

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 ($\theta^{\text{CM}} < 90^\circ$); modeled by versions of Regge theory

High $|t|$, high s :

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

Basic Regge Theory

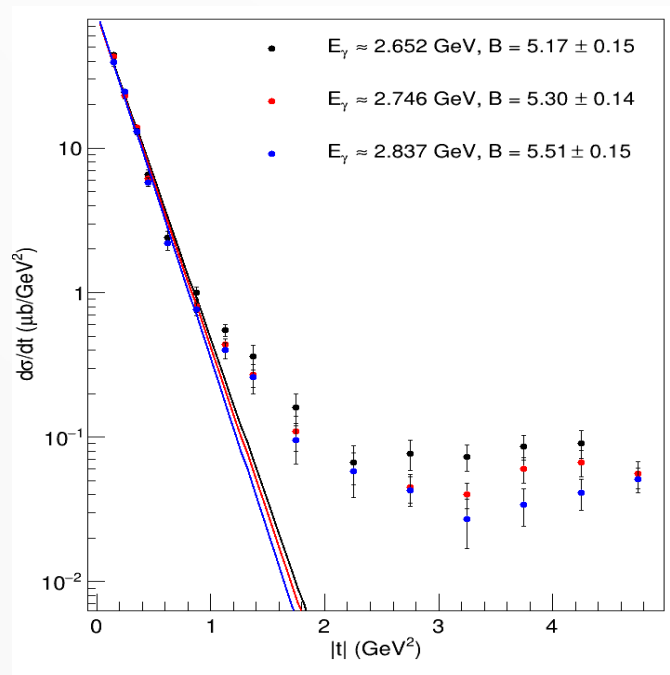
Regge theory $\rightarrow$ t-channel exchange of **families** of particles (“Reggeons”)

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

B is sensitive to exchanged Reggeon

$\alpha(t) = \alpha(0) + \alpha'|t| \rightarrow$ spin of Reggeon (“Regge Trajectory”)

$B = 2\alpha'\ln(s/s_0) \rightarrow$ t-slope



Data published by
(M. Battaglieri et al.
2001) [1]

Basic Regge Theory

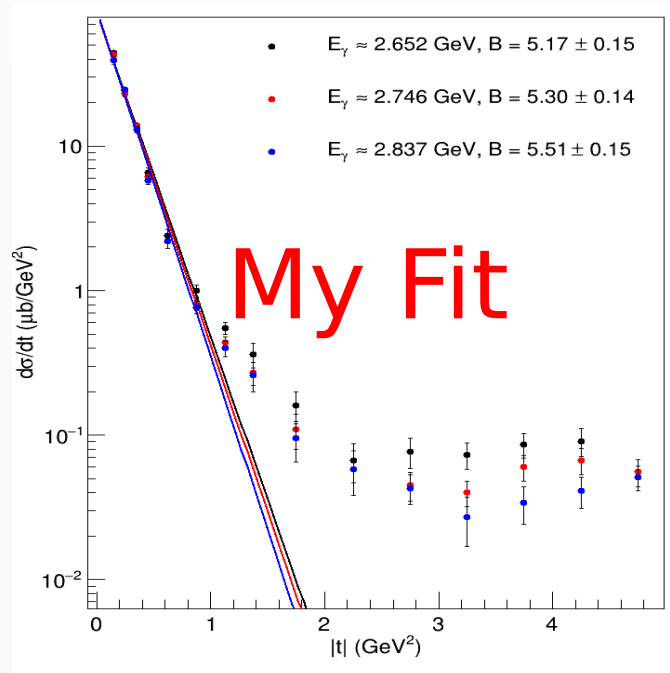
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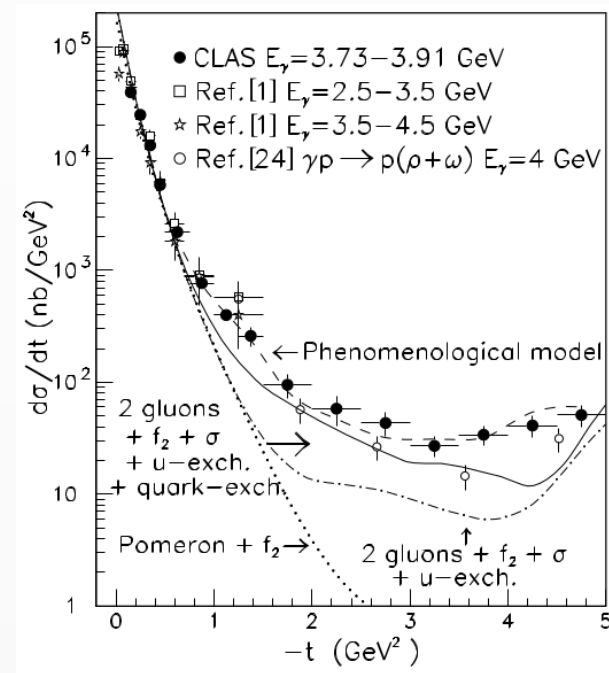
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Plot pulled from (M. Battaglieri
et al. 2001) [1]

