Study of ρ^0 Photoproduction off of Protons in CLAS6

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Introduction

Vector meson production typically studied using differential cross sections

Low -t:

- Experimental data has shown $d\sigma/dt$ exhibits exponential behavior in the forward region ($\theta^{CM} < 90°$); modeled by versions of Regge theory

High -t, high s:

- Behavior of $d\sigma/dt$ for V-production at $\theta^{CM} \approx 90°$ is predicted by Constituent Counting Rules

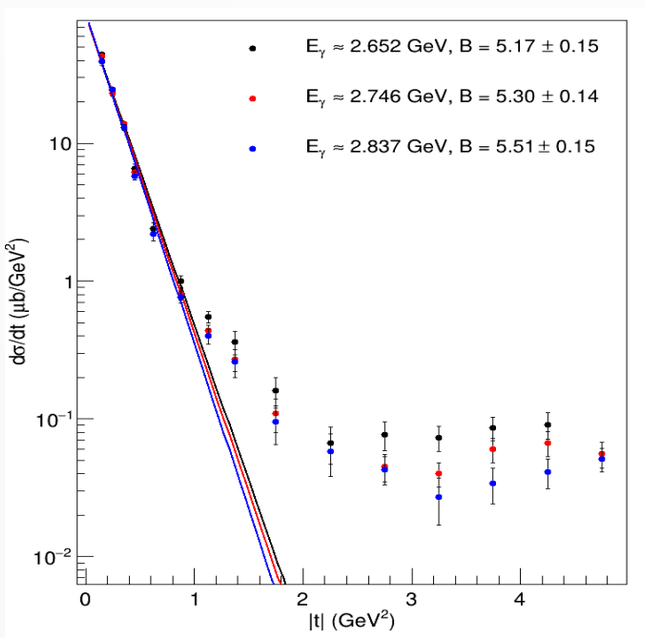
Regge Theory

Expect $d\sigma/dt \sim e^{-B(s)|t|}$ for small $|t|$

t-slope B(s) is sensitive to exchanged particles (from Regge theory)

$\alpha(t) = \alpha(0) + \alpha` |t| \rightarrow$ spin of exchanged particle (Reggeon)

$B(s) = 2\alpha` \ln(s/s_0) \rightarrow$ t-slope



Data published by (M. Battaglieri et al. 2001) [3]

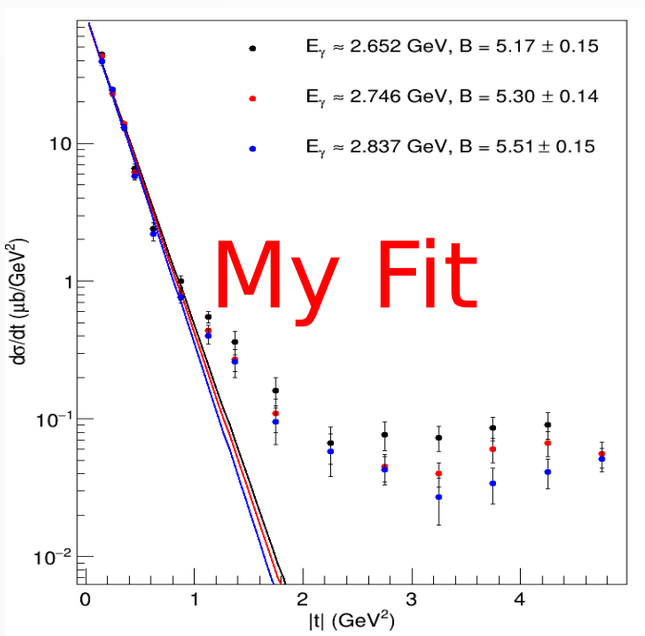
Basic Regge Theory

Expect $d\sigma/dt \sim e^{-B(s)|t|}$ for small $|t|$

t-slope B(s) is sensitive to exchanged particles (from Regge theory)

