Impact of Coil Diameter and Number of Coil Elements on B1 Destructive Interferences with Stripline Coil Arrays at 7 Tesla.

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Introduction

B1 transmit (B1+) inhomogeneity is a major concern at ultra high magnetic field. It has been shown that destructive B1+ interferences (**DB1I**) between complex B1+ vectors from coil elements result in "bright center, dark periphery" patterns in axial images of the brain with coil arrays at 7T[1,2,3]. Here we investigate, with 1, 8 and 16 stripline coil arrays, how B1+ profile is impacted by altering a) the distance between the coil elements and the imaged sample and b) the number of coil elements.

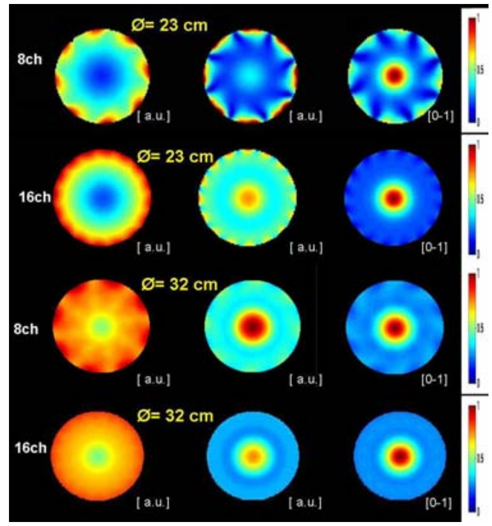

Fig1: **Simulation**. ***Left***:MOS, ***Middle***: SOM, ***right***: ratio MOS/SOM with four different coils. [a.u] means arbitrary units for color display

Material and Methods

Experimental data were obtained at 7Tesla (Magnex, Varian) with a 3 liter 90mM NaCl sphere phantom (90mM NaCl saline). We utilized 3 cylindrical transceiver array coils[4], using 7 cm wide and 14 cm long stripline elements (StEl). Coil diameter and number of StEl were respectively 23cm/8StEl, 23cm/16StEl, 32cm/16StEl. RF power was split with an 8-way or 16-way splitter, with incremental phases (45° or 22.5°). Signal was sampled with a multichannel digital receiver and magnitude images from all channels were summed together. We acquired B1+ calibration series consisting in 12 TurboFlash images with a preparation RF pulse (**PP**) of increasing duration as described in ref[4]. Additional experiments were performed with a single StEl positioned at 0cm, 2.5cm or 7cm from the phantom. In all experiments StEl were used both for transmission and reception. **Simulation data** were obtained with XFDTD software (Remcom, PA). Model designs reproduced the 3 coil arrays used with the phantom (permittivity 80, conductivity = 1.17Siemens/m) as well as an 8 channels, 32cm Ø coil. For each coil, 2D Complex B1+ profiles were generated for each individual StEl. Those complex profiles were then combined either as Sum of Magnitude (**SOM**) or as Magnitude of Sum (**MOS**). In **MOS**, the sum of complex profiles allows to reproduce the **DB1I** which occur when pulsing through all StEls, while in **SOM** B1+ magnitude profiles are added as positive scalar, which does not reflect the experimental reality. The **Ratio MOS/SOM** estimates the amount of destructive B1+ intereferences[1]: it equals one *without* **DB1I**, and falls within the range [0,1[*with* **DB1I.**

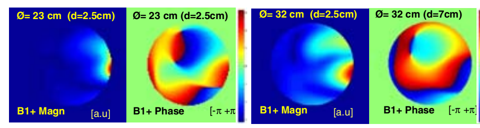

Fig 2 Simulated B1+ for one stripline element

Results and Discussion

Simulated data. Overall (Fig.1), strong **DB1I** are present in the periphery with all coil combinations, but: **a)** for a given number of StEls, **DB1I** are significantly more *homogenous* in the periphery for the larger coil than for the smaller. **b)** for a given coil diameter, **DB1I** are more *homogeneous* in the periphery with 16 rather than with 8 StEls. Combined together, those effects considerably reduce the variation of B1+ at various angular positions for a given radial position in the phantom periphery. In Fig.2, **B1+** phase and magnitude for a single coil element (on the right side in Fig2 display), at different distances from the phantom (d=2.5cm or 7cm) demonstrate a smoother pattern in phase (as well as in amplitude), when the StEl is further away from the phantom, consistent with the smoother destructive patterns with larger diameter coils. ***Experimental data*** confirm with Flash images obtained with a single StEl (Fig.3), that the signal pattern becomes smoother as the coil/sample distance (d) increases. Fig 4,5 and 6 demonstrate with a phantom the smoother **DB1I** pattern in the periphery with more numerous StEls and with larger coil diameter (image signal is nulled[1] when RF **PP** reaches 90° + n*180°).

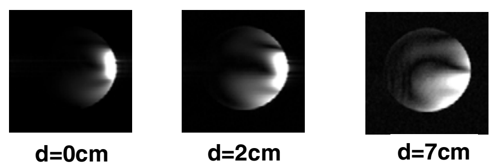

Fig 3. Flash images acquired with one stripline

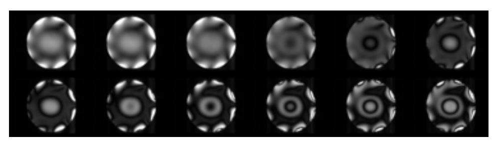

Fig 4. B1+ calibration, 8 stripline, 23cm Ø

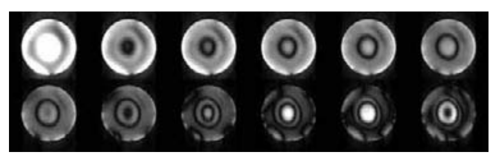

Fig 5. B1+ calibration, 16 striplines 23cm Ø

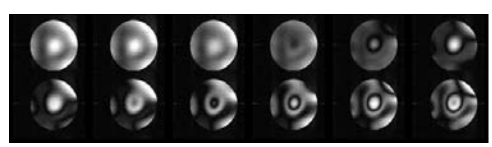

Fig 6. B1+ calibration, 16 striplines 32cm Ø

Discussion

Our investigation demonstrates, at 7 Tesla, experimentally as well as with simulated data, that larger diameter head coil arrays as well as more numerous coil elements result in much smoother patterns of B1 destructive interferences in the periphery of a phantom (even though those destructive interferences still have large amplitude). It remains to determine how such geometric properties can be integrated into global RF shimming approaches which include multiple levels of correction: coil design, RF phase/amplitude modulation for each coil elements, multidimensional RF Pulses, Transmit SENSE.

References: 1. Van de Moortele et al. MRM 2005 54:*in press*. **2.** Vaughan et al. MRM 2001 46:24. **3.** Collins et al, MRM 2001 45:684. **4.** Adriany et al. MRM 2005 53:434

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