Constituent Counting Rule

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

n : total number of elementary fields

For $\gamma p \rightarrow V p$, $n = 1+3+2+3 = 9$

$\rightarrow d\sigma/dt \sim s^{-7}$

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CCR inconsistent with VM
photoproduction experimental data:

ρ : s^{-8} (M. Battaglieri *et al.* 2001)

Need more ρ data!

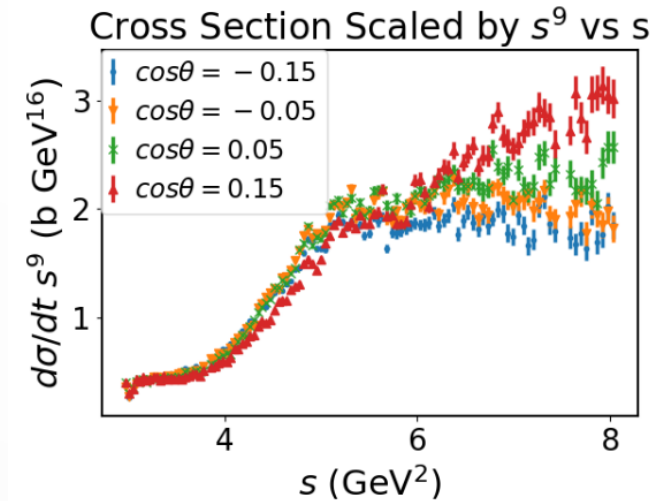
ω :

$s^{-7.2}$ (M. Battaglieri *et al.* 2003)

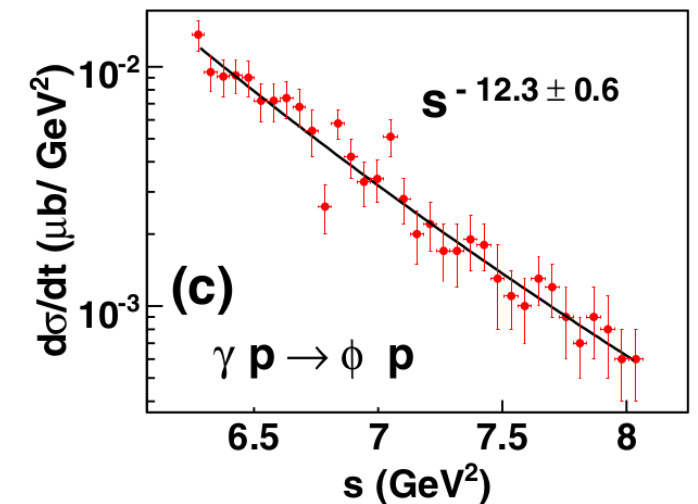
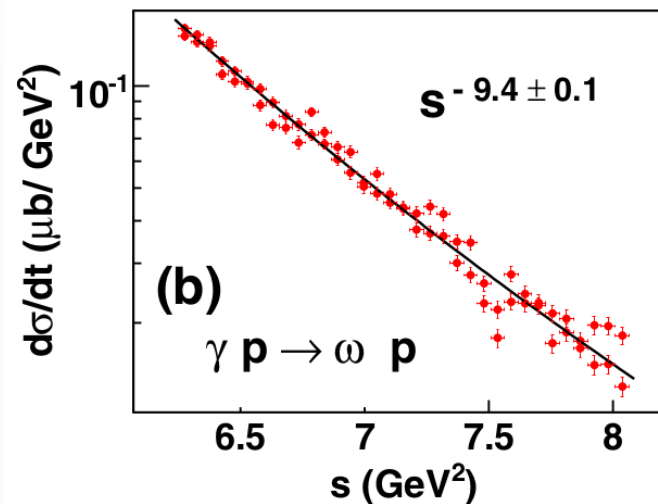
$s^{-9.4}$ (B. Dey 2014)