$\alpha(t) = \alpha(0) + \alpha` |t| \rightarrow$ spin of Reggeon

$B(s) = 2\alpha` \ln(s/s_0) \rightarrow$ t-slope



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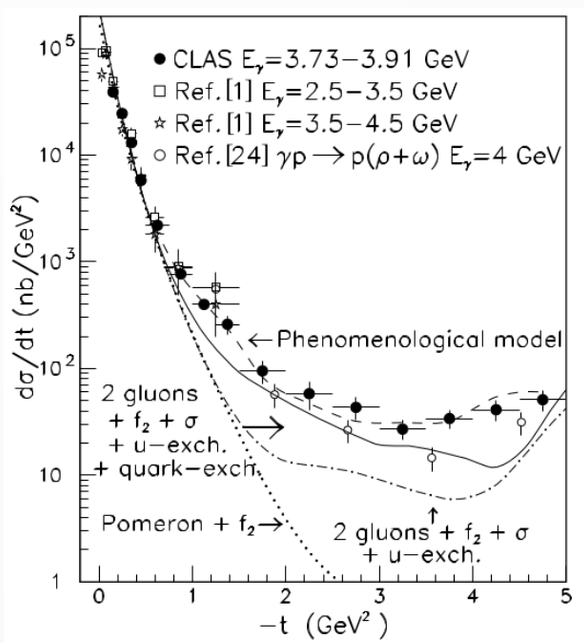

Plot pulled from (M. Battaglieri et al. 2001) [3]

Constituent Counting Rule

At $\theta^{CM} \approx 90°$, $d\sigma/dt \sim s^{-(n-2)}$

n: total number of elementary fields

For $\gamma p \to Vp$, $n = 1+3+2+3 = 9 \to d\sigma/dt \sim s^{-7}$

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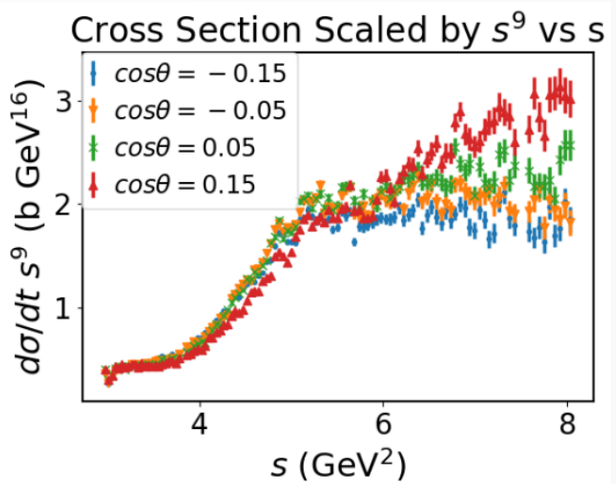
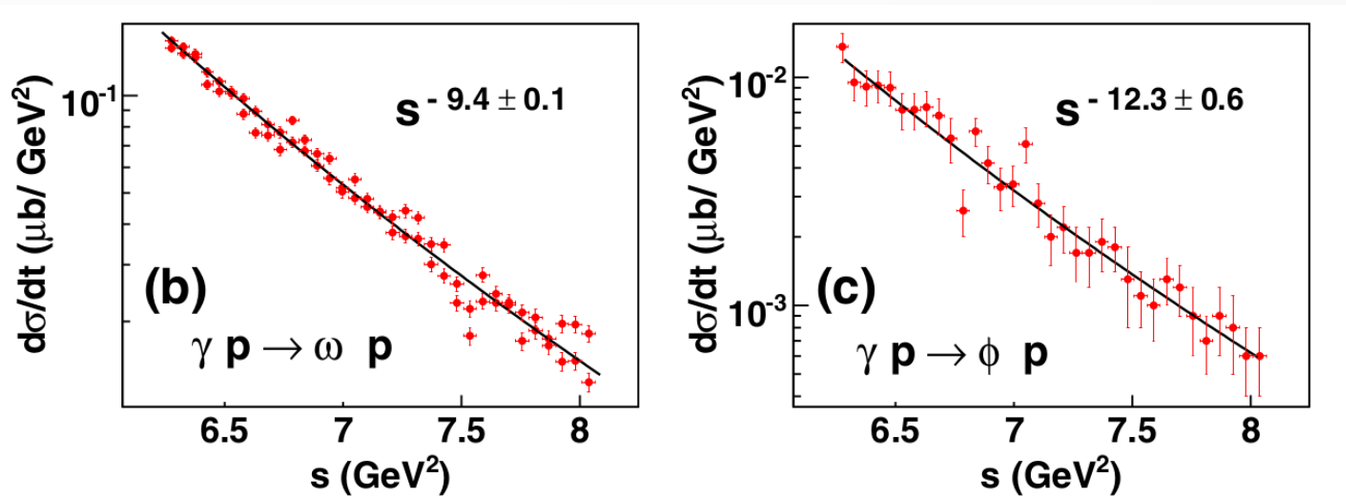
~~For $\gamma p \rightarrow Vp$, $N = 1+3+2+3 = 9 \rightarrow d\sigma/dt \sim s^{-7}$~~

