

Polarized He-3 Target Set Up

Hunter Duggin¹, Arun Tadepalli²

1. North Carolina State University Department of Physics, 2. Thomas Jefferson National Accelerator Facility

Abstract

He-3 is a strong candidate for a variety of effective polarized neutron experiments. The development of these targets was crucial in the G_E^n experiment (GEii) which ran in Hall A at Jefferson Lab in 2022. The development of the He-3 involves a circularly polarized laser beam hitting gaseous He-3 and exchanging spin information. Previously, the He-3 was polarized inside of Hall A, however, the equipment has since been dismantled and relocated. This motivates the setup of a target laboratory in the Experimental Equipment Lab (EEL) to begin the redevelopment of polarized He-3 targets. This work uses Helmholtz coils to induce a magnetic field on the gas and force the direction of polarization. Alkali-hybrid Spin-exchange optical pumping (AHSEOP) is discussed and its role in the creation of polarized He-3. The field in the target chamber is measured and plotted to showcase the setup's effectiveness. This new target lab is a feasible location to make polarized He-3 targets for future experiments.

Introduction

- Polarized He-3 is a convenient target because 90% of the atoms are in the antisymmetric S state (fig 1).
- We want to design high-performance He-3 targets using alkali-hybrid spin-exchange optical pumping (AHSEOP).

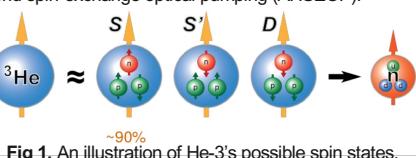


Fig 1. An illustration of He-3's possible spin states.

Methods

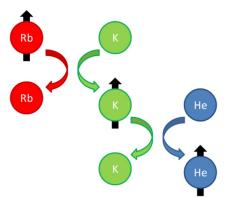


Fig 2 (left). High-density He-3 is placed into a cell with a Rb-K mixture. We can then use traditional SEOP techniques at 795 nm to transfer spin information through collisional mixing.

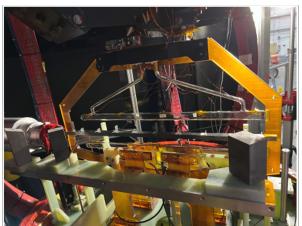


Fig 3 (right). Polarized target setup in Hall A. The laser is pumped through the glass tube while the bulb at the top is heated in an oven to induce convection. Originally, the targets were built in Hall A. This set up has since been moved to the EEL building.

Electronics

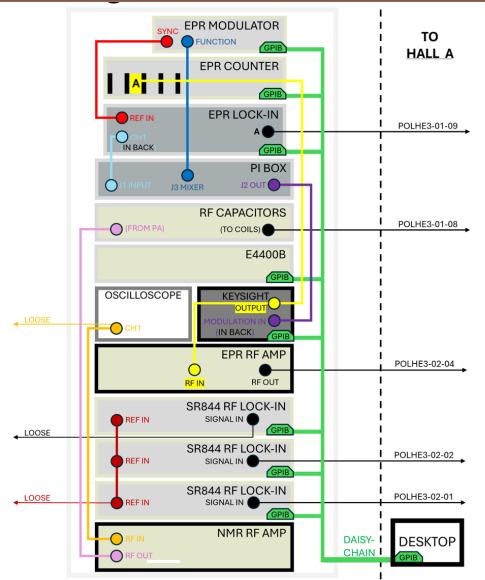


Fig 3. These electronics are used to induce the field that polarizes the atoms in a particular direction. There are also experimental probes for EPR and NMR.

Field Measurements

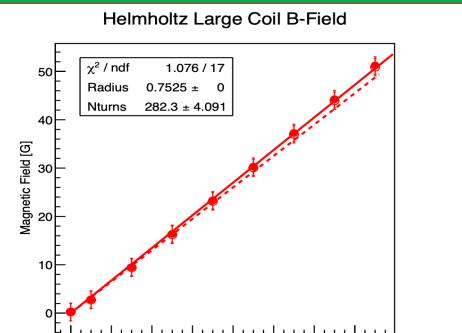


Fig 4. Magnetic field measurements read from the large Helmholtz coil. This image is taken from the previous setup in Hall A. Similar measurements were conducted for the set up in the EEL.

Helmholtz Coils



Fig 5. Helmholtz coils are used to induce the magnetic field. The coils were contaminated in the previous set-up, so we and RadCon cleaned them. This meant we all had to receive RadWorker II training.

Conclusion & Future Work

- The new polarized He-3 target lab is set up in the EEL building at Jefferson Lab.
- The lab uses laser light to polarize He-3 gas moving in a convection current, and Helmholtz coils induce the polarization.
- Targets need to be built in the lab to show its true effectiveness.
- These targets will be used to investigate the spin structure of the neutron.

References and Acknowledgements



I would like to acknowledge my mentor Arun Tadepalli, Lisa Surles-Law, Jalyn Dio, and the ESH & Q department for making this project possible. I could not have done it without any of these individuals. I would also like to thank the DOE SULI program coordinators for selecting me and funding this project.

References