$s^{-9.08}$ (T. Reed *et al.* 2020)

φ : s^{-12} (B. Dey 2014)



From (T. Reed *et al.* 2020) [2]



From (B. Dey 2014) [3]

Objectives:

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

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

CLAS6 at Jefferson Lab

Thomas Jefferson National Accelerator Facility

Located in Newport News, VA

Four halls: A, B, C, D (new)

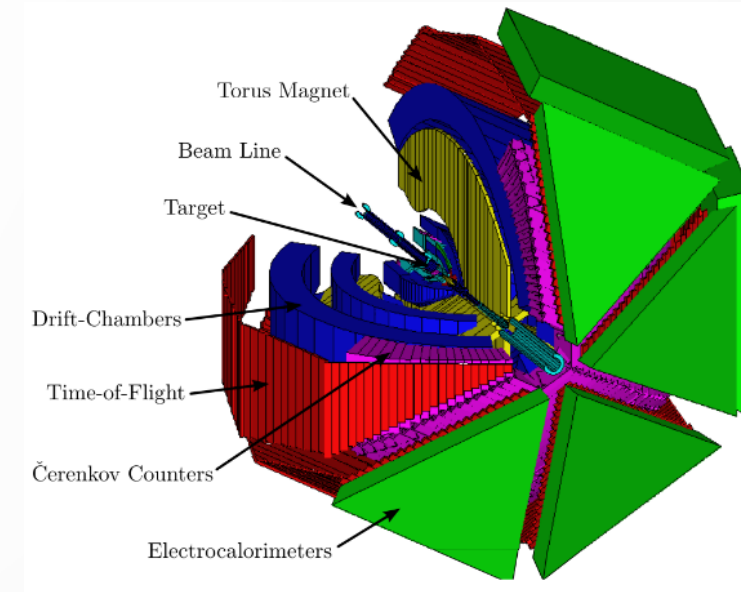
CEBAF: accelerated electrons up to 6 GeV

