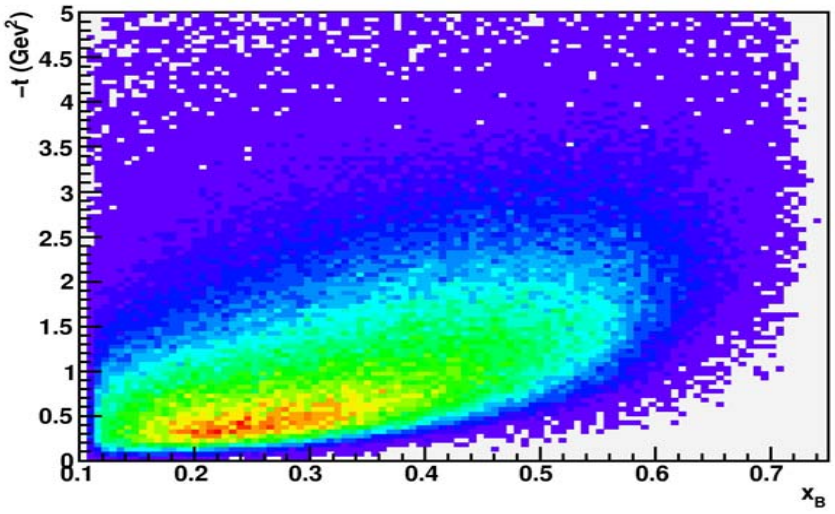
- Experiment
- Data analysis: ρ^+ cross sections
- Interpretation

The e1-dvcs experiment (March - May 2005)

$$e\ p \rightarrow e'\ n\ \rho^{+} \rightarrow e'\ n\ \pi^{+}\pi^{0} \rightarrow\ e'\ n\ \pi^{+}\ \gamma\ \gamma$$







