Parallel Imaging potential at 7 Tesla for multi channel headcoil with densely spaced elements.

Steen Moeller, Pierre-Francois Van de Moortele, Johannes Ritter, Gregory Adriany, Carl Snyder and Kamil Ugurbil

Center For Magnetic Resonance Research, University of Minnesota, USA

INTRODUCTION:

Parallel Imaging by sub-encoding with coil-sensitivities replacing gradient encoding offer a decrease in acquisition time. The feasibility of utilizing parallel imaging is limited by unwanted amplification of noise due to insufficient orthogonality of the coil sensitivities. For increased field strengths this orthogonality is increased, yielding less noise amplification [2]. The noise-amplification is measured with the geometry factor [1], and effectively defines the limits for feasible parallel imaging. A decrease in the g-factor means a decrease in unwanted noise-amplification, and is very dependent on the coil design and sample geometry. In [3] the impact of increasing the number of small surface coils was evaluated for a 32 channel head coil at 7 Tesla, and increase in the attainable reduction factor was demonstrated for up to 32 coils. Here we extend this comparison to

- The g-factor decrease for equal coil coverage/ surface area by merging neighboring coils.
- The relative g-factor, g_{rel}, which incorporates the total SNR reduction

$$g_{rel} = g * \frac{SNR^{32indi}}{SNR^{32comb}} = \frac{SNR^{32,comb}}{\sqrt{red}\ SNR^{32comb,red}} * \frac{SNR^{32indi}}{SNR^{32comb}}$$

where SNR^{32comb} is the SNR from a coil with simulated larger elements.

Inclusion of the relative SNR performance extends the comparison to also quantifying how larger coils perform relative to more numerous smaller coils. Small surface coils exhibits limited penetration and coverage, but when combined in arrays their performance is expected to be equivalent to larger surface coils.

METHODS:

Imaging experiments were performed on a 7 Tesla Magnet (Magnex Scientific, UK). We utilized a single RF amplifier (CPC, Brentwood, NY) and split the RF 32-ways utilizing a transmit-receive transmission line head-coil arrays [4] with radially distributed, identical transmission line elements as described in [5]. With only 16 receivers available the even and odd channels were acquired separately in time. The coil used ¼" wide copper conductor strips and decoupling capacitors between neighboring transmission line elements. For the sensitivity calibration 336x256 matrix images were acquired in an axial plane, with a standard gradient recalled sequence (TR/TE: 16ms/5ms, flip angle: 10 degrees, slice thickness 5 mm, 1 acquisition per phase encoding step (i.e. NEX=1). Phantom studies [3] have demonstrated that for this coil, the complete noise-correlation has limited impact on the g-factor compared with noise-correlation matrix from a 2x16 noise acquisition. Only the sparse coil-correlation matrix was assessed for in-vivo studies. The combination of signals from neighboring coils was performed as matching the DC-phase of the coils in the center of the FOV and matching the gain of individual channels.

RESULTS AND DISCUSSION:

A decrease in both the mean and maximal g-factor is found, when increasing the number of coils and maintaining equal coil coverage, as illustrated in figure 1. This is a larger reduction than when compared with fewer smaller surface coils as in [3]. Inclusion in the reduction of the relative SNR, as illustrated in figure 2, increases the gains in relative mean geometry factor of a 32 channel coil with both 16 and 8 channel coils.

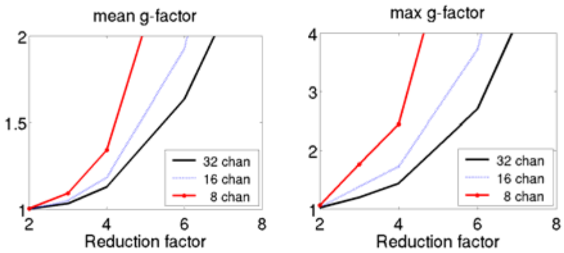

Figure 1: Left: The increase in mean g-factor for one-dimensional Reduction factors, for an 8, 16 and 32 channel coil with equal coil coverage. Right: The increase in the maximal g-factor for one-dimensional Reduction factors.

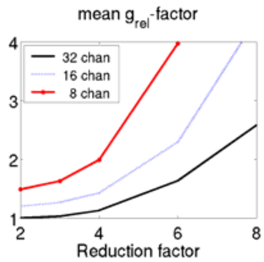

Figure 2: The increase in **relative** mean g-factor for one-dimensional Reduction factors, for an 8, 16 and 32 channel coil with equal coil coverage.

The parallel imaging performance in terms of the g-factor is demonstrated to be better for many small coils compared with fewer simulated larger coils. Smaller coils exhibit lower g-factors compared with larger coils for equal volume, but the received SNR of synthesized (quadrature like) larger coils is also reduced compared with the same number of individual coils.

REFERENCES:

[1]KP. Pruessmann and et al. MRM, 42:952:962, 1999.
[2] F. Wiesinger, ISMRM, 2002; Honolulu, USA. p 191
[3] Moeller et al. ISMRM
[4] Vaughan, J.T.: RF Coil for Imaging System US Patent Serial No. 6,633,161(2003)
[5] G. Adriani, et al, ISMRM 2003, nr 474

ACKNOWLEDGEMENT:

MIND institute, Keck Foundation, NIH RR08079