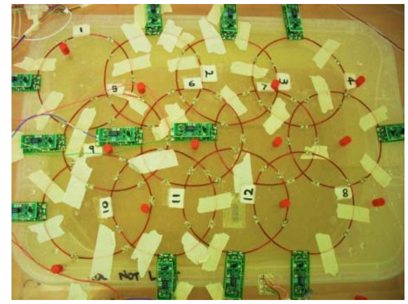
A 12-channel dorsal receive-only body array for 7 Tesla.

Ria Pradhan[1], Andreas K. Bitz[1], Stefan Maderwald[1], Oliver Kraff[1], Mark E. Ladd[1], and Stephan Orzada[1]
[1]*The Erwin L. Hahn Institute for Magnetic Resonance Imaging, Universität Duisburg - Essen, Essen, Nord Rhein Westfalen, Germany*

Introduction: At 7 Tesla, body imaging is usually performed with multi-channel transmit coils to reduce problems of inhomogeneous excitation. Many of the coils used are transmit/ receive coils, where the number of receive channels is usually equal to transmit channels[1, 2]. To improve parallel imaging performance, the number of receive coils can be increased by adding dedicated receive arrays. In this work we present a 12-channel dorsal receive-only array to be used in conjunction with an 8-channel transmit/ receive coil for body imaging at 7T.

Figure 1: 12-channel receive array (from below)



Methods: The receive-only array shown in Fig. 1 consists of 12 circular elements (mounted on a 0.5-cm-thick PMMA /Plexiglas board) made of copper wire having a diameter of 1.50 mm, coated with polyurethane. Elements were shaped by bending the wire around a cylindrical disc of radius 6.6 cm. Each element is divided into 6 sections separated by 5.6 pF capacitors. The array is 55 cm long and 40 cm wide. The pre-amplifiers with matching and detuning networks are placed directly adjacent to the elements. The individual coils are arranged as shown in Fig. 1, so that the maximum overlap is about 4 cm and the coils are geometrically decoupled. Also, pre-amplifier decoupling is used. The coupling between direct neighbours and between next-nearest neighbours was measured using a network analyser and a human tissue-simulating phantom. In normal use, a thin foam cushion (0.5 cm) separates the body tissue from the PMMA.

The array was used with an 8-channel transmit/ receive body coil with meander stripline elements[2]. The transmit coil has 2 arrays of 4 elements, which are placed dorsally and ventrally on the human body. The elements of the ventral array are enclosed in individual modules and are interconnected with neoprene, making the ventral array adjustable to the patient's contour. Imaging experiments were performed in an oil phantom and in vivo on a whole-body 7T MR system (Magnetom 7T, Siemens, Erlangen). The g-factor was calculated for acceleration factors of 2, 3 and 4 using the pseudo multiple replica method[3]. Phase encoding was in the anterior – posterior direction.

Results: Decoupling from -37 dB to -14.4 dB between direct neighbours, and from -38 dB to -17 dB between next-nearest neighbours was measured. Figures 2a, 2b, and 2c show the Grappa g-factor for R=4, noise correlation, and a gradient echo image also for R=4 from a vegetable oil phantom. Figures 3a, 3b and 3c show the Grappa g-factor for R=4, noise correlation, and a gradient echo image (R=4) from a male volunteer (1.72 m, 68 kg) when the 12-channel receive array was used along with the 8-channel body coil. Figures 4a, 4b and 4c show the Grappa g-factor for R=4, noise correlation, and a gradient echo image (R=4) from the same volunteer when only the 8-channel body coil array was used. Maps of g-factor show a lower g-factor in the presence of the 12ch Rx array. Strong noise correlation is present between a few elements, e.g. element 5 (back element of Tx/Rx coil) and the receive elements 10, 11 and 12.

