7 Tesla 16-Element TEM Tx Coil with Dedicated 14-Channel Receive-Only Array

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Introduction The clinical and research potential of MRI/S for head applications at ultrahigh (≥7 tesla) fields continues to grow. This growth is currently hampered by significant challenges that were not encountered at lower fields. The most notable of these challenges include 1) safety concerns regarding exceeding radiofrequency (RF) power deposition in tissue [1] and 2) large image inhomogeneity/voids due to "undesired" RF field inhomogeneity [2] across the anatomy. In this work we present a design for homogenous and efficient Tx head coil combined with receive-only array.

The Tx Coil The Tx coil is a 16-element TEM resonator [3] with 4-ports. The coil is relatively spacious and patient friendly with the following dimensions: strut diameter is 0.5", center of strut to shield is 1.25", O.D. of shield is 13.5" I.D. is 10", radius from the iso-center to the center of each strut is 5.5", and coil length is 7.5."

Decoupling the Receive-Only Array The receive array consists of 14 decoupled loops. The circuit for one element is shown in Fig. 2. The decoupling of the receive elements from the Tx coil (TEM design) is accomplished through the use of four decoupling circuits in each receive element. Two different types of decoupling circuits are used. The first circuit is for active decoupling (as shown in the shaded yellow box,) the diode used to switch is controlled using a DC voltage supplied by the MR scanner. The second type used is for passive decoupling (shaded blue box) the diode used to switch it is activated by the RF energy from the Tx coil. Since the decoupling circuits and the Tx coil are tuned to the same frequency, the Tx coil observes a high impedance across the decoupling circuits thus detuning the Rx-insert.

Decoupling Transmit Coil There are 4 distributed transmitters in the 16-element Tx coil. The decoupling of the transmit elements is accomplished though the use of the diodes positioned at the center of the TEM elements. During the receive portion of the scan, these diodes detune transmitters and lessens interactions with the Rx-only array.

Results and Discussion At the time of the abstract, the coil has been tested on 6 volunteers. Sample 3D MPRAGE, MIP/SWI, and GE images are shown in Figs 2-4. The coil exhibits excellent homogeneity throughout the brain volume. In addition, the coil is also highly efficient and is capable of achieving 180° flip angle without SAR violation.

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1. Vaughan, J.T., et al., Magn Reson Med, 2001. **46**(1): p. 24-30.
2. Wald, L.L., et al., Applied Magnetic Resonance, 2005. **29**: p. 19-37.
3. Vaughan, J.T., et al., Magn Reson Med, 1994. **32**(2): p. 206-218.

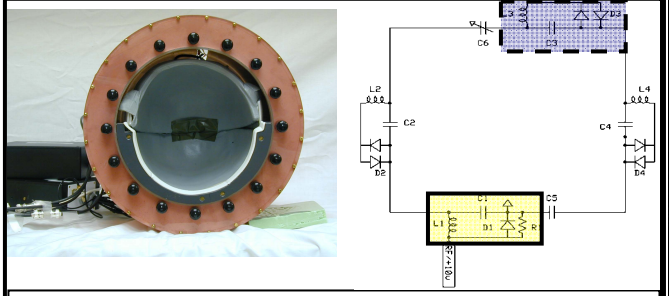

Fig. 1: (Left) Picture of the 16-element TEM Tx with 14-channel Rx-only insert and (Right) 1 element in Rx only array with passive & active decoupling (from the Tx coil) circuits.

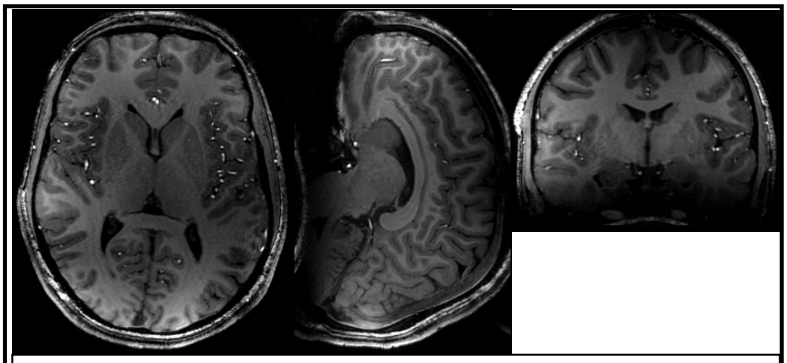

Fig. 2: Sample 7T 3D MPRAGE Images with $(0.5mm)^3$ isotropic resolution, and 23Min acquisition time.

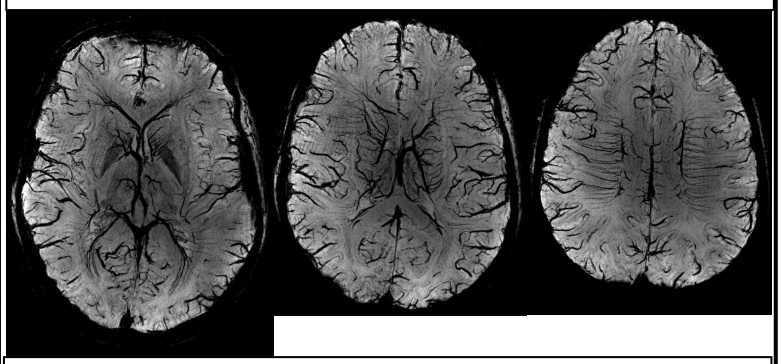

Fig. 3: Sample 7T MIP/SWI Images with 416x512 in-plane resolution, 10Min acquisition time and 1.2mm slice thickness.

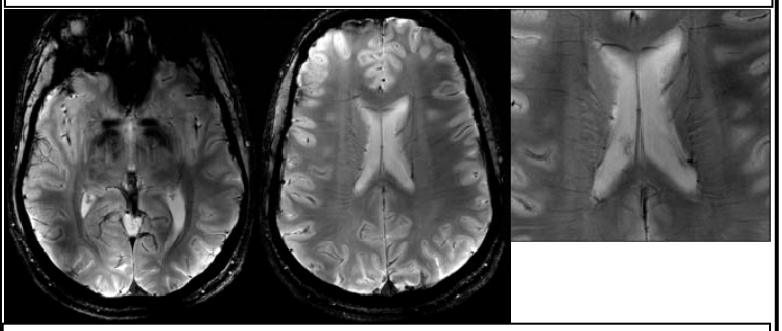

Fig. 4 Sample 7T GE Images with 1024x1024 in-plane resolution, 11Min acquisition time and 2.5mm slice thickness.