An 8 Channel Transmit Recieve Helmet Coil with Dodecahedral Symetry

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Introduction:

We describe here an 8-channel Transmit-Receive (TxRx) array, consisting of 8 capacitively decoupled loop elements, placed with dodecahedral symmetry at a safe distance from the average human head. The design was modeled after a previously proposed coil [1] which was designed to allow for full brain coverage as well as coil profile variation along all three directions, x, y, and z, but which could not be used for human imaging because of its small dimensions and fragile construction. It has been modified here to better fit around the head and is demonstrated with in vivo parallel transmit images.

Figure 1: Image of coil

Methods:

The dodecahedral coil array was tested on a prototype 7T scanner (Siemens Medical Solutions Erlangen Germany) with 32 receive channels and 8 transmit channels, and was compared to a 24ch Head Coil (Nova Medical, Wilmington, MA). The coil was mounted around a fiberglass helmet, designed to sit 1cm away from the head on all sides assuming the head norm for European males (helmet 242mm anterior-posterior, 181mm left-right, 220mm superior-inferior). The coil elements were constructed from 2mm thick wire around the coil edges soldered to small circuit board sections which provided solder pads and mounting points for capacitors (Figure 1). The corners of each coil were cut short, creating small triangles at each junction, to distribute capacitance and allow for tuning of each individual loop while neighbor-decoupling was provided by an adjustable capacitor on shared edges. The array is made up of 5 coils encircling the top of
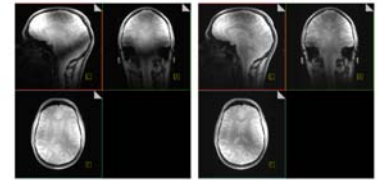

Figure 2: Original image (L) and parallel transmit image

the head and three in a lower row around the base of the head and neck. A lattice balun was attached to the free edge of each element, matching to 50 Ohms [2]. Tuning, matching, and neighbor element decoupling was optimized on the bench using a network analyzer (Agilent Technologies, E5061A), and cable length was chosen to provide preamp decoupling.

Both the dodecahedral coil and the Nova Medical 24ch coil were first tested and compared on a phantom shaped like a human head (consisting of H_2O, agar, and a biological concentration of salt), and additionally tested on a human subject after testing the dodecahedral coil for SAR limit. All volunteer measurements were made in accordance with our institution's IRB.

SNR was measured by acquiring two gradient echo scans in the three slice directions (TR/TE/TA/Flip/Slice/BW = 200ms/4.07ms/53sec/20°/3mm/300, matrix 256x256, FoV 200x100,), one with RF excitation and a noise scan with no RF excitation.
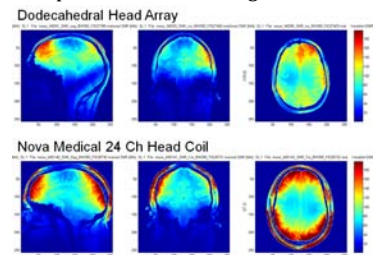
The B1 transmit profiles of the individual elements were assessed using a DREAM mapping technique [3]. **Figure 2** shows images were acquired in parallel transmit mode using the k-t points method (TR/TE/TA /BW = 25ms/1.8ms/5:57min/485, 1.1mm isotropic, matrix 224x224x144, FoV 246x246) [4].

Figure 3: SNR in human brain

Results:

S12 coupling between neighboring elements was measured with a human head load and all other coils tuned and terminated with 50 Ohms, and all values were -15dB or better. S11 match for the human head load was -10dB or better for each element. **Figure 3** shows the SNR comparison between the dodecahedral coil and the Nova 24ch coil. Though the use of only 8 channels for receive in the dodecahedral coil limits the SNR near the surface of the phantom, the SNR at the center of the phantom, especially in the area at the top of the head surrounded by the 5 coils in a loop, is significantly benefitted. **Figure 4** shows the B1 maps from the dodecahedral coil and the Nova coil for comparison.
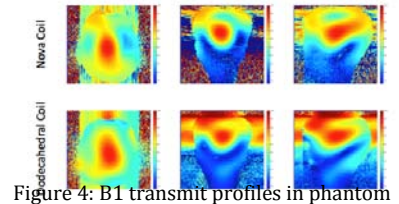
Figure 5 shows the B1 transmit profiles of each individual element, as well as the B1 transmit profiles of the 8 channels combined. The three elements at the bottom of the head (6, 7, and 8), appear low in intensity because the slice shown is in the superior hemisphere of the brain.

Figure 4: B1 transmit profiles in phantom

Conclusions:

The transmit efficiency, receive sensitivity, and brain coverage are comparable to that of the Nova 24ch head coil at the center of the brain. Additionally the double row of coils in this 8 element TxRx array allows for variation along all three directions, allowing for better control during a parallel transmission.
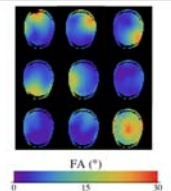
[1] Wiggins G, et.al. ISMRM, 2011 **148** [2] Peterson et all. ISMRM 2002 **885** [3] Nehrke et al. Magn Res Med. 2012 **20** 605 [4] Cloos et al. Magn Res Med. 2012 **67** 72-80.

Figure 5: Individual B1 transmit profiles