Beam energy = 5.75 GeV

Current: 20-25 nA

Integrated Luminosity ≈ 40fb^{-1}

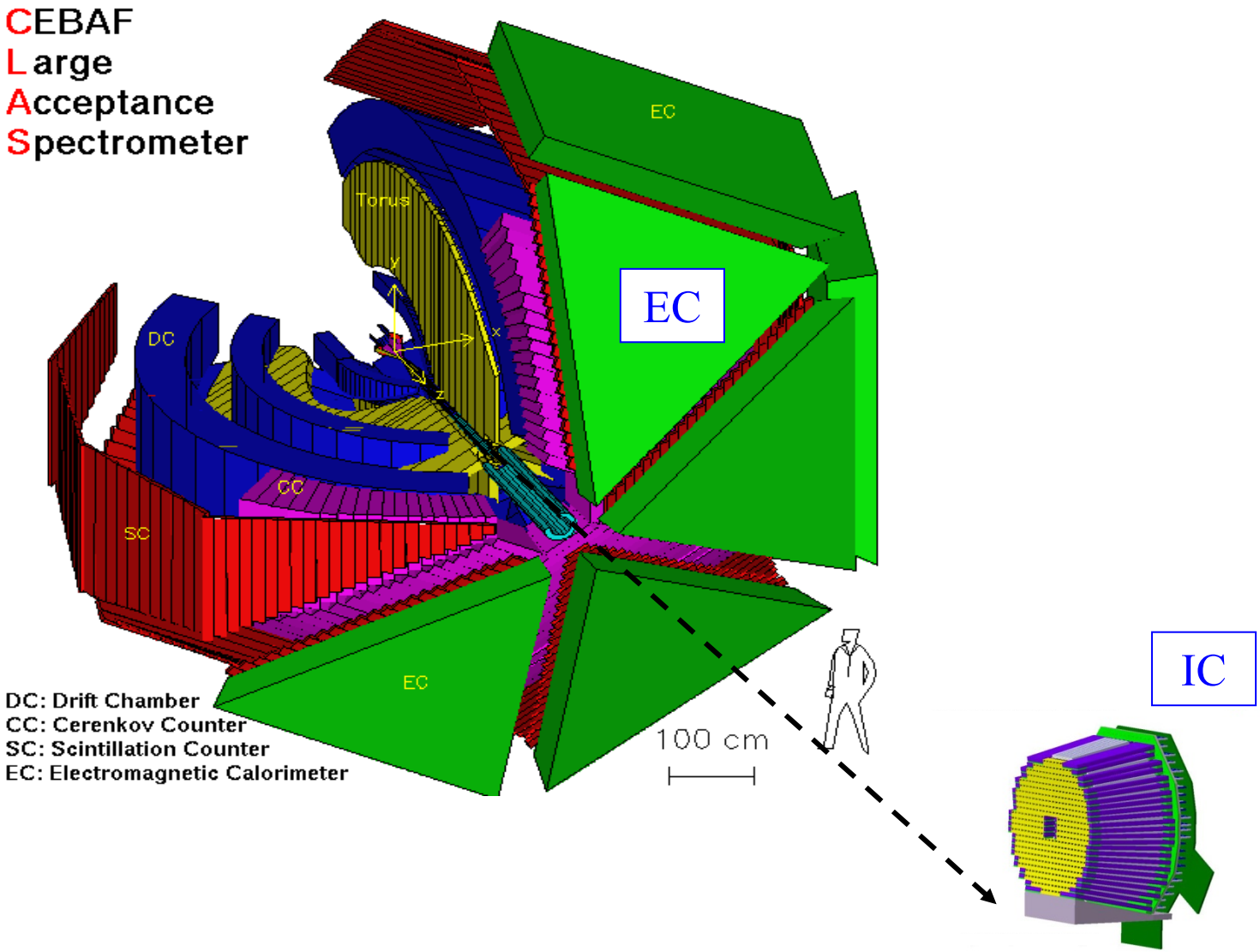
$0.1 < x_B < 0.65$

Q^2 up to 5 GeV^2

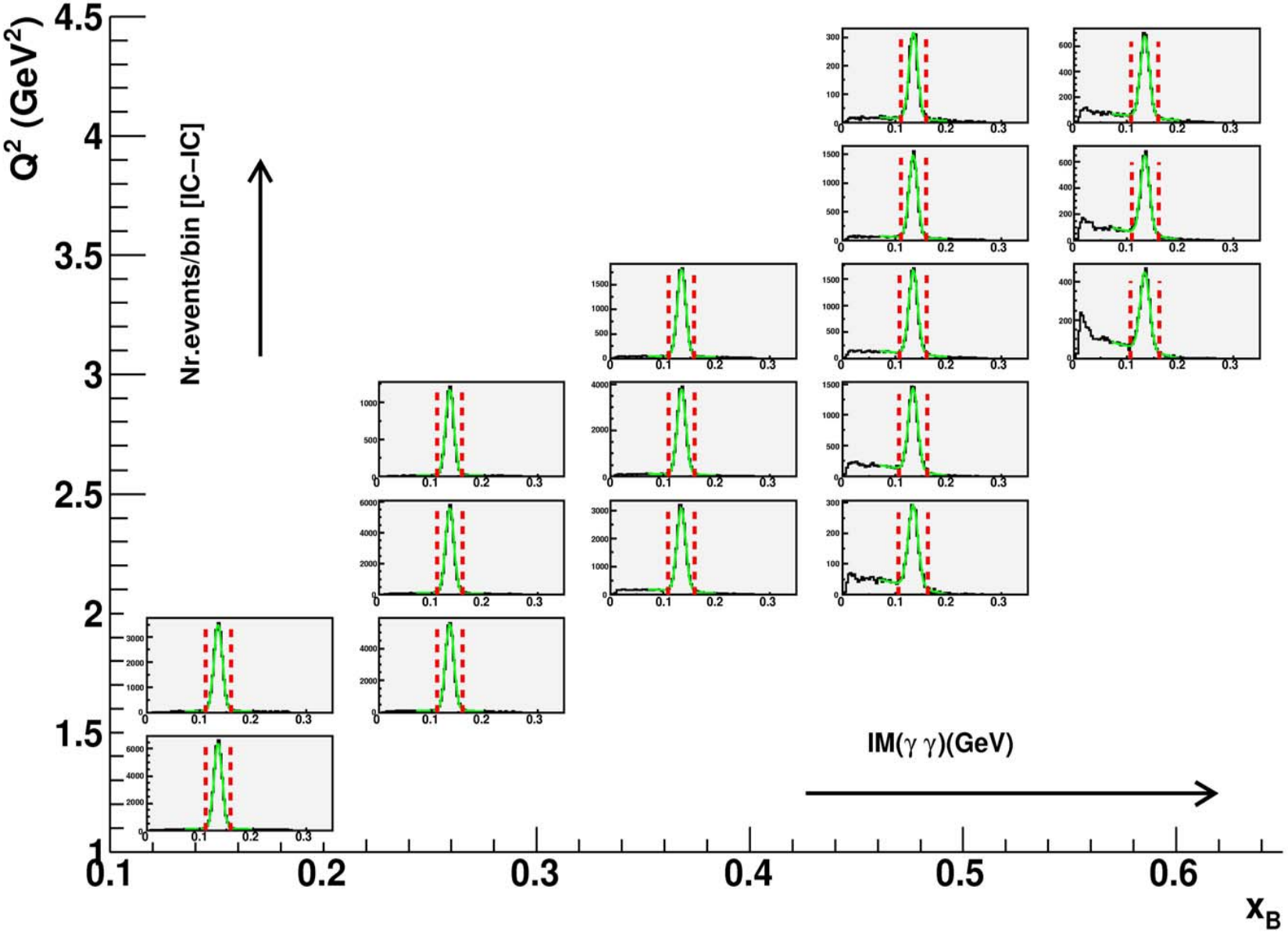
$-t$ up to 3.5 GeV^2

Channel selection

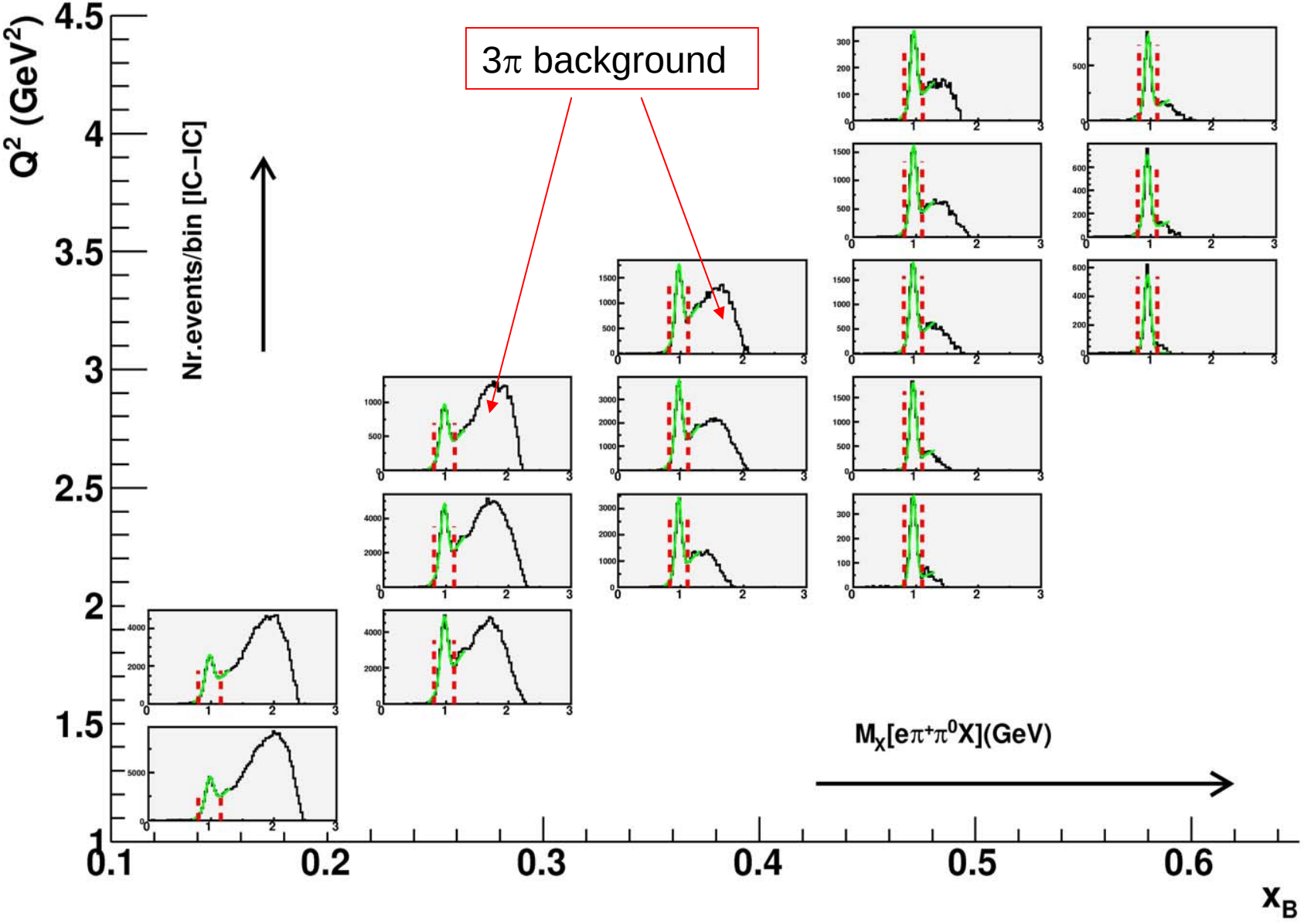
$$e\,p \rightarrow e'\,[n]\,\rho^{+} \rightarrow e'\,[n]\,\pi^{+}\pi^{0} \rightarrow (e')\,[n]\,(\pi^{+}\,\gamma\,\gamma)$$



