An RF magnetometer for low-field NMR measurements

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Nuclear magnetic resonance (NMR) is a powerful technique that allows for detection of specific nuclei in the presence of a magnetic field. In a standard NMR experiment, the nuclei are subjected to intense magnetic fields, typically on the order of 10's Tesla, and inductive sensors are utilised to pickup the nuclei's signal. Such high fields are desirable for measurements, but they come at the cost of expensive cryogenic cooling and large-scale equipment. Low-field and zero-field [1] sensors have become a well-studied system and are advantageous due to simpler design and non-cryogenic operation temperature.

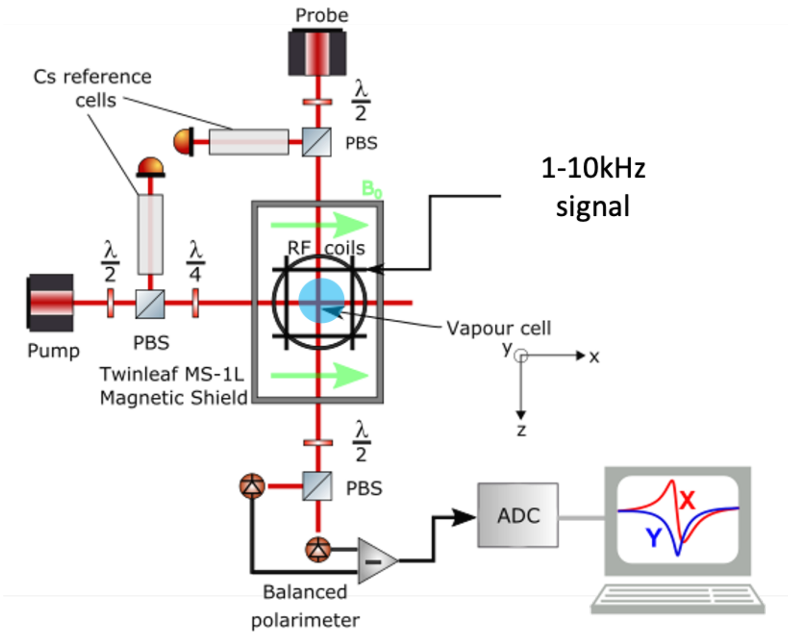

Figure 1: Experimental schematic of the RF magnetometer.

We are constructing a two part system, where we use a sub-10 fT/$\sqrt{\mathrm{Hz}}$ optically pumped magnetometer to measure an oscillating signal from an NMR sample in the low-field range between 1-10 kHz. The NMR signal is coupled to the magnetometer by a flux transformer, which measures detects the NMR sample outwith our magnetic shield, before electrically passing this signal into our magnetometer's sensitive region. Our nuclei polarisation is generated at 100s of $\mu\mathrm{T}$, negating the need for cryogenic cooling. Design considerations for a flux transformer are detailed, alongside experimental sequencing and noise considerations.

References

[1] P. Put; et al, Anal. Chem. 2021, **93**, 3226-3232.