A Novel TxRx head coil for visual stimulation fMRI with high signal stability

H. Zhu[1,2], Y. Li[2], B. Zhang[3], J. Wang[1], Y. Zhuo[2], and R. Xue[2]

[1]Radio Frequency Department, Siemens Mindit Magnetic Resonance Ltd., Shenzhen, Guangdong, China, People's Republic of, [2]State Key Lab. of Brain and Cognitive Science, Institute of Biophysics, Chinese Academy of Sciences, Beijing, China, People's Republic of, [3]Siemens Mindit Magnetic Resonance, Siemens Healthcare MR Collaboration NE Asia, Shenzhen, Guangdong, China, People's Republic of

INTRODUCTION A large portion of fMRI experiments include visual stimulation. Therefore, an unblocked vision window can improve subject's coziness, and improve the reliability of visual stimulation experiment. However, the current commercial head coil has more or less obstacles in the vision windows. In this work, we developed a Transmit/Receive (TxRx) head coil with a large rectangular window to provide a comfortable vision view for subjects.

METHODS To open a vision window of size 116mm by 74mm in the upper part of the coil, the coil elements are arranged as shown in Fig.1 (a) and Fig.1 (b).

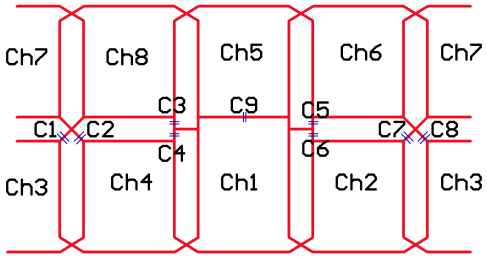

Fig.1 (a) 8-channel antenna loop distribution.

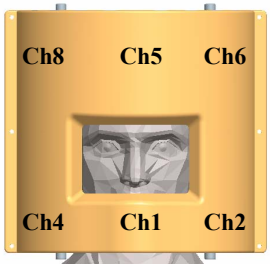

Fig.1 (b).3D mechanical top view of TxRx head coil

The element arrangement is symmetrical, except ch1 is larger than others, while ch5 is smaller, as shown in Fig.1. This design provides a sufficient viewing window, without significant interference on the homogeneity of B_1 field. This coil is well decoupled. All adjacent loops, but ch1 and ch5, are decoupled through suitable overlap regions. Ch1 and ch5 are decoupled through a common capacitor C9 [1]. The diagonal loops can be decoupled through the common capacitors from C1 to C8, for example, C1 for ch4/ch7, and C3 for ch4/ch5. As opposing loops, the coupling can be neglected, because the pre-amplifier decoupling is enough [1]. For example, the most severe coupling among the opposing loops is ch1/ch3, whose value is -12.8dB with the loading of water phantom. Except the opposing loops, the other decoupling can be adjusted to less than -16dB for each loop. Considering the high symmetrical coil element arrangement, a 1-to-8 power splitter is used to supply same RF power to all channels. Phase shifting is linear in each cluster as shown in Table 1.

Table 1. 8-ch phase distribution (in degree)

Ch1: 0	Ch2: 90	Ch3: 180	Ch4: 270
Ch5: 180	Ch6: 270	Ch7: 0	Ch8: 90

RESULTS In system integration test, the SNR is compared between the TxRx coil and the conventional 12-ch receive-only head coil (Siemens, Erlangen, Germany). The results are shown in Fig.2. The SNR analysis is conducted using P.B. Roemer's method and is calculated by home-developed Matlab algorithms [2]. Fig.2 (a) and (b) display the positions for SNR comparison along the center-line in the saggital images of the water phantom, and Fig.2 (c) shows the SNR comparison results. In Fig.2(c), the 8-ch coil has better SNR performance than the 12-ch head coil.

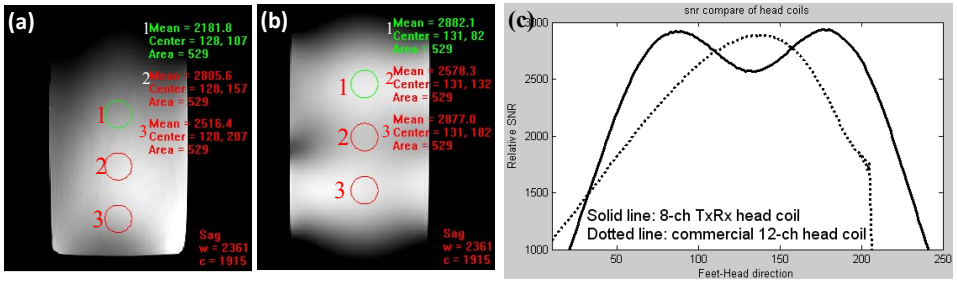

Fig. 2 (a) SNR image of 12-ch coil; (b) SNR image of 8-ch TxRx coil; (c) SNR comparison of the same position.

A signal shot EPI sequence is used to evaluate the signal stability, and 512 measurements are acquired with identical imaging parameters. For a fair comparison, a region of interest was chosen as similar as possible for the two different coils, as shown in Table 2 and Fig. 3. It is interesting that the significant improved signal stability of the TxRx coil, as the signal fluctuation decreased from 0.493% to 0.202%.

Table 2: Stability analysis results. Fig.3 shows the detailed result of #6.

	# 1	# 2	# 3	# 4	# 5	# 6	Mean	Unit	Scale
8-ch	0.24	0.18	0.17	0.20	0.21	0.21	0.202	percent	Peak to peak
12-ch	0.57	0.50	0.44	0.51	0.44	0.50	0.493	percent	Peak to peak

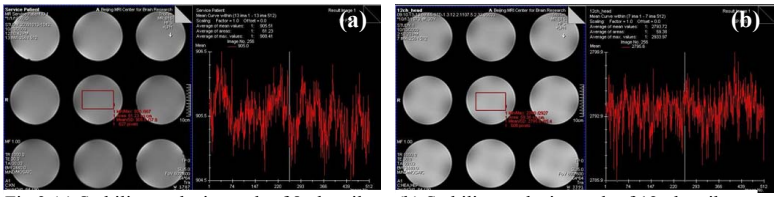

Fig.3 (a) Stability analysis result of 8-ch coil; (b) Stability analysis result of 12-ch coil.

DISCUSSION and CONCLUSION In this work, an 8-ch TxRx head coil was successfully developed with a comfortable viewing window for visual stimulation. In addition, this coil has better SNR performance and significantly improved signal stability compared to the conventional 12-ch head coil. However, the reason of the stability improve is not directly obvious to us. It may be contributed by the fact that the TxRx coil reduced the transmitting RF power. Comparing to the body coil, the TxRx coil is a local coil. Therefore, the RFPA output power can be reduced significantly. In this case, the output power of the TxRx coil is reduced by 49.3% compared to the system integrated Body Coil, which was used to transmit for the 12-ch head coil. The RFPA might be stabler with a lower power output. A lower power might result in a smaller temperature fluctuation in the electronic components of RFPA, hence a stabler power output for the RF pulses. A stabler RF pulse could provide a stabler flip angle, and in the end, a stabler MR signal. The future work includes experiments to further investigate this phenomenon.

REFERENCES [1] J Wang, Proc. ISMRM, New York, USA, 1996, 1434. [2] PB Roemer, WA Edelstein, et al. Magn. Reson. Med., 1990, 16, 192.