20-Channel Mouse Phased-Array Coil for Clinical 3 Tesla MRI Scanner

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Introduction: In animal models, parallel imaging is becoming more important. Human MRI already benefits from the use of array coils with large number of coil elements [1,2]. The purpose of this study was to develop a dedicated 20-channel phased-array coil for mice imaging using a clinical 3 Tesla MRI system. Furthermore, the feasibility of high accelerated parallel imaging in small phantoms is shown in this study. Especially the challenges for the miniature design and the construction of large numbers phased-array mouse coils is presented.

Material and Methods: Twenty circular elements were arranged in a 5x4 hexagonal matrix on a 34 mm dia. fiberglass tube. Each single coil element has a diameter of 32mm. In the first step three different designed loops were tested (flexible DuPont with bridges, wire, tiny tubular conductors) to obtain the best unloaded-to-loaded Q-ratio using a 25ml saline phantom. The tiny tubular conductors with an inner and outer diameter of 0.8 mm and 1.2 mm respectively was chosen to build all 20 coil elements. A coil overlap ratio of 0.73 was found to provide an optimal geometrical decoupling.

The geometrical structure of the whole design was engraved on the fiberglass before the loops were mounted (Fig.2a). Conductor crossings of nearest neighboring elements are realized by bridges. Loops and bridges are made out of tiny tubes with gaps for placement of capacitors (Fig1b,c). The crossing bridges were bent to empirically decouple adjacent loops. Two capacitor values were symmetrical distributed and split at the connecting point of the coupling network, which causes a virtual ground between the two divided capacitors. Each element has an active PIN diode trap decoupling during transmit. A series capacitor matches the network to 50Ω in load conditions. A toroidal coaxial cable trap was used to reduce cable common modes. The preamplifiers impedance was transformed to a short at the detuning circuits to provide preamplifier decoupling.

Initial phantom testing was done using a 3 T clinical whole body MR scanner (Magnetom, TIM Trio, Siemens Medical Solutions, Erlangen Germany) and a FLASH sequence (TR/TE/α=12ms/4.7ms/30°; 256x128; 0.31x0.31x2mm^3) and GRAPPA reconstruction.

Results: Figure 1 shows the ratio of unloaded-to-loaded Q for different designed coil elements. The loop which is build by the tiny tubes (Fig.1c) provides the best Q-ratio (2.0). Thus the noise is expected to be equally divided between sample and circuit. Bench tests shows a decoupling between immediate elements of -19dB, which is improved by additional reduction of 25dB via preamp decoupling. Active PIN diode decoupling between tuned und detuned modes causes a -48dB isolation. Figure 3 demonstrates good acceleration capabilities up to R=5x.

Conclusion: A phased-array mouse coil with twenty elements has been successfully developed. The small coil geometry shows good decoupling between elements and performs well in SNR. Special attention has been paid for preamp decoupling, because each element has 12 or 15 next-nearest neighbors, which do not obtain reduction of mutual induction from critical overlapping. The coil is well-suited to the use of parallel imaging and achieving 4-fold accelerated images in sufficient quality. Upcoming work will concentrate on further quantitative image evaluation and *in vivo* mouse experiments.

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References: [1] P.B. Roemer et al.; MRM 1990, 16(2): 192-225; [2] G.C. Wiggins et al., ISMRM 15th meeting 2007,p. 243, Berlin;

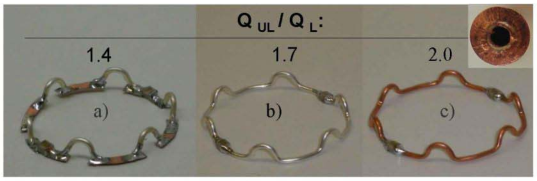

Fig.1. Three different designed loops: a) flexible DuPont with bridges, c) wire, d) tiny tube.

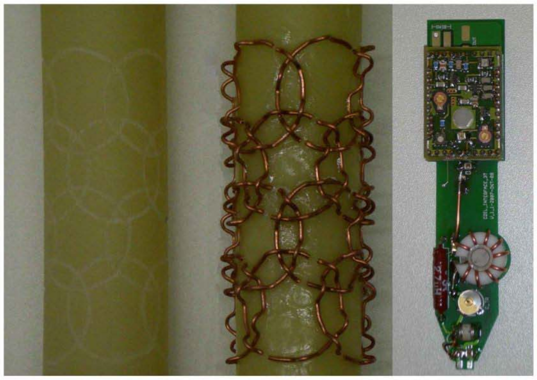

Fig. 2. a) Geometrical design engraved on tube of fiberglass. b) 20 plain elements. c) Top of circuit board.

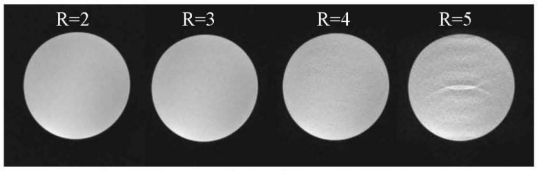

Fig. 3. Accelerated images obtained from GRAPPA technique.

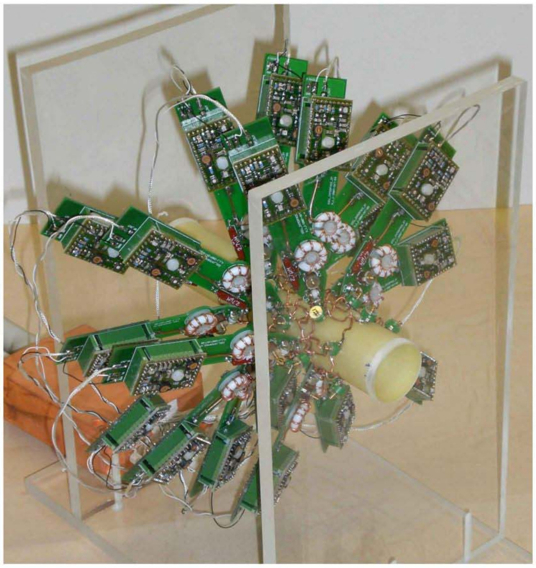

Fig. 4. 20-channel mouse coil.