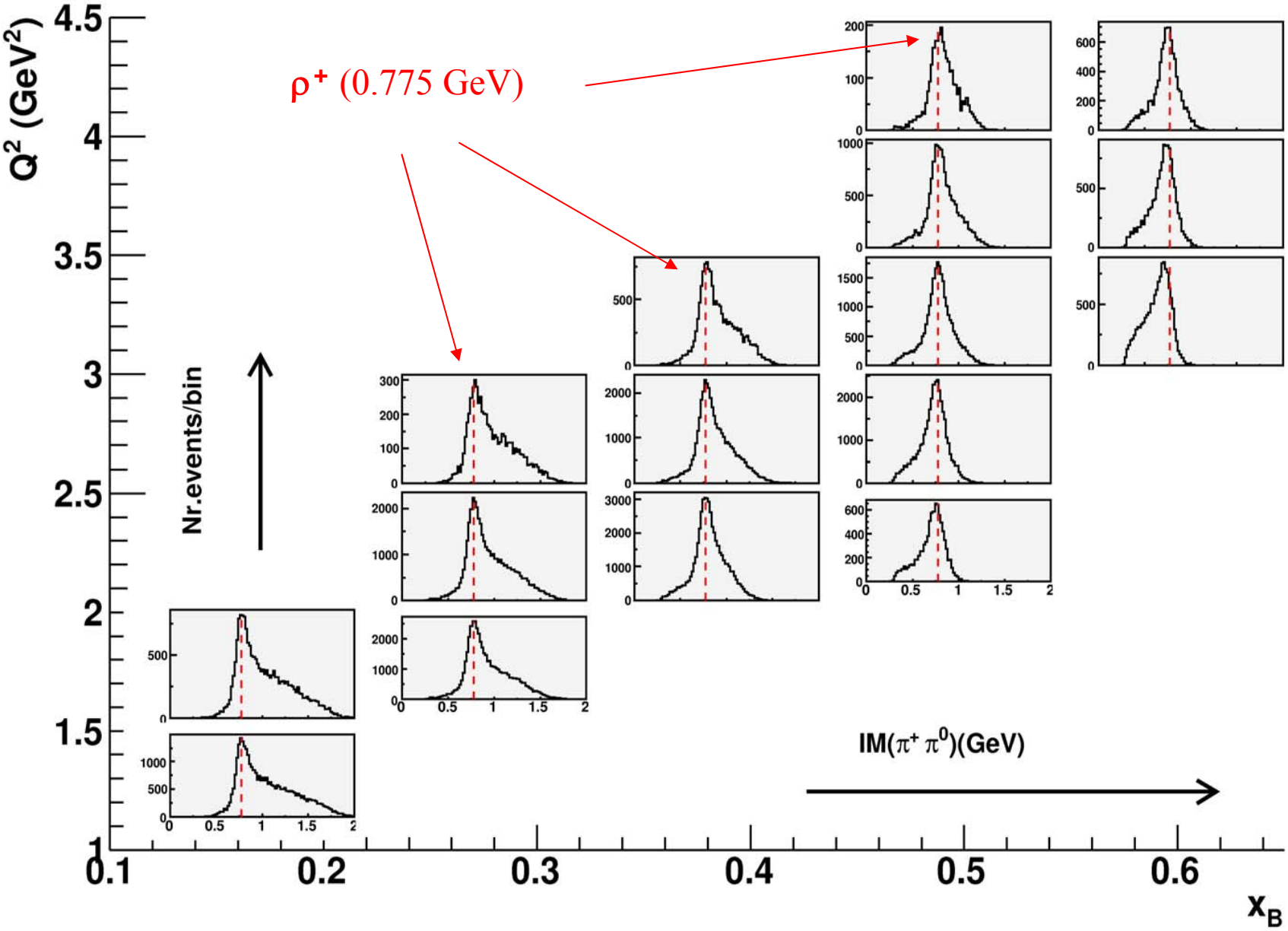
π^0 selection



Neutron selection



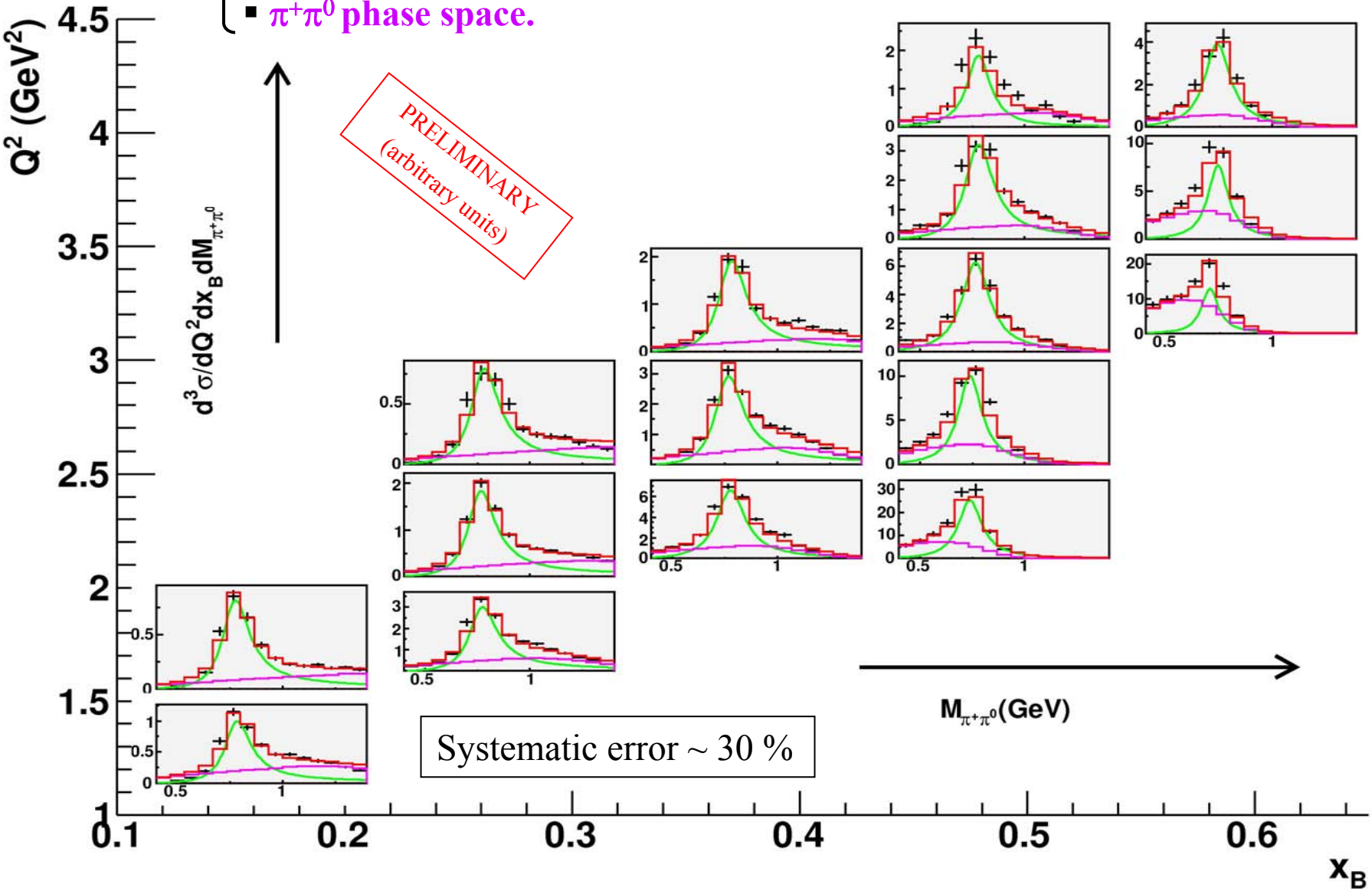
$\pi^+\pi^0$ invariant mass



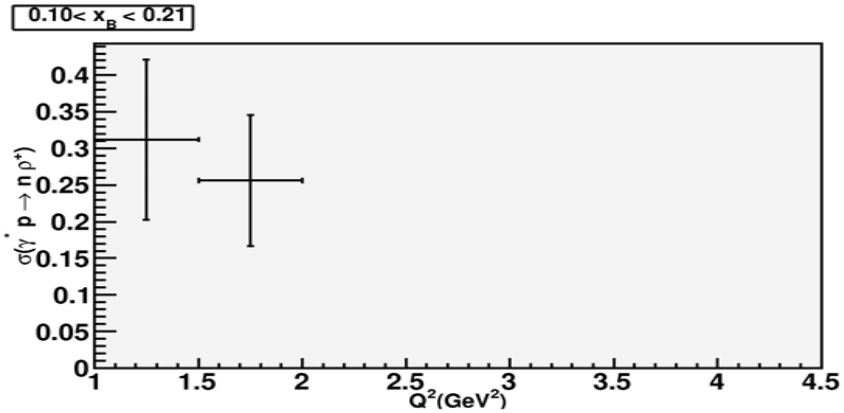
Background subtraction

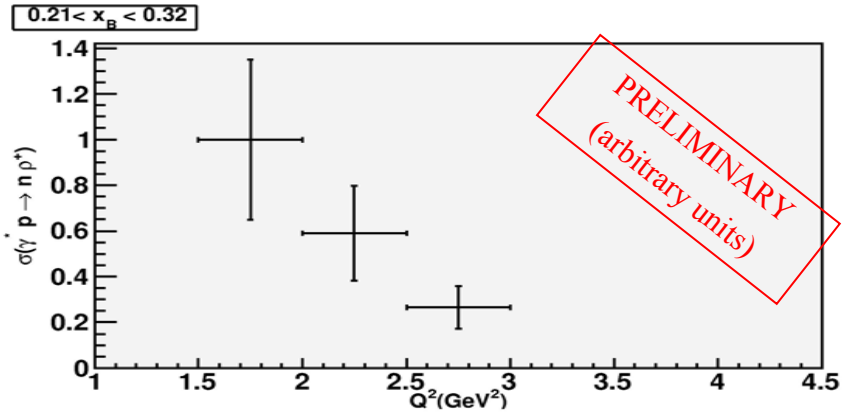
$$\frac{d\sigma_{\gamma^* p\to n\rho^+}}{dQ^2 dx_B d\tau} = \frac{1}{\Gamma_V}\frac{N_{\gamma^* p\to n\rho^+}}{L_{\text{int}}.Acc.\Delta Q^2.\Delta x_B.\Delta\tau}F_{corr}$$

