Reducing Temporal Field Fluctuations in Powered Magnets Using Inductive Feedback

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Introduction

High field powered magnets offer many advantages for nuclear magnetic resonance (NMR) experiments as they provide greater field strengths than SC magnets. However, both the magnet power supply and cooling system produce undesirable temporal field fluctuations. We previously demonstrated feedback control using inductive measurements to cancel high frequency field fluctuations from the power supply[1]. Due to 1/f noise, this approach is limited in attenuating low frequency field fluctuations caused by the cooling system. Additionally, the attenuation provided by the original inductive system is insufficient for some high-resolution NMR experiments. Over the past year, work has been done to improve the attenuation provided by the inductive feedback control system, as well as to design a compensator in cascade with an NMR feedback controller. This work is intended for the 36 T, 40 mm bore series-connected-hybrid (SCH) magnet.

Experimental

As the SCH is not yet completed, we demonstrated our feedback control method using a 7.1 T SC magnet, which has negligible field fluctuations, as well as in the Keck 25 T powered magnet. The Keck powered magnet suffers from field fluctuations due to the magnet power supply and cooling system. A method was developed to record these field fluctuations and play them back into the 7.1 T SC magnet test bed to evaluate control designs.

Results and Discussion

Figure 1 shows the performance of the inductive feedback controller in the Keck 25 T powered magnet. This shows a 30 dB baseband attenuation of field fluctuations, and an 80 dB reduction at the 60 Hz field component.

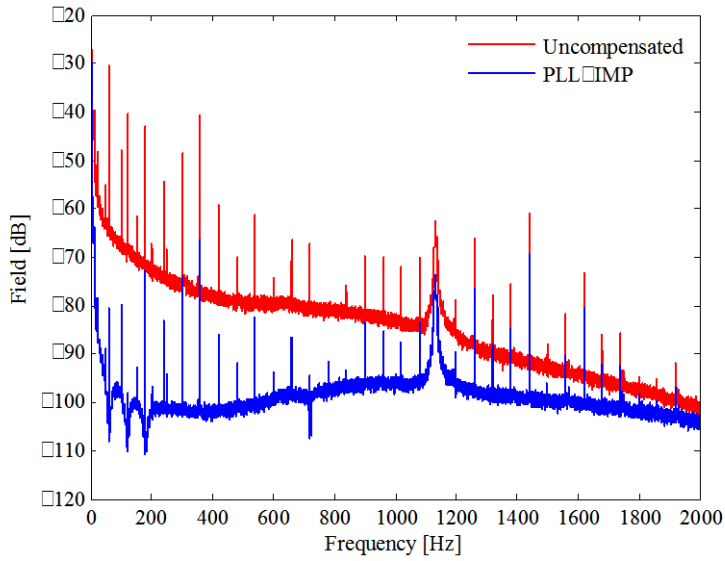

Figure 1: Feedback control method performance

Conclusions

We demonstrated an improved inductive feedback controller for reducing temporal field fluctuations. Work has been done to develop a cascade controller using both inductive and NMR measurements to reduce fluctuations from DC to 1 kHz, and this work will be continued in the next year.

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References

[1] Li, M., *et al.*, Reduction of magnetic field fluctuations in powered magnets for NMR using inductive measurements and sampled-data feedback control, Journal of Magnetic Resonance. **212**, 254-264 (2011).