High t Rates

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SRC/CT Daily Analysis Meeting

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Reproducing the proposal's back-of-the-envelope numbers

All numbers will be in terms of "Events per calendar day (50% live)."

$$N = \sigma \cdot \frac{A}{2} \cdot A^{-\frac{1}{3}} \cdot F \cdot \rho \cdot \epsilon \cdot t$$

- $F = 2{\times}10^{7}$ photons / s
- $\epsilon = 0.64$
- $t = 43{,}200\ s$
- $\rho_d = 1.5 \times 10^{24}$ deuterium nuclei / cm^2
- $\rho_{He} = 5.7 \times 10^{23}$ helium nuclei / cm^2

$$N_d = \sigma \cdot\ 6.6{\times}10^{35}\ \mathrm{cm}^{-2} = \sigma \cdot 6.6{\times}10^{2}\ nb^{-1}$$
$$N_{He} = \sigma \cdot 4.0{\times}10^{35}\ \mathrm{cm}^{-2} = \sigma \cdot 4.0{\times}10^{2}\ nb^{-1}$$

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Cross section model for $n(\gamma, \pi^-)p$

For a stationary neutron:

$$\frac{d\sigma}{d\cos\theta_{cm}} = 2.5\times10^7 nb\ GeV^{12} \cdot k_{cm}k'_{cm}s^7(1-\cos\theta_{cm})^{-5}(1+cos\theta_{cm})^{-4}$$

We have different ways to handle nucleon motion:

- **Ignore it**, treat all nucleons as stationary
- **Maria's model** (Meson mom. set by s, boost from CM frame)
- **Our generator's model** (Pair decay function, constrained E*)

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I now can run some version of the original code!

