

Tomographic Interpretations and Universality of Generalized Parton



Distribution with DDVCS

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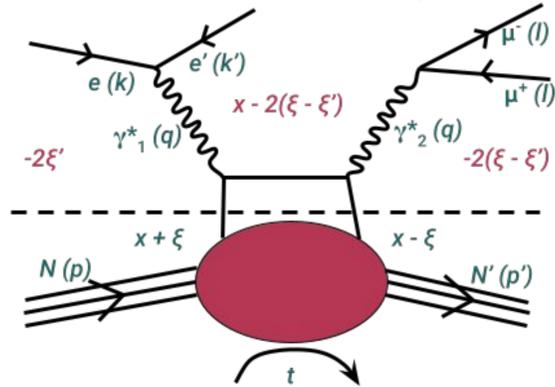
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Introduction

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.

Fig 1: DDVCS Reaction

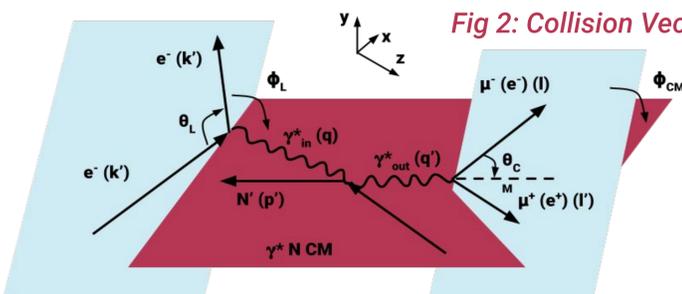


Motivation

The GDPs rely on the virtual photon p Q^2 and Q'^2 , the nucleon p t , bjorken x , and angles; $\theta_{CM'}$, $\phi_{CM'}$ and ϕ_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 ξ . 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.

Fig 2: Collision Vector



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 $\sum (W_x \Omega_x \mathcal{L} / N_{TOT})$. The data was analyzed to explore the kinematic relationships of DDVCS collisions and GPDs. The kinematic angles are $\theta_{CM'}$, $\phi_{CM'}$ and ϕ_L . While θ_{CM} and ϕ_{CM} (center of mass) are symmetric, ϕ_L (initial angle) showed asymmetric qualities that warrant future exploration.

```
if(tt < -0.55 and tt > -1.05){
  h_Cut3[1]->Fill(xi,xip);
  h_Cut3[2]->Fill(xi,xip, W_tot_unpol*PS);
  h_Cut3[3]->Fill(xi,xip, W_DDVC*PS);
  h_Cut3[4]->Fill(xi,xip, W_BH*PS);
  h_Cut3[5]->Fill(xi,xip, W_DDBH*PS);
  h_Cut3[6]->Fill(xi,xip, FBSA*PS);
}
if(tt < -0.55 and tt > -1.05){
  if(0.2 < xi and 0.25 > xi and -0.05 < xip
  and 0 > xip){
    h_QCut1[1]->Fill(Q2,Qp2);
    h_QCut1[2]->Fill(Q2,Qp2, W_tot_unpol*PS);
    h_QCut1[3]->Fill(Q2,Qp2, W_DDVC*PS);
    h_QCut1[4]->Fill(Q2,Qp2, W_BH*PS);
    h_QCut1[5]->Fill(Q2,Qp2, W_DDBH*PS);
    h_QCut1[6]->Fill(Q2,Qp2, FBSA*PS);
  }
}
```

