

Accomplishments During SURA Fellowship, Sept 07 - May 08

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Introduction

The span of my SURA fellowship spanned the fall semester of 2007 and the spring semester of 2008. During this time I was heavily involved in the preparation for the upcoming set of polarized ^3He target experiments at Jefferson Lab. The main focus of my research during this time included the following:

1. Designing and testing of a new 'oven' to contain the polarized ^3He cell while in beam
2. Development and improvement of both NMR and ERP polarimetry techniques to be used during the experiment.
3. Development and testing of a rapid spin flip process for the ^3He system.

Each of the above areas of research are explained in more detail in the following sections.

^3He Oven

During polarization, the top portion of the ^3He cell must be in an oven in order to vaporize the Rb and K contained in the cell. This is imperative, as the gas can not be polarized without the use of spin polarization transfer via the chain: $Rb \Rightarrow K \Rightarrow ^3\text{He}$. This has been the case for all past experiments that use this target - the twist is that we wanted to have the ability to polarize the target in all the coordinate directions. Complications arise due to the shape of the target cell, specifically, the 'pull-off' and 'transfer tube.' Furthermore, we must be able to get laser light into the top of the cell from each coordinate direction, while not interfering with the beams ability to cleanly traverse the target, or reducing detector acceptance. One can see that this presented quite a challenge. Over the course of more than a year, I worked closely with JLab designer and engineers to design and test several prototypes before finally settling on a final, successful design. Just recently, the oven has successfully been used in JLab experiments E06-010, E06-011 and E07-013. It is also currently in use in experiment E06-014. Finally, it will be used in the upcoming experiments E05-015, E08-005 and E05-102.

^3He Polarimetry

Both NMR and EPR have been in use in polarized 3 experiments for a long time, but we are always striving to make improvements. In a combined effort, myself and several other graduate students managed to make many improvements to the already successful polarized ^3He setup used at JLab. My main contribution was an improvement to the EPR set-up. A stronger EPR RF signal is delivered to the target cell by designing and implementing a design where the coil is actually INSIDE the target oven. The EPR technique relies on exciting a resonant transition in Rb. This transition is achieved by broadcasting an RF signal to the cell. The resulting 'D2' light that is received by the photodiode is very small, and it has always been a challenge to collect enough light to get a good signal. Since the power supplied by the coil to the cell falls off many fold with distance, it seemed the best solution was to come up with a design that allowed use to get the rf coil as close to the cell without introducing other interference. As a result, we are the FIRST ^3He experiment to be able to use EPR polarimetry with EASE, rather than the great difficulty that had been accepted as a given in the past.

Rapid Spin Flip

In order to form the asymmetries that our experiments aimed to measure, we had to flip the spin of the ^3He target. It is obvious that the shorter the time duration between flips, the better handle we have on systematic effects and false asymmetries due to the flip. However, there is an intrinsic polarization loss with each spin flip. A balance must be found such that we can flip the target spin with regularity, while preserving the overwhelming majority of our target polarization. Several tests were carried out in order to optimize the time duration between spin flips. It was found that a flip every 20 minutes allowed us to maintain a very high polarization. As a bonus, every time we flip the target polarization, we are able to get an NMR signal, resulting in a 'free' polarimetry measurement. We were the first experiment to implement this 'rapid' spin flip. The result was a wonderful systematic check combined with more polarization measurements per unit time than any other experiment in the past - all while preserving the quality of our target polarization.

Talks and Lectures

Friday, October 10th, 2008: "A Polarized ^3He Target System for Jefferson Lab"
Presented at SPIN 2008, University of Virginia

First Place in Jefferson Lab Poster Competition, 2007. Presented a poster on the physics of a Target Single Spin Asymmetry Measurement from Vertically Polarized ^3He .

Publications

Analysis is currently underway - publications to follow.

Travel

I used the travel funding provided by SURA to attend the APS April Meeting in St. Louis in April of 2008. All of the travel money was used. I am very grateful for this chance to attend my first major conference, as travel money is tight right now within our group, and I am currently behind another graduate student who has first priority to travel and present his thesis results. Attending the conference was an excellent opportunity to network with other scientists in my field, as well as spend several days exploring related areas of physics that I found interesting. My SINCERE thanks to JSA/SURA for providing me with this wonderful opportunity!