Proposal Figure for Deuterium

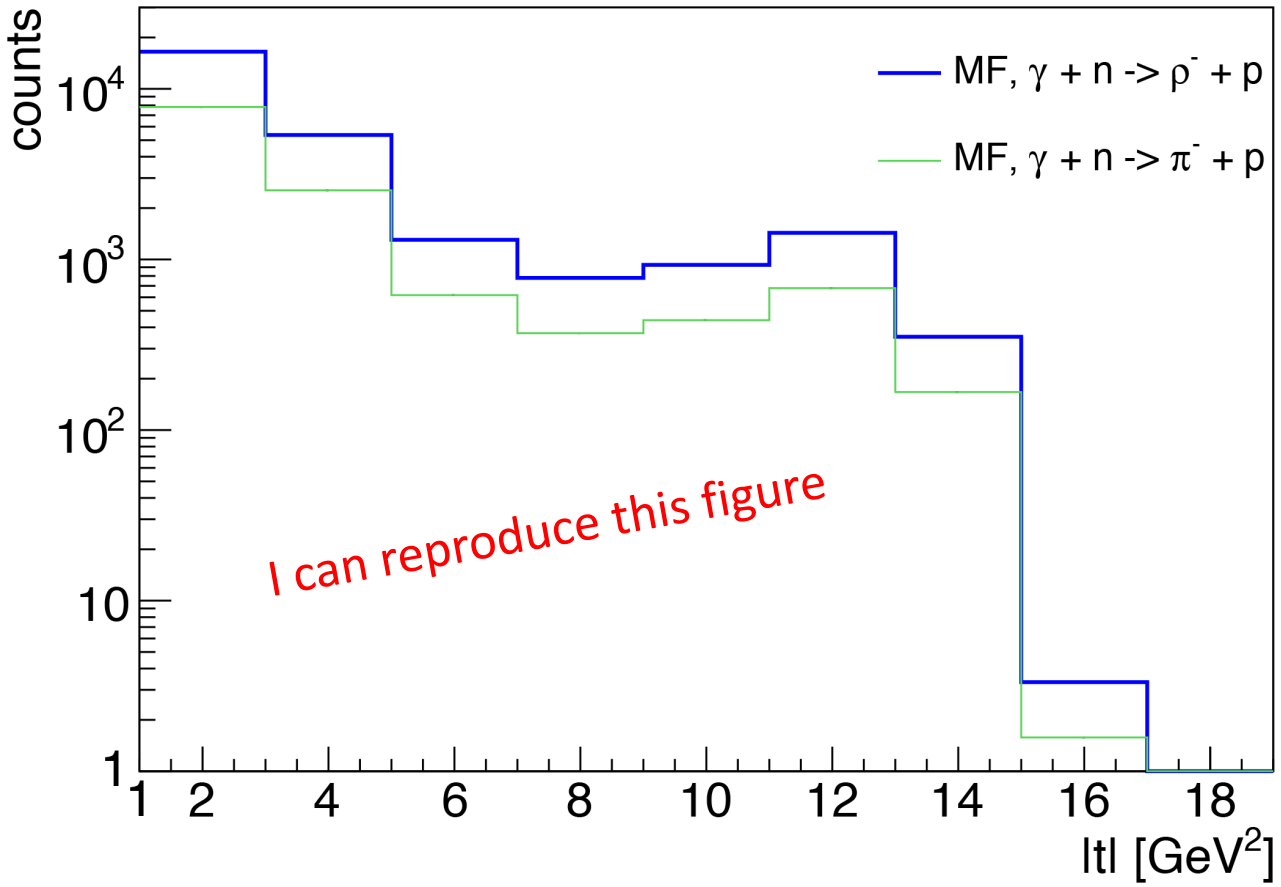
