A 4-element Receive Array with Integrated Preamplifiers for Mouse Brain Imaging in a 14T Vertical Bore Scanner

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Introduction. In order to take advantage of the sensitivity that high fields offer we have developed and describe here a 4-element receive-only array design for parallel imaging of the mouse brain at 14 T. To achieve the necessary decoupling between array elements we designed and built small, low noise and low input impedance preamplifiers which can fit in the limited diameter of the vertical bore magnet. This is offered as a possible alternative to a capacitively decoupled array (1) and a transmit/receive microstrip array (2) described previously for vertical bore scanners.

Method. Small footprint preamplifiers were built using a design similar to one previously presented (3) and modified to 600 MHz. A FET-bipolar transistor cascode was used instead of the dual FET design. The amplifiers were powered with a 10V supply fed onto the receive signal lines. Dimensions were 30 x 10.5 mm. The preamplifiers were able to achieve a gain of 26 dB with a noise figure of 0.8 dB and an input impedance of < 2 ohms. Decoupling from the linear birdcage transmit coil was achieved through geometric decoupling. Crossed diodes were used to limited transmitter noise during reception. The array fits onto a commercial animal bed with 25-mm i.d. transmitter coil (m2m imaging). The animal bed fits into a 78-mm 14 T magnet equipped with Micro-2.5 gradients (G=1.5 T/m, SR=2500 T/m/s) with i.d of 40 mm (Bruker Biospin Inc. Billerica MA, USA). The four receive coils were 7 x 9 mm wound using 1-mm diameter wire. The coils were arranged in 2x2 design with coils overlapping in the z-direction and with a small gap in the x-direction. Care was taken to avoid capacitor losses by using only fixed capacitors and where possible using two capacitors in parallel instead of one. Individual coil Q was measured to be 285 unloaded and 170 with a 0.45% w/v saline phantom. A pin diode circuit was used to detune the receive coils during transmission. Decoupling of >15 dB was achieved through the preamplifier in bench experiments. In-line cable traps were placed between the coil and preamplifiers. The prototype coil and preamplifier layout is shown in Figure 1. The MRI images were acquired using an Avance III RF console with 4-channel 1H receivers (Bruker Biospin, Inc.).

Results. The 4-element phased array was situated around a 15 mm tube containing a fixed mouse head. Gradient-echo images were acquired using a 1 mm slice, 19.2 mm FOV, 192x192 matrix size, TE = 10 ms, TR = 100 ms. Images from each element and the combined image are shown in Fig. 2. Some coupling is noted which may in part be due to imperfect geometric isolation from the transmit coil, leading to a tuning change in the elements.

Conclusion. We have demonstrated the possible utility of a 4-element receive only array with a separate transmit coil. We expect some improvement in performance with an actively decoupled transmit coil (in development) and with better filtering and shielding on lines to the magnet. This anatomically specific array will be a valuable tool for high resolution studies of mouse phenotypes.

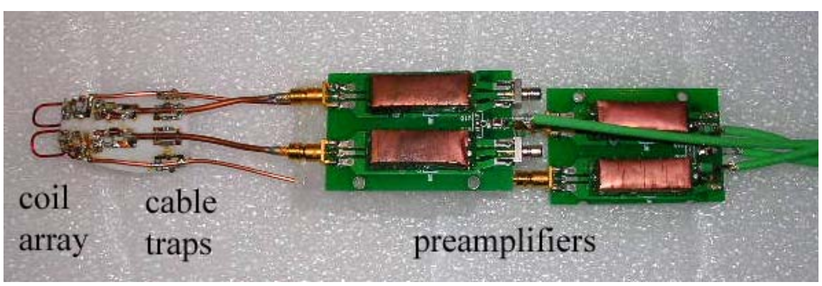
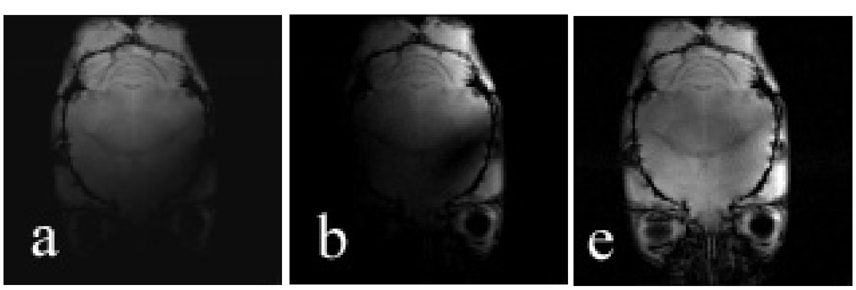


Figure 1. Prototype 4-coil array and preamplifier setup. Note that two of the coils are underneath the circuitry and cannot be seen in this photograph. The preamplifier footprint is 30 x 10.5 mm



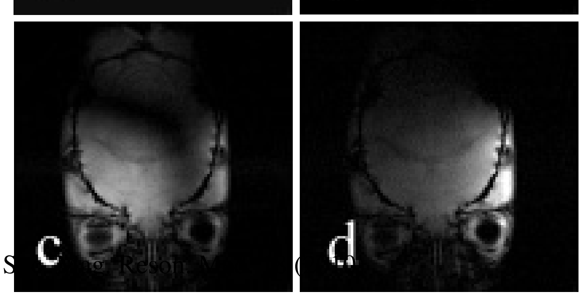


Figure 2. Individual coil images (a-d) and combined sum of squares images (e) from a coronal slice through a mouse head.

References
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