**Simultaneous Reception from the Head Volume Coil and the Array of Counter Rotating Surface Coils (CRC) at 4T– an Alternative to Using Actively Detuned Transmit Volume Coils.**

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**Introduction:** A common way to improve SNR from restricted regions is by using a transmit-only volume coil with a receive-only surface coil phased array. Although phased arrays have superior SNR near the coils, it has not been possible to achieve substantial SNR increases in comparison to volume coils from the central region (7-8cm depth) of a human head (1). Substantial improvements of the SNR near the center of the head can be obtained if the volume transmit coil is also used for reception. Previously Hyde et al used a volume coil and a single surface coil for simultaneous reception demonstrating improved SNR in areas where both coils have similar sensitivities (2). To avoid interactions between the two coils, the authors designed a counter rotating surface coil (CRC) consisting of two parallel rings carrying opposite currents (3). This configuration provides intrinsic isolation between the surface coils and the transmit coil, which enables simultaneous reception by both coils. Although the unloaded CRC coil has much lower sensitivity than a single-turn coil of the same size, when loaded such that sample losses dominate, the two coils become indistinguishable (3). This work describes the development of a CRC phased array for simultaneous reception with a volume coil for MRSI of the human brain at 4T.

**Methods:** The three-coil CRC array was constructed using 6.4mm wide copper tape. Each surface coil measured 8 x 7.5 cm and consisted of two coplanar loops connected in series and separated by 1.2 cm. When placed on acrylic former of 20 cm id with 1cm distance between the CRC coils, the array covered an arc of 138°. The intrinsic decoupling between surface coils was about 8dB. Using low input impedance preamplifiers (input impedance ~ 4 Ohm) provided better than 20 dB isolation between the coils. Intrinsic isolation between the volume and CRC coils was better than 18dB. A 16-element TEM volume coil (4) was used for transmission (element id - 31.8cm, shield diameter - 38cm, length 23.5cm). PIN diode detuning circuits were incorporated into the CRC coils and the volume TEM coil to enable comparison of coils' sensitivities with and without simultaneous volume/surface coil reception.

**Results and Discussion:** First, the sensitivity of a single CRC coil was compared to the regular single-loop surface coil of the same size. A 2l (16 cm OD) spherical phantom with 50 mM NaCl was used. During the CRC/volume coil simultaneous reception $B_1$ profiles of both coils were altered only near the CRC coil. The CRC coil sensitivity was lower than that of the single-loop coil at the depths under 2 cm. At larger depths both surface coils had similar sensitivities. The decrease in sensitivity immediately adjacent to the CRC coil surface is advantageous for human brain spectroscopic studies since contamination arising from the scalp and muscle can be decreased. The CRC coil profiles obtained with and without simultaneous volume/surface coil reception were nearly identical. Without preamplifier decoupling the volume coil sensitivity, however, showed distortions up to a depth of ~5cm. Preamplifier decoupling of CRC coils eliminated the volume coil sensitivity distortions such that the decrease in the volume coil's sensitivity was less than 5% over the entire FOV. Figure 1 shows the central plots of phantom images obtained simultaneously by the TEM and the CRC array as well as the plot of their SoS combination. Figure 2 depicts human head images also obtained during the simultaneous TEM/CRC simultaneous reception. Up to 35% SNR improvement near the head and phantom centers was achieved. Displayed in Fig.3 are spectra acquired simultaneously from the CRC array and the volume coil from two locations, one from the posterior of the brain (left) where the CRC coils dominate and one (right) from the middle of the brain where the volume coil dominates.

**Figure 1**

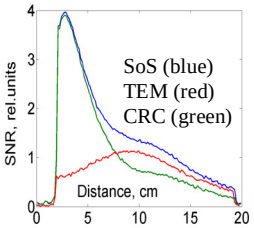



**Figure 2.** Human head images from the TEM (A) and array (B-D) obtained during the TEM/CRC simultaneous reception. E) SoS combined image.

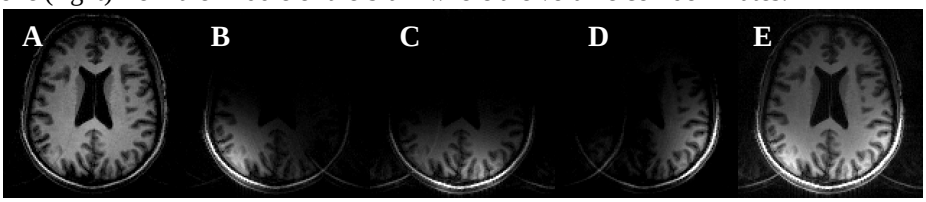
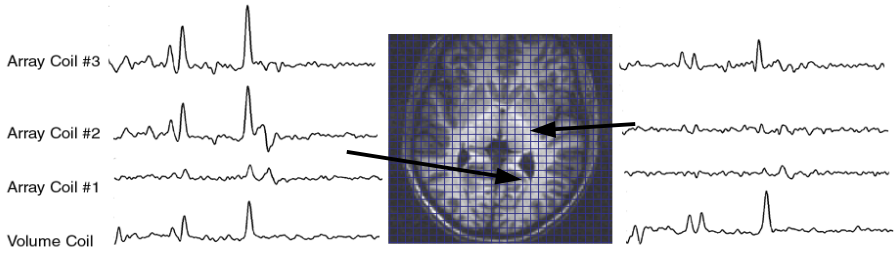



**Figure 3**




**Conclusion:** We have developed a CRC surface coil array for 4T MRSI of the human brain. The CRC coils provide sensitivity similar to a regular single-turn coil and can be used simultaneously with the homogeneous transmit volume coil for reception. Simultaneous reception improves the SNR up to 35% near the center of the head where the sensitivities of both coils are similar. No active detuning of the transmit volume coil is required due to intrinsic isolation of the CRC and volume coils.

**References:** 1) Wright SM et.al. NMR in Biomed 1997;10:394-410. 2) Froncisz W et.al., Magn Reson Med 1986;3:590-603. 3) Hyde JS et.al., Magn Reson Med 1988:6:235-239. 4) Vaughan JT et.al., MRM 1994;32:206-218.