A Coil System for Multiple-Mouse Imaging at 9.4 T

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Introduction

Applications of pre-clinical MR imaging continue to play an increasingly significant role in the development of new therapeutic drug compounds [1,2]. As new screening applications evolve, a challenging constraint is the inherently low throughput with MRI. This holds especially true where high resolution 3D imaging is needed. A number of acquisition schemes have been proposed to address the need to efficiently and economically increase animal throughput [3-5]. We report on a coil system for simultaneous imaging of four mice. The design, workbench data and MR results on phantoms are presented.

Methods

The coil system (RAPID Biomedical) consists of four volume coils and four animal holders (fig. 1). The coils are mounted in a common holder which allows easy mounting of all coils in the magnet in one step. The subjects can be prepared individually on the animal holders, they provide easy positioning of the subjects and an anaesthesia mask. The four coil assembly fits into a B-GA20 gradient set of a Bruker Biospec 94/310AS system (9.4 T), which provides a single RF transmitter and four receive channels. The coils are high pass birdcage resonators driven in quadrature for transmission and detection. The resonators are 62 mm in diameter and 90 mm in length, giving a homogeneous volume large enough for whole body imaging. The inner diameter of each coil housing is 54 mm. The resonators are tuned and matched manually. Each coil is surrounded by a cylindrical shield with a diameter of 77 mm. The coils are arranged in a square grid pattern with a distance between the coil axes of 82 mm. The inner coil tube is extended to support the insertion of the animal holders, giving the setup an overall length of 660 mm. The RF power is distributed to the four coils by a Wilkinson power splitter, signal reception is done for all coils individually. Images of cylindrical silicon oil phantoms were acquired to characterize the performance of the coil assembly, image reconstruction was done using GRAPPA [6] for accelerated imaging.

Fig. 1: Multiple-Mouse imaging system

Results and Discussion

Workbench results Typical quality factors of the resonators were Q_U=275 (unloaded) and Q_F=130 (loaded), i.e. a q-factor drop of Q_U/Q_F=2.1. The quadrature isolation was found to be better than -25 dB (loaded), the mutual decoupling between the coils at least -40 dB.

MR results

The isolation between coil pairings calculated from ROIs defined in ghost and signal regions (from single channel acquisitions) was found to range from -39dB to -50 dB. Example profiles showing the B_1 homogeneity are provided in fig. 2. The maximum signal variation in the transverse direction is ~7% (phantom diameter = 40mm) and ~14% over 45 mm in the longitudinal direction. The SNR of all coils was found to be very similar, a typical value calculated with the Bruker Auto SNR macro was ~3800/mm^3. The effect of applying different acceleration factors up to 4 has been evaluated, resulting in an expected decrease in SNR with increasing acceleration factor (fig. 3).

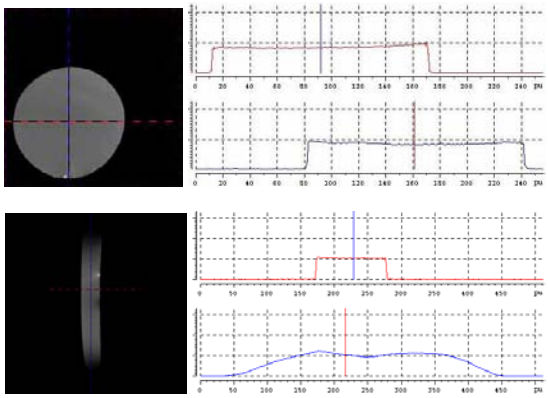

Fig. 2: Signal profiles through cylindrical silicon oil phantoms, imaged with a spin echo sequence.

Conclusion

We have demonstrated the operation of a multi-coil array for simultaneous animal imaging of four subjects at 9.4T. Our initial experience with the coil assembly has found a maximum coupling between coils of -39 dB and signal homogeneity across the coils sufficient for whole-body mouse imaging applications. The performance of the coil system allows parallel imaging in one large field of view with acceleration factors of up to 4. The design allows extension to higher numbers of coils.

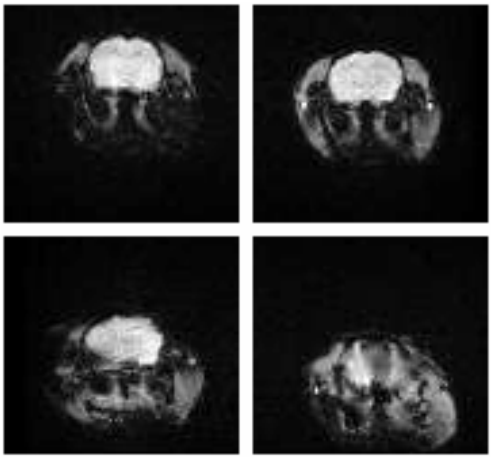

Fig. 3: Cut-outs from a large image (FOV=10.8 cm) of four live mice, acquired with a FLASH sequence and an acceleration factor of 2.

References

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