Naive CCR inconsistent with vector meson photoproduction experimental data:

- ρ: s^{-8} (M. Battaglieri *et al.* 2001)
- ω:
  - $s^{-7.2}$ (M. Battaglieri *et al.* 2003)
  - $s^{-9.4}$ (B. Dey 2014)
  - $s^{-9.08}$ (T. Reed *et. al.* 2020)
- φ: s^{-12} (B. Dey 2014)



From (T. Reed et. al. 2020) [6]



From (B. Dey 2014) [5]

Objectives:

Extract $d\sigma/dt$ for $\gamma p \rightarrow \rho^0 p$ using CLAS6 g12 data

- **Low -t: estimate B=B(s):** $d\sigma/dt \sim e^{-B(s)|t|}$ for small $|t|$
- **High -t, s: estimate n ←** $d\sigma/dt|_{90^\circ}$ vs. $s \sim s^{-(n-2)}$

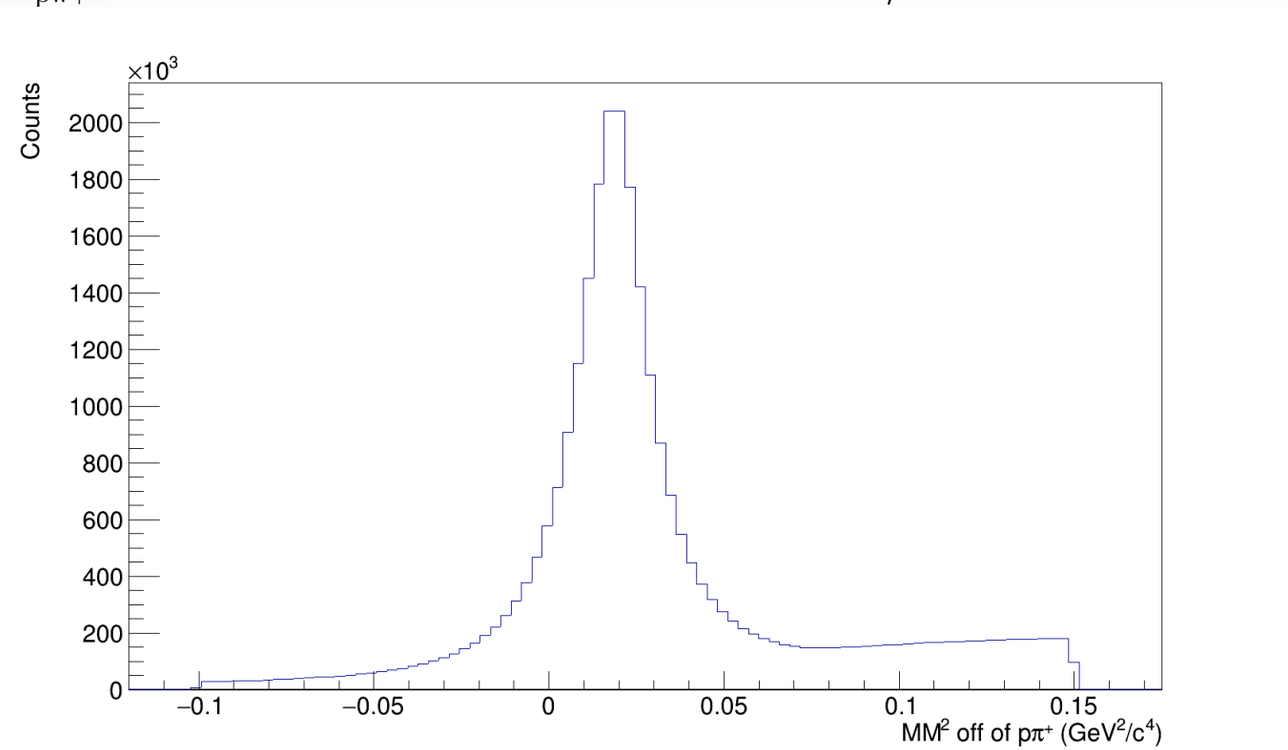
π^- Id. / Reaction Selection

$\gamma + p \rightarrow p + \pi^+ + (\pi^-)$

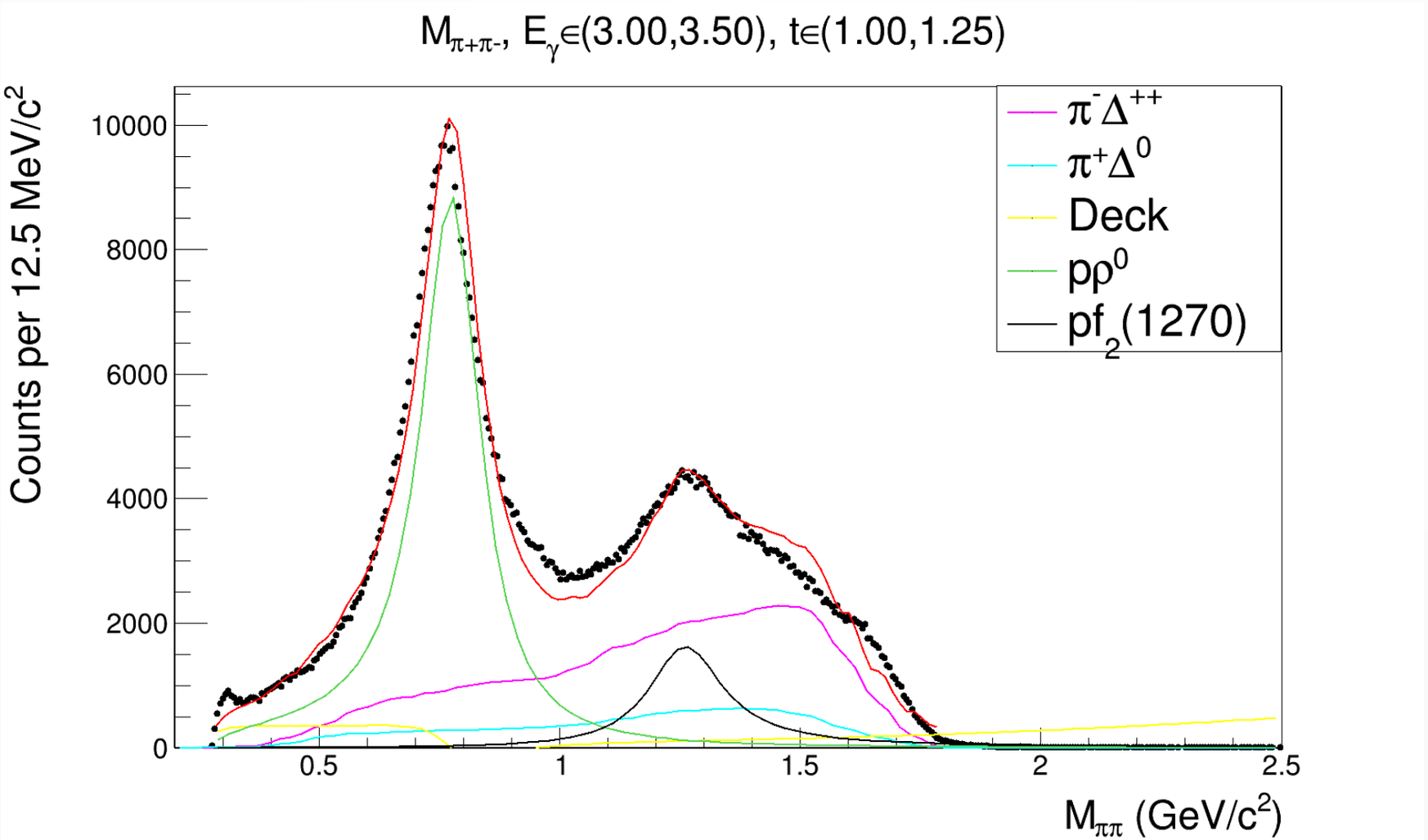
Missing $P_{p\pi+} = P_{beam} + P_{target} - P_p - P_{\pi+}$