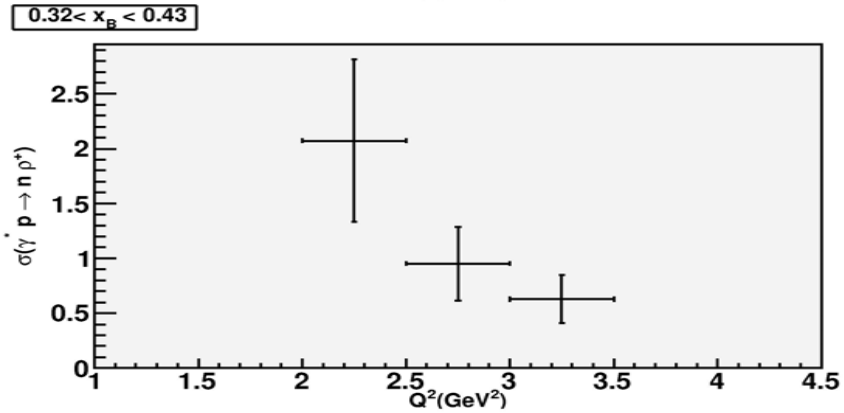
- **Ross-Stodolsky B-W for $\rho^+(770)$ with variable skewedness parameter.**
- **$\pi^+\pi^0$ phase space.**

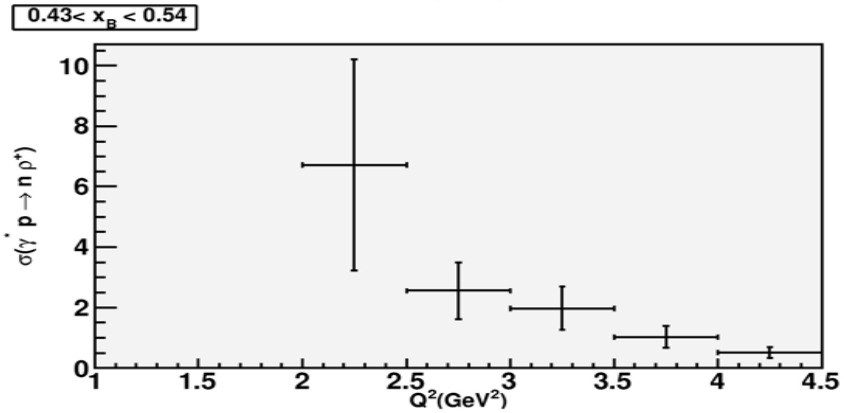


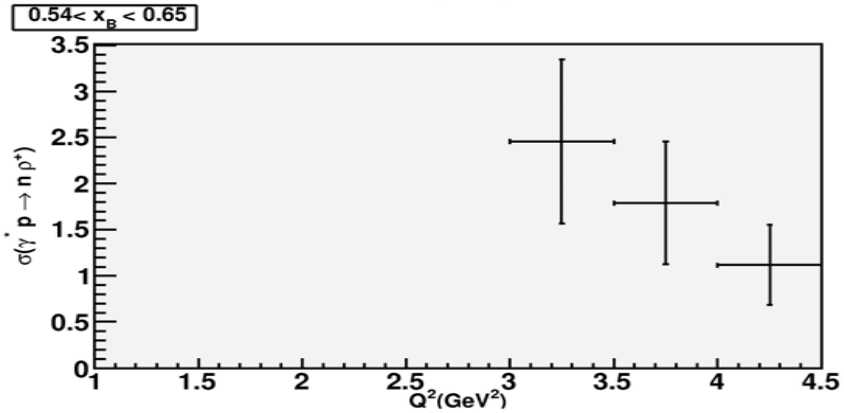
Total cross section $\sigma(\gamma^* p \rightarrow n \rho^+)$







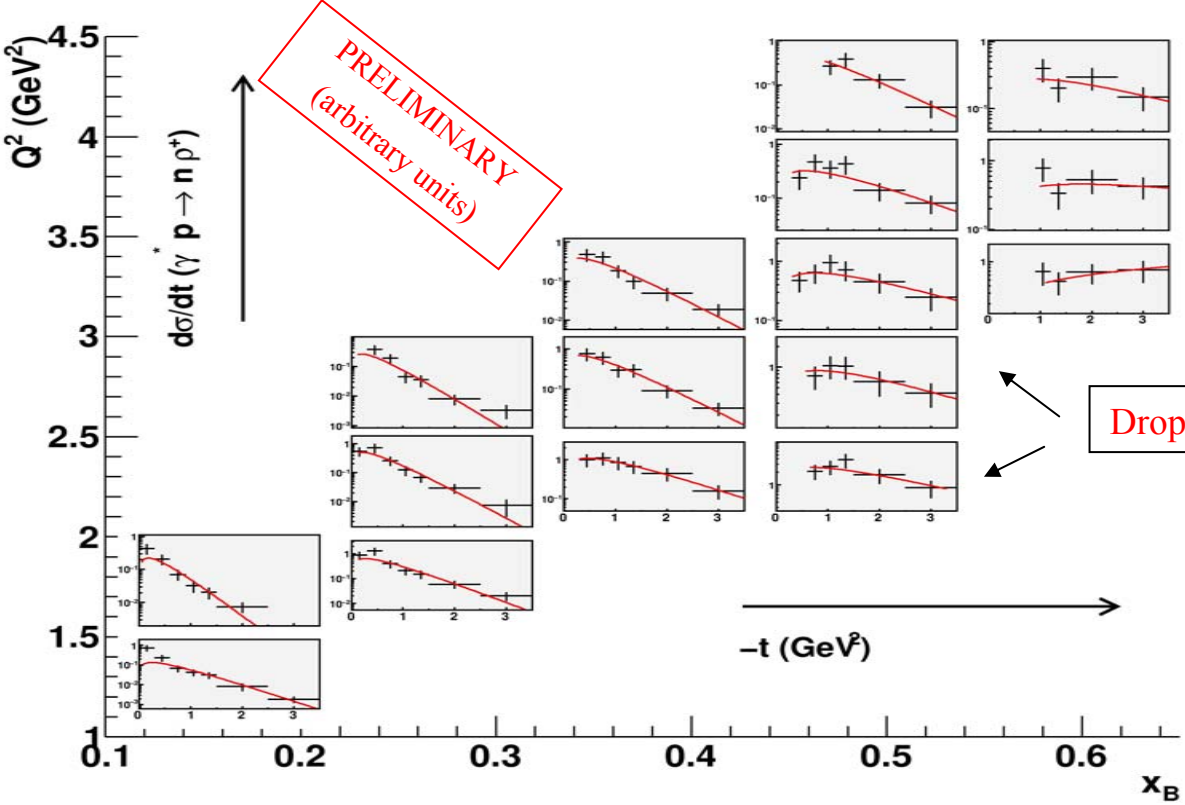




- Error bar: quadratic sum of statistical error and ~35% of systematics.

