Accommodation of Pulsed Field Gradients with Field Regulation in Powered Magnets

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Introduction

Previous work has shown that by feeding back measurements of field fluctuations, it is possible to significantly reduce temporal magnetic field fluctuations in powered magnets to allow magnetic resonance (MR) spectroscopy [1]. Despite these advances in reducing temporal magnetic field fluctuations, the feedback design does not accommodate the use of pulsed field gradients, which are necessary in many MR experiments. The inductive sensor used by the field regulation system detects pulsed field gradient signals and the controller response to these signals introduces additional field fluctuations. A feedforward method requiring knowledge of the compensation system has been developed to accommodate the use of pulsed field gradients with the existing field regulation designs [2]. To test this method, an experiment was performed on the 25 T Keck powered magnet in March 2014 to determine if gradient correction significantly reduces controller response to gradient signals.

Experimental

To test that pulsed field gradients can be used simultaneously with the field regulation system, a pulse sequence was developed which placed a pulsed field gradient signal immediately before a free induction decay (FID). Fig. 1 shows this g-FID pulse sequence. An 80 G/cm gradient is applied for 6 ms and followed by an RF pulse that induces a FID signal. The g-FID experiment is repeated for three cases: open loop, field regulation & no gradient correction, and field regulation & gradient correction on the Keck powered magnet at 25 T using a Doty Scientific 5 mm solutions probe equipped with a pickup coil and a single axis z-gradient.

Results, Discussion and Conclusions

Fig. 2 shows the resulting g-FID spectra for the three cases mentioned above. In the open loop case, shown in the upper plot, the field regulation system is turned off and the lineshape is unaffected by the gradient signal. When field regulation is activated with no gradient correction, shown by the center plot, the controller response distorts the lineshape. By activating gradient correction with the field regulation system, shown by the lower plot, the controller response no longer distorts the lineshape. The current system is limited in its ability to handle large gradients due to saturation of the measurement system. Improved hardware will allow for much larger gradient signals to be applied. This work demonstrates that gradient correction can be used to accommodate the use of pulsed field gradients with the field regulation system by reducing the controller response to gradient signals.

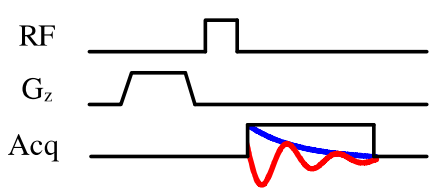

Fig.1 g-FID pulse sequence.

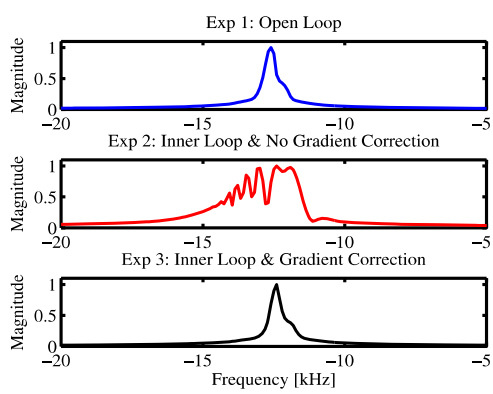

Fig. 2 g-FID spectra

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References

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