ep->Yp and backward production Monte Carlo production readiness

Spencer Klein with Zach Sweger

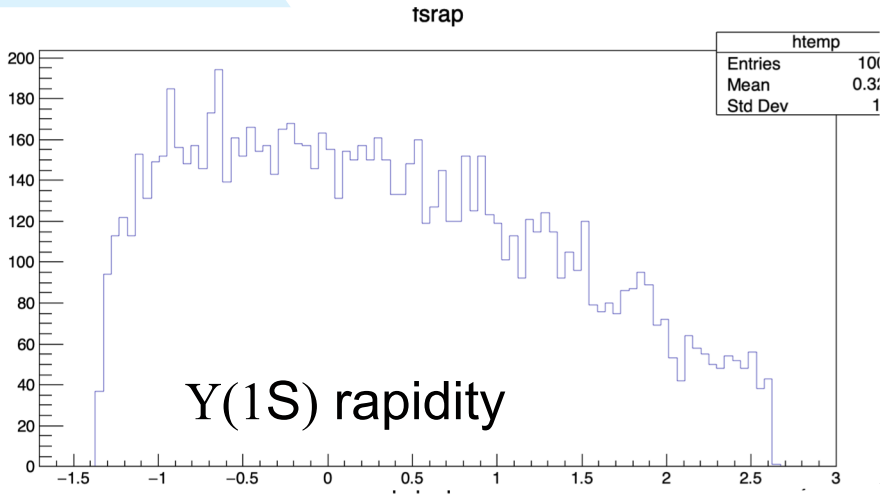
- Upsilon
  - Proposed productions
  - Some plots
- Backward production
  - Proposed productions
  - Some plots from Zach's EICUG Early Career talk
  - An open questions

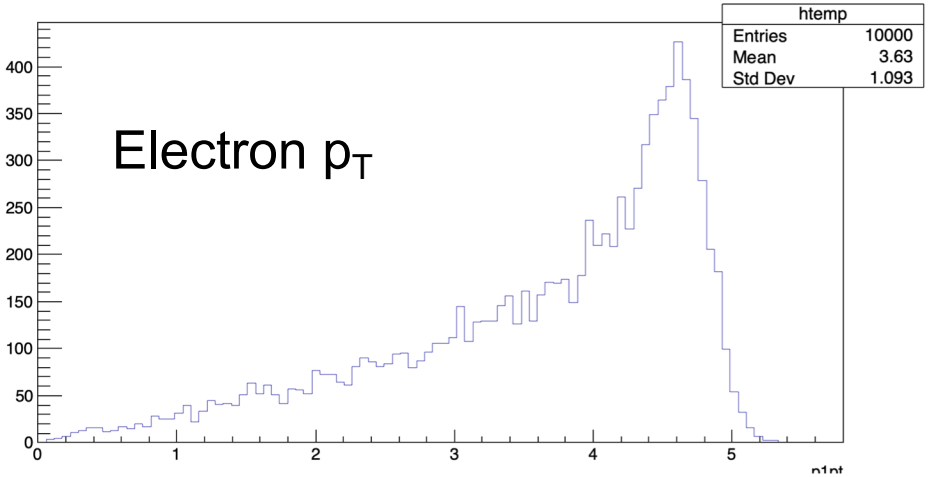
Υ production

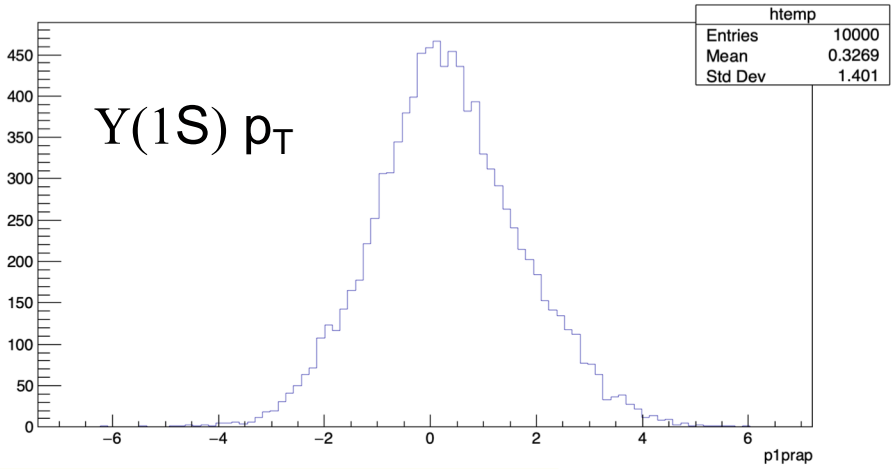
- Need Υ(1S) Υ(2S) and Υ(3S) to show peak separation
- Only make sense at maximum ep energy
- Original plan ee and $\mu\mu$ final states.
  - Given compressed time scale simplify to just ee?
- Cover full Q^2 range, but with a reasonable number of events
  - Cross-section falls rapidly with increasing Q^2
  - Simulate in two ranges
    - $Q_{min}^2 < Q^2 < 1$ GeV^2
    - 1 GeV^2 < Q^2 < 5 GeV^2
    - Not much cross-section left at higher Q^2
- 50,000 events over full rapidity (Bjorken-x) range/combination
  - Acceptance and momentum resolution drops at large |y| (large/small Bjorken-x)
  - Higher Q^2 run could be smaller
- 6/12 runs combinations (3 peaks/1-2 final states/2 Q^2 ranges)

