Quadrature RF Surface Coil for *In Vivo* Rodent Imaging at 21.1 T

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Introduction

The use of ultra-high magnetic fields for MRI intrinsically improves the available *SNR* and spatial resolution. Additionally, the use of surface coil designs helps to ensure optimal use of the available sensitivity, particularly for *in vivo* applications for which multi-coil configurations can provide reduced imaging times with sufficient image *SNR*. This work develops a transmit-receive quadrature-driven saddle pair for *in vivo* rodent imaging at 21.1 T.

Experimental

Experiments were performed on an ultra-widebore (105-mm) 21.1-T magnet equipped with a 63-mm microimaging gradient set. The quad driven saddle pair was constructed from a 60-µm copper-clad laminate, which consisted of the conducting element (~32 x 30 mm) adherent to a polyimide film. The laminate was placed on top of a cylindrical G10 fiberglass epoxy cylinder with a 36-mm O.D. that can accommodate up to 350 g rats (**Figure 1**). The coils of the saddle pair were decoupled across a common conductor leg using a Giga-Trim variable capacitor (Johanson, Boonton, NJ). A hybrid coupler (R&D Microwaves, East Hanover, NJ) was used to achieve a 90° phase shift between channels. Performance was tested against both a similarly sized linear surface saddle coil and a 33 mm birdcage coil [1], utilizing physiologically relevant phantoms and *in vivo* Sprague-Dawley rats.

Results and Discussion

The isolation achieved between channels was approximately -10 dB (S_{21}) when loaded with a 220 g *in vivo* rat. Image *SNR* comparisons show that the quad coil yields an improvement by a factor of 1.34 over the linear saddle (with phantom load), a value close to the theoretical improvement ($2^{1/2}$). The gain of 34% in *SNR* had previously been reported when comparing a birdcage to a quad coil at 17.6 T [2]. In comparison to our birdcage coil (**Figure 2**), the quad coil (**Figure 3**) gave an improvement by a factor of 3.4 in terms of the image *SNR* when loaded with the same *in vivo* rat. Although the quad coil improved upon the available signal sensitivity, it should be noted that the birdcage still achieved better homogeneity across the sample, which was expected due to the geometry and balancing signal contribution from each loop of the quad saddle. Finally, in order to achieve the same flip angle (90°), the quad coil required nearly half the power (5 dB less) of the birdcage coil.

Conclusions

The saddle coil implementation takes advantage of a two-coil quadrature configuration in order to improve upon signal sensitivity from circularly polarized fields. As an alternative to the birdcage coil, the improved sensitivity achieved by the quad surface coil at 21.1 T may add to the currently available applications of ultra-high field imaging systems, such as in the areas of fast acquisition techniques and fMRI for example. This coil is now implemented as a user coil available to a host of *in vivo* applications.

Acknowledgements

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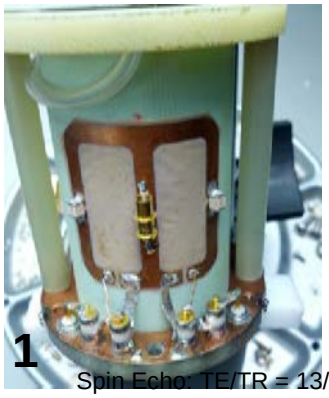
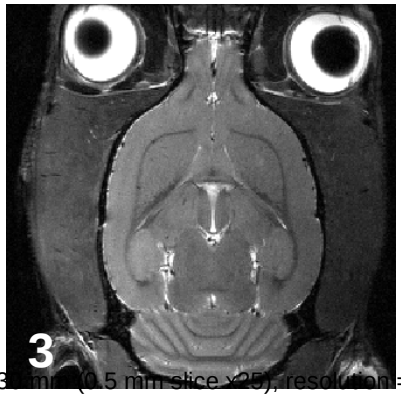
References

[1] Qian, C., *et al*., JMR, **221,** 110-116 (2012).
[2] Gareis, D., *et al.,* Concept Magn Reson, **29B**, 20-27 (2006).





Spin Echo: TE/TR = 13/6000 ms, NEX = 2, FOV = 20 x 30 mm (0.5 mm slice x 25), resolution = 100 x 100 um

Figure 1:
900 MHz quadrature surface coil.

Image slice (brain)
Figure 2:
Birdcage Coil

Figure 3:
Quadrature Coil