Introduction

When a high energy particle beam hits a target, the data determines the internal structure of the particle. Double Deeply Virtual Compton Scattering (DDVCS) aims to expand Generalized Parton Distributions (GPDs), currently the most detailed structure function.

Motivation

The GPDs rely on the virtual photon $pQ^2$ and $Q'^2$, the nucleon $p_t$, Bjorken $x$, and angles; $\theta_{CM}$, $\xi_{CM}$, and $\xi_L$. Two motivations incentivize our study into DDVCS, the ability to extrapolate new GPDs and potential universality. In DDVCS, $\xi \neq \pm \xi'$, which decouples $x$ and $\xi$. This region provides new ideas about nuclear forces and parton densities. Current theories expect GPDs to be universal for all scattering experiments, but there is no experimental proof. DDVCS reactions have the ability to compare GPDs in spacelike and timelike regions to assess the validity of the universality.

Method & Code

The DEEPGen Event Generator, which simulates DDVCS collisions, utilizes the following weights:

- $W_{tot}$: Proportional to measured events
- $W_{BH}$: Hard region (QED)
- $W_{DDVCS}$: Soft region (QCD)
- $W_{DDBH}$: $W_{DDVCS}/W_{BH}$: events with higher potential for physical interpretation
- FBSA: measures asymmetric polarization

These weights are normalized by $\sum (W_{x, \theta, \xi}/N_{TOT})$. The data was analyzed to explore the kinematic relationships of DDVCS collisions and GPDs. The kinematic angles are $\theta_{CM}$, $\xi_{CM}$, and $\xi_L$. While $\theta_{CM}$ and $\xi_{CM}$ (center of mass) are symmetric, $\xi_L$ (initial angle) showed asymmetric qualities that warrant future exploration.

Summary

- DDVCS accesses off the diagonal regions and studies the GPDs universalities.
- DEEPGen created events that were weighted and analyzed. Data analysis identified optimal events for interpretation and found limits of the experiment.
- Moving forward, opportunities for data analysis exist in the relationship between $x_{BJ}$ and the other 7 variables and accounting for angular corrections.

Results

- FIGURE 5: Finding physically interpretable events is vital. The spacelike-timelike events must be excluded because interpretations become difficult when $Q^2 = Q'^2$.
- FIGURE 6: $\xi$ and $\xi'$ gives us insight of how off the diagonal events can be measured. GPDs have been restricted by the diagonal $x=\pm \xi$. There are hand drawn cuts for $Q^2$ vs $Q'^2$ graphs.
- FIGURE 7: These graphs are restricted in terms of $t$ for valid approximations. Measuring $Q^2$ and $Q'^2$ is impossible, however, $Q^2$ and $Q'^2$ can be calculated and used to determine the structure of the proton.

Acknowledgements

We would like to thank our mentor Marie Boër, the National Science Foundation, and the Virginia Tech Center for Neutrino Physics. We acknowledge the outstanding support from the National Science Foundation, the Virginia Tech Physics department and the Virginia Tech Center for Neutrino Physics. This work was made possible by the National Science Foundation under grant No. PHY−2149165.

References

[1] Boër, Marie. "Double Deeply Virtual Compton Scattering: Jefferson Lab Hall C; Why?&quot;