

Enhancement of transmit and receive efficiencies with hybridized meta-atom in 7T head coil array

Marc Dubois⁽¹⁾, Lisa Leroi⁽²⁾, Alexandre Vignaud⁽²⁾, Stefan Enoch⁽¹⁾, Redha Abdeddaim^{*(1)}

(1) Aix Marseille Univ, CNRS, Centrale Marseille, Institut Fresnel, Marseille, France, e-mail : marc.dubois@fresnel.fr; stefan.enoch@fresnel.fr; redha.abdeddaim@fresnel.fr

(2) CEA, DRF, JOLIOT, NeuroSpin, UNIRS, Université Paris-Saclay, Gif-sur-Yvette, France, e-mail : lisa.leroi@cea.fr; alexandre.vignaud@cea.fr

B_1^+ heterogeneity remains an important challenge for ultra-high field MRI scanners ($B_0 \geq 7T$). There are two methods to mitigate this problem: parallel transmission pTx [1], and passive shimming using high-dielectric pads [2], in this paper we will focus on passive shimming.

High-dielectric constant pads have been proposed and optimized for passive shimming purposes [2-4]. Common formulations of dielectric pads for 7T applications are based on $BaTiO_3$ mixed with water present some drawbacks such as performance decay over time. While previous studies tackled directly the formulation problem introducing new dielectric materials and solvent [5], we adopted a new approach based on metamaterial [6]. We demonstrated that the hybridization of four parallel metallic wires arranged on a square unit cell provides the ability to control radiofrequency field inside a 7T head birdcage.

In the first part of this work, we show that these hybridized meta-atom (HMA) can be used like a dielectric pad placed on the side of the patient's head. In this configuration, we observe a strong enhancement of B_1 amplitude near the metamaterial as well as a significant reduction of the inhomogeneities on the metamaterial side. Moreover, a significant gain in terms of signal to noise ratio is also observed as the reception of the MR signal is enhanced in a 1T/1R birdcage coil.

In a second part, we address the HMA performances when used with a single channel transmit birdcage equipped with 32 channels receive array. In this configuration the HMA is deported between the emission coil and the receive array in order to maintain the patient's comfort. We demonstrated analytically using the impedance matrix [6], numerically and with measurement that the HMA structure is perfectly compatible with a birdcage emitter and does not perturb the receive array. Moreover, it has the ability to enhance both transmit and receive signal with the possibility to fill gaps usually observed in the brain temporal lobes.

This metamaterial based passive shimming strategy would provide a cost effective and long-lasting solution without impacting the patient's comforts during the examination, especially in the presence of a head receive array routinely used for *in vivo* MRI protocol.

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