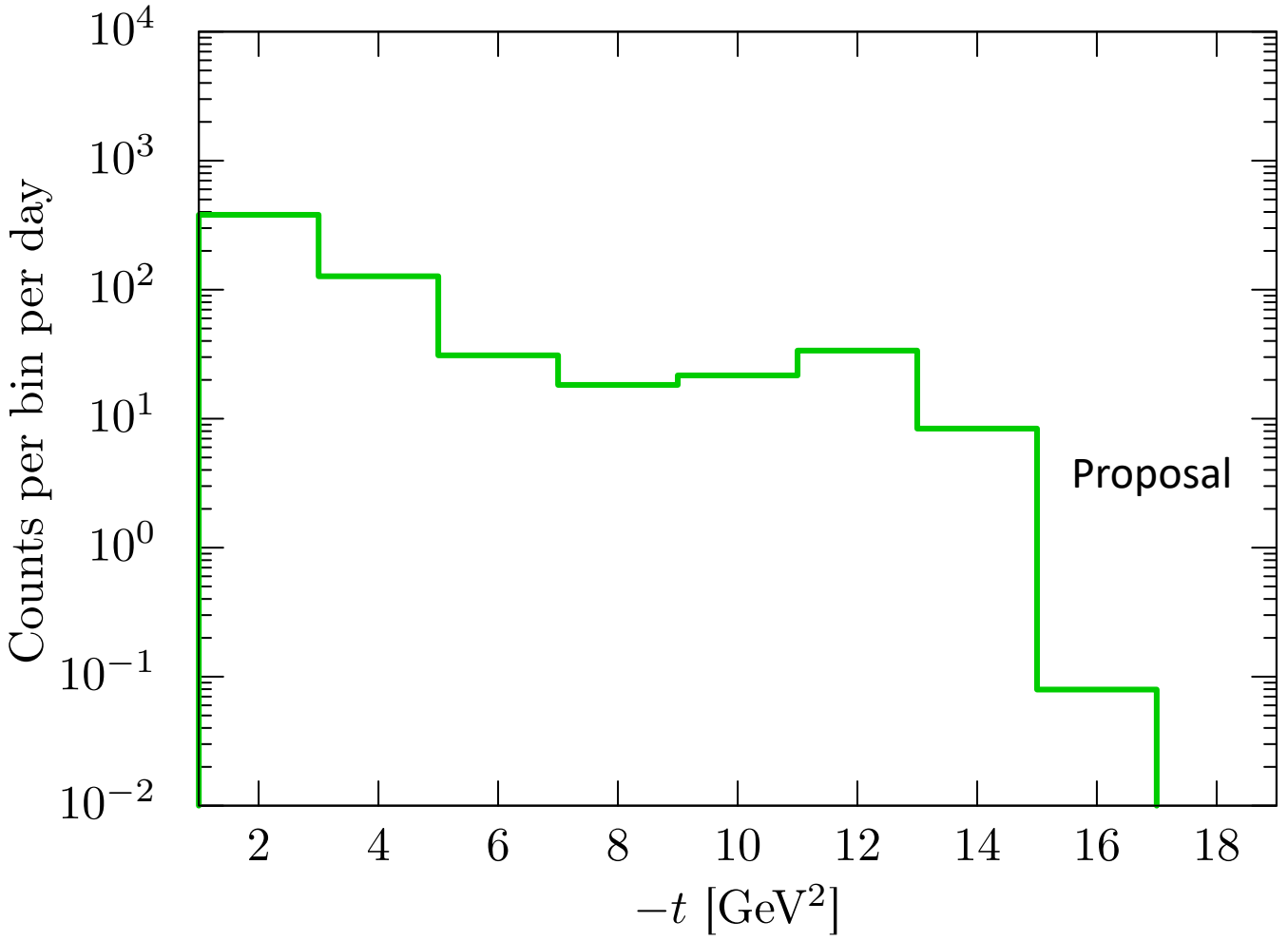
