SWITCHABLE BILATERAL/UNILATERAL 7T BREAST COIL USING FORCED CURRENT EXCITATION

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Introduction: Breast imaging and spectroscopy is of interest at 7T because of high SNR and its diagnostic potential [1]. In many cases it is desirable to excite the breasts bilaterally [2]. However the inhomogeneity of RF field created at both breasts due to 7T high frequency effects and the large field of view must be overcome. Additionally, switchable unilateral breast excitation mode is desirable because it can achieve higher SNR at a target breast, create the highest B1+ possible at the desired area (e.g. for proton decoupled ^{13}C spectroscopy [3]), and avoid slice fold-over from the contra-lateral breast in high-resolution unilateral sagittal 3D acquisitions. In view of these advantages, we developed a dual mode coil for 7T which could be switched electronically between unilateral and bilateral mode. Coupling between the two closely spaced Helmholtz pair in bilateral mode is avoided by using Forced Current Excitation (FCE) to the all array elements [4-5].

Methods:
Two FCE driven Helmholtz pairs were constructed (i.d: 14.8cm, o.d: 16cm, separation between individual loops of the Helmholtz pair: 7.4cm, separation between the axis of two Helmholtz pairs: 18cm). The two pairs are connected together at their Common Voltage Point (CVP). This ensures equal currents on all four loops when in bilateral mode. The two Helmholtz pairs share one Match and Tune circuitry and one RF input/output and form a Transmit/Receive system (Figure 1). The integrated CVP board was upgraded to a PIN diode switching network to enable unilateral excitation. In unilateral mode, forward biasing a shunt diode at the CVP for the unwanted pair effectively open-circuits and decouples those elements. A second PIN diode disconnects that decoupled pair from the CVP board. The voltage polarity of the two external DC power supplies enables/disables the two Helmholtz pair individually, allowing switching among four states: Image with left coil only/Image with right coil only/Image with both coils/Turn off both coils. The latter state is saved for future use with receive coil inserts. The developed system is shown in Figure 2.A. The system was tested using a whole-body Philips Achieva 7T scanner .

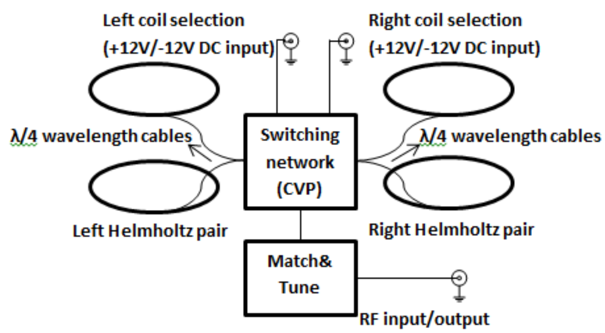

Figure 1. Diagram of the developed system

Results:
Two identical, half-spherical, canola coil phantoms were used in the two Helmholtz pair throughout all experiments to simulate the coexistence of both breasts. Images were acquired in the coronal plane near the center of the sensitive region, in the three desired modes (Figure 2). Results show excellent suppression of excitation from the "off" coil, and uniform homogeneity in all three cases. The FCE excitation eliminates the difficulty of mode-splitting that would otherwise occur. As expected, the SNR is approximately 1.36 times higher in unilateral mode than in bilateral mode (433: 318).

Conclusion: Forced Current Excitation is successfully implemented for bilateral excitation. It is also proved to be a convenient way to create a bilateral coil that can be electronically switched to unilateral coil. The FCE approach also prevents mode splitting that could complicate tuning of the different modes under different loading conditions.

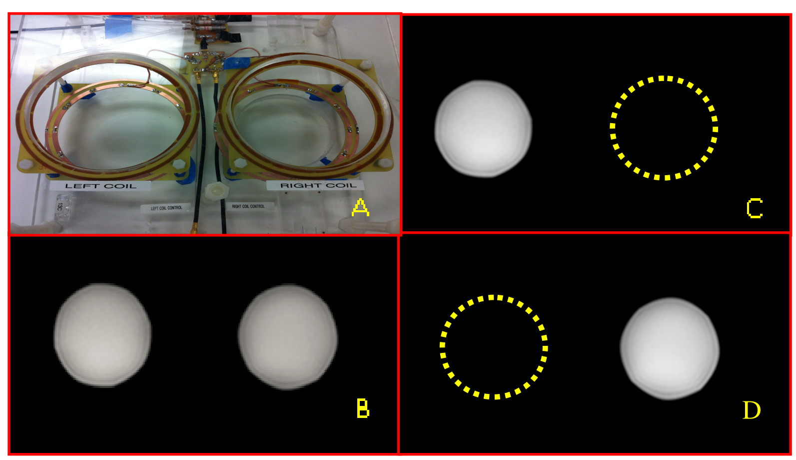

Figure 2. MRI images from the three different modes. Figure 2.A shows the developed switched-mode coil. Figure 2.B shows image taken at bilateral mode, Figure 2.C shows image taken at unilateral mode, with left coil enabled, Figure 2.D shows image taken at unilateral mode, with right coil enabled. For images taken at unilateral mode, the location of the non-excited phantom is marked by a dashed-line circle.

References: [1] Korteweg et al., Invest Radiol, 2011 Jun; 46(6): 370-376 [2] S.Orzada et al., Proc. ISMRM 2012, #0430. [3] S. Cheshkov et al., Proc. ISMRM 2012, #4428. [4] S.M. Wright et al., Proc. ISMRM 2011, #3847. [5] J.V. Rispoli et al., Proc. ISMRM 2012, #2635.