Fig 3: Code Sample

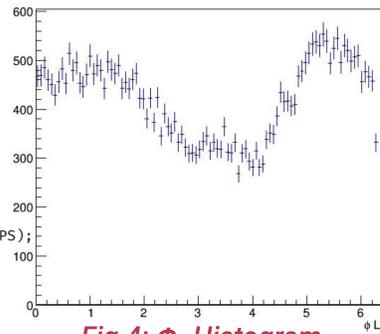


Fig 4: ϕ_L Histogram

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

Fig 7: Selection bins of Q^2 vs Q'^2

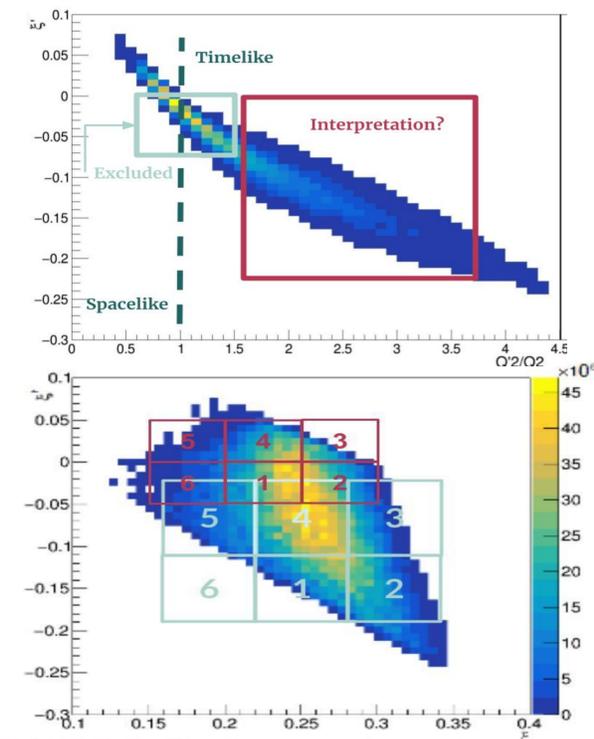
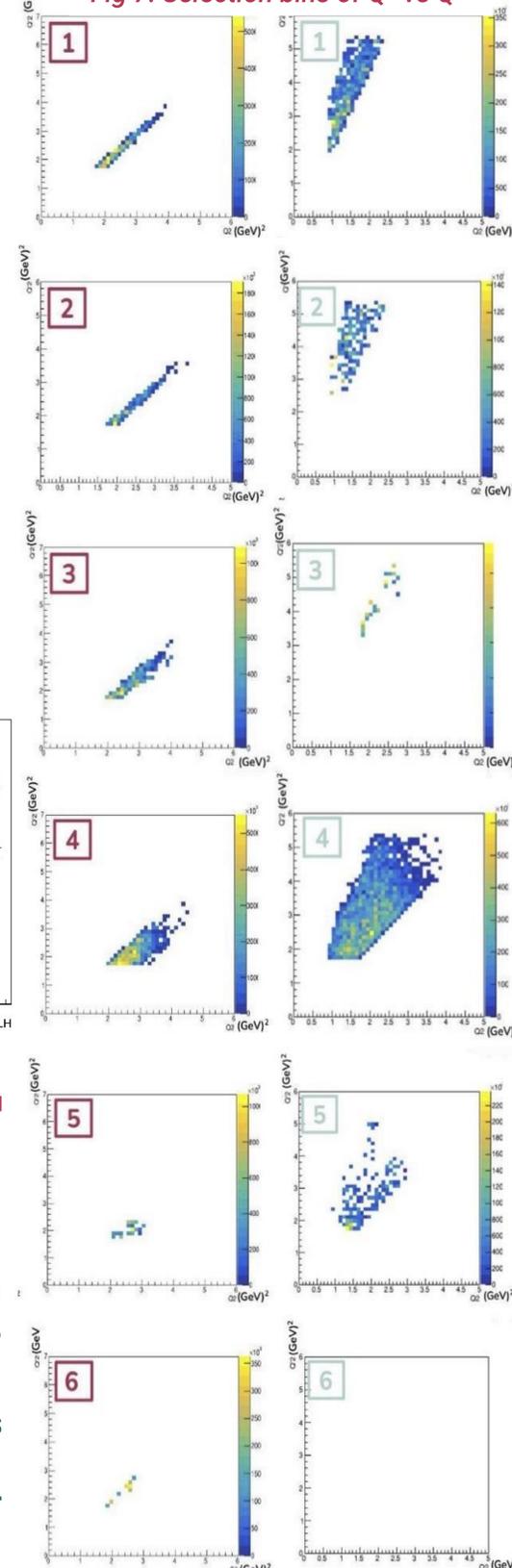


Fig 5: Excluding Events along Spacelike-Timelike Cut

Fig 6: ξ vs ξ' with Q^2 and Q'^2 binning

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: ξ and ξ' 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

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