Helium Recapture & Enhancement of Tensor Polarization by HoleBurning

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Introduction

In our Dynamic Nuclear Polarization(DNP) lab in order to understand spin polarization of a material we will be using around 500LL of Helium in a single cool down. Helium Recapture system is used to recapture once used helium and bring it in reuseable form. So, it is helping us run the frequent cooldown to enhance tensor polarization.

Methodology

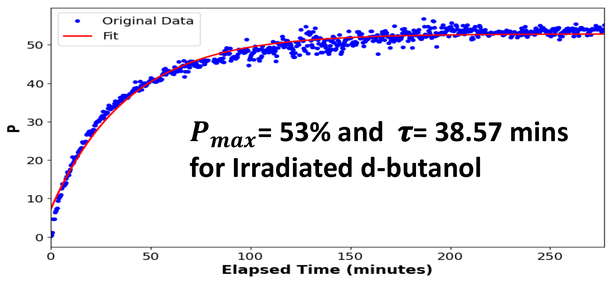
- Spin polarization is happening inside the Polarized Target the second image in the experimental set up. Now, the tensor polarization of the spin is done by AFP and the hole burning: the process of selective enhancement of the certain spin state of the electron spin system by microwave irradiation.
- When we performed cool-down 500LL of Helium is used to cool down the superconducting 5T capacity of magnet and boil-off is collected though the collection manifold sending it to collection bag, then follows the compressor to the Banks, Then it is sent for the purification to the purifier and once purified fed to cold-heads for liquefication and stored in the Mother Dewar.

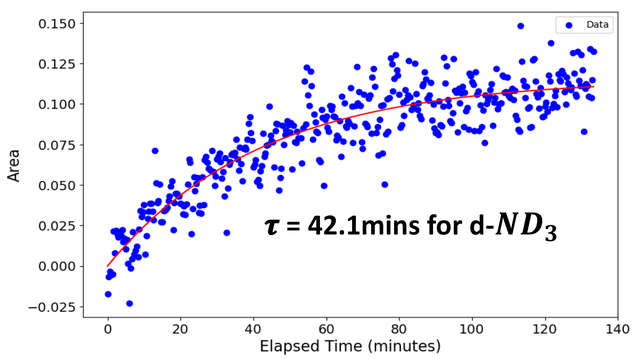
Polarization Analysis

The following is extraction of tau for deuterated butanol and deuterated ammonia for positive spin up polarization

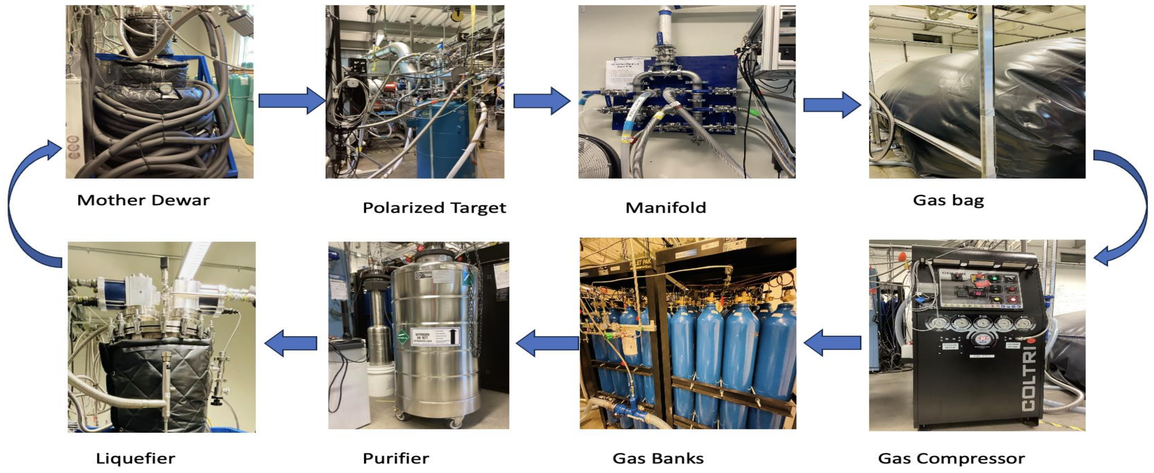
$$\mathbf{P} = -(\mathbf{P_{max}} - \mathbf{P_0})\, e^{-\frac{\mathbf{t}-\mathbf{t_0}}{\tau}} + \mathbf{P_{max}}$$

