High Resolution Imaging at 4.7 T using Four Irregularly-Shaped Receiver Coils

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Introduction Array coils are typically used for reception only; RF excitation is provided by a uniform volume coil that allows uniform MR contrast to be imposed on the resulting image. We have developed a four-coil receiver array where each of the coils is irregularly shaped but provides approximately the same RF penetration as a 12.5 cm surface coil. The simultaneous use of four such coils placed around the head is designed to approximately match the sensitivity of a close fitting (28cm) birdcage volume coil in the centre of the brain, yet provide an improvement of up to a factor of three in signal to noise ratio (SNR) at the surface of the brain. The coil array was designed to operate in a 4.7T/ 90cm magnet.

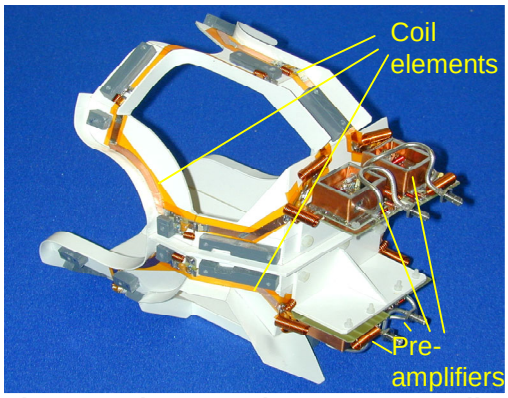
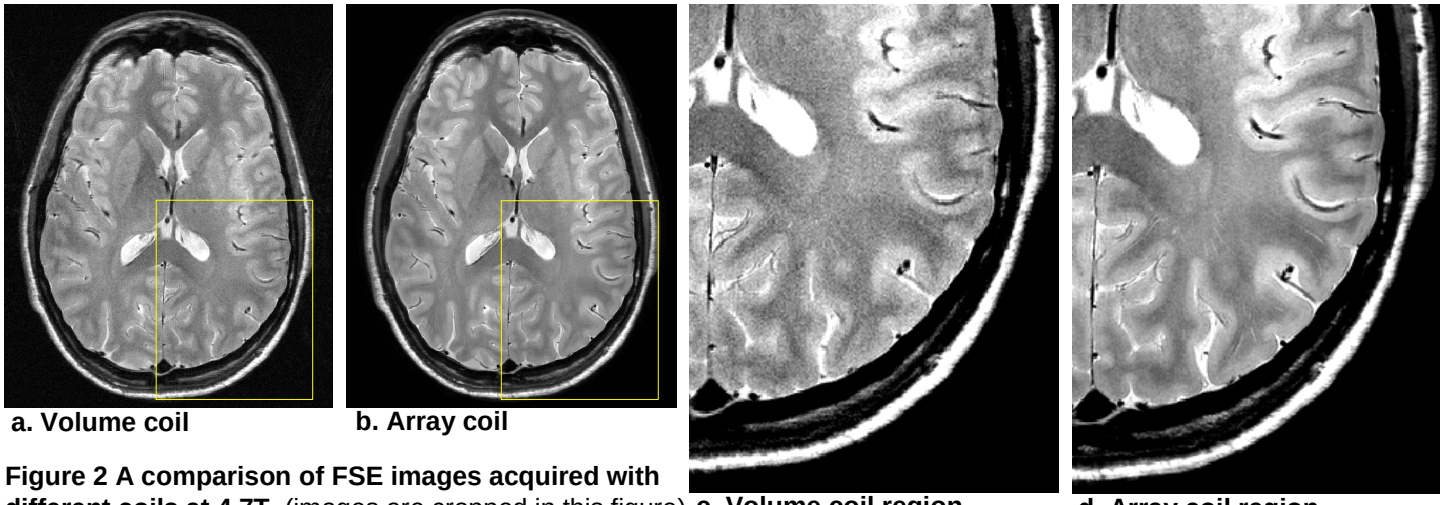


Figure 1. The Four Element Array Coil

Methods Figure 1 shows an image of the four element array coil. Each element relied on high impedance matching to the pre-amplifier circuitry to minimise mutual coupling (4). Both transmit and receive coils relied on pin-diode decoupling to avoid cross-talk. The coils were constructed of 1cm wide copper tape with distributed capacitance. Coils were positioned at 45 degrees to the main Cartesian imaging axes to optimise RF spatial receptivity profiles for SENSE imaging when using the principal gradient axes for read and phase encoding of signal. Experiments were performed on a 4.7 T/90cm system provided by Philips Medical Systems based on a design by SMIS Ltd. Imaging was performed with a Fast Spin Echo (FSE) procedure with 8 echoes spaced 22ms apart, effective TE=22ms, 2mm slice thickness and an image array of 1024x768, field of view 360x270mm, in-plane resolution 0.35mm. The total scan time was 5mins 40s. Cut-outs around the eyes and ears allow the placement of earphones and prismatic goggles for audio and visual communication with the patient; a necessity for fMRI.

Results Figure 2a shows a transverse head image obtained with the standard (28cm) head coil. Figure 2b shows an image obtained from the same section using the four-coil array as the receiver. The four signals were weighted on a pixel by pixel basis according to their sensitivity before being combined to form an image of uniform sensitivity and optimal SNR (4). Figure 2c shows an exploded region obtained from Figure 2a and for comparison, Figure 2d shows the same region obtained using the four-coil array as the receiver. The SNR is clearly better in outer brain regions (up to a factor of three) and matches that of the standard coil in the centre of the brain.

Discussion While improving the performance of standard image acquisitions, the coils also provide good RF spatial receptivity profiles for speeding up data collection using parallel imaging (1,2,3). In addition, the coils have been designed to be compatible with good audio-visual communication with the patient.



a. Volume coil **b. Array coil** **c. Volume coil region** **d. Array coil region**

Figure 2 A comparison of FSE images acquired with different coils at 4.7T (images are cropped in this figure)

References 1. Sodickson D.K. et al; Magn. Reson. Med. 38, 591 (1997) **2.** Pruessmann K.P. et al; Magn. Reson. Med. 42, 952 (1999) **3.** Weiger, M. et al; Magn. Reson. Med. 45, 495 (2001) **4.** Roemer P.B. et al; Magn. Reson. Med. 16, 192 (1990)

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