World's first-ever measurement

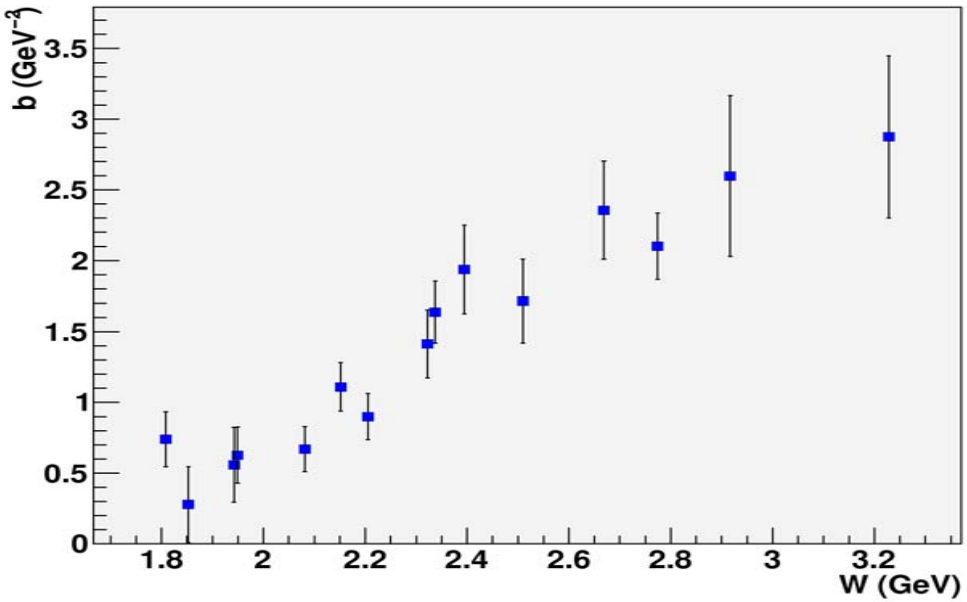
$d\sigma/dt\ (\gamma^* p \rightarrow n \rho^+)$



Drop of $d\sigma/dt$ for $t \rightarrow 0$

Fit function:

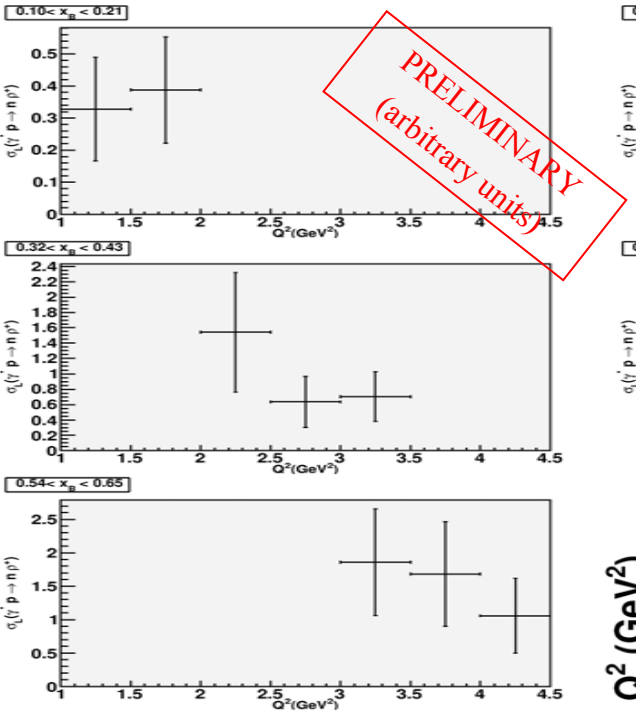
$$A\sqrt{-t}e^{-bt}$$



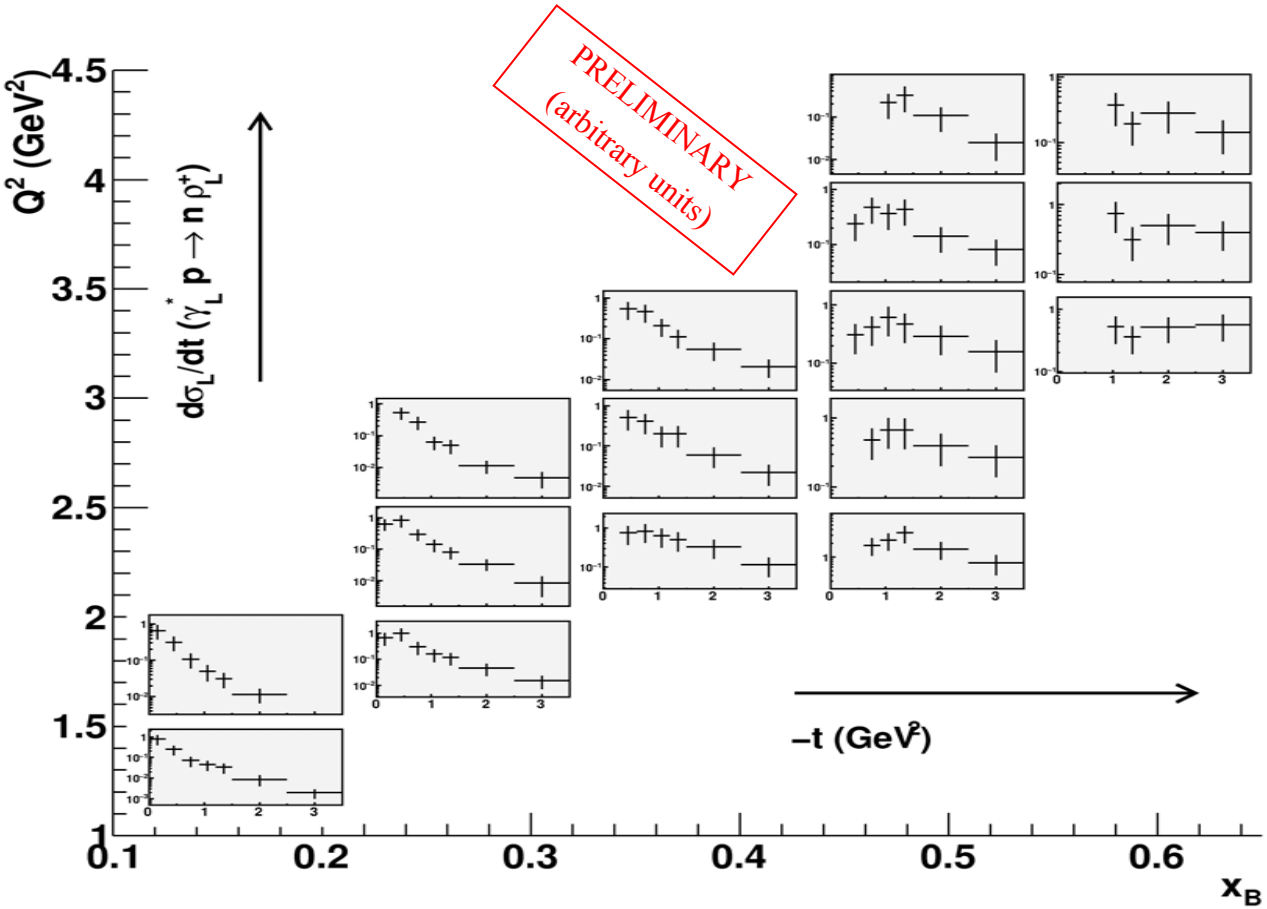
Longitudinal cross sections

Longitudinal/Transverse separation:

- Angular distribution analysis ($\cos\theta_{HS}$)
- SCHC



PRELIMINARY (arbitrary units)

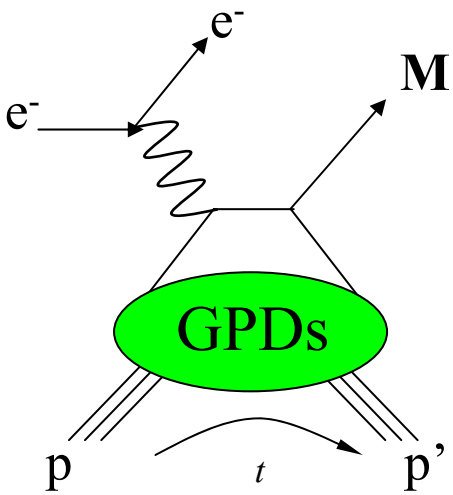


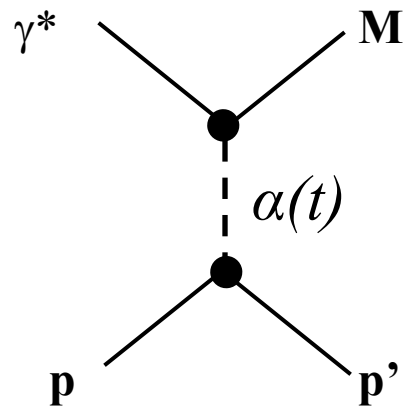
PRELIMINARY (arbitrary units)

