# Space optimized birdcage body coil for animal MR at 500 MHz

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**Introduction:** MRI gradient performance is related to the diameter of the gradients. Therefore, space is a premium for animal imaging at high field, and therefore MR imaging or spectroscopy greatly benefits from any RF probe that leaves sufficient space for the animal setup, including the animal holder and associated life support and monitoring devices, such as air lines and temperature control, as well as devices for presentation of fMRI paradigms. A combination of a volume transmit coil to deliver homogeneous excitation to the animals, and local reception surface probes is an approach to obtaining high quality images. In the present work, we describe a volume transmit resonator that is permanently mounted within a gradient of 90 mm inner diameter (ID) that is located in an 11.7 Tesla horizontal magnet, which allows for 70 mm of available space. Details of the probe construction, phantom and rodent images are shown.

**Methods:** Experiments were conducted in an 11.7 Tesla, 30 cm horizontal magnet (Magnex Scientific, Ltd.), interfaced to a Biospec-Avance console (Bruker-Biospin, Corp.). The system is equipped with a 90 mm ID gradient set capable of delivering 45 G/cm in 75 µs rise-time (Bruker-Biospin, Corp.) embedded in a six-coil shim set (Resonance Research Inc.). The high-pass birdcage coil (figure 1, schematic; figure 2, picture) was constructed from eight 3 mm oxygen-free copper rods of 65 mm length, located within groves that were milled in a polycarbonate former. The end-rings contained multilayer ceramic capacitors; for tuning and matching, high voltage capacitors NMKJ10HV (Voltronics, Corp.) were utilized. Four UN9415 pin-diodes (Texas Instruments, Inc.) were used for actively detuning the resonator, by shorting four of the ring capacitors adjacent to the matching capacitor. At the positions where pin diodes were placed the ring capacitor values were reduced. Logic and connectors are compatible with the Bruker decoupling unit. A third ring, made from a 19 mm wide copper stripe (3M, Corp.), was introduced for ground return through two balance capacitors. The coil was shielded using two overlapped insulated layers of 12 mm wide copper stripes (3M, Corp.) mounted on a polycarbonate tube.

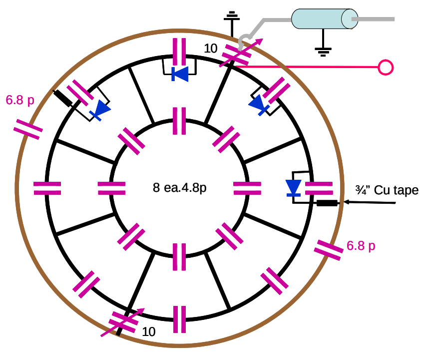


Fig. 1: Schematic of high-pass coil

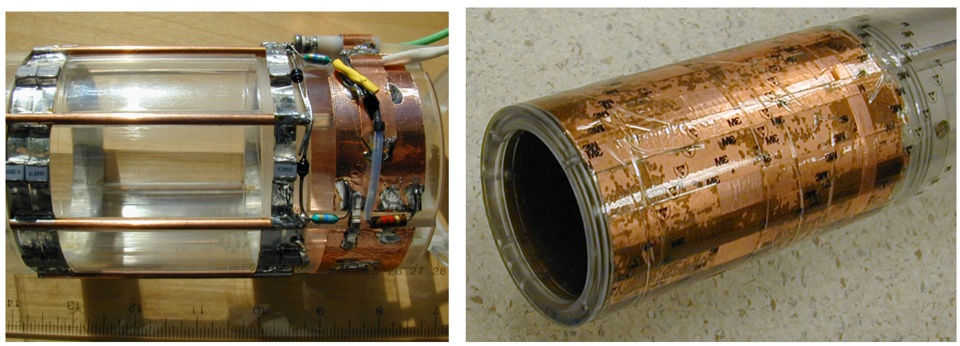

**Fig. 2: (a)** RF coil, with slotted RF shield removed; **(b)** Coil and shield in polycarbonate former

**Results and Discussion:** Figure 3 shows an axial spin-echo image of a 57 mm OD mineral oil phantom, demonstrating the obtained homogeneity of the RF coil. The coil produces a linear polarized $B_1$ field with a homogeneity which is sufficient for all rodent imaging and spectroscopy applications, in particular of the brain and the heart. Figure 4 shows typical high resolution images of a mouse brain, acquired with the birdcage coil in the transmit-only mode and using an actively decoupled saddle shaped surface coil for signal reception. The transmit coil covers a tune- und match range which has allowed us studies so far ranging from 20 g mice up to rats of more than 300 g. Power for a 90 degree excitation (200 g rat) is 25 W using a 600 µs block pulse. The coil is used in our laboratory now for several months and enables nearly every study together together with local detection probes. Indeed, following standard practice in clinical scanners, we leave the "body" transmit coil "permanently" mounted in the gradient and move the animal with receive coils in and out of the mounted transmit coil. Simplicity of construction as well as ease of use of this transmission coil makes it a valuable asset.

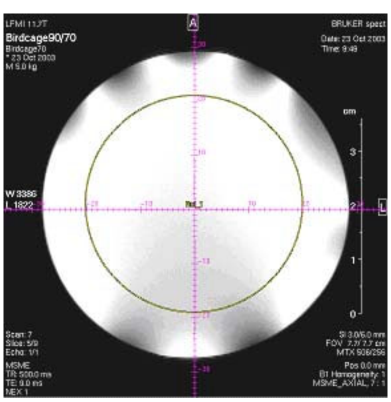


**Fig. 3:** Spin-echo image of oil phantom

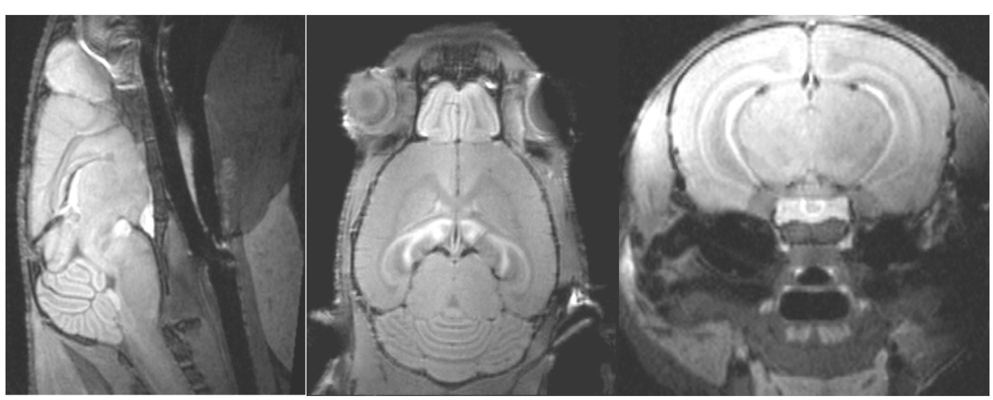

**Fig.4:** Sagittal, coronal and axial views of mouse brain from a 3D data set with 0.1 mm resolution