

UNIVERSITY OF CALIFORNIA  
RIVERSIDE

Measurement of the Longitudinal Single Spin Asymmetry,  $A_L$ , for Polarized  
Proton-Proton Collisions in the  $W \rightarrow \mu$  decay channel

A Dissertation submitted in partial satisfaction  
of the requirements for the degree of

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in

Physics

by

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The Dissertation of Michael J. Beaumier is approved:

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In no particular order now, but say something nice about each person.

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Some say that it takes a village to raise a child. The same can be said of raising a graduate student up to earning a PhD. This thesis is dedicated to the multitude who have helped me become the man I am today, and to students who struggle, and their mentors who do not give up on them.

## ABSTRACT OF THE DISSERTATION

Measurement of the Longitudinal Single Spin Asymmetry,  $A_L$ , for Polarized  
Proton-Proton Collisions in the  $W \rightarrow \mu$  decay channel

by

Michael J. Beaumier

Doctor of Philosophy, Graduate Program in Physics  
University of California, Riverside, August 2016  
Professor Kenneth Barish, Chairperson

This thesis discusses the process of extracting information about the spin structure of protons, specifically, spin contributions from the sea of quarks and antiquarks, which are kinematically distinct from the 'valence quarks'. We have known since the 'proton-spin crisis' **REFERENCE NEEDED** of the 1990s that proton spin does not entirely reside in the valence quarks, so the thrust of experimental efforts since then have been designed to determine both how to probe the proton spin structure, and how to validate models for proton spin structure. Here, I discuss one particular approach to understanding the sea-quark spin contribution, which utilizes the production of real  $W$ -bosons, and the  $W$  coupling with polarized spin structure in the proton sea, as produced from polarized protons collisions. Only one of the colliding protons is longitudinally spin polarized, in this analysis, and they are collided at an energy of  $500\text{GeV}$ . The experimental observable used is referred to as " $A_L$ " which is expressed mathematically as a ratio of sums and differences of various helicity combinations of singly polarized interactions between two protons, i.e.  $p + p^{\rightarrow} \rightarrow W \rightarrow \mu + \nu$ . Once  $A_L$  has been experimentally measured, it can then be used to determine appropriate polarizations of proton sea-quarks, within a given uncertainty, if we write the cross-sections used in the calculation of  $A_L$  in terms of polarized parton distribution functions. Finally, this thesis will also include a discussion of my work experimentally determining the absolute luminosity of collisions at RHIC, which is needed as a normalization on any cross section used in the analysis. In particular, studying the cross section of the  $W$  interaction can help to validate our models for assigning a signal-to-background ratio to the  $W \rightarrow \mu$  events.



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