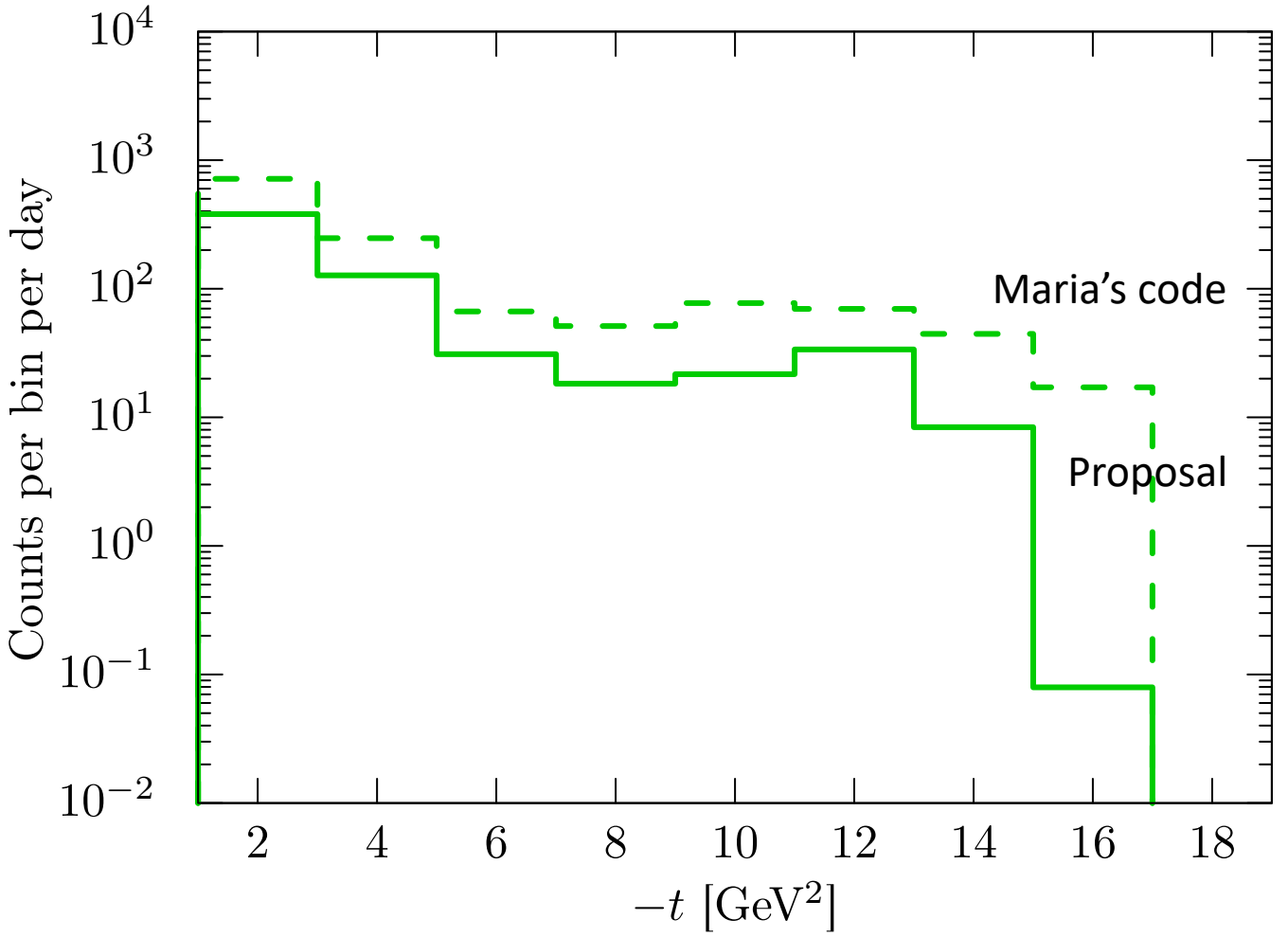


