Using Separated Volume Transmit and Local Receiver Arrays for Body Imaging at 7T

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Introduction: To date, most 7T body imaging has been performed with local tranceive arrays (1,2). However, it is know that using a larger volume array in conjunction with local receivers provides higher spatial sensitivity and SNR when compared to either local transceivers or large volume coils (3,4). To minimize known coil losses at higher field strengths, we developed a conservatively-sized volume stripline/TEM array for body imaging at 7T. Active PIN diode detuning allows it to be used in conjunction with local receive-only arrays. This TEM array is also a clamshell design, allowing it be either used as a whole- or half-volume array.

Methods: The volume transmit coil is a clam-shelled 12-channel TEM array (fig 1a,b). Each coil element was individually tuned to proton's resonant frequency at 7T and interconnecting capacitors were used to decouple nearest neighbor elements. Active PIN diode detuning allowed this coil to be a transceive array or transmit-only array when used in conjunction with the receiver array. The clamshell design allowed the volume array to be split into two separate 6-channel arrays (fig 1b) and used as either a whole- or half volume array.

The outer diameter of the transmit array is approximately 53 cm, only 2 cm smaller then the diameter then the Siemen's bore liner. A 182 cm long patient platform was imbedded in the array and designed to be mated to the Siemen's patient table bed. This allowed patient positioning and tuning and matching to be performed outside the then the patient platform and array would be rolled into the magnet. (fig 1a,b)

A two 8-channel square-loop receiver arrays were etched on a flexible printed circuit board (fig 1c). Each loop was independently tuned to proton's Larmor frequency at 7T and neighboring coils were decoupled using both preamplifier decoupling as well as interconnecting capacitors. Active PIN diode detuning was used to detune the receiver arrays during transmission.

Local B_1 shimming was employed to optimize the transmit phase for each element on the array.

All imaging experiments were performed on a 7T (ω_o=296.8 MHz), 90cm bore magnet (Mangex Scientific, UK) equipped with Siemens console and whole body gradients. Twelve 1KW amplifiers (CPC, Brentwood, NY) with independent phase and amplitude modulation capabilities were used for excitation.

Results: The spatial coverage of the combined transmit and receiver arrays can be seen in figure 1d,e. FLASH images (TR/TE=100/4.08ms, image resolution = 0.89 x 0.89 x 5.0mm for the sagittal and 0.57 x 0.57 x 5.0mm for the axial image) of the female pelvis were acquired. Both the sagittal and axial images show increased sensitivity near the periphery body due to the close proximity of the receiver arrays; some RF shading is noticed, this is due to the short wavelengths in the human body (12cm) at 300 MHz. Large ROI B_1 shimming methods will help reduce these artifacts.

Figure 2 show two images from a retro-gated FLASH cine of the left ventricular outflow track(TR/TE= 38.48/2.08ms; image res= 2.08 x 2.08 x 6.0 mm, time of acquisition = 13. 6s) at diastole (fig 2a) and systole (fig 2b).

Figure 3a shows the TEM array being used as a half-volume transceive array. Bilateral FLASH images (TR/TE=40/4.08ms; img res=0.65 x 0.65 x 5.0 mm) of the breast were acquired with the bottom six elements. Using the TEM array as a half-volume array provides homogeneous bilateral images of the breast while minimizing cardiac and chest excitation.

Conclusions: To minimize known coil losses at ultra-high field strengths, we have developed a conservatively sized volume stripline/TEM array that can be used in conjunction with local receiver arrays for body imaging at 7T, as we have shown with both cardiac and pelvis imaging studies. Additionally, since the TEM array has a clamshell design, it is suitable to be used as a half-volume array, as we have shown with our bilateral breast imaging studies.

References: 1) Metzger G. et al. MRM 2008; 59:396-409. 2.) CJ Snyder et al. "Initial Results of Cardiac Imaging at 7T. MRM 2008 (in press) 3) Vaughan JT. et al. Magn Reson Med 2002; 47:990-1000. 4) Wiggins GC. et al. Magn Reson Med 2005;54:235-240

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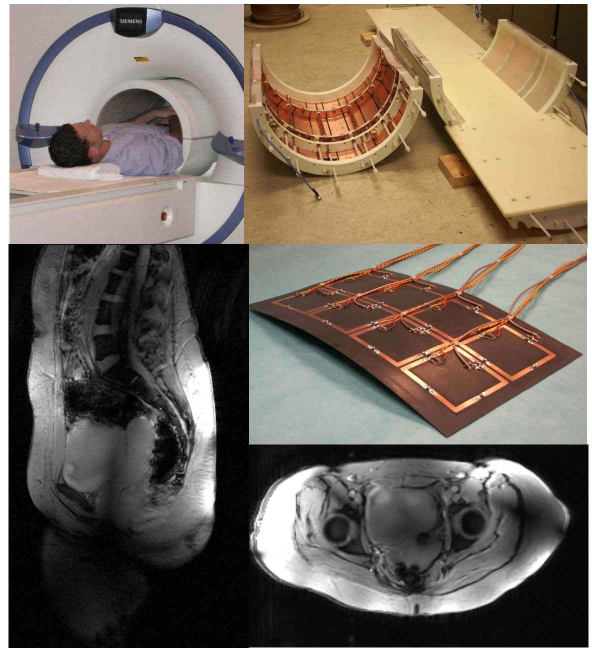

Figure 1: a) The transmit array in the magnet; b) the two halves of the clamshell transmit array; c) receiver array; d) sagittal FLASH image of the female pelvis; e) axial FLASH image of the female pelvis

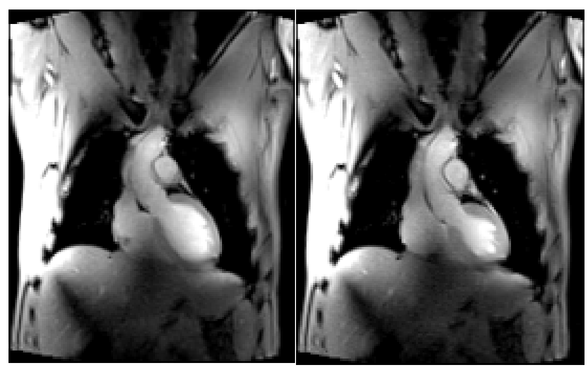

Figure 2) Retrogated FLASH cine images while the heart is in a) diastole and b) systole.

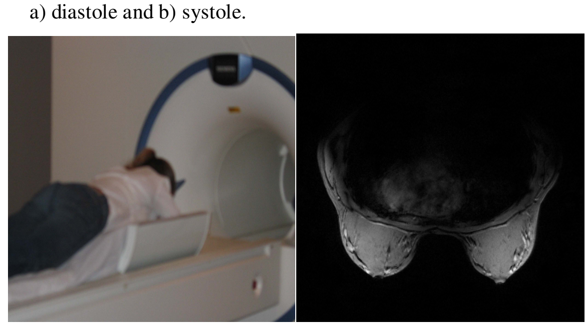

Figure 3: a) Using the bottem six elements of the TEM array as a half-volume transceive array; b) resulting FLASH image.