B1 Shimming with a Multi-Mode Travelling Wave Antenna at 9.4T

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Introduction

Travelling waves have been introduced as an alternative excitation technique for MRI [1]. Recently, the extension to multi-channel excitation was presented at 7T [2] using dielectric fillings of the magnet bore. At 9.4T (~400MHz), to excite multiple modes without the necessity of such a dielectric filing becomes feasible. Building on initial performance measurements of the multi-mode antenna [3], here we report on the prospects of RF shimming with the multi-mode antenna.

Methods

The multi-mode antenna is based on the design of a previously developed patch antenna [4] with an additional monopole connected at the middle of the patch. Both patch ports and the monopole were fed independently by the parallel transmit system of a 9.4T MR scanner (Siemens Healthcare, Erlangen, Germany). Data were acquired on a human post-mortem brain in a cylinder filled with formalin. The cylinder was placed on the patient bed with the long axis coinciding with the longitudinal axis of the MR scanner.

B_1 maps of the measurement setup were acquired with a Bloch-Siegert shift based gradient echo sequence [5] with the following protocol parameters: FOV: 220x156x154mm^3, 3mm isotropic resolution, TR=250ms, TE=11ms. A 5kHz off-resonant Fermi pulse with duration of 8ms with a transmitter voltage of 132V was used for the experiment. The measurement was repeated for all three ports of the antenna. The resulting B_1^+ maps were normalised to the transmit voltage. RF shimming was performed using a magnitude-least squares approach [6] with the target being a uniform excitation of the slice shown in Figure 2.

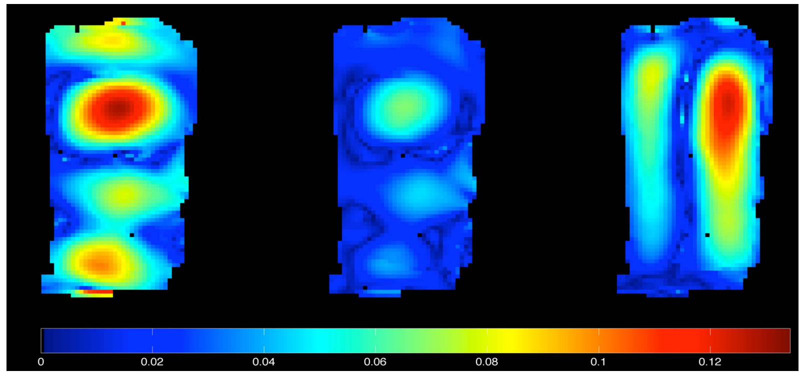

Figure 1: *Measured B_1^+ maps for the two patch ports (left and middle) and the monopole (right). The monopole shows the anticipated drop of field strength in the middle, corresponding to the excitation of the TM01 mode.*

Results

Fig.1 shows the B_1 efficiency maps for the individual channels. The distinct field patterns corresponding to the patch ports, i.e. the TE11 mode, (left and middle) and the monopole port (TM01 mode) are well visible. Fig.2 shows a sagittal localizer image before and after the RF shimming procedure. Despite the fact that the shimming procedure could not completely homogenise the excitation, some severe signal dropouts (white arrows) were reduced or even removed in some given areas.

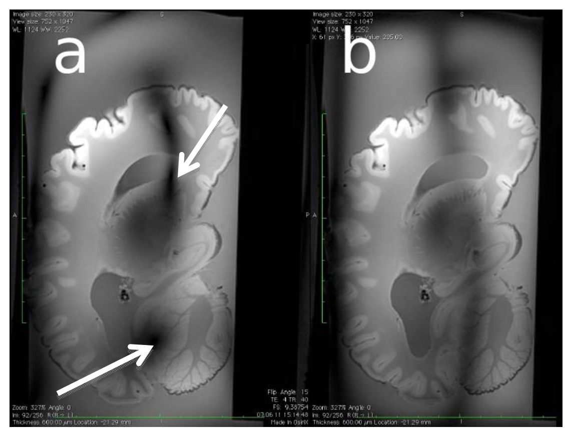

Figure 2: *Sagittal localizer images obtained before (a) and after (b) RF shimming. The total power of the RF shimmed excitation was significantly reduced and did primarily emphasize the monopole channel.*

Conclusion

As expected, simple RF shimming is not capable of removing the high degree of the RF inhomogeneity encountered at 9.4T. Though even with the low number of channels it is capable of reducing the encountered inhomogeneity in particular regions of interest and reduces the power requirements. Further studies will aim at the performance and verification of the RF shimming with the multi-mode antenna for *in vivo* imaging and the application of more sophisticated pTX techniques to further reduce the excitation inhomogeneities.

References

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