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 Advanced Magnetic Resonance Imaging and Spectroscopy Facility, with a high sensitivity quadrature birdcage coil for rat brains and whole mice, with active switching to allow 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

We finished the design of the probe-body for which fabrication is nearly complete (see **Figure 1)**. The probe body consists of a base to house RF coil inputs and panel-mount gas inputs for anesthesia and animal warming, as well as a bottom plug to provide guides for catheter lines, RF connectors, and tuning rods for the volume resonator. The body extension tube is coupled to the bottom plug and centers the probe in the magnet bore. The upper plug is interfaces with the animal cradle (rat) and volume RF coil form shown in position at the top of the animal cradle.

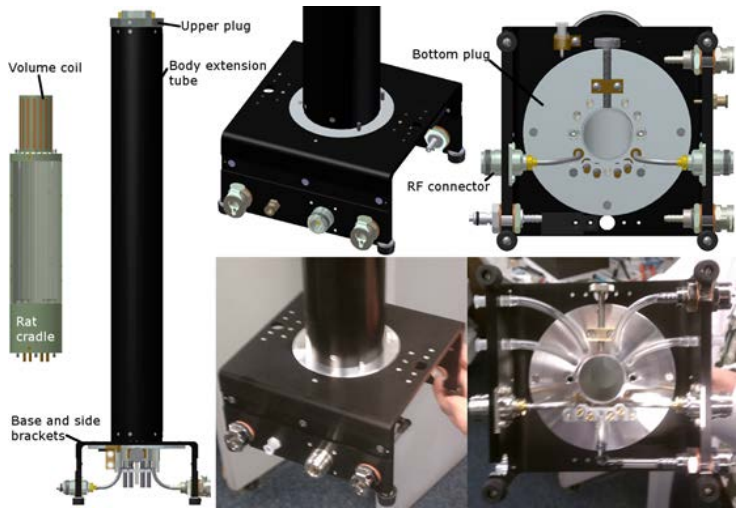

Figure 1: CAD drawings (left and top row) and photographs of completed probe-body (bottom row).

We designed and began assembly of a 33 mm ID ^{1}H transmit/receive quadrature volume coil with a sliding ring gearbox for tuning the coil [1]. We will construct a linear version of the volume coil, then a quadrature version of the coil, plus a linear and quadrature transmit-only resonators for use with a RX-only quadrature surface coil for mouse studies.

We designed a mouse stereotaxic cradle and receive-only quadrature surface coil to fit within the larger rat cradle (see **Figure 2**) and plan to fabricate the stereotaxic cradle, using a 3D printer. The front end of the stereotaxic cradle has a bite bar and ear bars. When positioning the animal, the ear bar arms are slipped over the bite bar holder and their vertical position is adjustable. Taking advantage of the inherent elasticity of the 3D printed material, the ear bars can be flexed outward and then released so that the ear bars enter the ear canal of the mouse and fix the vertical position of the head.

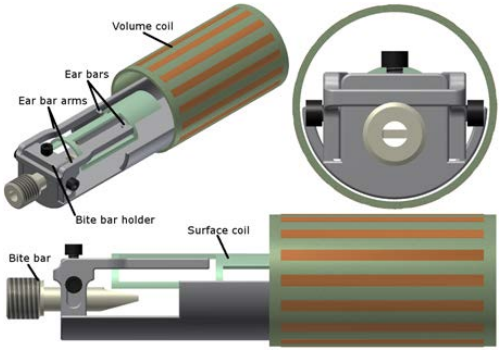

Figure 2: CAD drawings of the mouse stereotaxic cradle with bite bar and ear bars showing surface coil inside volume coil.

Conclusions

Although a challenging design, we successfully completed the foundation elements of this *in vivo* probe and anticipate the probe will be completed and initial tests performed during the 2013.

Acknowledgements

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Reference

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