In-situ Overhauser-enhanced nuclear magnetic resonance using an atomic magnetometer

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The low detection sensitivity due to the Boltzmann distribution of nuclear spins is a primary limitation of magnetic resonance spectroscopy and imaging. Several methods have been developed to enhance nuclear spin polarization which typically requires high magnetic fields of up to 1 tesla. To circumvent the requirement of a high magnetic field, ultra-low field (ULF) nuclear magnetic resonance (NMR) measurements have been proposed and investigated [1]. In this work, we demonstrate a series of *in situ* NMR measurements with an atomic magnetometer (AM) based on a spin-exchange relaxation free regime that facilitates high sensitivity and has the advantage of non-cryogenic operation. In the ULF, an NMR signal from water is detected using hyperpolarization through dynamic nuclear polarization (DNP).The ^{1}H NMR signal of a nitroxide radical solution was observed at 13.83 Hz, which corresponds to 325 nT. Signal-to-noise ratio was 32 after sixteen averages. The experiment results are promising with respect to implementation of *in situ* nuclear spin hyperpolarization with AMs, for application to ULF magnetic resonance imaging with non-cryogenics.

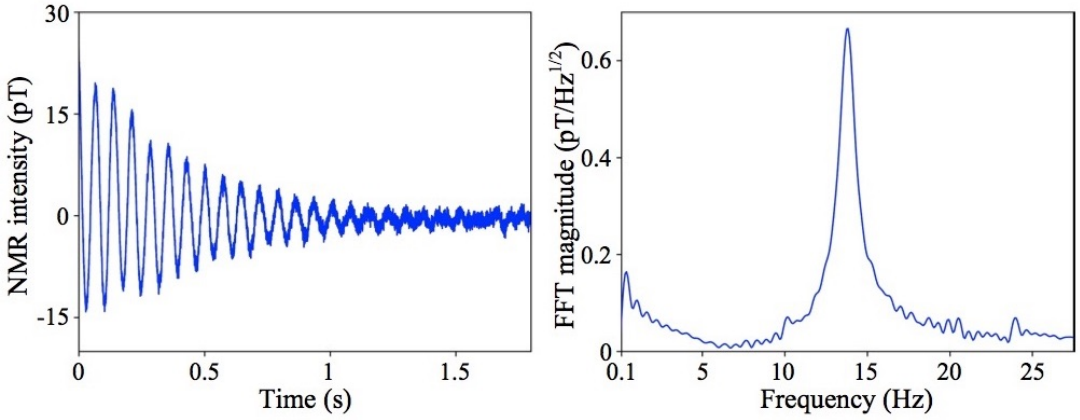

Figure 1. The *in-situ* DNP measurement for an average of 16 samples and its FFT spectra. The pure NMR signal was obtained by signal processing which entailed subtracting the signal that oscillates at a Larmor frequency of the Rb atoms from the experimental results.

[1] S.-J. Lee, K. Kim, C. S. Kang, S.-m. Hwang, Y.-H. Lee, Pre-polarization enhancement by dynamic nuclear polarization in SQUID-based ultra-low-field nuclear magnetic resonance, Supercond. Sci. Tech. 23 (2010) 115008.