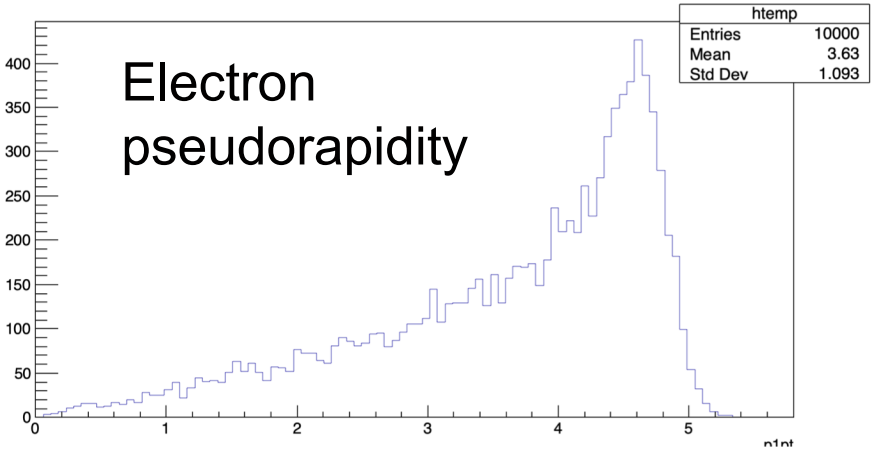
Plots from an Υ(1S) eSTARlight test run

- Not using HEPMC3 format – this needs checking
- 10,000 events









Backward production of $\omega \rightarrow \pi^0\gamma \rightarrow 3\gamma$

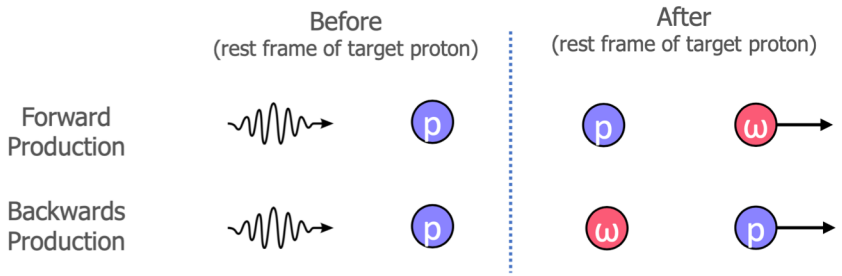
- Backward production goes in the far-forward region
  - Lower beam energies move production toward central region
  - Proposal: study lowest beam energies 5 GeV e on 41 GeV p
  - Could also consider 10 GeV on 100 GeV.
- Same Q^2 ranges as U
  - If things get tight, could drop higher Q^2 range, since extrapolation is very iffy there
- Single assumption about ω helicity:
  - s-channel helicity conservation or isotropic?
- 50,000 events/combination
  - 2 combinations (different Q^2 ranges)

Backward/ u-channel production model

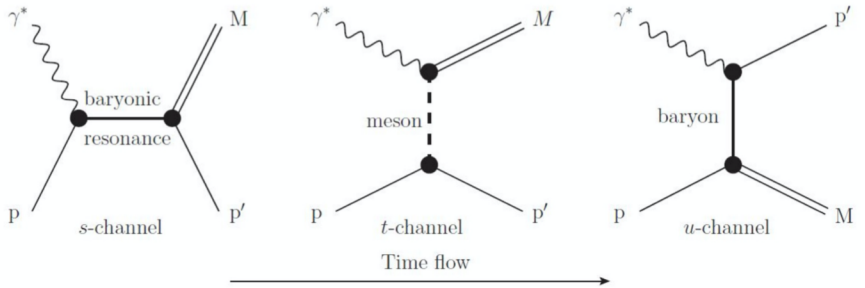
- Mandelstaam u is small t is large
  - Target proton and meson switch places
  - Baryon is stopped, like in heavy-ion collisions

$$\frac{d\sigma}{dt} \sim e^{-Bt} \longrightarrow \frac{d\sigma}{du} \sim e^{-Cu}$$