Figure 24: The expected count rate for 10 days running as a function of |t| for Deuterium

Proposal Figure for Deuterium



Proposal Figure for Deuterium



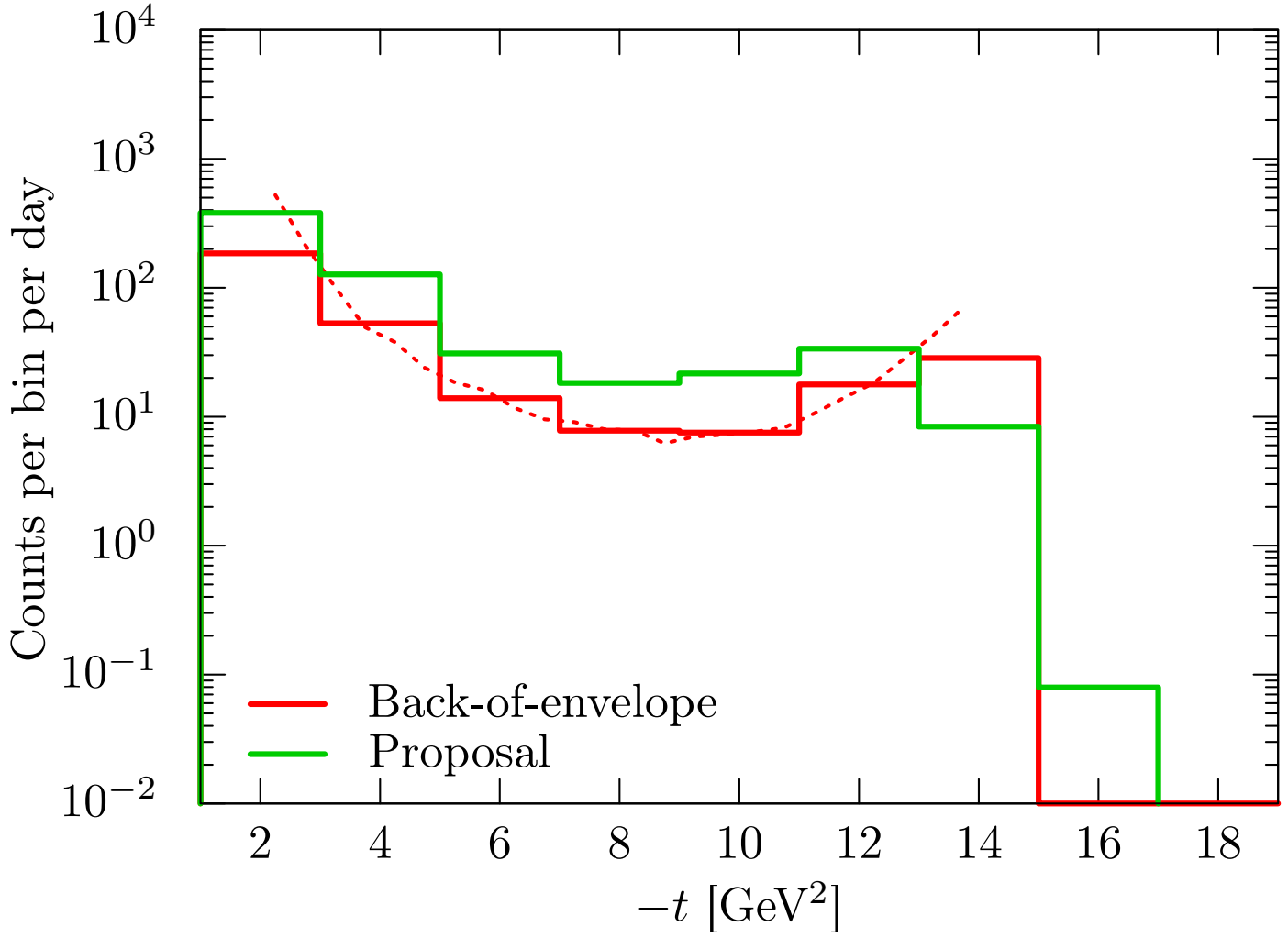
(from github, dated Aug. 2018)