$(\text{Missing } P_{p\pi+})^2 \rightarrow MM^2_{p\pi+}$

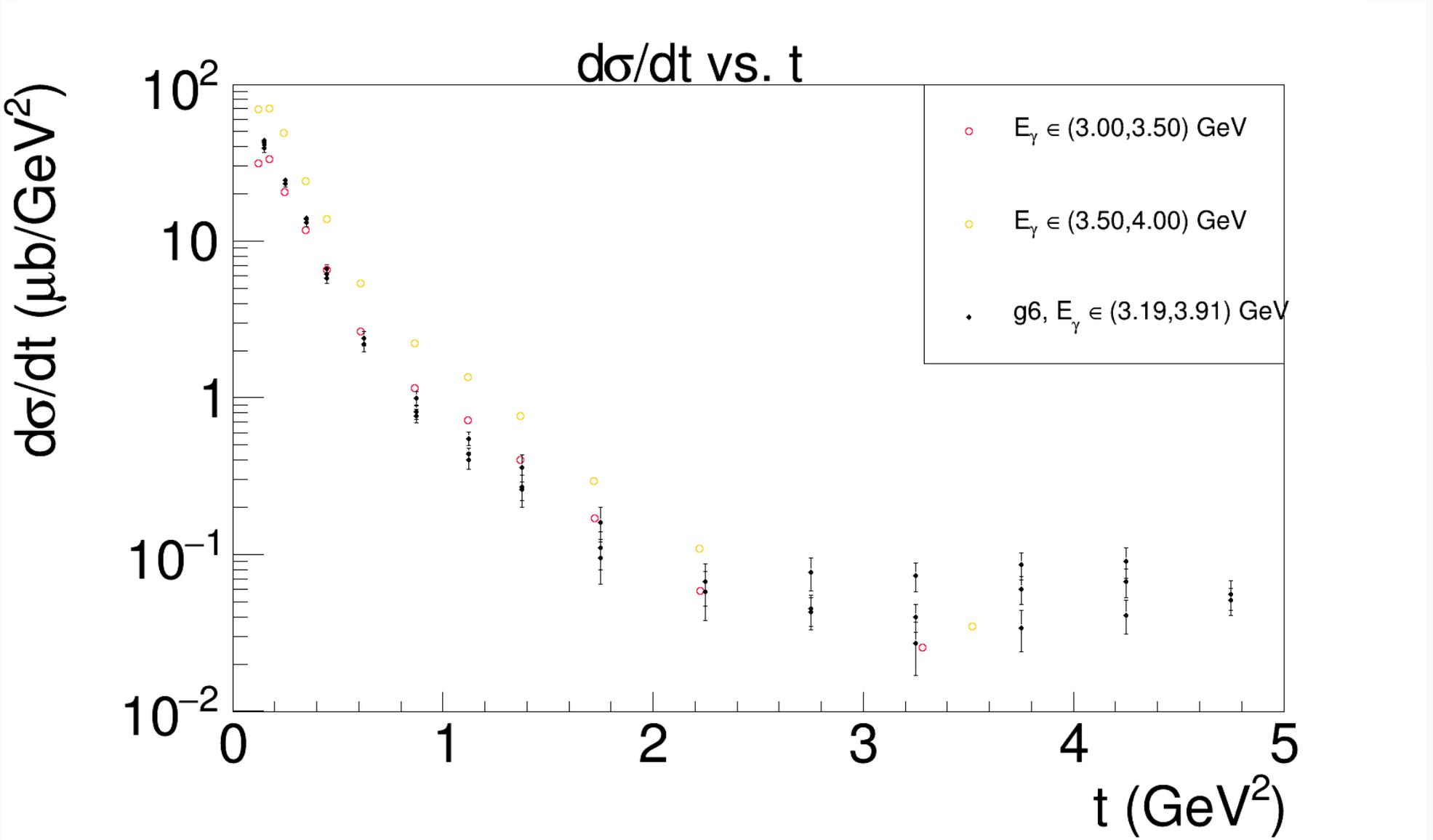
Keep $MM^2_{p\pi+}$ events between -0.1 and 0.15 GeV^2/c^4