$$P = \rho_+ - \rho_- \qquad Q = 1 - 3\rho_0$$

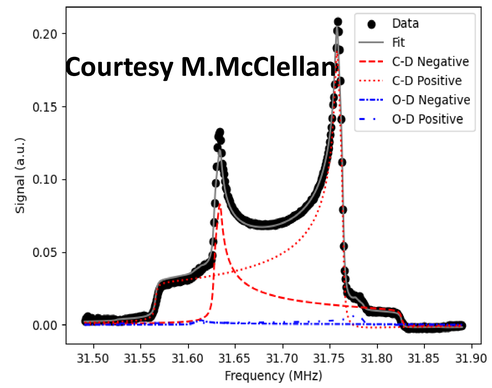


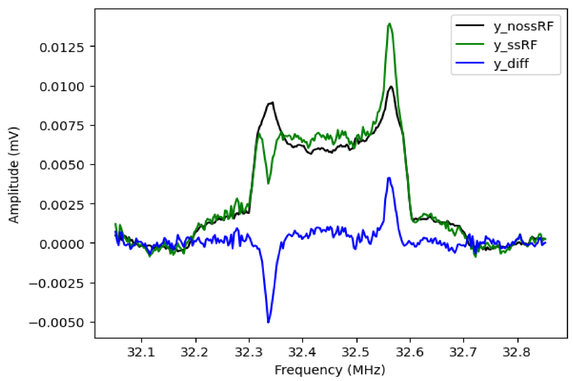


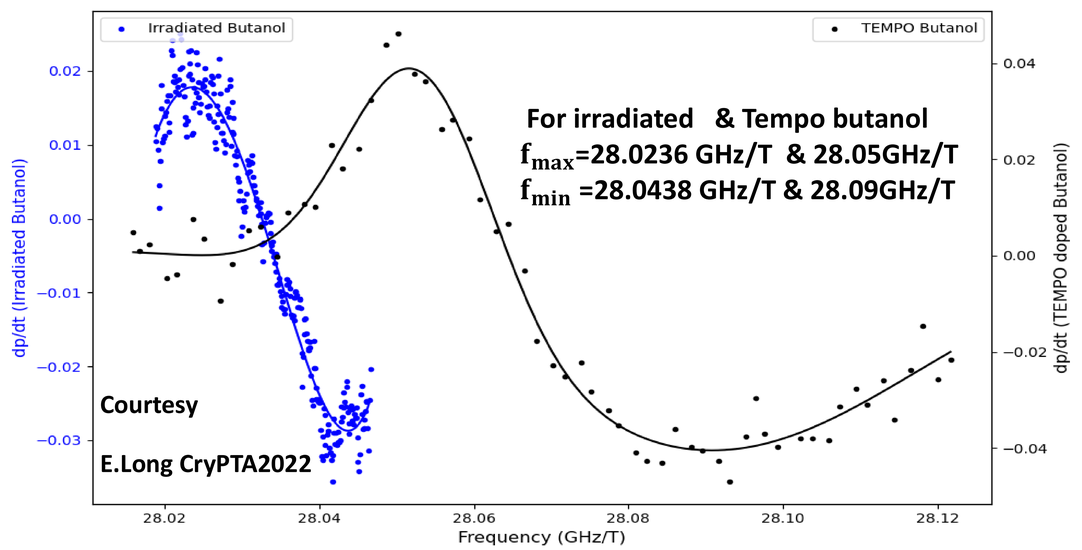
Experimental Setup



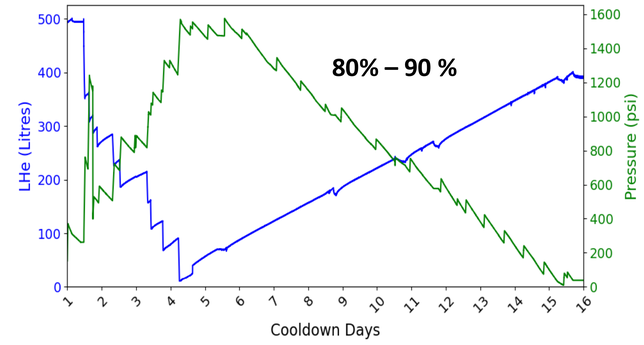
Tensor Enhancement and ESR width

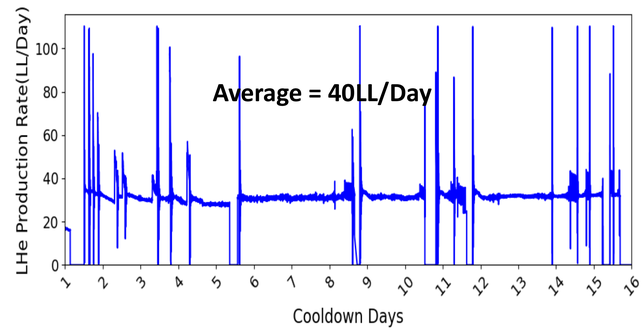






Liquid Helium Recovery Rate





Conclusions

We are able to recapture 80% - 90+ % of the helium used with 40LL/day production rate so we are running multiple cool –down at the price of the one cool-down. This is giving us enough time to set the parameters to analyze the Tensor Polarization enhancement Technique like HoleBurning and AFP.

Acknowledgements

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References

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[3] Quantum Technology Quantum Technology Helium Recovery System.