

An 8-channel rat-body array coil for transceive at 9.4T

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Introduction:

In the last years the field of parallel transmit- and receive imaging has become more important, especially in the domain of high field MRI. In this context new hardware, including novel RF-coil concepts, is needed. The aim of this work was the development of a basic concept for a volume-array, that can be used as an instrumentation for PEX (PEX=Transmit SENSE=SSE with parallel RF transmission via independent TX-channels) and parallel reception on small animals. This work discusses the development of a novel 8 channel array-coil for Transmit-SENSE applications at 9.4 T, which is optimized for investigations on rats. For this, we focused special attention to SNR performance, decoupling performance and transmit efficiency.

Methods:

All measurements were performed at 9.4T, 30cm BioSpec-system (Bruker BioSpin MRI GmbH; Ettlingen, Germany) equipped with eight transmit/receive channels. The coil consists of 8 loop-elements on a 60mm GRP tube with a length of 80mm in z-direction and an inner-diameter of 35mm. Every coil is decoupled from four neighbour coils by using geometrical (overlap) or transformer decoupling. The remaining three coils are decoupled from their geometrical arrangement with a value of minimum -15dB. Every single coil has tune- and match-capabilities for optimal performance at different loading conditions. The Q-value was measured to a value of about 45 for loaded conditions, using a phantom which represents an equivalent load of a mid-sized rat ($\epsilon=76$ and $\delta=2.2S/m$). For the measurements at the MR-system, an 8-channel TX/RX-switch was used. Each channel of this TX/RX-switch is equipped with low noise pulse-protected preamplifiers ($R_{input}=50 \Omega$, $NF=0.6$ dB, gain 22 dB). Every TX- and RX-channel of the whole system could be controlled independently; all combinations of the coil-elements for transmitting and receiving during the MR-experiment were possible.

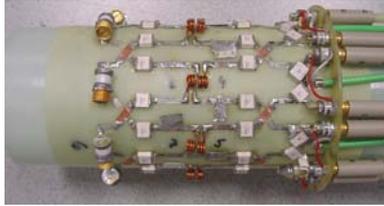


FIG.1. Inner assembly of the coil

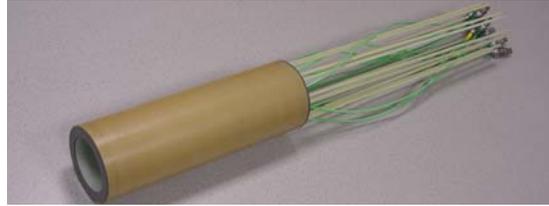


Fig.2. 8 channel coil

Results:

The 8 channel array-coil was tested at a Bruker BioSpec 9.4T system while it was loaded with the phantom described above. As can be seen in Fig. 4, the transmit sensitivity of all eight coils were determined and converted to the sensitivity-map of the whole array-coil when the coil-elements were driven by a birdcage-like excitation mode. All elements are decoupled from all other elements in a proper way, as can be seen in the sensitivity maps of the single elements. Additionally, accelerated imaging techniques were used. The results show images without limitations of artefacts up to an acceleration factor of 3 (Fig. 5).

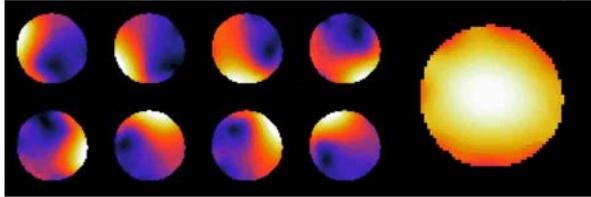


FIG.4. transmit sensitivities

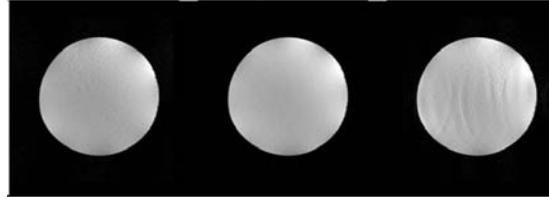


FIG.5. phantom imaging with acc. Factor 1 to 3

In addition to the phantom measurements, different imaging techniques with fruits like a kiwi (Fig.6, gradient echo) and rats in-vivo (Fig.7, rat-brain, spin echo/rare) were tried out. First both objects were measured in the whole ROI (region of interest). An overview scan was carried out for both objects. In this overview scan a region for excitation was selected (kiwi slice, brain, brain domain). Using Transmit-Sense methods [3] this region was then scanned with a full FOV and a reduced FOV.



FIG.6. Transmit-sense images of a kiwi.

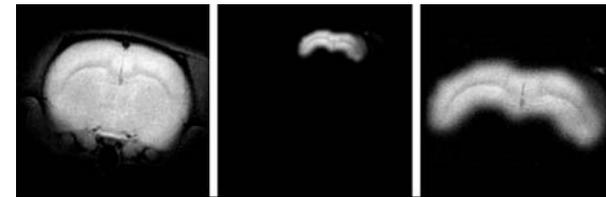


FIG.7. Transmit-sense images of a rat brain.

Conclusion:

A novel phased array-coil with 8 channels for rat whole-body applications was developed. Together with a multi-channel MRI-system, parallel transmission including PEX is possible. This allows undersampling and shortening of the k-space trajectory. Individual pulse shapes for each TX coil element are selectable. In the future, the basic coil concept will be adapted to other inner diameters to realise dedicated applications, e.g. cross-coil operation with local receive-surface coils.

References:

- [1] P. Ullmann, et al., "Development of a Multi-Channel Transmit Extension for a Broadband RF-Electronics", ISMRM 2008
- [2] E. Weber, et al., "A novel 8-channel transceiver volume-array for 9.4T animal scanner", ISMRM 2008
- [3] P. Ullmann, et al., "Flexible Feature Specific Inner-Volume Selection with Transmit SENSE: Methods and Applications in Humans, Animals and Biological Samples", ISMRM 2006

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