

**Measurement of the Deeply Virtual Neutral Pion  
Electroproduction Cross Section at the Thomas  
Jefferson National Accelerator Facility at 10.6 GeV**

by

Robert Johnston

Submitted to the Department of Physics  
in partial fulfillment of the requirements for the degree of

Interdisciplinary PhD in Physics and Statistics

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2023

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**Abstract**

Deeply virtual exclusive reactions provide unique channels to study both transverse and longitudinal properties of the nucleon simultaneously, allowing for a 3D image of nucleon substructure. This presentation will discuss work towards extracting an absolute cross section for one such exclusive process, deeply virtual neutral pion production, using 10.6 GeV electron scattering data off a proton target from the CLAS12 experiment in Jefferson Lab Hall B . This measurement is important as exclusive meson production has unique access to the chiral odd GPDs, and is also a background for other exclusive processes such as DVCS, making the determination of this cross section crucial for other exclusive analyses.

Thesis Supervisor: Richard Milner  
Title: Professor of Physics

# Acknowledgments

To Be Completed. Currently this will serve as a to-do list:

- input list of figures

- input list of tables

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# Chapter 1

## Introduction

### 1.1 Background - Structure of the Proton

Understanding the structure of matter has been a fundamental research pursuit for centuries.

Proton not a point mass - it has structure

### 1.2 Deeply Virtual Neutral Pion Production

#### 1.2.1 The Handbag Approach

#### 1.2.2 The Goloskokov-Kroll Model

#### 1.2.3 Status of Measurements

#### 1.2.4 Analysis Overview

Hi ([Bedlinskiy et al., 2014](#)) see more in section [1.1](#) just a test





# References

Bedlinskiy, I., Kubarovsky, V., Niccolai, S., Stoler, P., Adhikari, K. P., Anderson, M. D., . . . Zonta, I. (2014). Exclusive  $\pi^0$  electroproduction at  $w > 2$  gev with clas. *Physical Review C - Nuclear Physics*, 90. Retrieved from <https://arxiv.org/pdf/1405.0988.pdf> doi: 10.1103/PhysRevC.90.025205



# Appendix A

## A.1 Full Cross Section Data

To be completed



# Appendix B

## B.1 Cross check between Andrey Kim and Bobby Johnston

As an additional cross check, Bobby calculated a  $DV\pi^0P$  beam spin asymmetry and compared to Andrey Kim's results. This check will not comment on any acceptance, luminosity, or virtual photon flux factor calculations, but does validate exclusive event selection criteria. By examining figure [B-1](#) we can see that agreement is reasonable, especially considering Bobby's calculation does not have sideband subtraction included.

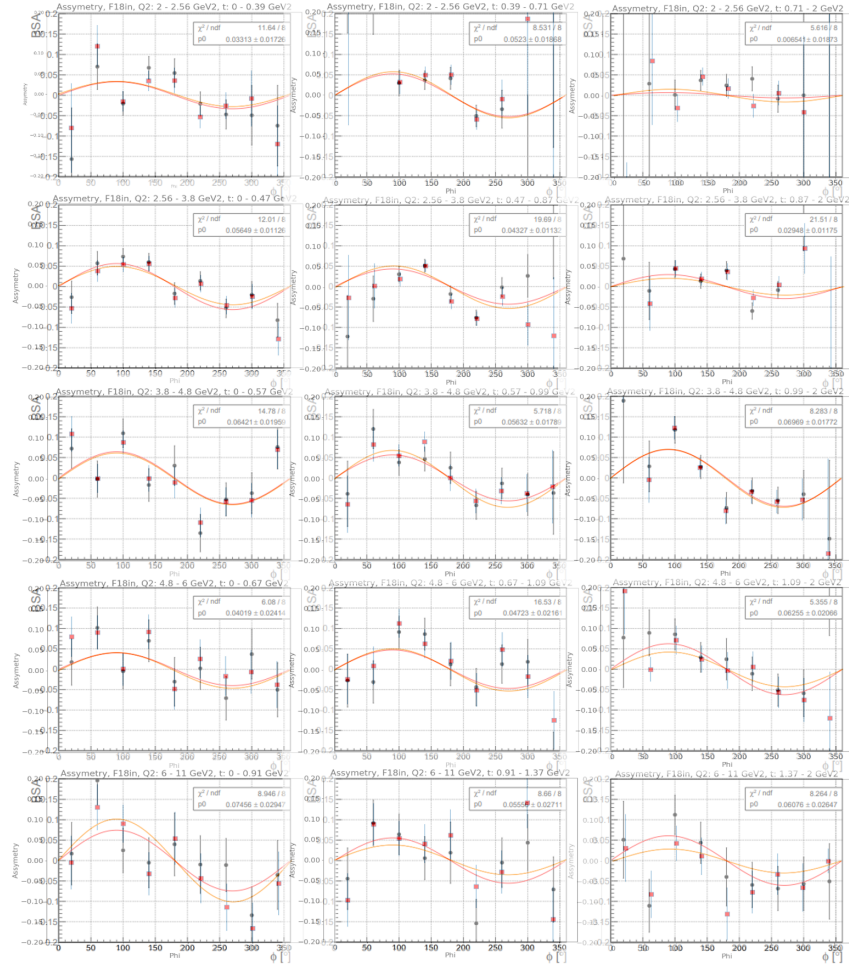


Figure B-1: Overlay comparison of Andrey Kim's results (black datapoints, red fit line) and Bobby's results (red datapoints, orange fit line).