# Design of an MR Probe for In Vivo Studies in a 17.6 T, 89 mm Vertical Magnet

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## Introduction

Vertical NMR magnets provide higher fields at a lower cost than comparable horizontal magnets, while providing the field stability, homogeneity, and increase in MR signal strength needed to make high temporal and spatial resolution measurements possible in living animals (e.g. rodents). But appropriate probe hardware for animal studies is virtually non-existent. Therefore we are developing an *in vivo* rodent probe, for a 17.6 T, 89 mm bore magnet in the NHMFL Users Program of the Advanced Magnetic Resonance Imaging and Spectroscopy Facility. This probe will have a high sensitivity quadrature birdcage coil for rat brains and whole mice, along with active-switching for TX-only operation (with a RX-only mouse brain quadrature surface coil), a quadrature RX-only surface coil for the mouse head, and an animal support system with rat ear bars in the volume coil and a mouse stereotaxic cradle.

## Probe Design

During the past 12 months, we assembled the parts for the fabrication of 4, 33 mm inside-diameter volume birdcage coils with sliding ring tuning [1], and installed new wide-bore magnetic field gradient coils (57 mm inside diameter) in the 17.6 T magnet needed to accommodate this probe. As shown in Figure 1, we finished the construction of the probe and installed a linear H-1 transmit-receive birdcage coil, which was tested in the 17.6 T magnet by measuring images of a phantom at 750 MHz (Figure 2).

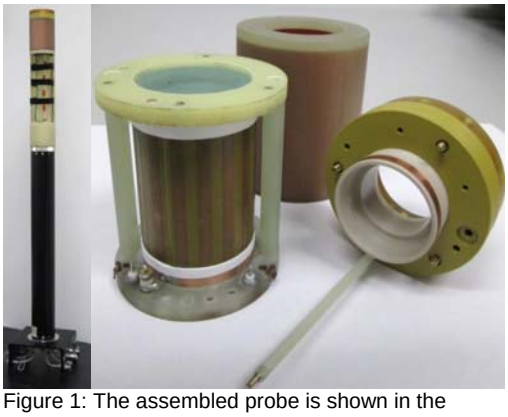

Figure 1: The assembled probe is shown in the image on the left. The image on the right shows the linear birdcage coil (left foreground), shield (middle background) and sliding ring tuning (right foreground).

We completed a redesign of the central portion of the probe body to enclose the capacitor tuning rods and isolate these probe elements from the animal body. In addition, we evaluated a prototype of the mouse stereotaxic cradle and surface coil design using a live mouse under anesthesia and used that information to finalize the design of these components of the mouse handling system. All these components are now being printed in ABS-like plastic by a 3D fabrication lab at the UF.

We will retain the linear H-1 transmit-receive birdcage coil (shown in Figure 1) and construct the following additional volume birdcage coils: 1) Quadrature transmit-receive H-1 coil and 2) linear transmit-only H-1 coil. In addition, two quadrature surface coils for mice will be constructed 1) Quadrature transmit-receive H-1 coil, and 2) a receive-only quadrature surface coil. Also we will explore the construction of circularly polarized receive-only surface coils for C-13 and P-31 for studies of the mouse brain *in vivo*.

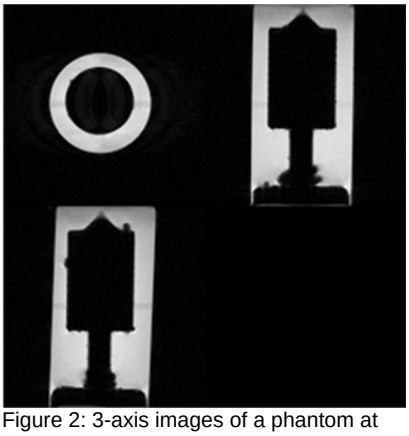

Figure 2: 3-axis images of a phantom at 750 MHz on the 17.6 T magnet with newly acquired commercial wide bore gradient.

## Conclusions

Although a challenging design, we successfully completed the first 750 MHz sliding-ring tuned, volume birdcage coil for the 17.6 T magnet. As other coils are completed, the various coil combinations will be tested first with phantoms then with live rats and mice before final testing by our collaborators. The final probe will become part of the NHMFL Users Program of the 17.6 T magnet in the Advanced Magnetic Resonance Imaging and Spectroscopy Facility at the McKnight Brain Institute of the University of Florida.

## Acknowledgements

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## Reference

[1] Qian C, et al. J Magn Reson 2012;221:110-116