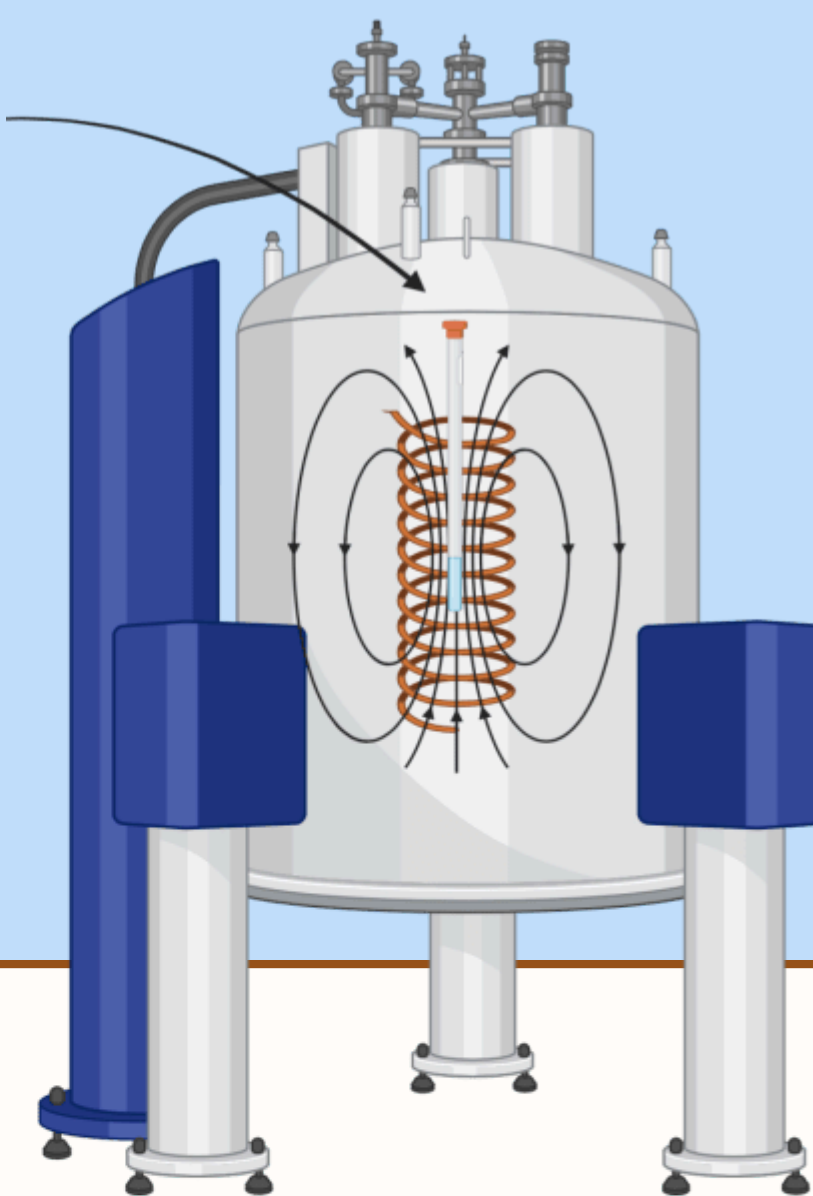


IMPROVING NMR LINE RESOLUTION OF 1.5 MM 600 MHz ^{13}C -OPTIMIZED ULTRASENSITIVE NMR PROBE WITH HTS-BASED RF RESONATORS



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INTRODUCTION

Nuclear Magnetic Resonance (NMR) spectroscopy is an important technique when it comes to the structural analysis of molecules. It requires high precision and high magnetic field homogeneity to achieve a proper resolution. One way to achieve a higher resolution is to fine-tune the homogeneity of the magnetic field down to parts per billion. At the NHMFL, we have a unique 1.5 mm 600 MHz ^1H - ^{13}C ultrasensitive NMR probe built with superconducting radiofrequency coils [Ramaswamy et al., 2013]. The probe is available, free of charge, to researchers from across the globe through the Magnet Lab User Program. To further boost its performance, the probe must be optimized to the best degree possible so that it can provide the best resolution signal for NMR.

