A 7-Tesla High Density Tx/Rx Mammography Coil

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Introduction:
With the advantage of no radiation risk, breast MR imaging presents an excellent alternative of mammography for early breast cancer detection. In order to improve the signal-to-noise ratio, breast coils have been built for 7 Tesla MRI systems with single transmit-receive coil element for each side of the breast.[1][2] However, to fully utilize the field strength advantage of the 7T scanner to get even higher SNR, multi-channel receive array coils appear to be a more effective choice [3]. We have constructed a7T transmit-and-16-channel receive array breast coil for Siemens Magnetom 7T scanners to push the envelope of pursuing the highest possible spatial resolution which is essential to identify the earliest breast cancer detection .Volunteer images were acquired and benchmarked against a 3T 4 channel breast array coil.

Methods:
The transmit part of the 7T breast array coil layout is shown in Fig (1). It consists of two identical sections for left and right breasts; each section has two horizontally mounted loop transmit coils, which are driven in parallel configuration. The transmit coil is surrounded by a partial shield, which is proven to be effective to confine electromagnetic field [4] while attaining the effective B1 field inside the target FOV. Signal from both sections is then combined into a mode switch circuit, which allows the user to switch between unilateral and bilateral modes. The configuration of the receive elements is shown in Fig (2). The receive part of the breast coil also consists of two identical parts for left and right breasts, each section having six vertical loops, one horizontal loop and one underarm loop. Signal for each coil element is amplified with ultra-compact, low noise, pre-amplifiers [5]. Picture of the enclosure of the breast array coil is shown in Fig (3).

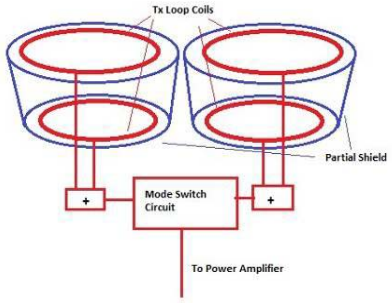


Fig. 1Layout of transmit section of the 7T breast array coil

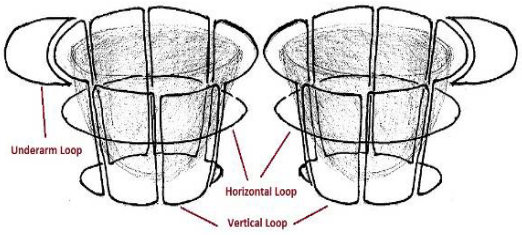
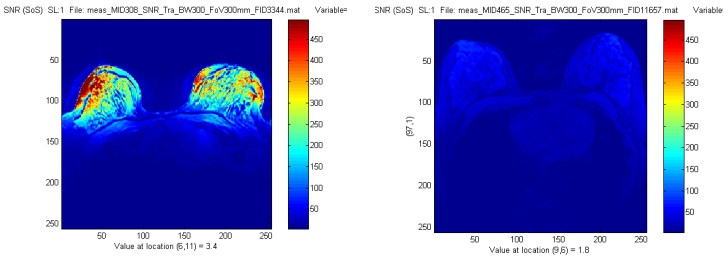


Fig. 2 Layout of receive elements of the 7T breast array coil

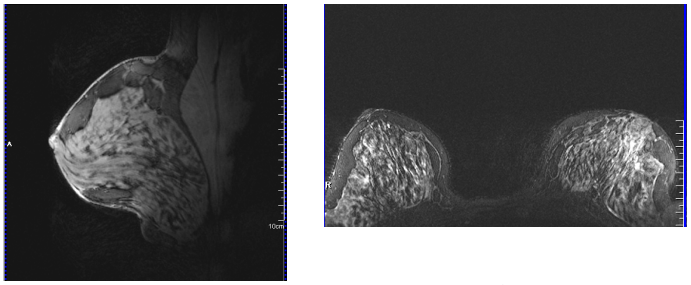
Fig, 3 Picture of the 7T breast array coil

Results:
A healthy volunteer was scanned, under an IRB approval, with the 7T transmit-and-16-channel-receive array and with a commercially available 4 channel breast array coil at 3T using the same imaging protocol. Comparison of the signal-to-noise ratio maps for the same volunteer is shown in Fig (4). It is observed that the SNR for the 7T breast array coil is approximately 4-6 times higher than that from 3T 4 channel breast array coil at the breast region. Clinical images from the 7T breast array coil are also acquired. Fig. (5a) shows image from 3D GRE isotropic (0.6mmx0.6mmx0.6mm) scan, and Fig. (5b) shows image from high resolution 2D TSE scan with FatSat. Results indicate that even with ultra high spatial resolution, the images still have abundance of SNR which can be applied to parallel imaging for reduction of scan time.



(a) (b)

Fig 4 Signal-to-noise ratio map for the (a) 7T breast array coil and (b) 3T breast array coil



(a) (b)

Fig. 5 Volunteer images obtained with the 7T breast array coil (a) 3D GRE isotropic (0.6x0.6x0.6mm) and (b) 2D TSE with FatSat

Conclusions:
A transmit-and-16-channel-receive breast array coil was constructed and tested on a Siemens Magnetom 7T scanner. Comparison of *in vivo* volunteer images with a commercially available 4 channel breast array coil at 3T showed significant advantage of the 7T breast array coil with its ultra high spatial resolution, which is critical to the early breast cancer detection.

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