Fig. 2a: g-factor in phantom with Rx array

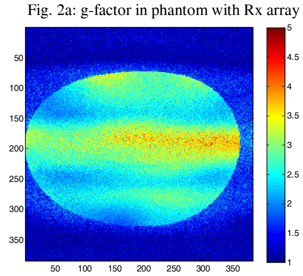


Fig. 2b: noise correlation in phantom with Rx array

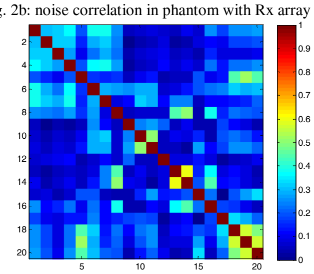


Fig. 2c: gradient echo in phantom with Rx array

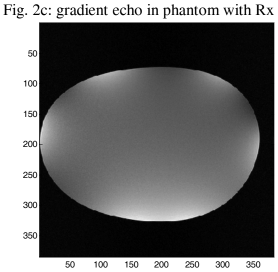


Fig. 3a: g-factor in vivo with Rx array

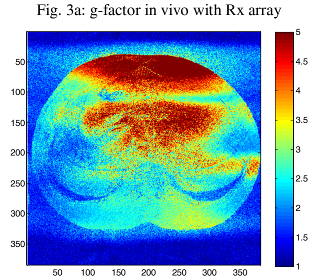


Fig. 3b: noise correlation in vivo with Rx array

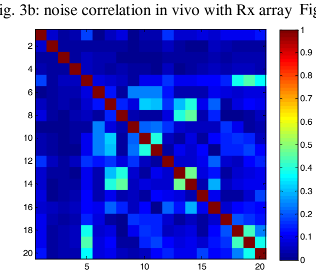


Fig. 3c: gradient echo in vivo with Rx array

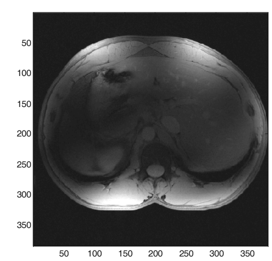


Fig. 4a: g-factor in vivo without Rx array

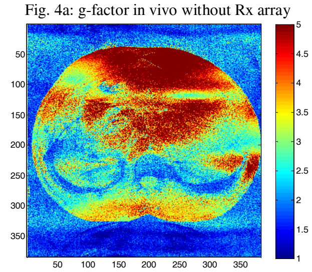


Fig. 4b: noise correlation in vivo without Rx array

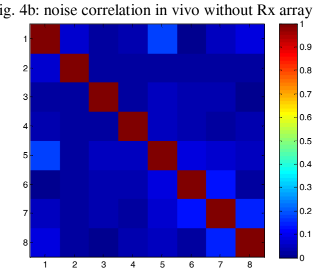
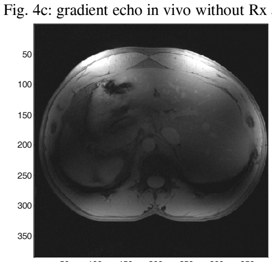


Fig. 4c: gradient echo in vivo without Rx array



Discussion & Conclusion: A 12-channel receive array was successfully used in conjunction with an 8-channel transmit/ receive coil to enhance parallel imaging performance. The results show that this receive array is operational and can be used with the existing transmit array. The decoupling between neighbouring elements was below -14.4 dB. As the combination of geometrical and pre-amplifier decoupling sufficed, it was not necessary to introduce additional decoupling through capacitors or inductors. The transmit elements of the 8-channel body array and the elements of this 12-channel array were not decoupled during receive, which may have affected the image quality. The g-factor is lower in the measurement made with the receive array than in the one without the receive array, i.e. with only the 8-channel transmit / receive body coil. This shows the enhancement in parallel imaging capability due to the 12-channel receive-only array. Future work will include modifications for making a 32-channel receive body array using this array together with a 20-channel ventral receive array.

References: 1. Vaughan et al. (2004), Efficient high-frequency body coil for high-field MRI. Magnetic Resonance Medicine, 52: 851–859. doi: 10.1002/mrm.20177; 2. Orzada et al. A Flexible 8-Channel Transmit/Receive Body Coil for 7 T Human Imaging. In: Proceedings of the 17th Annual Meeting of ISMRM, Honolulu, Hawaii, USA, 2009, p 2999; 3. Robson et al. (2008), Comprehensive quantification of signal-to-noise ratio and *g*-factor for image-based and *k*-space-based parallel imaging reconstructions. Magnetic Resonance Medicine, 60: 895–907. doi: 10.1002/mrm.21728