An optimized four channel BIGMAC-Array for 7.05 T

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Introduction

An increased SNR or imaging efficiency over large volumes has been achieved by the development of multicoils or phased arrays[1]. In general, these arrays have been limited to lower field strength because of more complicated decoupling and the lack of body resonators for homogeneous transmit pulses. The recently introduced transmit/receive microstrip array[2,3,4,5] is one potential way to overcome these limitations, but has some problems. One practical problem is that one has to connect both the tune capacitor and the matching network to both sides of the substrate, which is mechanically difficult and results in a loss of space for the probe. Another problem of the design itself is the intrinsic asymmetry of the gap in one corner of the conductor ring, resulting in an intrinsic inhomegenity of the transverse magnetic field. This abstract shows an in this respect optimized four channel **B**i-**G**round **M**icrostrip **A**rray-**C**oil (**BIGMAC**)-Array for 7.05 T (300 MHz). It is shown that there is no substantial coupling between the individual coils, although there is no overlap or additional preamplifier decoupling used.

Methods

One difference between the BIGMAC-design and the traditional microstrip coils is the additional shielding loop around the conductor loop. This loop has the same potential and the same current distribution as the ground ring although they are not connected. The effect of the loop is a better shielding to neighboring coils. Additionally this makes the coupling network easier to be build because it does not have to be connected to both sides of the substrate. Another major difference is the tuning of the coil with a capacitor across the gap, which is now positioned symmetrically on the conductor ring. We have seen that this results in a better decoupling of neighboring coils and achieves a better homogenity of the transverse magnetic field. In order to test this, a four channel BIGMAC array was built for a proton frequency of 300 MHz. The maximum useable inner diameter of the array is 85 mm. Each of the single BIGMAC-coils is arranged in 0, 90, 180, 270 degree position around the center and has a size of 90 mm x 75 mm (Fig.1,2). The coils have a 3 mm thick PTFE plate as dielectric medium. All conducting surfaces are made of adhesive-baked copper tape. The thickness of the PTFE plate was the result of a pre-experiment in which we determined the maximum thickness for acceptable coupling between opposing coils. Decoupling of the neighboring coils was achieved with an additional capacitance. A shield trap was added to each coil to prevent cable coupling. For a better shielding the whole array was surrounded by a 80 µm thick copper foil. In order to achieve a homogeneous transmit profile, a phase shifter was placed ahead of each coil for the correct phasing and the array was connected to a four way power splitter. The imaging experiments were performed on a one channel 7.05 T Bruker Biospec.

	S_{21}(ch.1)/-dB	S_{21}(ch.2)/-dB	S_{21}(ch.3)/-dB
Ch. 1		-	-
Ch. 2	31,6		-
Ch. 3	18,8	29,3	
Ch. 4	24,6	18,3	31,6

Fig. 3 S_{21}-parameter between the single coils (unloaded)

Results and Discussion

All four coils could be tuned and matched without load and with saturated NaCl-solution. No resonance peak split could be observed. The decoupling of the four coils was achieved by adjusting the four decoupling-capacitors. The average transmission between neighboring and opposing coils was measured to 29.6 and 18.6 dB respectively (Fig. 3). The Q_0/Q_L ratio was 253/88 with a 85 mm diameter 6 g/l (150 mmol) NaCl-solution phantom. Imaging experiments confirmed the good isolation and showed a relatively homogeneous transmit profile(Fig.4,5).

Conclusion

It was shown that for 300 MHz arrays, the BIGMAC design is an interesting alternative to the traditional loop arrays and an improvement of the basic microstrip concept. Advantages of our array are the large usable diameter due to the relatively small thickness of the coils and the possibility to easy decouple the four channels without overlap or active decoupling circuitry.

References

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Fig. 4: Transmission with all four channels shows a homogeneous transmit profile. The receiving channel was placed on the left side. A 10π-pre pulse was used to aquire a qualitative B_1-map. This means that there are 10% variation between two black stripes. The used phantom was a 6 g/l NaCl-solution (84 mm diameter) placed in the center of the array.

Fig. 1: The 4 channel BIGMAC-array

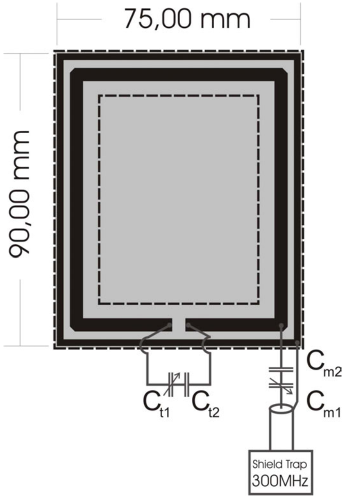

Fig. 2: Schematic of the BIGMAC

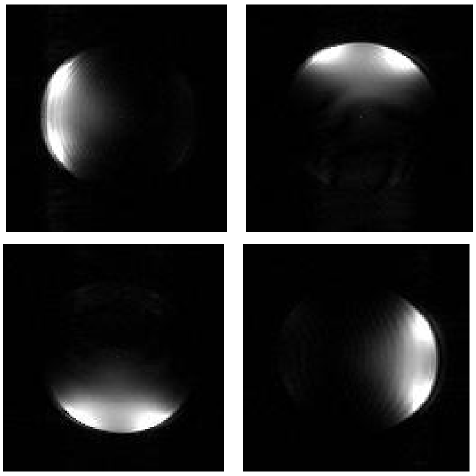

Fig. 5: Images from each of the single coils