Longitudinal Polarized Target for CLAS

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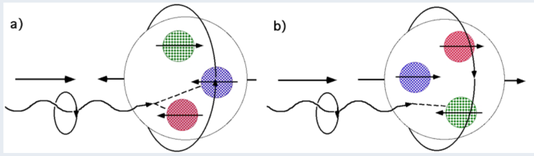
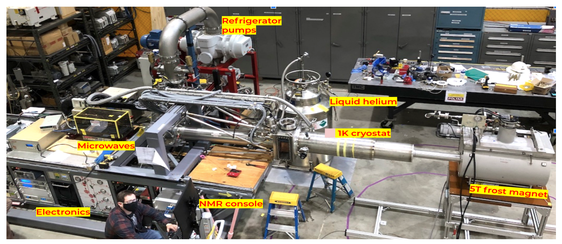
Objectives

- Study the spin structure of the nucleon through virtual photon asymmetries in inclusive and semi-inclusive deep inelastic scattering as well as deeply virtual compton scattering during Run Group C with CLAS12 in Hall B of Jefferson Lab.



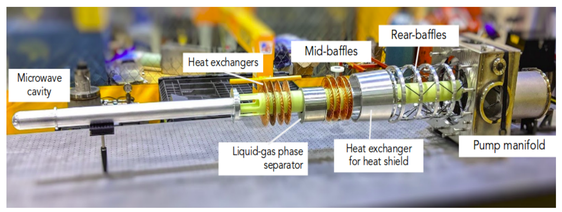
Introduction

A polarized target is an ensemble of particles with spin aligned in a given direction. For the experimental Run Group C, we are building a target of solid ammonia ($\mathbf{NH_3}$ and $\mathbf{ND_3}$), polarized at very low temperature along the beam direction using the high magnetic field of the CLAS12 solenoid. This "APOLLO" target is being built in the EEL building of Jefferson lab.

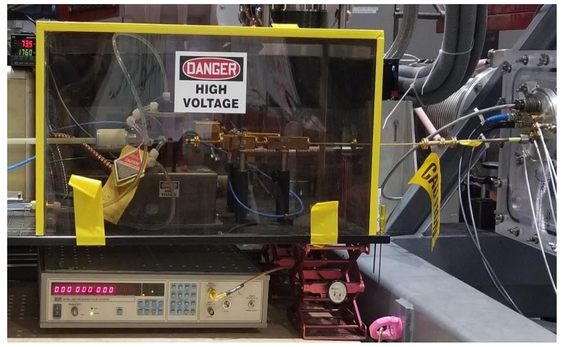


Components

- ^{4}He evaporation refrigerator cools the target sample to 1 K.

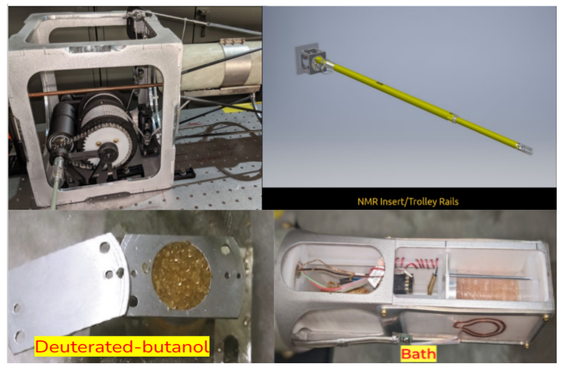


- Microwave Irradiation (140GHz):To increase the nuclear polarization, a microwave generator (EIO) is used to transfer the electron polarization to the nuclei.



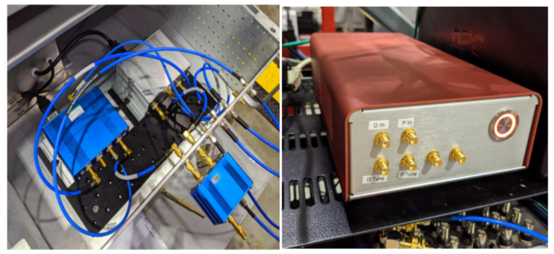
- 5T field of the central solenoid.

- NH_3 and ND_3 (irradiated to create paramagnetic centers) as target materials, and trolley to swap the targets efficiently and with less beam time loss.



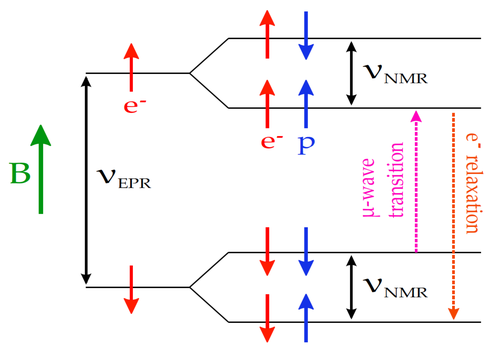
- Nuclear Magnetic Resonance (NMR) to monitor the target polarization.
  For this project, we built new NMR electronics to replace the Liverpool Q-meters and wrote new control software in Python.

Newly built NMR Equipment



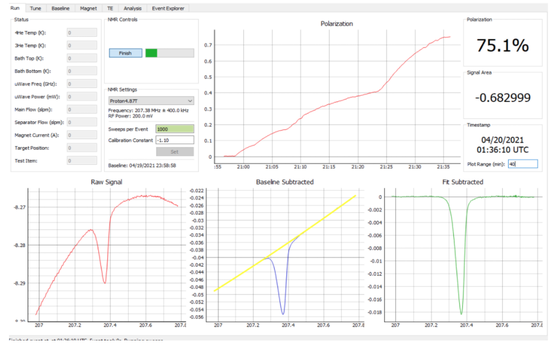
Method

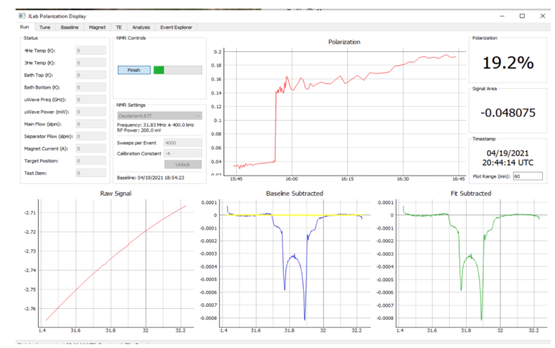
Dynamic Nuclear Polarization (DNP) is one of the most effective methods used to increase the nuclear spin polarization. Unpaired electrons polarize to over 99% in the magnetic field of 5 T at 1 K temperature at thermal equilibrium, while nuclei would have only 0.5% polarization. Microwave irradiation excites transitions that transfer the electron polarization to the nuclei, with over 80% achievable for protons.



Results

All systems have been successfully tested, most recently during a 1-week long cool-down. All components work as expected. High polarization was measured in both proton and deuteron samples.





Conclusion

- On final track for the scheduled run of RG-C in the second half of 2022 (starting in May).

References

1. https://www.jlab.org/exp_prog/proposals/06/PR12-06-109.pdf
2. https://clasweb.jlab.org/wiki/index.php/Run_Group_C_Longitudinally_Polarized_Target

Acknowledgments

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