# A multi-purpose cardiac and abdominal surface coil with up to 36 elements

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**Introduction**

With the advent of multi channel array coils, the limits of parallel imaging using large numbers of small loop antennas have been investigated. In research applications, head coils at 1.5T have been developed up to 32 channels, and up to 96 elements at 3T [1, 2]. For abdominal imaging, examples with coils up to 128 elements have been demonstrated [3]. Commercial products are available with up to 32 channels for head coils and for cardiac coils at 1.5T and 3T. With the large number of antenna elements and their comparatively small size, peripheral SNR and parallel imaging performance could be dramatically improved. One major challenge especially for anterior thorax/abdominal coils with high channel count is to integrate both the electronics and the antennas in a housing which is mechanically flexible along the x- and the z-direction. Flexibility in both directions is important for optimum adaption of the antenna to the variations in human anatomy which is largest in the abdominal region. We present the design of a mechanically flexible 36 element multi-purpose anterior coil for 3T and demonstrate its performance for both cardiac as well as abdominal imaging applications.

**Method and Experimental Setup**

The antenna design consists of a posterior and an anterior part. Each part has 3 rows with 6 rectangular loop antenna elements in each row along the left-right-direction. The anterior antenna has a size of 37cm along the z-direction and 58cm along the LR-direction. Especially the large size along the LR-direction allows good lateral coverage of the patient. The posterior antenna array covers 46cm in the z-direction, while it covers 52cm in the LR-direction. The antenna design is based on mutually decoupled loop antennas. The decoupling is achieved by optimizing the overlap between adjacent antennas. All electronics are integrated into a housing right on the antenna, so that no SNR loss due to cabling occurs. In order to examine the performance of this design, a comprehensive comparison with state of the art antennas using 12 elements was done. The comparison is not only based on SNR results but also includes MR images using clinical protocol parameters. The reference antenna is a 6-channel anterior Body Matrix coil and the respective 6 posterior elements in the Spine Matrix coil of a Siemens Trio a Tim System 3T scanner (2 rows with 3 antennas in each row). The antenna elements in the reference antenna cover the same dimension in the z-direction, while the anterior antenna (Body Matrix antenna) is 5cm smaller in the LR-direction and 6cm smaller in the z-direction. Results for abdominal imaging are based on a volumetric interpolated breath-hold examination (VIBE). Results for cardiac imaging are based on a SSFP CINE. Images are compared for an acceleration factor (AF) of 4.

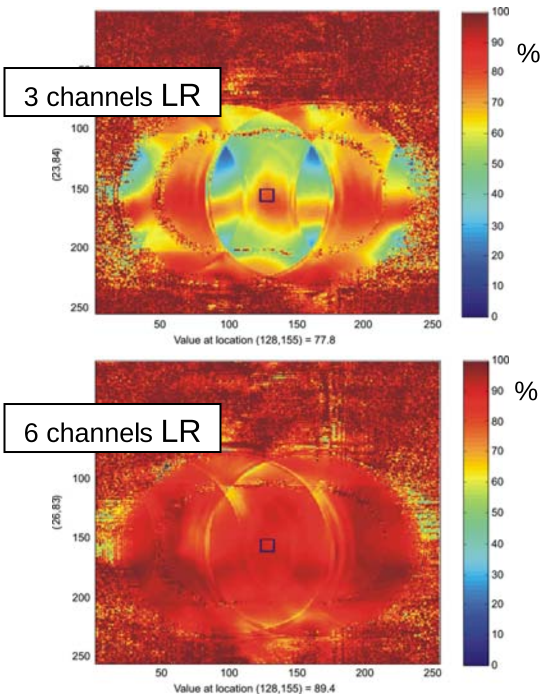


Fig. 1: 1/g-factor showing the percental SNR loss (AF=4) 100% = no SNR loss; phantom; acceleration in LR-direction


Fig. 2: T1 weighted VIBE Q-FatSat iso breathhold; breathold time 16s; AF=4;

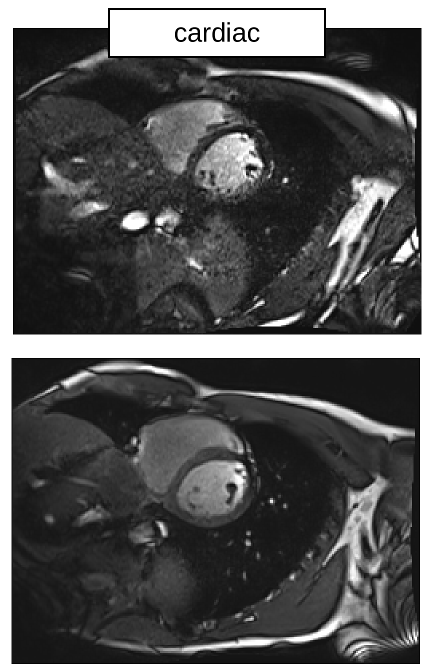


Fig. 3: Segmented SSFP CINE with T-GRAPPA, temporal res. 37ms, TA=2s, AF=4

**Results and Discussion**

By increasing the size along the LR-direction and doubling the number of elements along that direction, it could be shown that the SNR loss due to parallel imaging can be significantly reduced (Fig. 1). The results in Fig. 1 were derived from phantom measurements with phase encoding in LR-direction and AF=4. At the same time, acceleration factors of up to 4 could be demonstrated for parallel imaging with phase encoding in left-right direction (Fig. 2) as well as in anterior-posterior direction (Fig. 3). The increased acceleration factor allowed reducing the breathhold time by 20% from 20s to 16s. As shown in Fig. 3 the reduced element size also allows high quality cardiac CINE imaging with good temporal resolution in a very short scan time (acquisition time TA=2s) with an acceleration factor of 4.

**Conclusions**

We have demonstrated a 36-element coil giving excellent results for both highly accelerated cardiac as well as abdominal imaging. Acceleration factors up to 4 with high image quality could be shown.

**Reference**

[1] T. Witzel et al., Single-shot Echo-Volumar Imaging using highly parallel detection; Proc. of the ISMRM 2008 in Toronto;
[2] G. C. Wiggins et al. ; Design Optimization and SNR Performance of 3T 96 Channel Phased Array Head Coils; Proc. of the ISMRM 2007 in Berlin
[3] M. Schmitt et al.; A 128 Channel Receive-Only Cardiac Coil for 3T; Proc. of the ISMRM 2007 in Berlin;