$\sigma_L(\gamma^* p \rightarrow n \rho^+)$

$d\sigma_L/dt\ (\gamma^* p \rightarrow n \rho^+)$

Theoretical interpretation





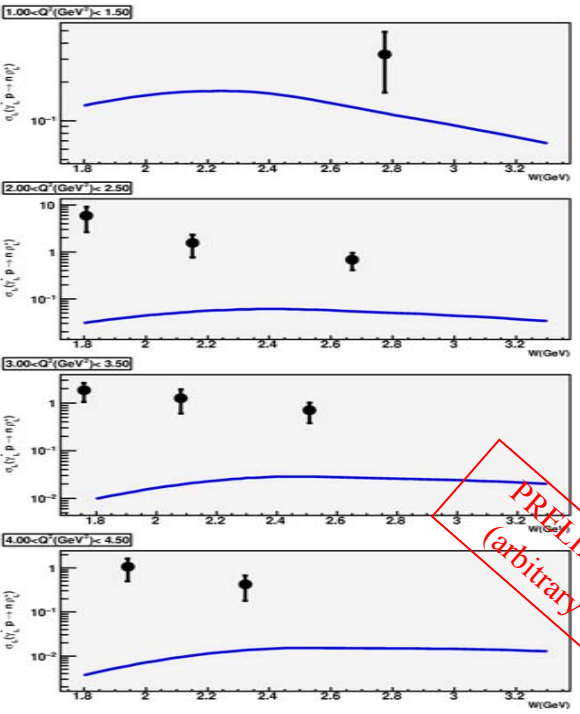
Partonic approach:

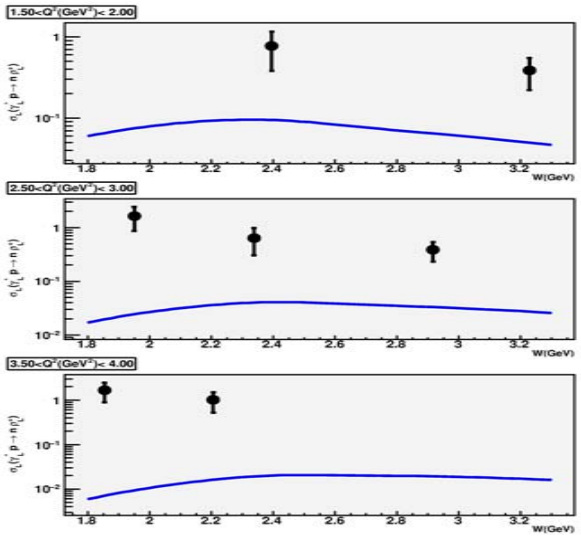
Handbag diagram and GPDs

Hadronic approach:

Regge theory and meson trajectory exchanges

"Partonic approach"

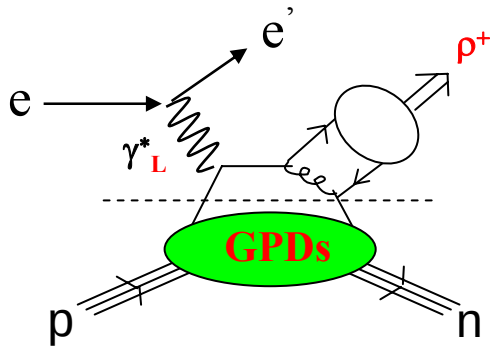




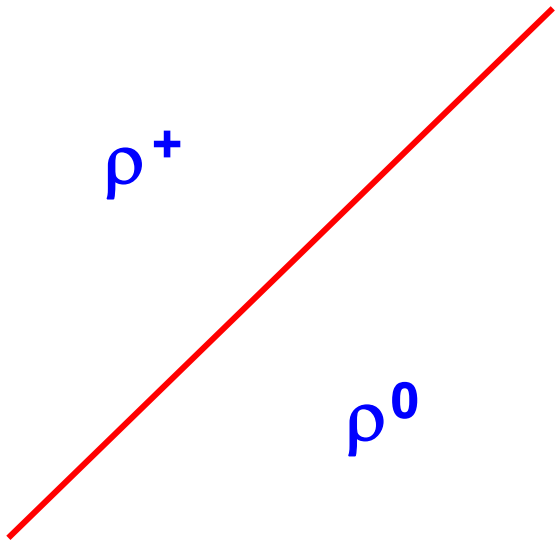
PRELIMINARY (arbitrary units)

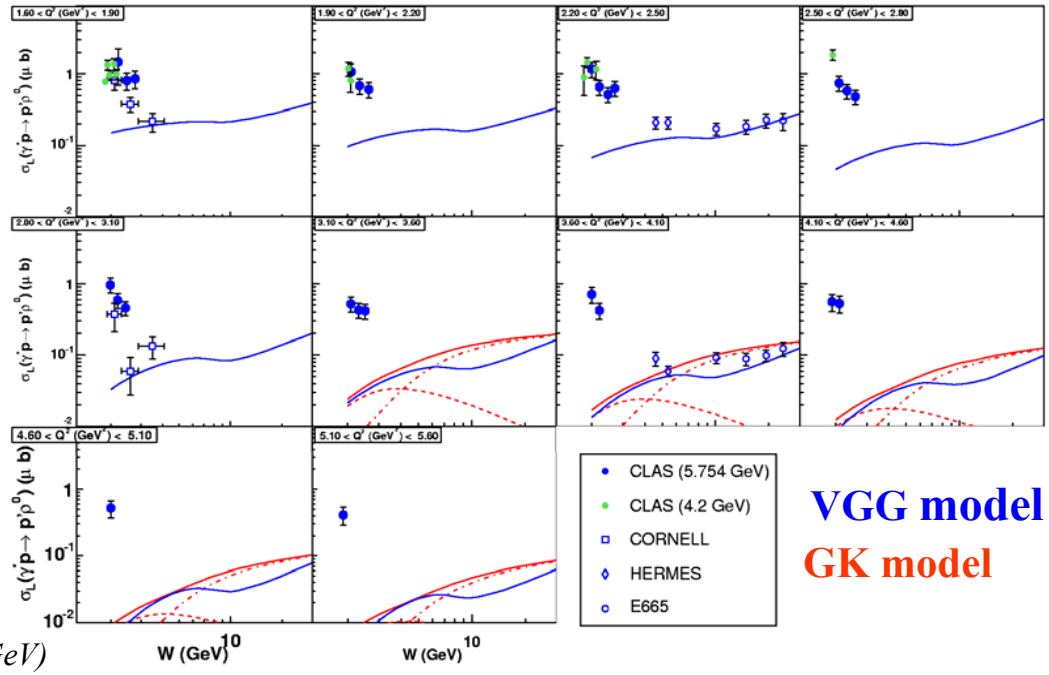
$\sigma_L(\rho^+)$ [CLAS@5.776 GeV]

$\sigma_L(\rho^+)$ [VGG]



VGG: *M.Vanderhaeghen, P.A..M Guichon, and M.Guidal, Phys.Rev.D* ***60****, 094017 (1999).*