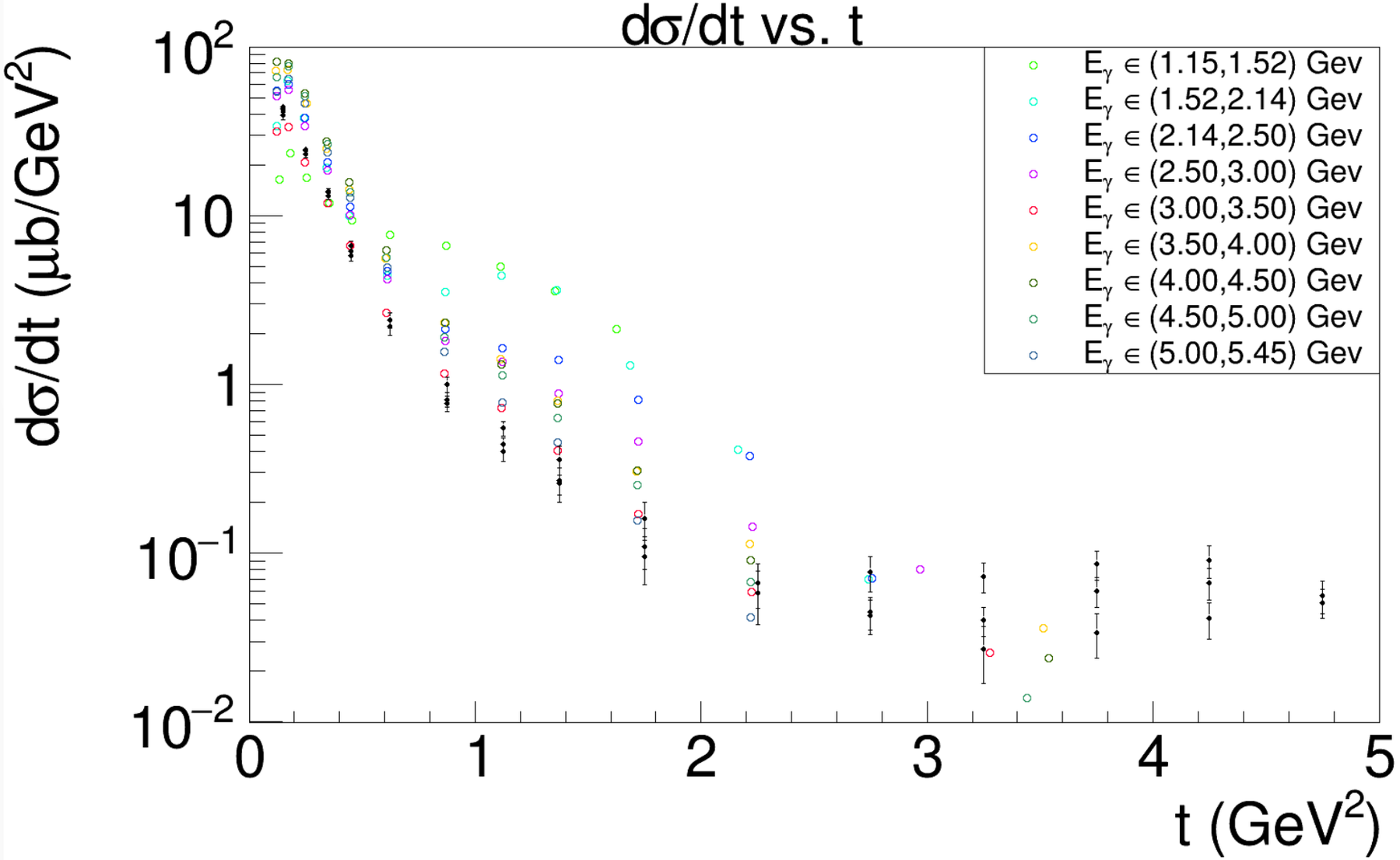
Yield Estimation



Differential Cross Section



Differential Cross Section



Summary and Outlook

- Need many more simulated events
  - larger -t range
  - $p\rho^0 \rightarrow$ efficiency
  - $\pi\Delta(1232) \rightarrow$ background
- Get covariance matrices
  - Kinematic fitting (better π^- id)
- Uncertainties
  - Statistical
  - Systematic