A Four Channel Transmit Receive Microstrip Array for 17.6T

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Introduction

Multicoil or phased arrays [1] have essentially revolutionized clinical MRI over the last decade. These arrays provide an increased SNR or increased imaging efficiency over large volumes. However, the application of multicoil arrays has been primarily limited to lower field strengths because of the increased complexity of building high frequency arrays, due to increased coil coupling, decreased active decoupling efficiency and the general lack of body resonators for homogeneous transmit pulses. This is especially true for high field microscopy systems, where there is the additional constraint of the limited space in the relatively small magnet bores. In this abstract, we describe our application of the recently introduced transmit/receive microstrip array [2,3] to our high field 17.6 T (750 MHz) microimaging system. It is shown that the individual elements of the array do not couple substantially, even though no overlap or preamplifier decoupling was used. In addition, the four coils of the array can be used together to form a homogeneous transmit coil, eliminating the need for an additional resonator and the associated active decoupling circuitry. We believe this array configuration offers a promising alternative to the more traditional loop arrays based on overlap.

Methods

The four channel microstrip coil array was designed for a proton frequency of 750 MHz. Each of the four coils was 30mm x 44mm in size and they were oriented in 0, 90, 180, 270 degree position around an inner diameter of 43 mm (Fig. 1). The microstrip coils had a 0,7 mm thick G10 plane as dielectric medium between the strip conductor loop and the ground plane. No additional decoupling, such as overlap or preamplifier decoupling was used. A custom made probehead was made to house this array consisting of a G10 tube with a copper shield around the coil area and supporting signal and matching rods. In order to keep the probehead as simple as possible, no tuning rods extended to the outside of the magnet. The coils could be tuned only from above while outside the magnet. This was found to be acceptable for all imaging experiments performed to date, since no significant observed frequency changes were observed upon insertion into the magnet. Shield traps were added to each of the semirigid cables to prevent cable coupling. In order to achieve a homogeneous transmit profile, each coil was fed with a cable of a specific length after a power splitter in order to obtain the correct phasing of the transmit signals.

Results and Discussion

All for coils could be tuned and matched without load and with saturated NaCl-solution. No resonance peak split could be observed with the coils in their final positions. The average decoupling of two neighboring coils with an 15g/l NaCl load was -20,4dB while for two opposing coils it was -30,2 dB. The Q_0/Q_L-ratio was approximately 220/130. Imaging experiments confirmed the good isolation of the coils (Fig. 3) as well as the relatively homogeneous transmit profile (data not shown).

Conclusion

The four element transmit receive microstrip array seems to be a promising coil arrangement for high field microscopy experiments. The primary benefit is the lack of a need for a homogeneous transmit coil. This is especially critical in small-bore microscopy experiments where the lack of space is the largest limiting factor for all coils. The microstrip array is especially promising in this regard since it is relatively thin and can therefore be used on relatively large samples.

References

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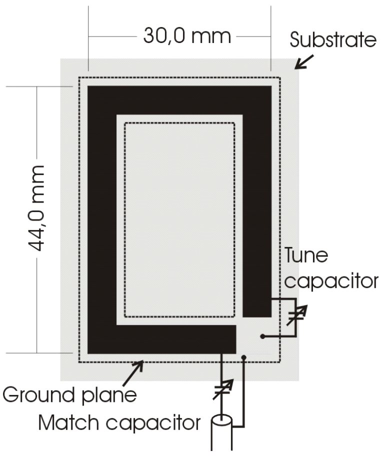

Fig. 1: Schematic of the microstrip coil

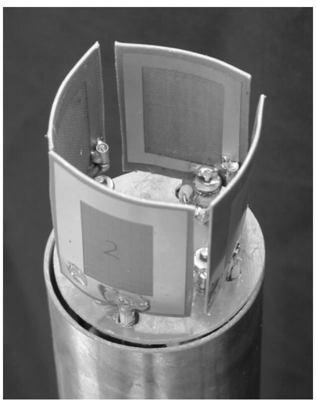

Fig. 2: The 4 channel microstrip coil array

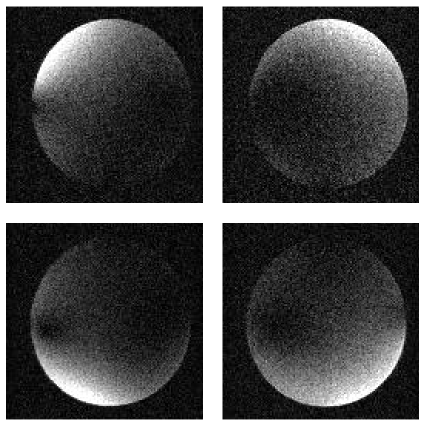

Fig. 3: Images from each of the single coils