A Volume Head Array with 8 Transmit / Receive Channels for 7 T

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Introduction

Recently, very high field human MR scanners became available. These high frequencies promise high SNR and new contrasts in human applications. Especially in combination with parallel acquisition techniques substantial improvements in image quality are to be expected. Special challenges at these high frequencies are dielectric resonances and - for array construction - the decoupling of the coil elements. The aim of this work was to develop an 8 channel array for investigating the human head at 7 T.

Methods

In order to gain space a transmit / receive array setup was chosen. This further yields the advantage that no active decoupling mechanism is necessary. The array consists of 8 independent channels. All of them are used for excitation as well as for signal detection. Each array element is a loop with a rectangular shape with the loop area facing towards the sample. This geometry yields lower coupling to dielectric resonances than other designs (e.g. TEM resonator) which is essential at the frequency of 300 MHz. The array elements are arranged in a slightly elliptical manner for adaptation to the average human head shape. This enables uniform loading conditions for each element when loaded with the head. Thus, the housing has free inner diameters of 23 cm (short axis) and 27 cm (long axis).

Since multiple transmitters were not available, the array can only be quadrature driven during transmission. Therefore, the transmit power is equally divided by an 8-fold power splitter. Appropriate phases are applied to the transmit signals. The phases are chosen to match the geometric position of the corresponding elements. During reception, 8 independent receivers are available. Low noise high input impedance preamplifiers are used to further improve the decoupling of the array elements. This preamplifier decoupling is established through the transmit-receive switches during receive mode only. All MR measurements were done on a Siemens 7 T MR system.

Results

The unloaded Q of a single element is 400 with a Q drop by a factor of 3 when loaded. This indicates that sample noise is the dominant noise source. The isolation between the elements in transmit mode are as follows: neighboring elements -8.5 dB, all other combinations < -20 dB. Figure 1 shows a gradient echo image of a human head in vivo (spin density contrast). Acquisition parameters are TR = 501 ms, TE = 4 ms, FOV = $(250\ \mathrm{mm})^2$, matrix $(256)^2$, slice thickness 2 mm. Figure 2 shows the same image taken on the same volunteer but with a quadrature head TEM resonator. The dielectric resonance is only apparent in the image taken with the TEM resonator.

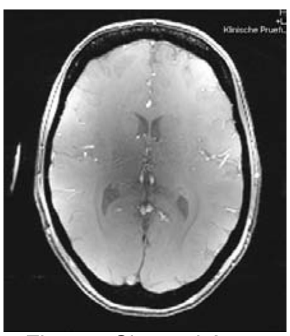

Fig.1: 8 Channel Array

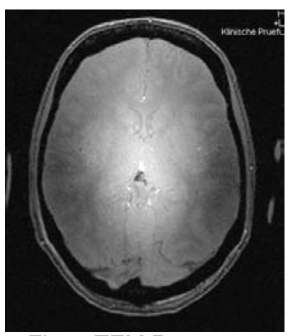

Fig.2: TEM Resonator

Discussion

We built an 8 channel transmit / receive array for imaging the human head at 7 T. Due to the scanner architecture, the array is quadrature driven during excitation whilst it has 8 independent receive channels. Dielectric resonances were minimized by the orientation of the coils elements which is shown by comparison to an equivalent TEM resonator. Future work will show the performance of the array in parallel imaging applications. Factor 2 acceleration in one dimension has been tested without artifacts. Moreover, the array is capable of future transmit sense techniques. Currently we are working on an equivalent 3 T version of the array.

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