Conditions for this plot:

- Fixed 9 GeV beam
- $p_{miss} < 0.25$ GeV
- $|t| > 2$ GeV
- $|u| > 2$ GeV
- $40^\circ < \theta_{CM} < 140^\circ$

Remaining factor is too small to care about.

Comparing to back-of-the-envelope



Back-of-envelope:

- $E_{beam} = 9$ GeV
- $|t| > 2$ GeV
- $|u| > 2$ GeV

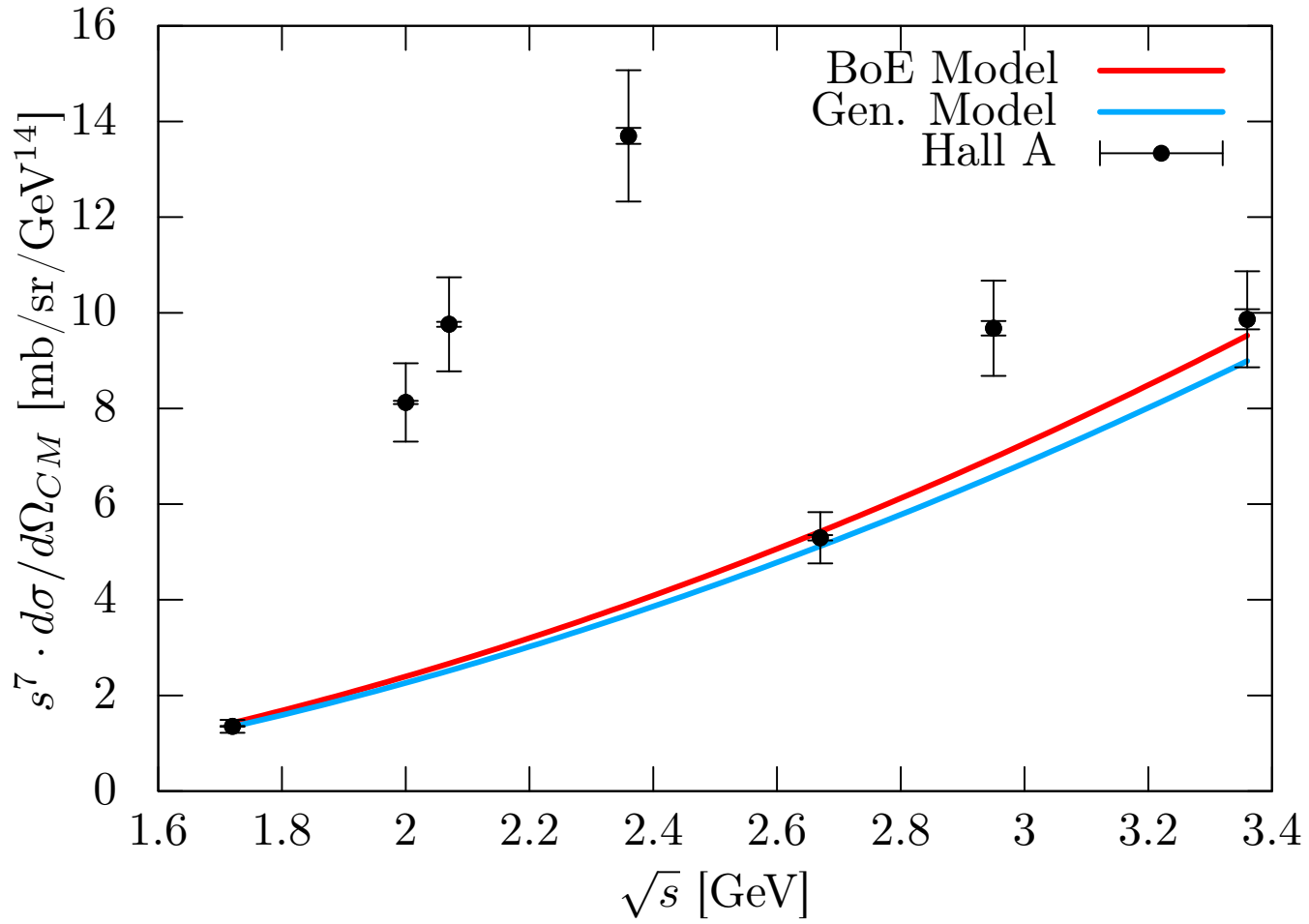
Proposal:

- $E_{beam} = 9$ GeV
- $|t| > 2$ GeV
- $|u| > 2$ GeV
- $p_{miss} < 0.25$ GeV
- $40^\circ < \theta_{CM} < 140^\circ$

I would expect Proposal to fill in more due to Fermi motion.