CLAS housed in Hall B

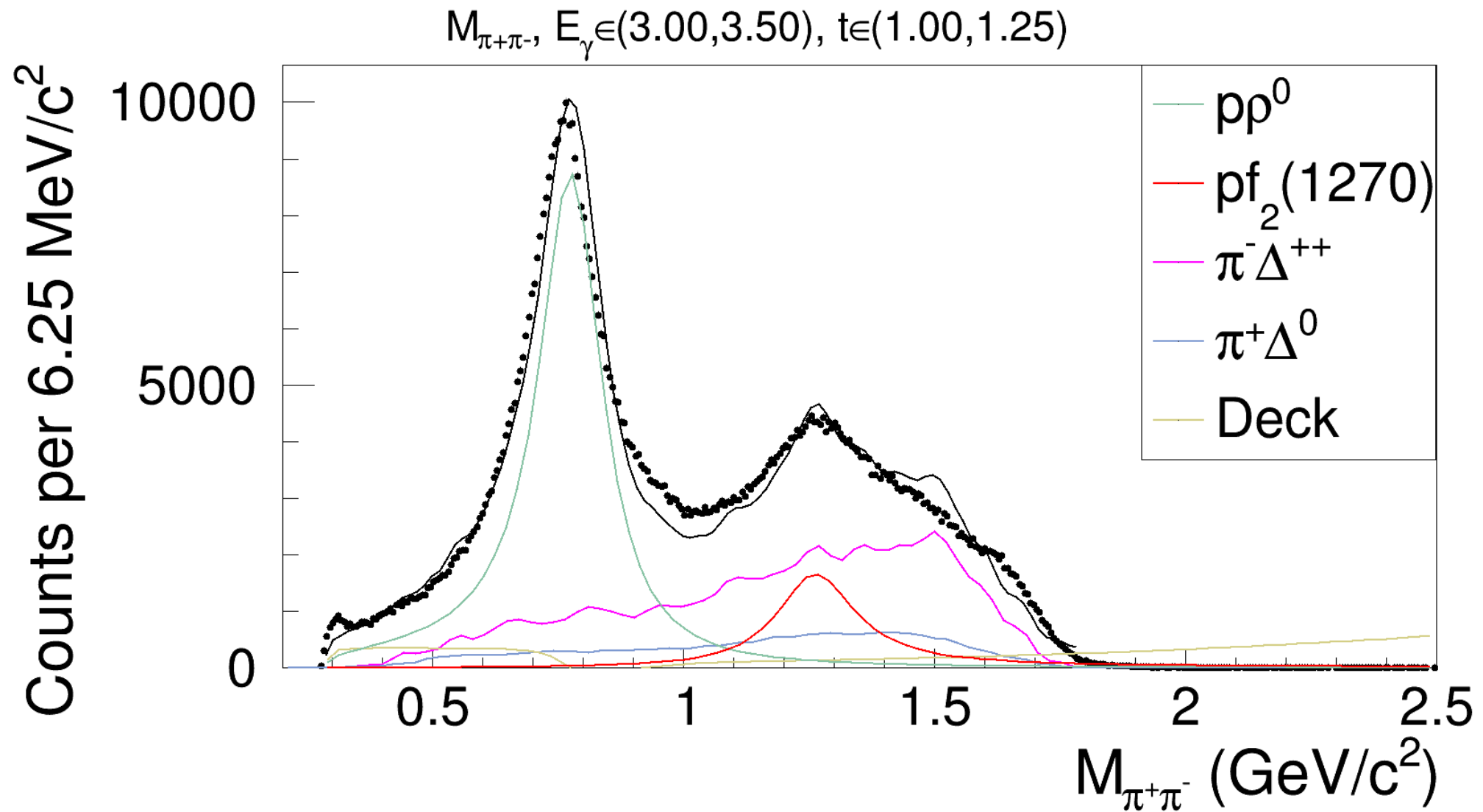
Data from g12 run period (Apr 2008 to Jun 2008)