METHODS

- To improve the line shape of the signal, we measured the RF field of the ^1H coil (B_1) of the probe and the static field of the magnet (B_0). The maps of the B_1 and B_0 field serve as guides on how to fine-tune the shim coils.
- To accomplish this, we used a 1 mm sample of water (H_2O). Addition of 10^{-3} M manganese chloride (MnCl_2) reduces relaxation time and reduces time between successive scans. B_1 was calculated from the pulse width at 90° . B_1 is useful in determining points that contribute to the signal. Then, we acquired the B_0 field by varying the position of the sample.

DISCUSSION

After acquiring the B_1 and B_0 map, we are able to tune the shims. However, the precision of the B_0 map is not yet adequate and it needs improvement. We also found that the field of the magnet drifts significantly sometimes and the signal has a line width of approximately 200 Hz. As we explore methods to decrease the line width with a small sample that affects local homogeneity, it is difficult to measure the peak to precision. Further exploration of optimization methods should be considered to fix the 200 Hz line width.

B_1

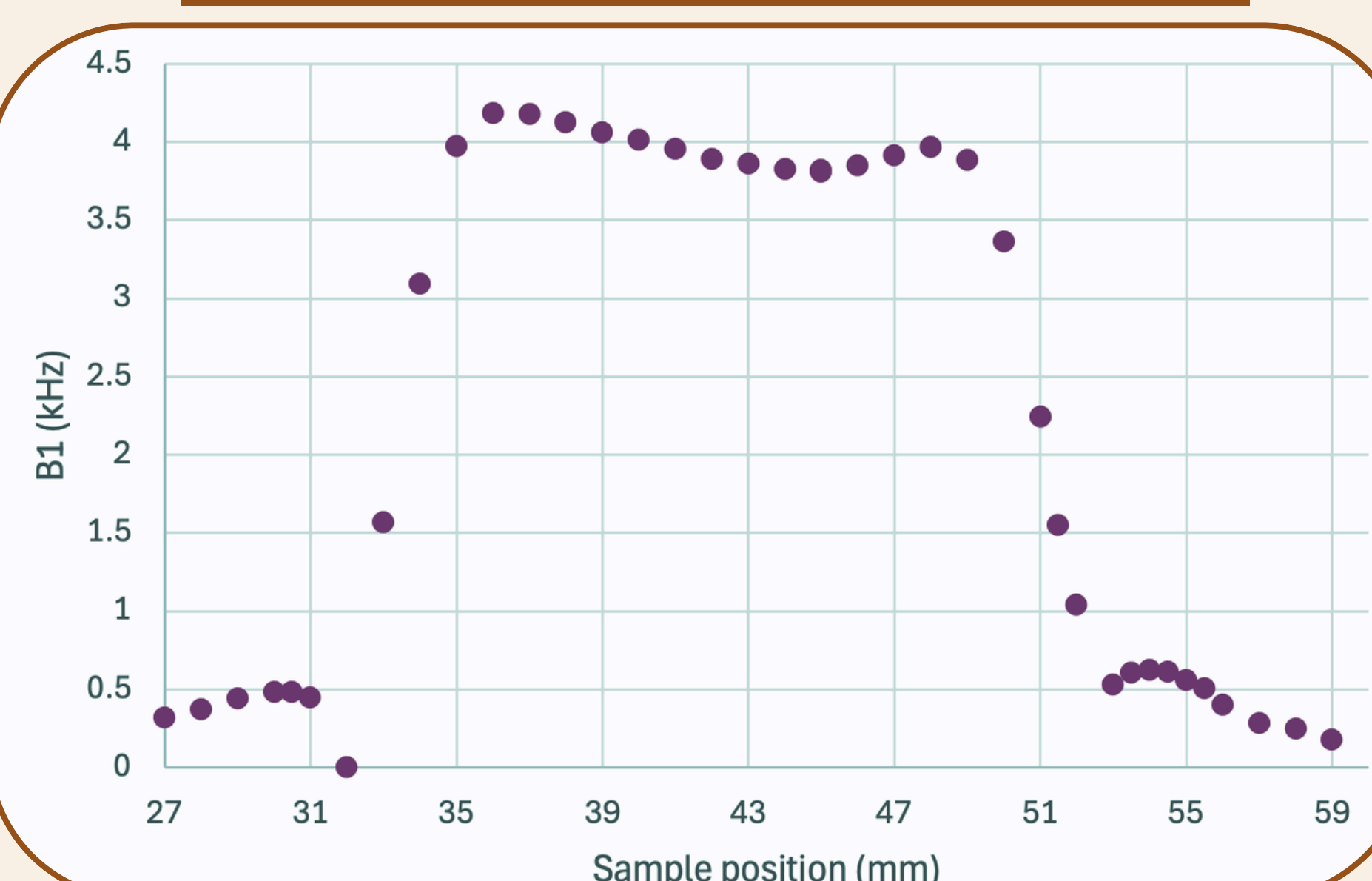


Figure 1: B_1 strength vs position inside RF coil at 14.0 W incident power. Position of the sample is determined using an NMR sample gauge. The center of the RF coil is near the 43 mm mark.

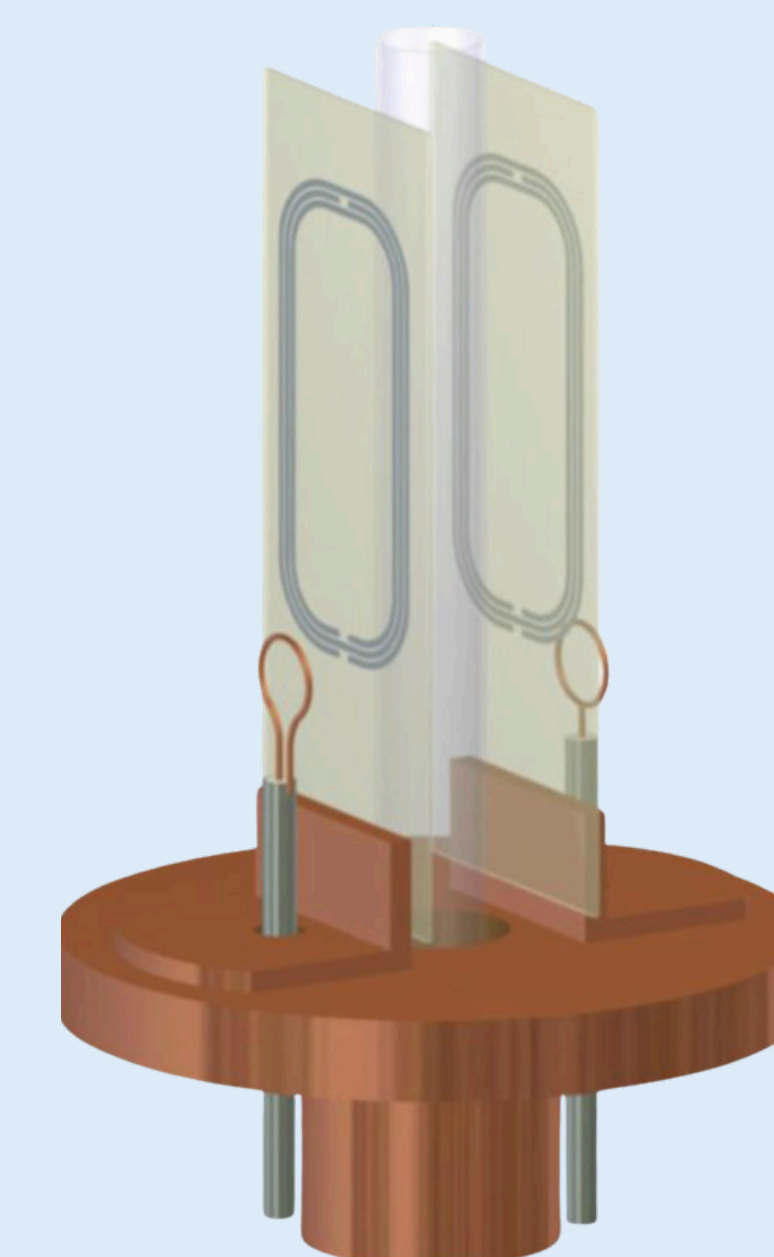


Figure 1.1: This is the depiction of superconducting RF coils in the 1.5 mm 600 MHz ^1H - ^{13}C ultrasensitive NMR probe. The length of the coil is ~ 20 mm [Ramaswamy et al., 2013].