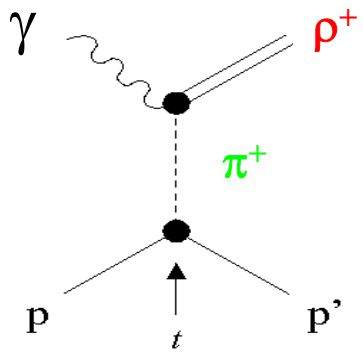


VGG model

GK model

S. Morrow et al., Eur.Phys.J.A39:5-31,2009 (r^0@5.75GeV)

“Hadronic approach”: Laget model



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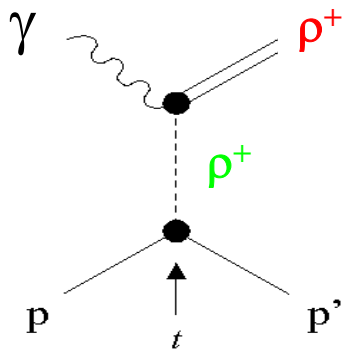
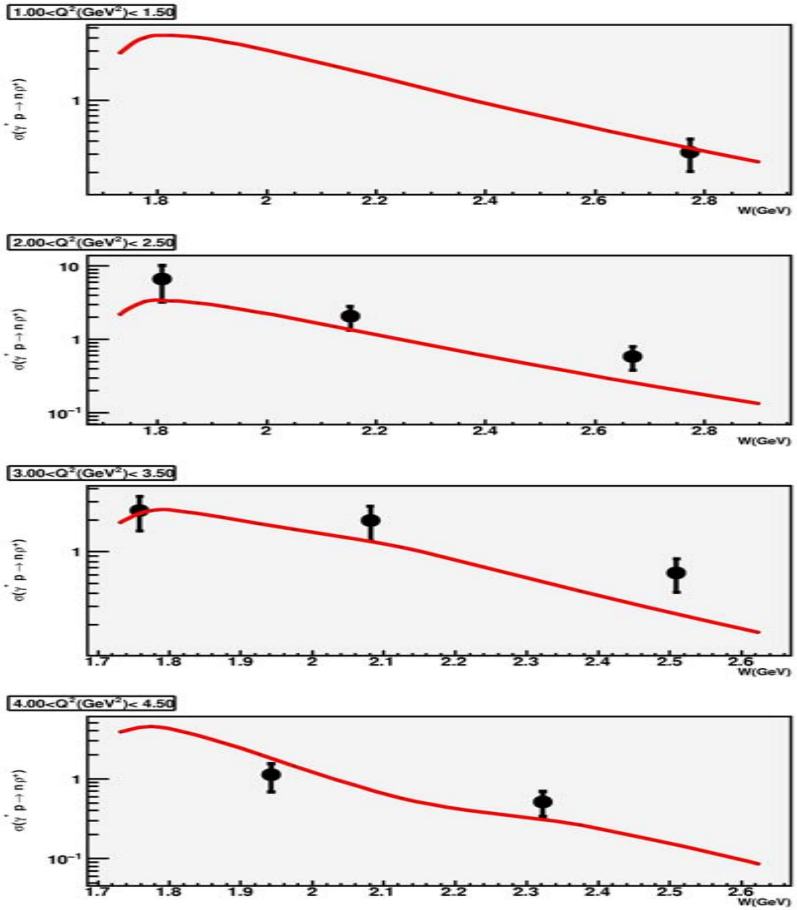
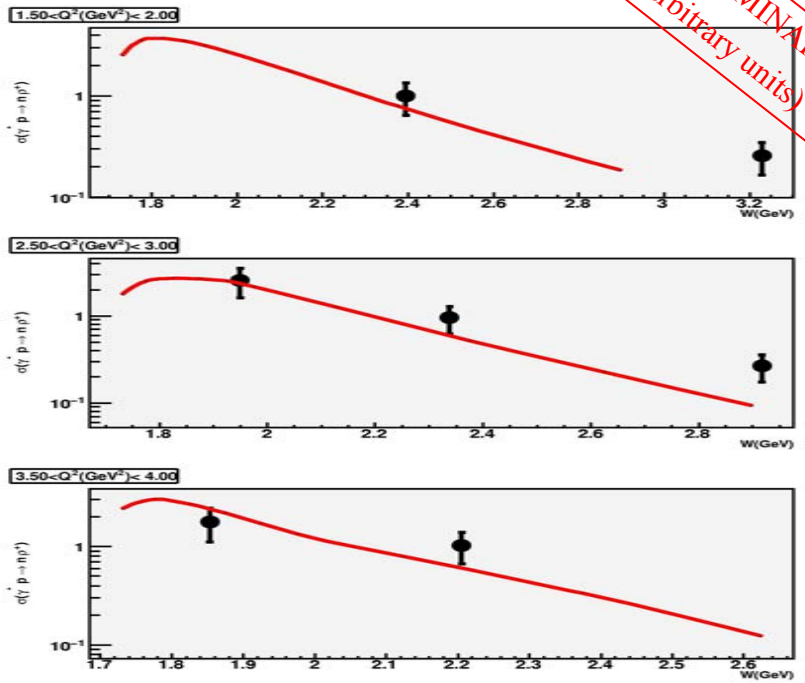


PRELIMINARY
(arbitrary units)



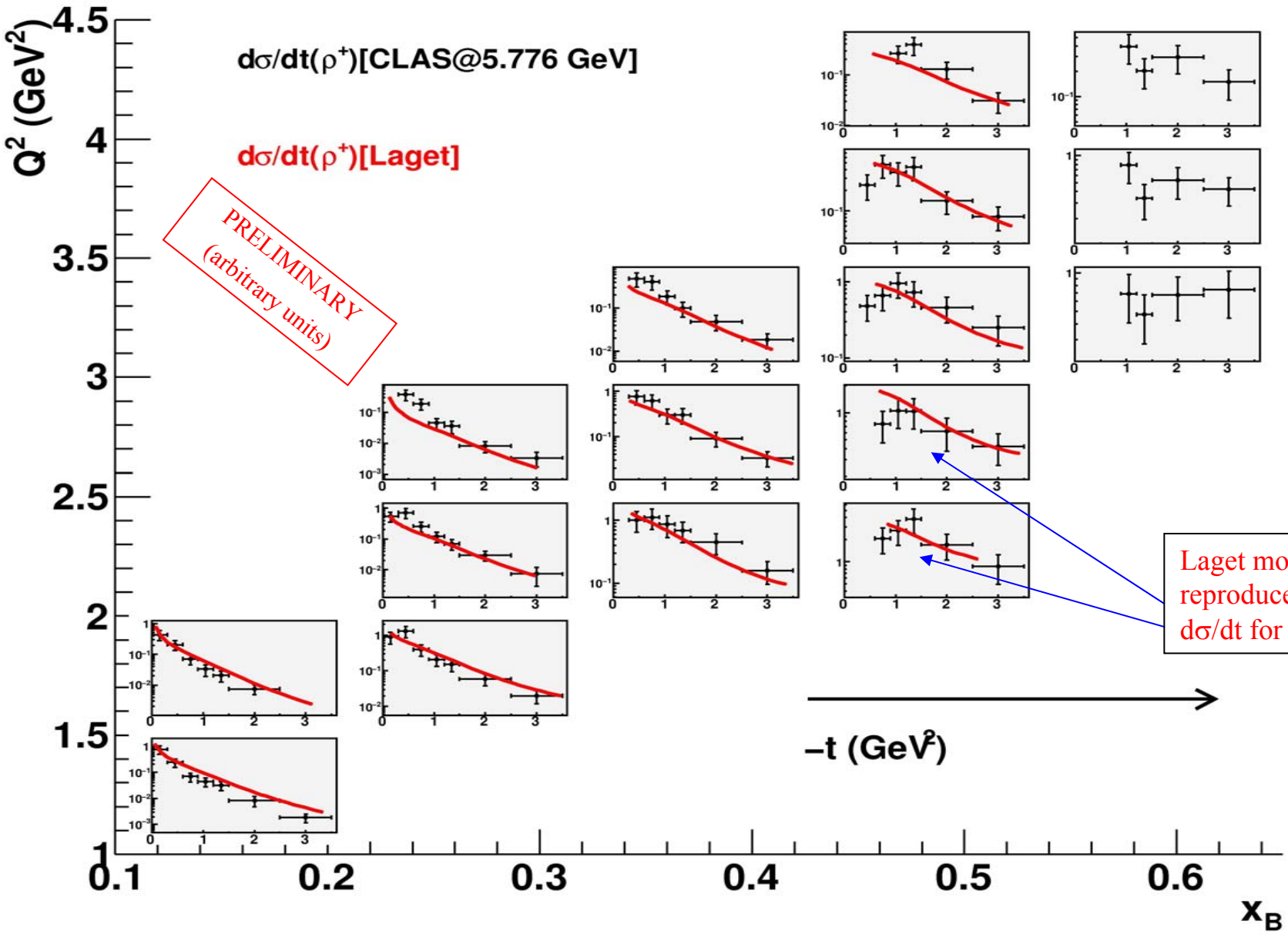


σ(ρ⁺) [CLAS@5.776 GeV]

