Improved Volume Localization for MRSI at 7T Using RF Shimming and RF Multiplexing

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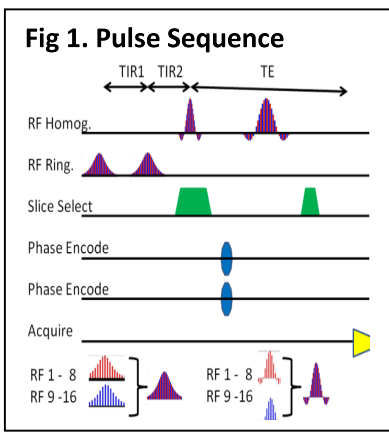
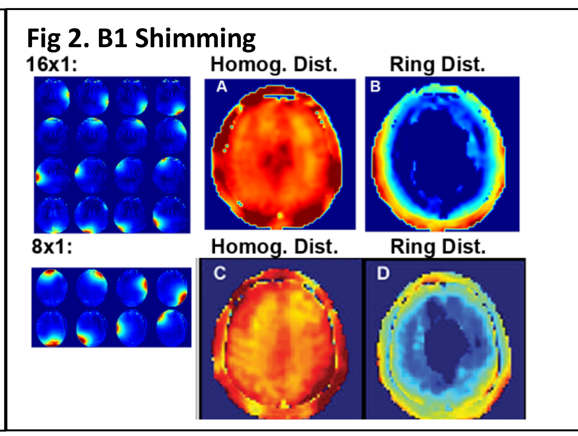
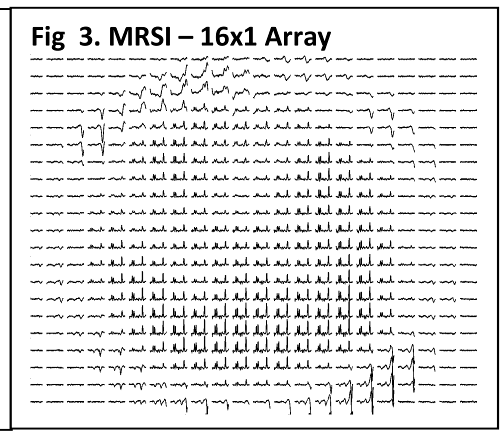
Introduction: At 7T, when using in-plane localization for human brain ^{1}H MRSI, decreased available B_1 and increased SAR result in dramatic increases in chemical shift dispersion artifacts. To overcome this limitation, previously we developed an outer volume suppression method utilizing RF shimming and an 8 coil transceiver array. A ring distribution was created which selectively excited the periphery of the brain, enabling suppression of extracerebral tissue while leaving central brain regions untouched. However, due to the low number of independent RF channels and coils (8), some suppression of peripheral brain regions occurs. To retain SNR for neocortical measurements we have developed a 16 channel transceiver array and an RF multiplexed sequence which improves the selectivity of the ring distribution. RF multiplexing enables the 16x1 array to be driven with only 8 Tx channels but maintain independent drive phases and amplitudes for all coils in the array.

Methods: Data was acquired at 7T using a 16x1 array (16 coils x 1 row). To drive all 16 RF channels with independent amplitudes and phases using the 8 transmit channels available, RF multiplexing was used. RF multiplexing was achieved using a moderate power (1kW) fast (<1us) switch to route the RF from a single output channel to 2 or more coils. The RF coils were driven in two groups corresponding to the right (coils1-8) and left (9-16) halves of the array. The pulse sequence (Fig. 1) uses two different RF distributions, a ring distribution which selectively excites the periphery of the head (skull and scalp) for outer volume suppression and a homogeneous distribution which is used for water suppression, slice selection and refocusing. MRSI data was acquired using TR/TE of 40/1500ms with 24x24 encoding over a FOV of 192x192. The IR delays, TIR1 and TIR2 were optimized to provide suppression of resonances with T1s between 400-2000ms.

Results: Displayed in Fig 2. are B_1 amplitude maps of the individual coils along with the B_1 maps for the homogeneous and ring distributions (2a,b). For comparison purposes, we also acquired equivalent data with an 8x1 array from the same individual (Fig 2c,d). Notably the ring distribution shows much greater selectivity, minimizing spill-over of B_1 into the brain. Figure 3 shows data from the MRSI acquisition using the 16x1 coil. Note the retention of signal amplitude from the peripheral brain regions.







Conclusions: The 16x1 array provides for greater flexibility in RF shimming enabling more selective B_1 distributions to be generated. RF multiplexing enables transceiver arrays where the number of coils in the array (e.g. 16 or more) exceeds the number of available independent transmit channels (e.g. 8) to be used but retain full flexibility with regards to the amplitudes and phases used. Combined these methods provide for improved localization for ^{1}H MRSI, including neocortical regions, immediately adjacent to the skull.