16-Channel Receive Array Insert for Breast Imaging at 7T

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INTRODUCTION: The enhanced signal-to-noise ratio (SNR) of high field MR imaging and spectroscopy at 7T promises improved quantification of various metabolites useful for diagnosis and monitoring of breast cancer. High fields, however, increase B1 inhomogeneity and pose several challenges to radiofrequency coil design. Our group has reported the concept of "forced current excitation" (FCE) to address this issue, which allows for straightforward tuning and homogenous transmission for breast imaging despite unequal loading [1]. The known disadvantage of using FCE is on the receive side, however, as the inclusion of transmission line lengths in the resonant structure decreases the SNR. This abstract discusses a 16-channel receive insert for the FCE breast coil that mitigates the SNR loss while still taking advantage of the substantial benefits during transmission.

METHODS: Transmission: The FCE transmit coil is described in detail in [2], but is briefly depicted in Fig. 1. Nominal quarter wavelengths connecting the elements to a common voltage point (CVP) effectively force equal currents on the elements independent of loading conditions and enable a straightforward detuning method during receive. Activation of a PIN diode during receive short circuits the transmission line at the CVP, creating a high impedance at the feed point of all elements and moving DC control lines away from the field-of-view.

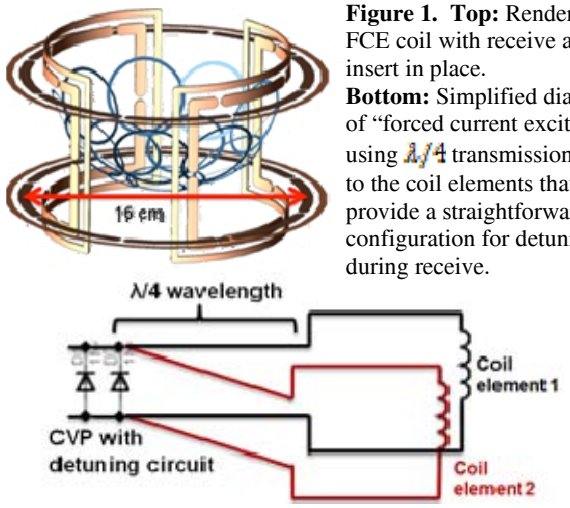

Figure 1. Top: Rendering of FCE coil with receive array insert in place. **Bottom:** Simplified diagram of "forced current excitation" using $\lambda/4$ transmission lines to the coil elements that also provide a straightforward configuration for detuning during receive.

Reception: A 16-channel receive array was constructed on a spherical shell customized for insert into the breast volume transmit coil. The receive array was designed using a soccer ball element geometry [3], utilizing pentagon and hexagon tiles to effectively pack corresponding smaller (I.D. 58.5 mm) and larger diameter (I.D. 70 mm) coil elements onto the shell. All coil elements were fabricated on 7-mil thick, single-sided, copper-clad FR-4 PCB. Coil overlap was implemented to minimize mutual reactance between nearest neighbors. Decoupling between non-nearest neighbors was provided through isolating preamplifiers [4] in the 16-channel receiver box**.** During transmit, passive blocking circuits and active traps were used to keep currents from being induced in the receive elements. Imaging: All imaging was performed on a whole-body 7T scanner (Philips Medical Systems) under an IRB approved protocol. *In vivo* images were obtained using a 3D THRIVE sequence with fat suppression (TE =1.8 ms, TR=3.5 ms).

RESULTS & DISCUSSION: A photograph of the coil is in Fig. 2. The data acquired from a human volunteer is shown in Fig. 3. As seen in the image profiles in Fig. 3c, the increased sensitivity of the receive array insert provided an SNR improvement of up to six times over the FCE coil. This work demonstrates the effectiveness of using the 16-channel receive array insert with the FCE coil. Further, it indicates the significant potential in the combined use of both methods for breast imaging.

Figure 2. Photograph of custom designed housing with FCE coil with receive array insert.

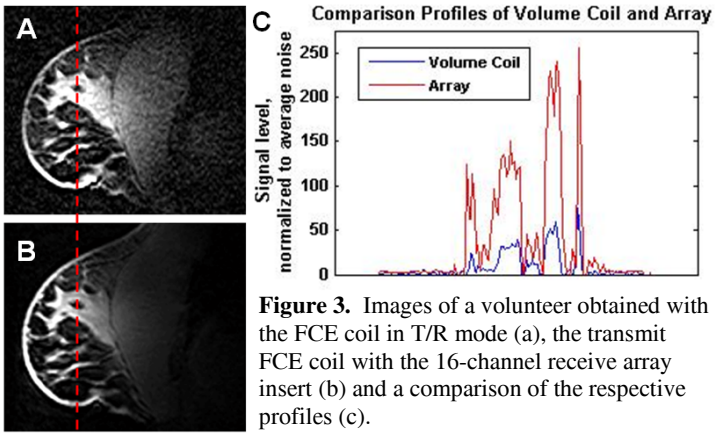

Figure 3. Images of a volunteer obtained with the FCE coil in T/R mode (a), the transmit FCE coil with the 16-channel receive array insert (b) and a comparison of the respective profiles (c).

REFERENCES: [1] Wright et al., Proc. ISMRM 2011, #3847. [2] Rispoli et al., Proc. ISMRM 2012, #2635. [3] Wiggins et al., MRM 56: 216-223 (2006). [4] Roemer et al., MRM 16: 192-225 (1990).

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