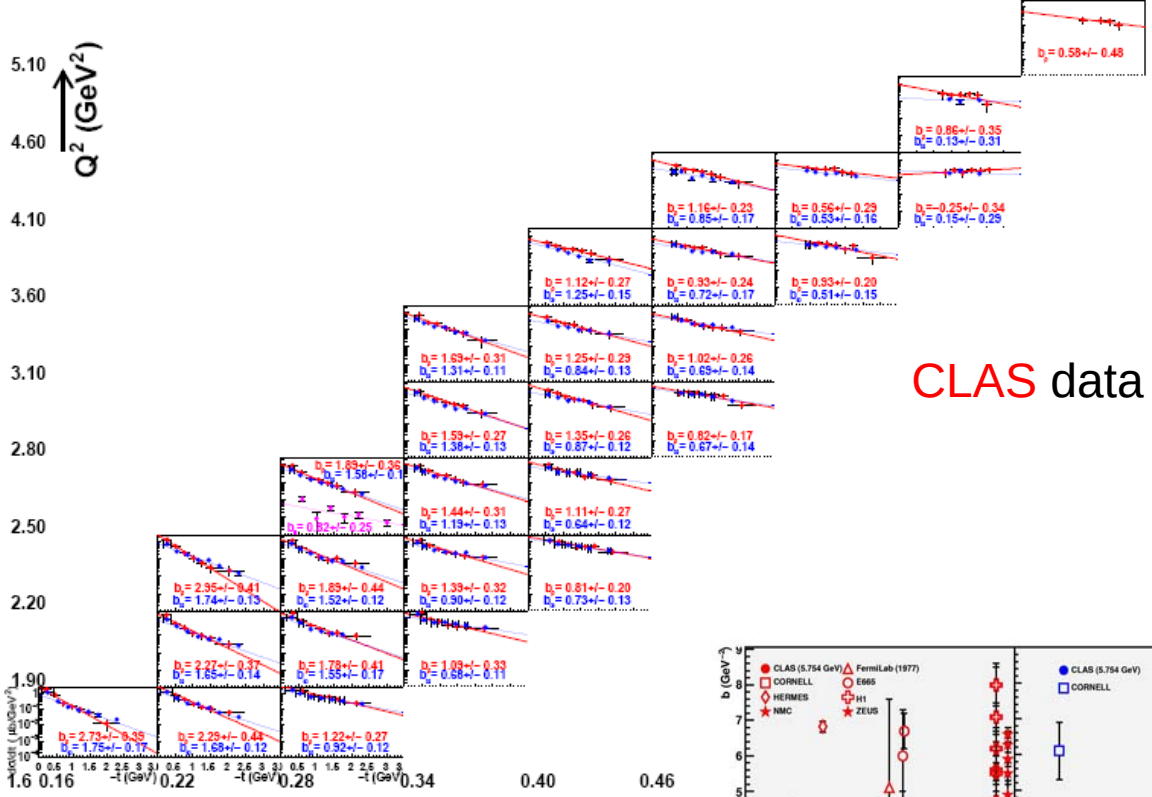
σ(ρ⁺) [Laget]

Laget: *based on Phys. Rev.* ***D 65****, 074022 (2002)*

"Hadronic approach"



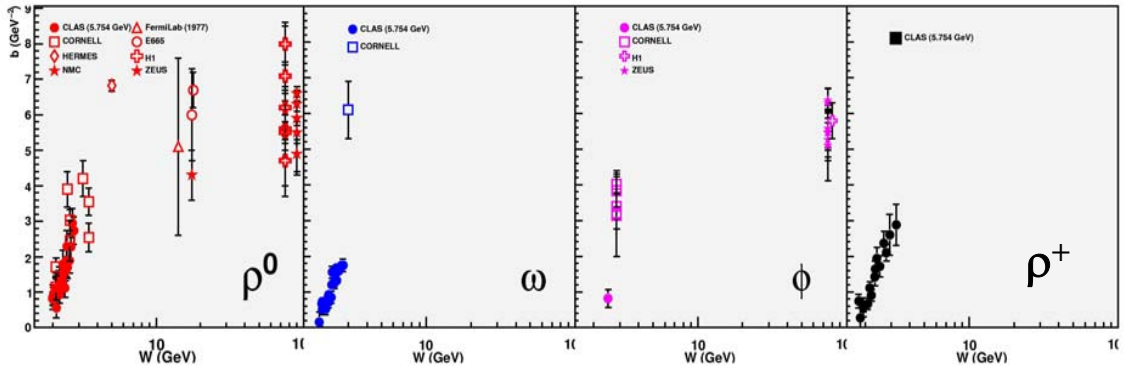
$d\sigma/dt$ for ρ^0, ω, ϕ

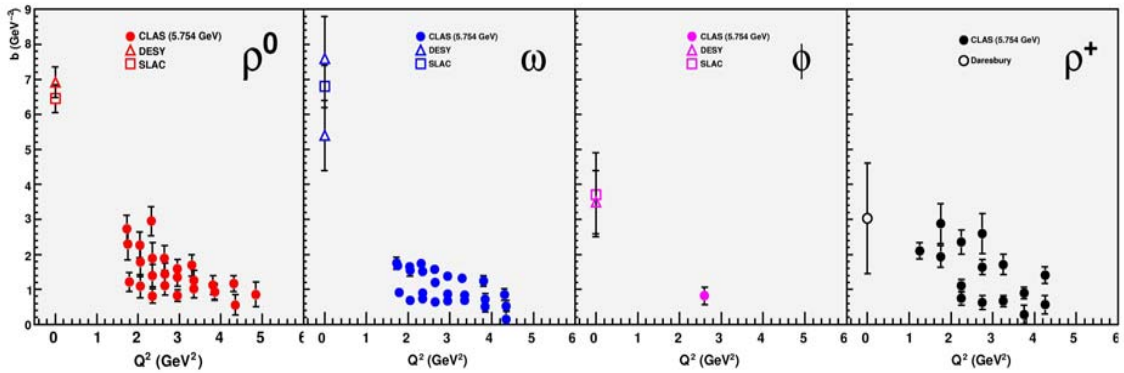


CLAS data

- *C. Hadjidakis et al., Phys.Lett.B605:256-264, 2005 (ρ^0@4.2 GeV)*
- *S. Morrow et al., Eur.Phys.J.A39:5-31, 2009 (ρ^0@5.75GeV)*
- *L. Morand et al., Eur.Phys.J.A24:445-458, 2005 (ω@5.75GeV)*
- *K. Lukashin, Phys.Rev.C63:065205, 2001 (ϕ@4.2 GeV)*
- *J. Santoro et al., Phys.Rev.C78:025210, 2008 (ϕ@5.75GeV)*

Fit function: Ae^{-bt}





b reflects the size of the meson-nucleon system

Summary

- In this analysis, we measured for the first time the ρ^+ cross sections.

- "Partonic approach": handbag diagram and GPDs.

VGG misses the data especially for small W.

- "Hadronic approach": Regge theory and meson trajectory exchanges.

Laget model reproduces well the data up to $Q^2 \approx 4.5\ GeV^2$.

- Comparison with (ρ^0,ω,ϕ) in progress:

common features, ratios (cancel higher twists ?),…