Reducing Temporal Field Fluctuations in Powered Magnets Using NMR Measurements

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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 superconducting (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. This past year we demonstrated a feedback control method for estimating and reducing low frequency field fluctuations using NMR measurements. This work is intended for the 36 T, 40 mm bore series-connected-hybrid (SCH) magnet.

Experimental

We are developing our feedback control method using a 7.1 T SC magnet which has negligible intrinsic field fluctuations. In order to assess the feedback control method, we superimposed a field fluctuation onto the SC magnet using a disturbance coil, and observed the NMR field fluctuation estimate.

Results and Discussion

Figure 1 shows the performance of our feedback control method. A low frequency square wave disturbance (blue curve) was superimposed on the magnet's field while the regulated NMR estimate (red curve) was observed. After a transient response, field fluctuations are regulated close to zero as shown by the NMR estimate.

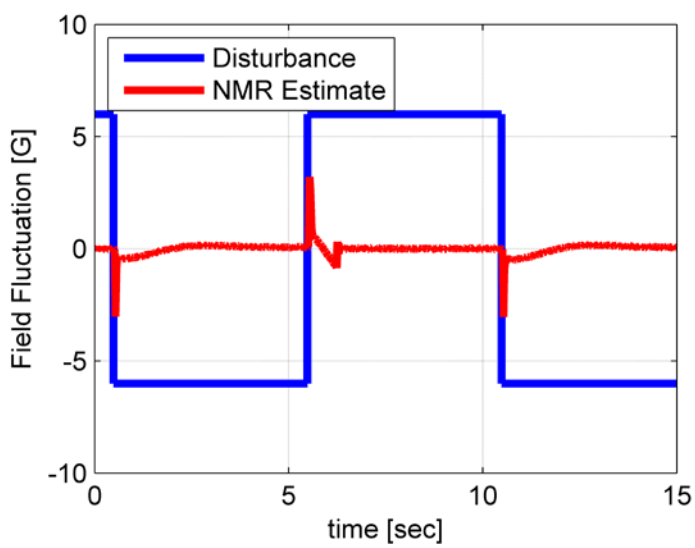

Figure 1: Feedback control method using NMR measurements

Conclusions

We demonstrated a feedback control method for estimating and reducing low frequency field fluctuations on a 7.1 T SC magnet using NMR measurements. This technique can reduce field fluctuations up to a frequency limited by the repetition rate of the NMR pulse sequence. Research is underway to develop a feedback control method using both inductive and NMR measurements to reduce fluctuations from DC to 1 kHz.

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References

[1] Li, M., *et al.*, Journal of Magnetic Resonance, **212**, 254-264 (2011).