PROBING PARTON DISTRIBUTIONS IN PROTON WITH CHARMONIUM PRODUCTION WITH 120 GEV PROTON BEAM AT FERMILAB

BY

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DISSERTATION

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Abstract

E906/SeaQuest is a fixed-target experiment at Fermilab with a 120 GeV proton beam. Muon pairs with mass between 2 to 9 GeV from the interaction of proton beam with various targets has been detected. The primary goal of the experiment is to study the partonic structure of the nucleon. In particular, the charmonium production data can be used to probe both the quark content as well as the gluon content. The preliminary result from the analysis of the SeaQuest charmonium production data will be presented. E1039/SpinQuest is a follow up experiment of SeaQuest. By utilizing a transversely polarized target, we could extend this study to the transverse momentum distribution of the partons.

To Father and Mother.

Acknowledgments

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Chapter 1

Introduction

1.1 Deep Inelastic Scattering

1.2 Parton Model

1.3 Drell-Yan Process

1.4 Charmonium Production

Chapter 2

SeaQuest Experiment

2.1 Introduction

SeaQuest is a fixed-target experiment utilizing the 120 GeV proton beam from the Fermilab Main Injector. Details of the SeaQuest spectrometer can be found in Ref. [1]. A schematics of the spectrometer is shown in Fig. 2.1. The target system consists of seven interchangeable targets, including a flask with liquid hydrogen, a flask with liquid deuterium, an empty flask (vacuum), solid carbon, iron, and tungsten targets as well as a space with no target (air). The targets are interchanged periodically to reduce systematic uncertainties in the measured cross section ratios for different targets.

The spectrometer consists of two magnets and four tracking stations. FMag, placed 104 cm downstream the target, is a 5 m solid iron magnet that acts as the beam dump as well as a focusing magnet. It is then followed by the first tracking stations. Stations 1, 2 and 3 each consists of plastic scintillator hodoscopes and drift chambers. An open air dipole magnet (KMag) is placed between station 1 and station 2. The vertical magnetic field from both magnets bends the muons horizontally, allowing the measurement of the momentum of the muons. Downstream of station 3, there is a 1 m iron wall acting as a hadron absorber. Station 4 is located behind the hadron absorber and acts as a muon identifier. Station 4 consists of a hodoscope array and 4 layers of proportional tube planes. Tracks that pass through the hadron absorber and produce hits on station 4 are assumed to be from muons.

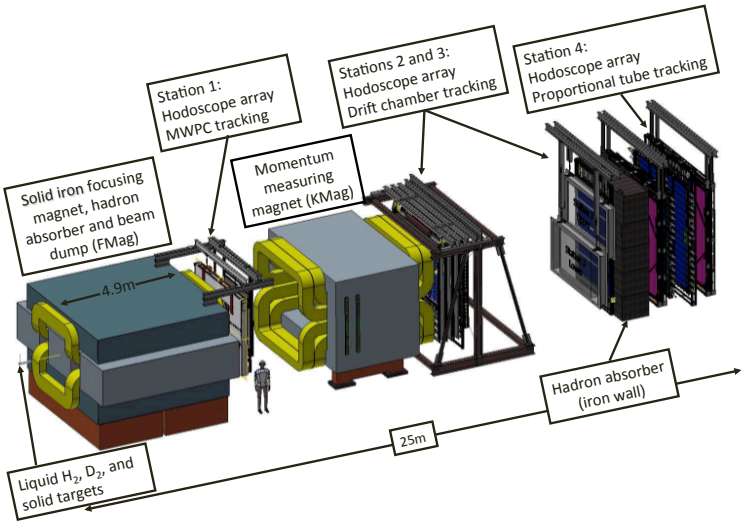

Figure 2.1: schematics of the SeaQuest spectrometer. Taken from Ref. [1]

Chapter 3

Analysis

3.1 Data Sets

3.2 Track Reconstruction

3.3 Event Selection

3.4 Intensity Extrapolation

3.5 Mass Spectrum Fitting

Chapter 4

Results

4.1 Drell-Yan Cross Section Ratio

4.1.1 $\bar{d}/\bar{u}$ in proton

4.2 Charmonium Cross Section

4.2.1 Nuclear Dependence

Chapter 5

SpinQuest Experiment

Chapter 6

Conclusions

We conclude that graduate students like coffee.

References

[1] C. A. Aidala et al., "The SeaQuest spectrometer at Fermilab", Nucl. Instrum. Methods Phys. Res., Sect. A **930**, 49 (2019).

Appendix A

An appendix

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