Evaluation of a phase shifting matrix for body coil B1+ shimming in a dielectric phantom

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Introduction: One challenges in high field MRI is the *B*1-field inhomogeneity due to particular patient RF permittivity. This results in artifacts in the MR images and thus can compromise their diagnostic value. RF shimming and parallel transmit offer a potential solution to this challenge. In order to interface an 8-channel system with a 16-channel transverse-electromagnetic (TEM) body-array, the use of a phase shifting or Butler matrix [2] was investigated and B1 shimming in a dielectric phantom was performed.

Theory and Methods: Parallel transmit uses the spatially distinct transmit field from each array element for spatial encoding of transmit pulses. The Butler matrix produces naturally decoupled orthogonal modes in free space that do not require decoupling strategies [1]. The design for an 8x8 matrix was developed and a low power matrix was build, using mechanical phase shifts and low power hybrids. The study compared measurements performed with and without the phase shifting matrix. For all measurements the body coil's channel count was decimated from 16 to 8 by equally splitting and appropriately phasing signals to neighboring elements. The performed measurements included single and multi-coil excitations of the array.

Results and Discussion: The magnitude profiles obtained with the matrix verified the expected performance. The modes with the same phase shift difference at the output, but circular or anti-circular polarized, were modes 4 and 7, 5 and 6, and 3 and 8 (Figure 1). The best homogeneity is expected from mode 7 due to small phase shift differences at the output. No phase shift is obtained from port 1 and a phase shift of π from port 2.

After shimming of magnitude and phase, the mean and the corresponding standard deviation of the obtained homogeneity was calculated. Using coil all channels 1 to 8 with and without the matrix yielded an equal standard deviation of 10%. Almost the same homogeneity could be obtained using 3 instead of 8 amplifiers. This result was obtained with the combination of mode 7, 5 and 3 simultaneously. The results for a dielectric phantom thus indicate that the advantages of using a phase shifting matrix are similar to those in a non-dielectric phantom previously published [1]. This offers new freedom for the design of a parallel transmit system, potentially allowing highly efficient, high element count volume coils to be driven with a limited number of amplifiers.

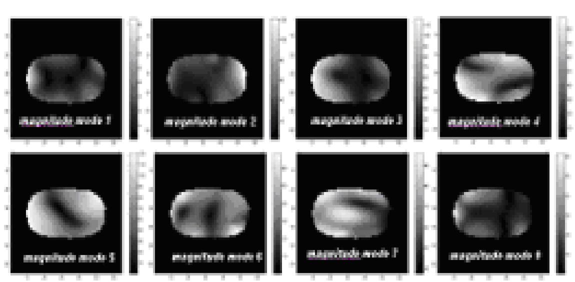

Figure 1: magnitude profiles produced with the phase shiftingmatrix

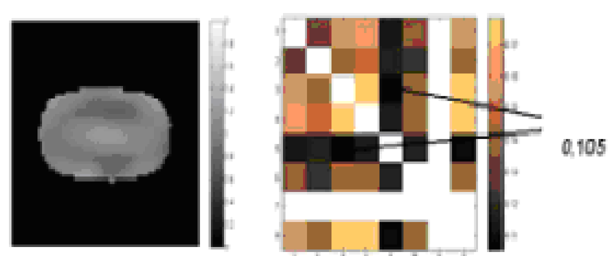

Figure 2: homogeneity map and visualization of homogeneity disposition

References:

[1] V. Alagappan et al. : Degenerate Mode Band-Pass Birdcage Coil for Accelerated Parallel Excitation, Magnetic Resonance in Medicine 57:1148–1158 (2007)
[2] J. Butler. R. Lowe. Beamforming matrix simplifies design of electronically scanned antennas. Electron. Design 1961; 9; 170-173

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