B_0

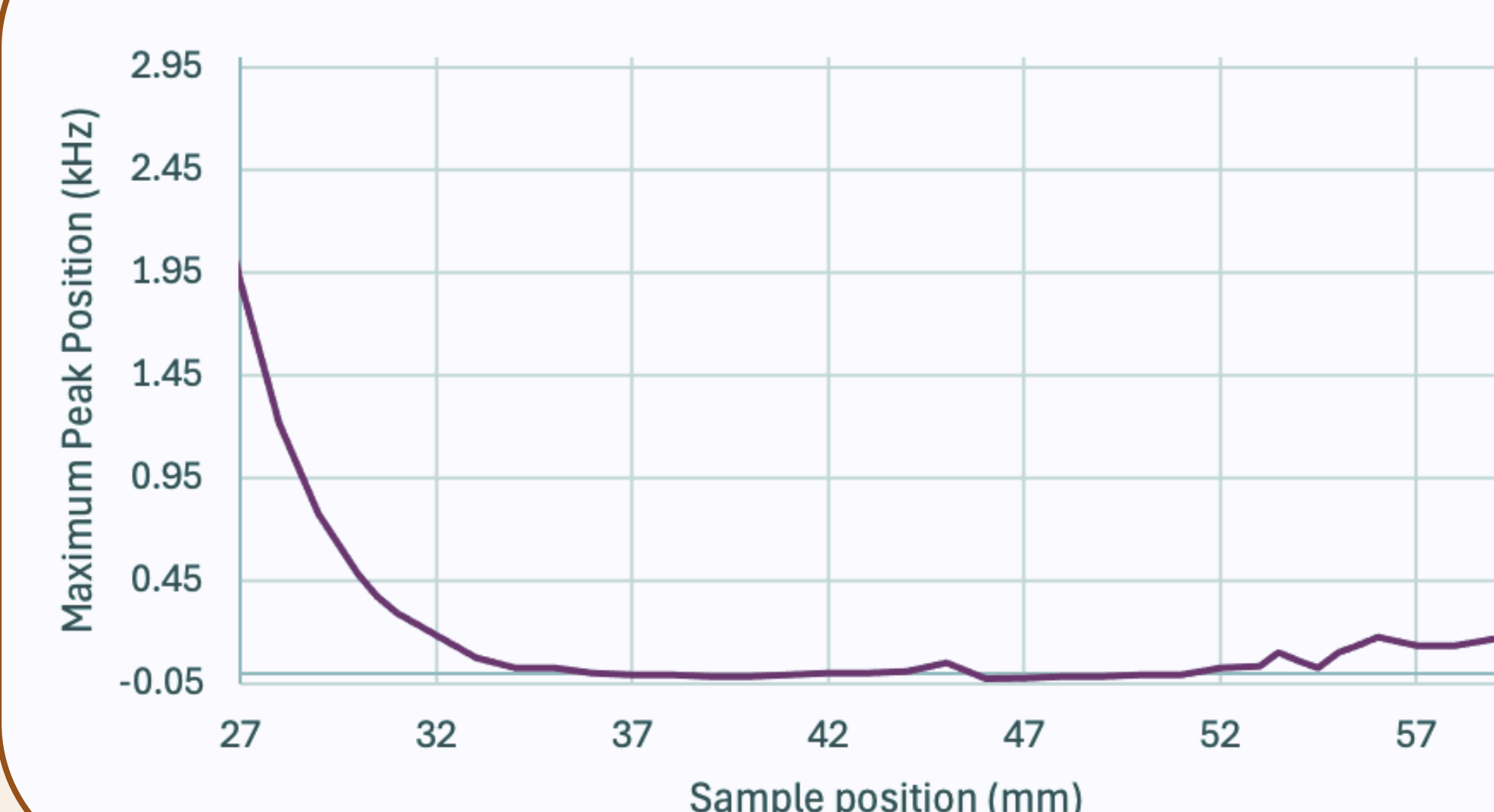


Figure 2: Axial B_0 Field map.

FUTURE DEVELOPMENTS

Future steps involve using a new solvent and realizing new mechanisms to install the sample. Solvents like acetone could be useful in future research. Other methods could suggest using magnetic susceptibility-matched solvent plugs to suspend the sample. These methods have not been tested with our 1.5 mm 600 MHz ^1H - ^{13}C ultrasensitive NMR probe and further investigation is necessary.

REFERENCES

