An 8 Channel Cardiac SENSE Array

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ABSTRACT
In recent years SENSE has become a common method to reduce scan time. The SENSE reconstruction poses additional guidelines to optimal coil design, especially for Cardiac imaging, where double oblique imaging is the standard. An 8 channel cardiac SENSE coil was developed, that allows the user reduced acquisition time in any slice orientation.

INTRODUCTION
The concept of SENSE has been previously described in (1).
A detailed approach in optimizing coil design for SENSE has been described in (2).
To reduce scan time, undersampling is reasonable only in the phase encoding direction and since cardiac imaging requires double-oblique slice orientations, the receiver element distribution was determined to be 2x2x2 (see fig 1), therewith providing the basis for arbitrary phase encoding direction.
In order to achieve different sensitivity profiles for each element, i.e. optimize the geometry factor, the elements should not be decoupled by means of critical overlap, other methods to cancel mutual inductance should ideally be used.

METHOD
In the course of development simulations were done to optimize the G-factor distribution for given FOV and geometry requirements. Shown are local G-factor maps and B-field plots. Several prototypes were built and phantom images were acquired.

RESULTS
The actual coil consists of 8 elements arranged parallel to the 3 main axes, 2x2x2, as shown. To optimize decoupling and performance, 3 different methods of decoupling neighboring elements are used, critical overlap (z-direction), transformer (3) (x-direction, not shown), and low input impedance preamplifier decoupling (y-direction, not shown).

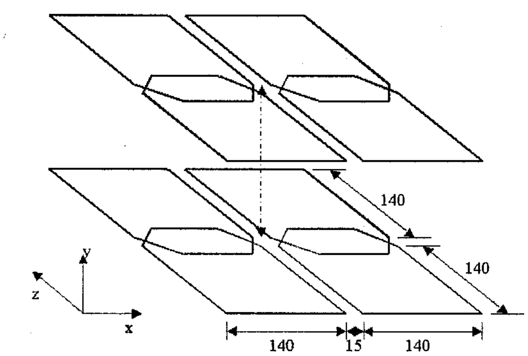

Figure 1: Coil element distribution.

Since the analysis of the G-factor is critical in coil design, simulations for different geometries / sizes were performed and the decision criterion was the optimal predicted performance, lowest maximum local G-factor and homogeneity of local G-factors. The new (overlapped in z-direction) cardiac array has lower peak G-factors in axial (3.5 vs. 4.19) and sagittal (1.89 vs. 1.99) directions (Fig 2) than the preliminary array (underlapped also in z-direction). The average is the same in both cases. Fig 3 shows B1 field distributions for coronal slices. Fig 4 shows phantom images acquired with the new array, reconstruction done with the Sum of Squares algorithm.

CONCLUSIONS
There is negligible difference in G-factor distribution and peak value between the completely underlapped and the partially overlapped neighbors that are shifted in the z-direction. The reason for this is that the spins are precessing in the xy-plane and therefore there is no difference in the phase of the signals between underlap and overlap. It is advantageous to have the overlap in this direction since it will avoid a dark band in the sensitivity profile due to B1 field in the z-direction, i.e. a more homogeneous sensitivity is obtained with an overlap...

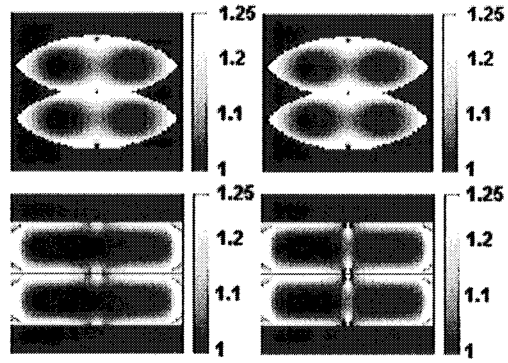

Figure 2: G-factor maps (simulations are done for R=3 FOV 35cm)
left: new array (as shown in Fig 1); right: preliminary array (same as new array, but underlapped also in z-direction)
top: axial slice through center of superior elements; bottom: sagittal slice through center of left elements.

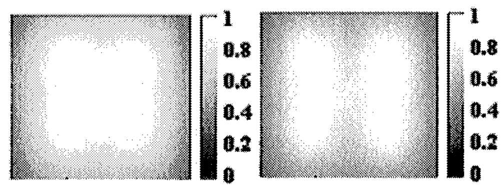

Figure 3: Coronal sensitivities (μT): (FOV 35cm)
left: new array; right: preliminary array (same as new array, but underlapped also in z-direction). Slice location in the middle between anterior and posterior coil elements.

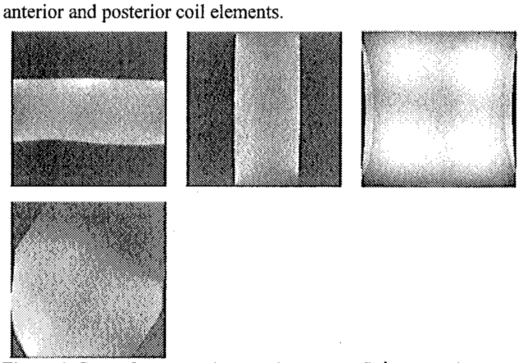

Figure 4: Sum of squares phantom images on flat square phantom:
Slices shown are: (FOV 30cm (double-oblique 35cm))axial slice through center of superior elements, sagittal slice through center of left elements, coronal slice through center A-P, and double-oblique in average heart location.

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