Benefits of cryogenic coils for routine in-vivo mouse brain imaging and spectroscopy at 9.4 T

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Introduction

Cryogenic coils show a significant increase of SNR ratio compared to conventional room temperature coils. The gain can be used for higher spatial or temporal resolution or for shorter scan times [1]. Results are presented to demonstrate the high performance of a MRI CryoProbe™ for *in-vivo* mouse brain experiments. The SNR of this single loop copper transmit/receive (Tx/Rx) coil is compared to a conventional receive only quadrature coil of the same size.

Methods

A flexible cryogenic coil setup operating at about 25K was used for proton imaging and spectroscopy, basing on the standard BRUKER CryoProbe™ platform [2]. The inner coil diameter was less than 20 mm. The system was installed at a 9.4 T 20 cm bore BioSpec®. The SNR comparison was performed with a room temperature quadrature coil with an optimized geometry for the mouse head.
RARE experiments were performed with a RARE factor of 8, TE 38 ms, TR 4200 ms. The EPI experiments were acquired in the FID mode with 8 segments, TE 14 ms, TR 2500 ms, 9 slices with a slice thickness of 0.5 mm, covering the whole mouse brain.
The automatic RF power adjustment for the transmitter pulses was configured with respect to the specific demands of a Tx/Rx surface coil: the slice position for the adjustment was specified individually based on a reference image: a coronal slice in the centre of the brain was selected to reach an almost homogeneous intensity over the whole brain. To correct for the different B1 intensity profiles of the Tx/Rx cryo coil and the receive-only room temperature coil, the signal was integrated over the whole mouse brain for the SNR comparison.

Results

The images acquired with the cryo coil show a high SNR despite the high resolution, very fine structures in the mouse brain can be resolved. Especially the EPI scans demonstrate the benefit of the SNR increase compared to the room temperature coil: the numerical analysis reveals a gain averaged over the whole brain of 98% for the EPI experiments (Figure 2) and 81% for the different RARE images. With the configurable automatic RF pulse power adjustment the image homogeneity is optimized, and no marked loss of signal within the mouse brain is visible (Figure 1).

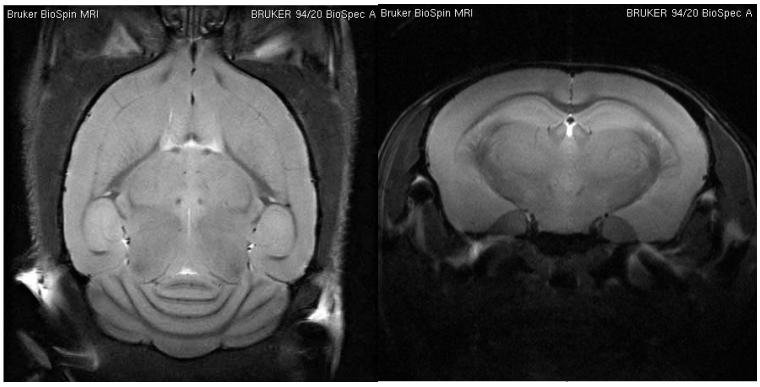

Figure 1: High resolution *in-vivo* mouse brain RARE images, cryo coil
Total scan time 6:40 min
Spatial resolution 50 µm in plane
Slice thickness 0.7 mm for the axial orientation, 0.5 mm for the coronal orientation

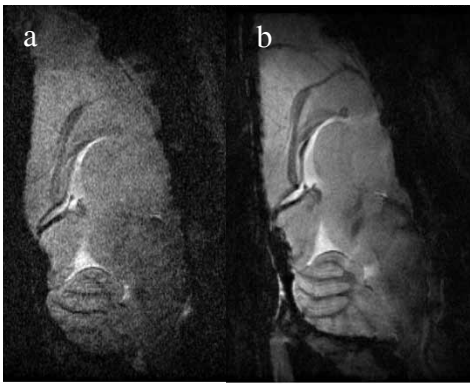

Figure 2: Comparison of FID-EPI images
a) room temperature coil, b) cryo coil
Total scan time 20 s
Spatial resolution 62 x 47 µm in plane, slice thickness 0.5 mm

Discussion & Conclusion

The high sensitivity of both coil setups allow to acquire highly resolved *in-vivo* images with 50 µm in plane resolution. The increased SNR of the cryo coil could in principle be used to increase further the in plane resolution by a factor of $1/\sqrt{2}$ for anatomical studies, e.g. for molecular imaging techniques. However the greater SNR allows a reduction of the total acquisition time for the same resolution by a factor of 4, leading to a considerable increase in temporal resolution of time course studies, in fMRI, or to an increase of screening throughput.

References
[1] L. Darasse et al., Perspectives with cryogenic RF probes in biomedical MRI, Biochimie 85, 915-937, 2003
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