- Parameterized fixed-target data
  - Same Q2 evolution as forward production
  - Final state polarization unclear
    - S-channel helicity conservation?
- Rate ~ 1% of forward production
- Implemented in eSTARlight



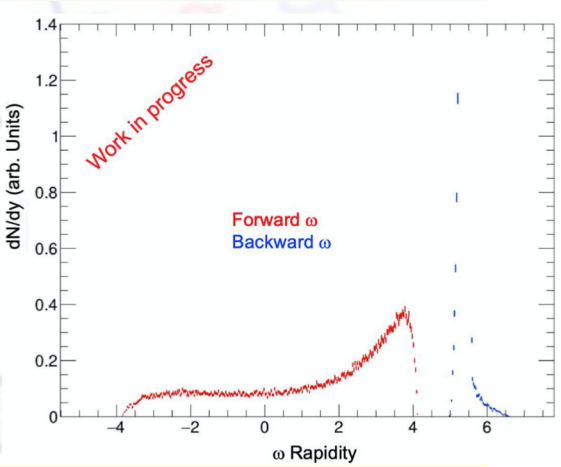
$$|t| = |(p'_N - p_N)^2| \qquad |u| = |(p_M - p_N)^2|$$

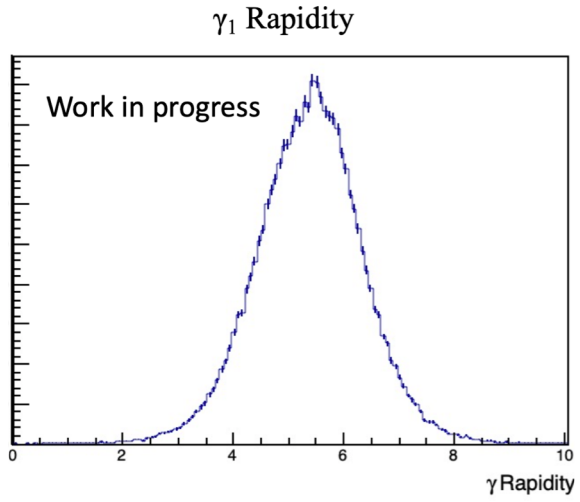


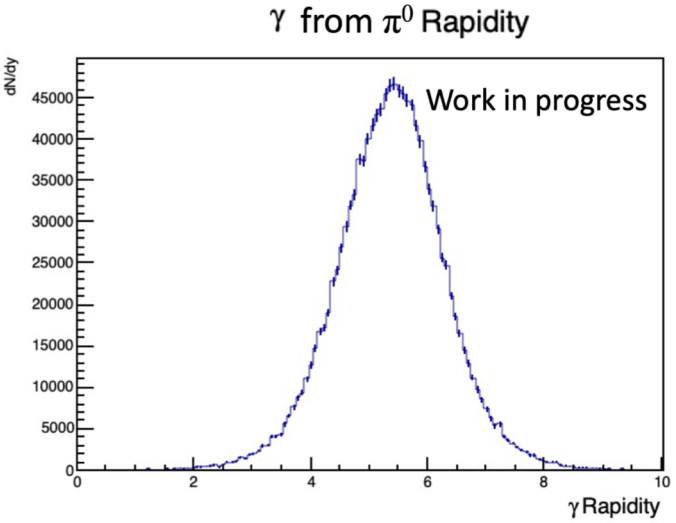
Contributions to VM production from Mandelstam variables. Wenliang (Bill) Li (William and Mary). GPD Workshop at Stony Brook University

eSTARlight backward/u-channel distributions

- 18 GeV e on 100 GeV p
- ep-> epω -> ep$\pi^0\gamma$-> epp$\gamma\gamma\gamma$
- Challenges forward calorimetry
  - Reducing energy to 5 GeV on 41 GeV will shift particles to lower rapidity







From Zach Sweger's EICUG Early Career Wkshp talk

Bonus slide – vector meson Monte Carlo comparison

- Wednesday discussion with Markus Diefenthaler on Tuesday
- This is getting started
- List of channels will take input from ATHENA and ECCE golden channels
- MC owners will produce samples in HEPMC3 format
  - This is faster than having the comparison group generate their own samples, using containers, but may lose some control/reproducibility