4 Channel Rat Head Arrays for 7 T and 11.7 T

T. Lanz[1], T. Steinberger[1], S. Dodd[2], F. F. Paiva[2], A. C. Silva[2], A. P. Koretsky[2]

[1]Rapid Biomedical GmbH, Rimpar, Germany, [2]National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland, United States

Introduction

Coil arrays are attractive tools for increasing SNR, spatial or temporal resolution. Especially for parallel acquisition techniques [2,3] in human applications like functional MRI of the brain or fast imaging of the heart, coil arrays are indispensable. Since multi-channel systems become available for high field research systems, these techniques can be transformed to small animal applications. In this work we present a 4 channel coil array design for the rat head which is implemented at two field strengths, at 7 T and 11.7 T.

Methods

Both arrays have the same geometry but are tuned to different frequencies, 300 MHz and 500 MHz respectively. Each array is made of four rectangular coil elements (Figure 1) which are aligned on a cylindrical surface along the xy-plane. This geometry is advantageous for acceleration by parallel imaging in transverse direction. The elements are decoupled by a shared conductor with an adjusted decoupling capacitance. In contrast to overlap or a gapped design, this design yields both good NMR-sensitivity and parallel imaging properties. The size of the array matches the size of a rat brain in z-direction and in the penetration depth.

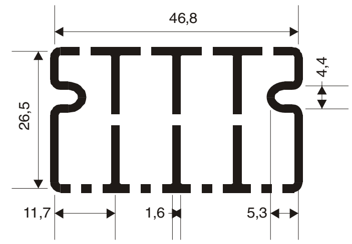

Fig. 1: Geometry of arrays.

Each coil element is tuned and matched to 50 Ω for physiological load with a simple capacitive coupling scheme. For decoupling of elements which are not decoupled by a shared conductor, we use the high input impedance of the preamplifier which is transformed into the NMR coil. The preamplifiers have a input reflection coefficient of >0.9, an amplification of 27 dB (300 MHz) and 24 dB (500 MHz) and a noise figure <1 dB. Each element is actively decoupled by a tuned trap circuit including a PIN diode.

Results

The coil elements showed Q drops of 2 fold (300 MHz) and 3 fold (500 MHz) from unloaded to loaded. The isolation between neighboring channels was better than -20 dB (300 MHz) and -15 dB (500 MHz). Channels with no shared conductor were only decoupled by the preamplifiers. Here, the frequency of optimum decoupling was adjusted to be w_0±0.8 MHz (300 MHz) and w_0±0.8 MHz (500 MHz). Active decoupling by the traps was measured to be better than -30dB.

Figure 2 shows coronal MR spin echo images of a rat brain obtained at 7 T with the four single coil profiles and the combined image (SOS). The four coil elements are well separated. In Figure 3 three transverse images of a rat brain with different acceleration factors (SENSE reconstruction) are shown at 11.7T. Good homogeneity, RF penetration and SNR were obtained from the entire brain without acceleration. At an acceleration of 3 no artifacts are apparent.

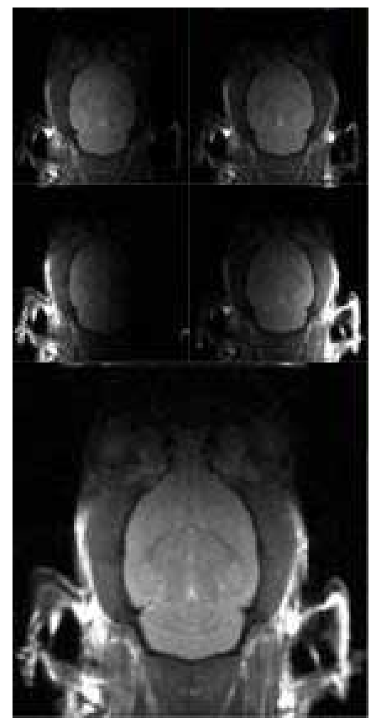

Fig. 2: TR = 2s, TE_{eff} = 60ms, FOV = 3.84 x 3.84 cm^2, slice = 2mm, matrix = 128 x 128

Conclusion

A 4 channel array for very high field strengths was designed and realized for two frequencies. It shows good performance with good isolation of neighboring channels through the use of capacitive decoupling. Preamplifier decoupling for nonadjacent coil elements was shown to be sufficient. Coil elements are well isolated in the MR images and parallel imaging shows very good properties.

References

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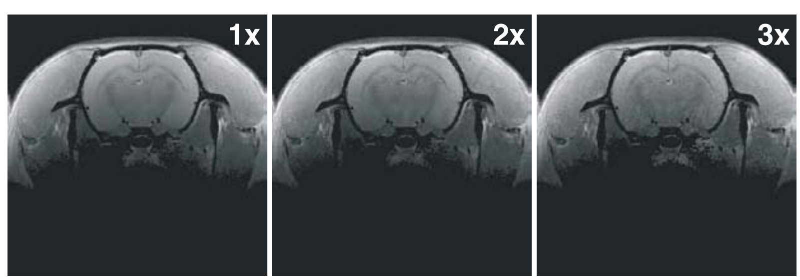

Fig. 3: TR=4s, TE=12ms, Matrix 240x240, FOV 3.3cm