Validating the Back-of-Envelope

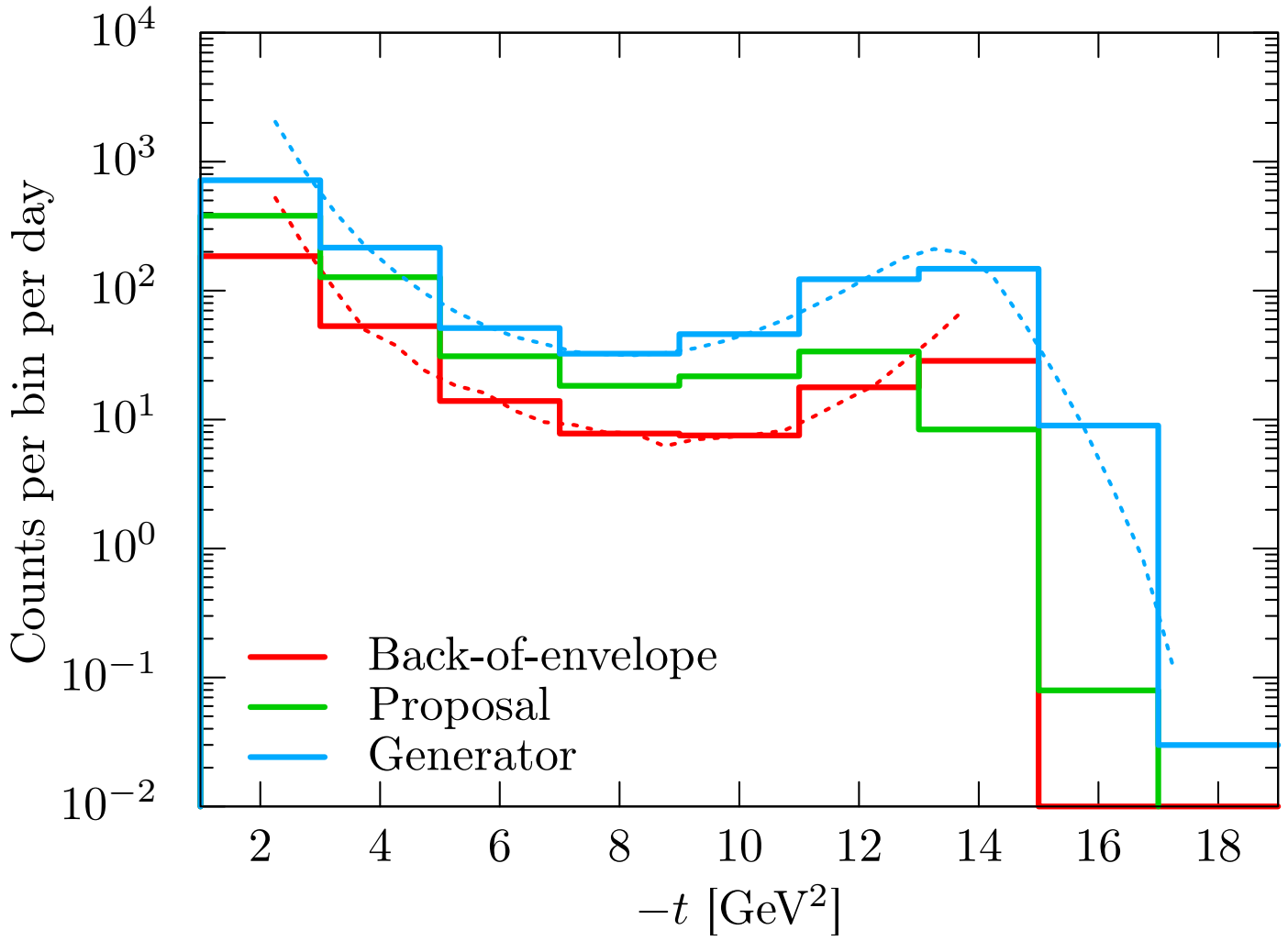
Hall A, L. Y. Zhu et al., PRC 71 044603 (2005)



Cross section at $\theta_{CM} = 90°$

No alarming factors.

Comparing to Generator



Back-of-envelope:

- $E_{beam} = 9$ GeV
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- $|u| > 2$ GeV

Proposal and Generator

- $E_{beam} = 9$ GeV
- $|t| > 2$ GeV
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- $p_{miss} < 0.25$ GeV
- $40^\circ < \theta_{CM} < 140^\circ$

Comparing Generator to Data

Some caveats:

- I'm assuming nominal proposal flux, 50% running efficiency
- I'm using an outdated energy spectrum (real coherent edge is slightly lower)
- I'm not using Geant, just generator output

