TOWARDS A MODEL-BASED FIELD-FREQUENCY LOCK FOR FAST FIELD CYCLING NMR: EXPERIMENTAL VALIDATION

G. Galuppini,[a] R. Rolfi,[b] Y Xia,[b] , C. Toffanin,[c] D. Raimondo, [c] G. Ferrante, [b] L Magni [a].

[a] Dipartimento di Ingegneria Civile e Architettura, University of Pavia, Pavia 27100, Italy
[b] Stelar s.r.l., Via Enrico Fermi, 4 Mede (PV), Italy
[c] Dipartimento di Ingegneria Industriale e dell'Informazione, University of Pavia, Pavia 27100, Italy

*E-mail: giacomo.galuppini01@ateneopv.it

Fast Field Cycling Nuclear Magnetic Resonance (FFC NMR) relaxometry allows to investigate molecular dynamics of complex materials. FFC relaxometry experiments require the magnetic field to reach different values in few milliseconds and field oscillations to stay within few ppms during signal acquisition. Such specifications require the introduction of a novel Field-Frequency Lock (FFL) system. In fact, control schemes based only on current feedback may not guarantee field stability, while standard FFLs are designed to handle very slow field fluctuations, such as thermal derives, and may be ineffective in rejecting faster ones. The aim of this work is then to propose a methodology for the synthesis of a regulator that guarantees rejection of field fluctuations and short settling time. Experimental trials are performed for both model validation and evaluation of the closed-loop performances. Relaxometry experiments are performed to verify the improvement obtained with the new FFL. The results highlight the reliability of the model and the effectiveness of the overall approach.

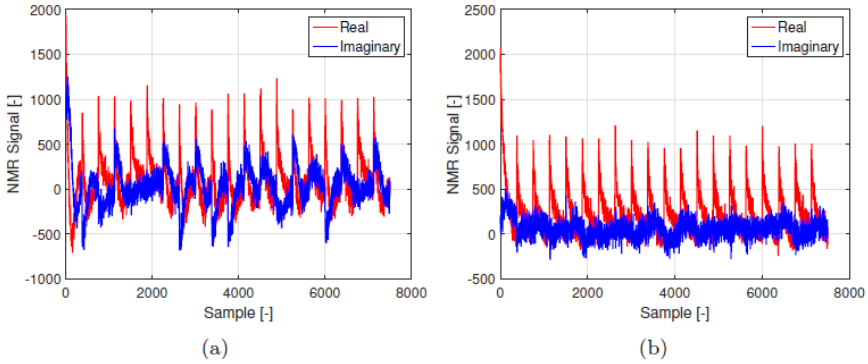

Figure 1 FFC NMR experiment without lock system (a) and with lock system (b), in presence of a 10 Hz sinusoidal current disturbance.

Acknowledgment

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 668119 (project "IDentIFY").

References

[1] Galuppini, G., Toffanin, C., Raimondo, D. M., Provera, A., Xia, Y., Rolfi, R., ... & Magni, L. (2017). Towards a Model-Based Field-Frequency Lock for NMR. IFAC-PapersOnLine, 50(1), 13020-13025.

[2] Galuppini, G., Toffanin, C., Raimondo, D. M., Provera, A., Xia, Y., Rolfi, R., ... & Magni, L. (2019). Towards a Model-Based Field-Frequency Lock for Fast Field Cycling NMR. To appear on Applied Magnetic Resonance.