A 7-channel receive array insert for enhancement of SNR and acquisition speed in the cerebellum and visual cortex at 7T

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Introduction

Since Roemer et al. [1] introduced the concept of multichannel Rx-arrays, they have commonly been used in MRI to enhance SNR and, with the introduction of parallel imaging, acquisition speed. To improve image quality and acquisition speed of a commercially available Tx/Rx coil, a 7-channel receive insert was designed to improve imaging in the cerebellum and visual cortex.

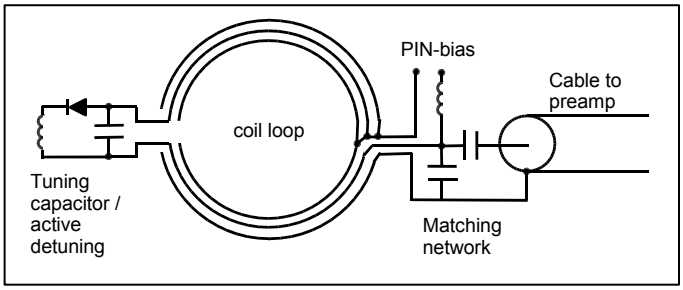

Figure 1: Sketch of a single loop element.

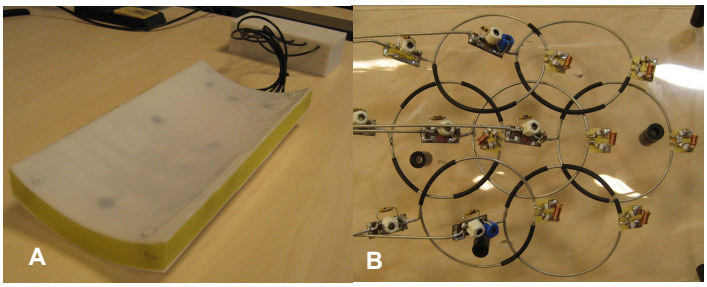

Figure 2: A) Array with housing; **B)** 7-ch array viewed from the bottom.

Materials and Methods

The array consists of 7 loop elements which are arranged in a hexagon with one element in the middle; the elements are overlapped for geometrical decoupling. The loops, each with a diameter of 5 cm, are formed from semi-rigid cable. Because of the symmetry of the loops, there is no need for a cable trap close to the loop feeds (Fig. 1). Active detuning is achieved with an inductance parallel to the tuning capacitor on one side of the loop. The housing of 3 mm PMMA is concave to provide a good fit to the human head (Fig. 2). The cables to the preamps contain cable traps just outside the transmit coil to prevent shield currents during transmit.

The array is inserted into a commercially available 8-ch head coil [2] which cannot be detuned. No decoupling during reception except preamp decoupling was performed between the commercial coil and the 7-ch receive array. The preamplifiers were situated in a box outside the coil. Images were acquired in a phantom and a healthy volunteer on a Siemens 7 T whole-body system, including parallel imaging (GRAPPA) at various acceleration factors.

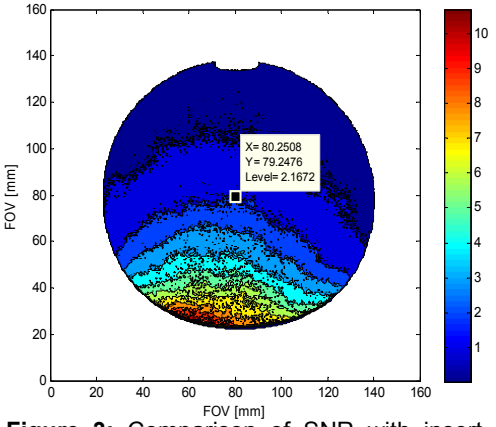

Figure 3: Comparison of SNR with insert versus SNR without insert in a transverse plane through a 12 cm oil bottle. Spoiled gradient echo image with a 320*320

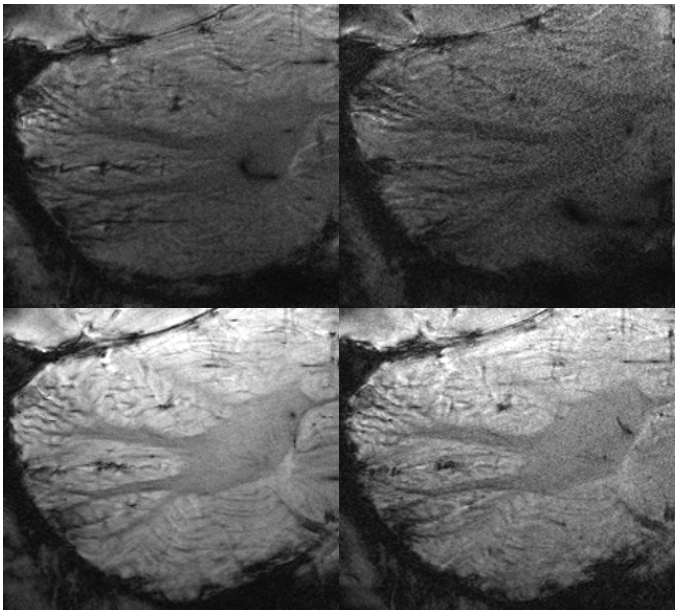

Figure 4: Image quality comparison. Images show identical sections in the cerebellum of a healthy volunteer acquired with a T2*-weighted gradient echo sequence. Resolution 0.22x0.22x3 mm^3. Upper row: 8-ch only, lower row: 8-ch + 7-ch. Left column: acceleration factor 2, right column: acceleration factor 4.

Results and Discussion

Gradient echo SNR measurements on a 12-cm-diameter bottle filled with oil show an enhancement of a factor 2 in the center and up to a factor 11 close to the array (Fig. 3). The decoupling during transmission works well, only minor flip angle enhancement of less than 10% in the vicinity of the array is measured.

Figure 4 shows a comparison in image quality in the cerebellum between the original 8-ch configuration and the new configuration with 8+7 channels. The images reveal that even with an acceleration factor of 4 (bottom right), the image quality is enhanced compared to the original configuration with a speed up factor of 2 (upper left), though no other means of decoupling than preamp decoupling was implemented between the 8-ch coil and the insert during reception.

The 7-ch Rx-array insert provides an easy means of enhancing image quality and acquisition speed in a standard commercial 7T coil. This enhanced sensitivity is expected to be of particular value in function and structural studies of the cerebellum and visual cortex.

[1] P. B. Roemer et al. MRM 16, 192-225 (1990). [2] RAPID Biomedical GmbH, http://www.rapidbiomed.de/