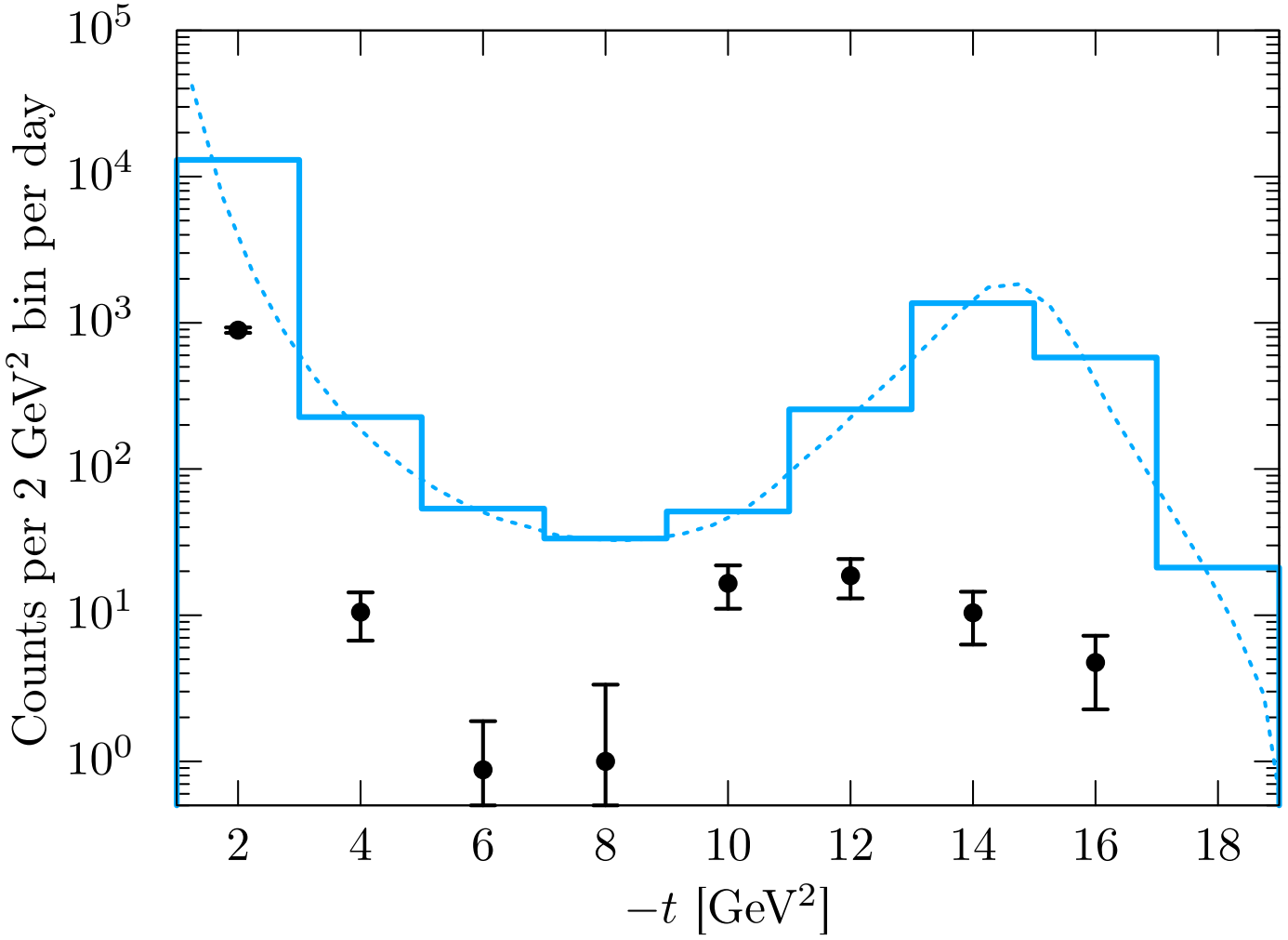
Cuts common to data, GCF

- $|t| > 2$ GeV
- $|u| > 2$ GeV
- $k_{miss} < 0.25$ GeV
- $\theta_p > 2^{\circ}$
- $E_\pi + E_p > 7$ GeV
- $E_\gamma > 6\ GeV$

Luminosity assumptions for the GCF:

- 2E7 photons / s in 8–9 GeV
  - (37% of our simulated spectrum)

Comparing Generator to Data



π^- generator run for Deuterium

ρ^- Data from Jackson

Rough list of problems with this study

- Generator doesn't have a ρ^- cross section model
  - We've assumed same as ρ^0 in the past, but that's not compatible with our data.
- Didn't pass events through GlueX Geant
- No experimentally determined flux
- Beam energy spectrum is not completely accurate
- Trigger efficiency?
- Reconstruction efficiency?