Dedicated 8-channel Transceive Array for Rat Head MRI at 9.4T

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Introduction

A 9.4T 8-channel actively detunable transceive volume array for small animal MRI had been presented in our previous work [1-3]. Each element of the array coil can be driven independently with individual excitation profile and the array coil can operate in transmit and/or receive mode according to different applications. It has been shown that the volume array is capable to perform standard MR imaging, Parallel Excitation (PEX)/Transmit SENSE and Spatially Selective Excitation (SSE) imaging to circumvent some associated high-field problems. However, in the case of smaller filling factor (small rat or rat head only) independent local receive-only coil is more favourable to use to gain higher SNR. To benefit from the advantages of these techniques, a dedicated 9.4T phased-array for rat head MRI was developed. An 8-channel transceive array coil was modelled /simulated and a prototype was constructed and tested in a Bruker 9.4T Biospec MRI system. Preliminary experimental results presented herein demonstrate the potential of the work.

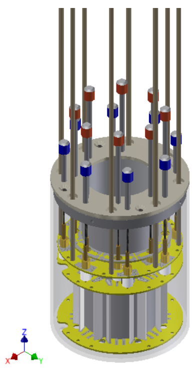


Fig 1

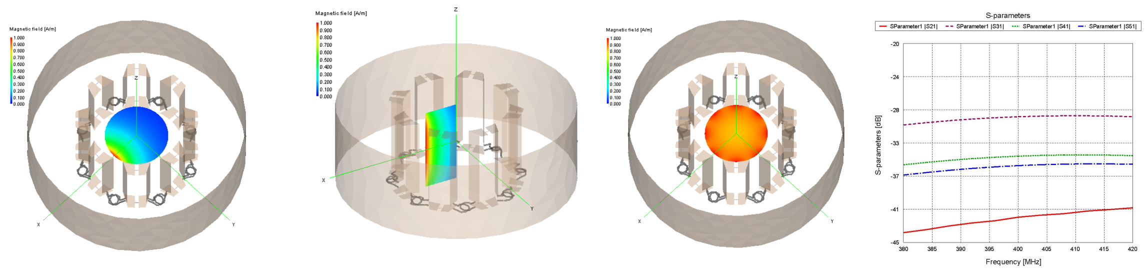


Fig 2(a) **(b)** **(c)** **(d)**

Methods

Depicted in Fig 1 is the structure of the prototype transceive rat head array without showing of RF shield. Rods on service side with red and blue knobs are used for tunning and matching. Eight coil elements circumferentially positioned on a tube of 40mm in diameter. Each coil element is 40mm long. The entire array structure is similar as that of the volume array coil. The coil element design was also based on the angularly-oriented coil blade technique which was described in our previous work. For mutual decoupling, a counter-wound inductor (CWI) decoupling method is implemented and performed very well in EM simulation (FEKO) (as shown in Fig.2). To realise mutual decoupling between first, next neighbour and the fourth coil elements, capacitive decoupling network was also employed in prototype construction procedure. The prototype of 8-channel rat head array loaded with cylindrical phantom was tested in a 9.4T 30cm BioSpec-system (Bruker BioSpin MRI GmbH; Ettlingen, Germany) equipped with eight separate transmit and receive channels.

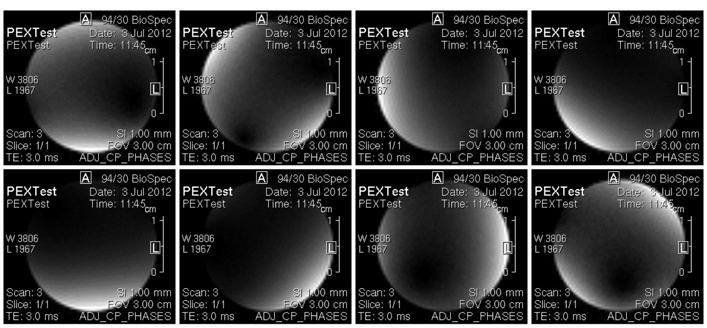
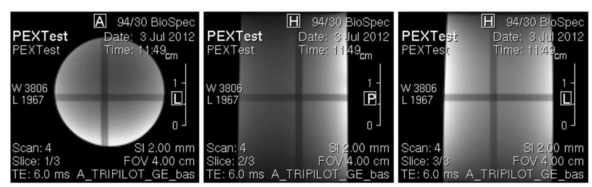
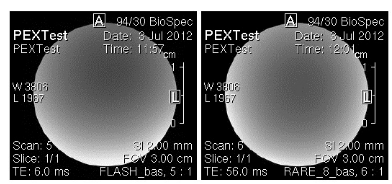


Fig 3(a)

(b)



(c)



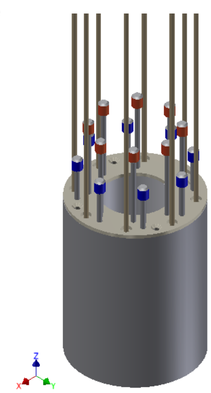


Fig 4

Results and discussion

Shown in Fig 2(a-c) is the modelling of the proposed 8-element transceive array coil without loading. All the modelled coil elements are tuned to 400MHz and matched to 50Ω and excited with a voltage source. Depicted in Fig 2(a-b) are the normalized magnetic fields of one coil element on the transverse and coronal planes. The normalized magnetic field on the transverse section, with the decoupled coil elements excited in a CP mode (simultaneous excitation of all the decoupled coil elements with voltages sources of 1V but with 45° phase shift individually) is shown in Fig 2(c). By FEKO simulation, CWI decoupling method can realize mutual coil elements decoupling independently (as shown in Fig 2(d)). EM simulation was based on ideal situation without any interference or manufacture tolerance. However, in coil construction procedure, extra capacitive decoupling network was required and utilized to compensate the decoupling between the rest of neighbour coils. Single-element transmit imaging on a cylindrical rat head phantom is first performed. Shown in Fig 3(a) are the acquired axial images of each coil element. Slightly residual coupling between opposite elements still can be seen from Fig 3. This interference could be eliminated by refine the decoupling network and improvement of coil element uniformity. Fig 3(b) shows a pilot scan in three planes in CP-Mode and Fig 3(c) shows CP-Mode FLASH and RARE scans with higher resolution. Entire appearance of the prototype is shown in Fig 4.

Conclusion

In this work, a dedicated 8-channel transceive phased-array coil for 9.4T rat head MRI is modelled and constructed. The array was designed within the limited space available by using a dedicated coil structure. The preliminary experimental results demonstrated the array coil is promising for multichannel rat head MRI with high SNR.

References [1] Li *et al*, ISMRM, pp. 2801, 2012. [2] Li *et al*, ISMRM, pp. 3833, 2010. [3] Weber *et al*, ISMRM, pp. 3836, 2011