Photon beam with energies up to 5.7 GeV

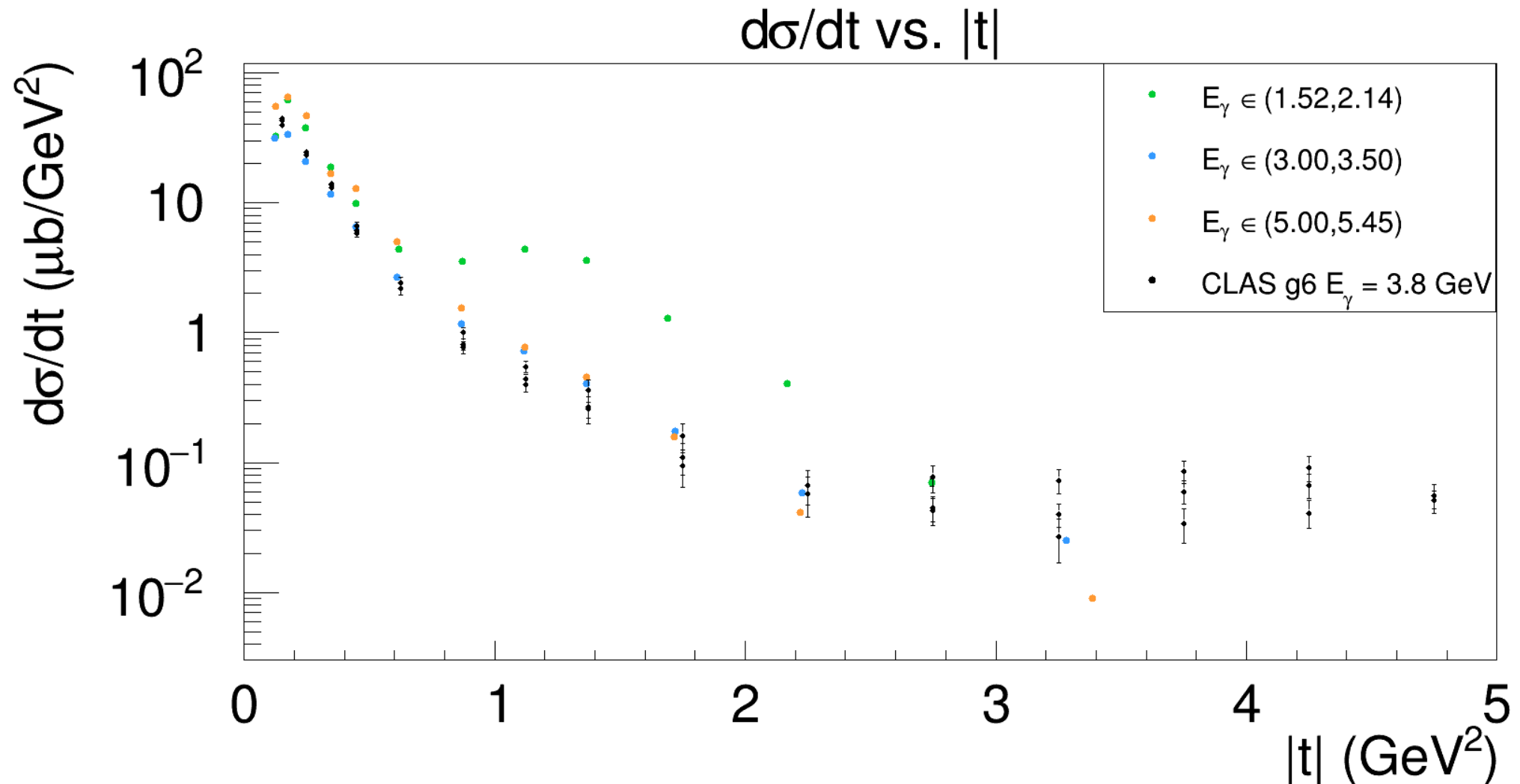
40 cm long ℓH_2 target



Yield Estimation



Differential Cross Section



Summary and Outlook

Must modify event generators

- $p\bar{p}$: more realistic efficiency
 $d\sigma/dt \rightarrow \text{weight generator} \rightarrow \text{efficiency} \rightarrow d\sigma/dt \rightarrow \dots$
- $\pi\Delta(1232)$: decay angular distributions + many more events

Need systematic uncertainties

References

- [1] Battaglieri, M. et al. "Photoproduction of the rho Meson on the Proton at Large Momentum Transfer." Phys. Rev. Lett. 87, no. 17 (2001): 172002, doi: 10.1103/PhysRevLett.87.172002.

- [2] Reed, Trevor et al. "Constituent counting rule and ω photoproduction." Phys. Rev. C 103, no. 6 (2021): 065203, doi: 10.1103/PhysRevC.103.065203

- [3] Dey, Biplab. "Scaling behavior in exclusive meson photoproduction from Jefferson Lab at large momentum transfers"