# DC gated high resolution 3D MRI of the human lung under free breathing

**S. Weick[1], P. Ehses[2], M. Blaimer[2], F. A. Breuer[2], and P. M. Jakob[1,2]**
[1]Department of Experimental Physics 5, University of Wuerzburg, Wuerzburg, Bavaria, Germany, [2]Research Center for Magnetic Resonance Bavaria (MRB)

## Introduction

Motion artefacts due to respiration or blood flow degrade image quality and limit the acquisition time in human lung MRI. Furthermore, the inherently low proton density as well as rapid signal decay due to the short $T_2^*$ are challenging. Several techniques have been proposed to avoid respiratory motion artefacts. To synchronise data acquisition with motion, external gating or trigger devices can be applied [1]. Navigator echoes can be placed along the diaphragm to monitor respiratory and cardiac motion [2]. Additional RF pulses for the navigators extent the acquisition time and additionally result in severe artefacts by saturating parts of the imaged volume. Recently it has been shown that the k-space centre (DC) signal can be used for respiratory self-gating [3-5]. In this work, we applied this concept in order to achieve high resolution images of the human lung during free breathing. Because of the short $T_2^*$ of the lung tissue short echo times (TE) are required in order to provide sufficiently high SNR. It is shown that the DC signal can be acquired after the actual imaging module still providing sufficient quality for respiratory gating and simultaneously providing very short echo times.

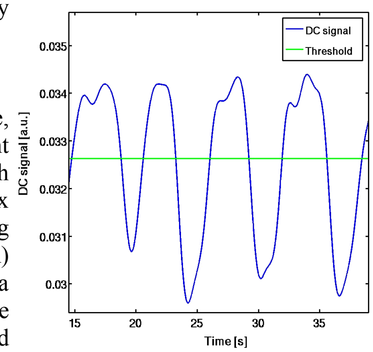


Fig.1: Respiratory variations of the DC signal

## Materials and methods

All measurements were performed on a 1.5 T clinical MR scanner (Siemens Avanto, Siemens Healthcare, Erlangen, Germany). Image reconstruction was done offline using the Matlab programming environment (The MathWorks, Inc., Natick, MA, USA). The acquisition of the DC signal was added to a 3D Flash sequence (TE/TR/α = 1.3ms/4.3ms/7°, 3.2mm slice thickness, 40 partitions, matrix: 320 x 480, FOV = 420 x 420 $mm^2$, BW = 600 Hz/ pixel, resolution: 1,3 x 0,9 x 3,2 $mm^3$). After image data acquisition and rephasing of all imaging gradient moments 64 points of the remaining signal were sampled within each repetition (TR) to obtain the DC signal. For data reception a six-channel phased-array body matrix in combination with a spine matrix coil was used. The coil element positioned anterior close to the diaphragm was used to evaluate fluctuations in the DC signal due to respiratory motion [4]. In a total scan time of 9 min 10 fully encoded measurements were performed under free breathing condition. The maxima and minima of the DC signal were used to define threshold values for data rejection [6]. K-space lines accepted multiple times were averaged.

## Results

In Fig. 1 respiratory fluctuations of the filtered DC signal of the selected coil can be seen following the respiratory motion. Furthermore, a calculated threshold value for data acceptance is displayed. Data above the threshold was used for image reconstruction. A single partition of a 3D volume reconstructed using 48% of the acquired data is shown in Fig 2. (left). In addition the orresponding partition from the full data set (10 Averages) is shown (right). In contrast to the DC-gated reconstruction the non-gated averaged reconstruction shows severe blurring, which is also highlighted in Fig. 3 (zoom out region indicated by the yellow box). In Fig.4 a maximum intensity projection of the reconstructed 3D data set can be seen

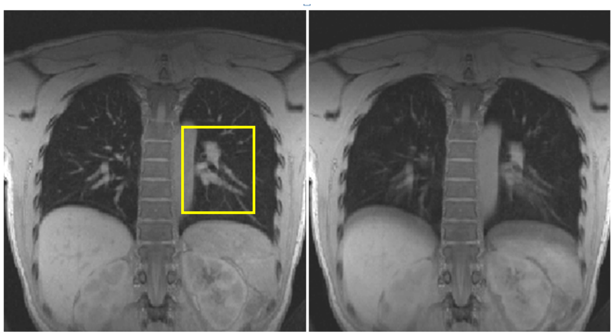

Fig.2: Corresponding gated (left) and non-gated (right) partition

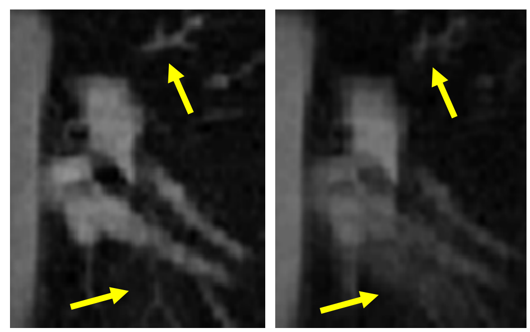

Fig.3: Impact of blurring on image quality

Fig.4: Maximum intensity projection

## Discussion

In this work we have demonstrated that the remaining signal available after the imaging module in a 3D Flash sequence is still sufficient for respiratory gating. Thus, allowing for high resolution images of the human lung in 3D under free breathing conditions. In future work, the DC signal will be used for prospective gating. To this end, a real time analysis of the DC signal and realtime feedback to the scanner Ewill be implemented, potentially allowing further reduction of scan-time.

## Acknowledgement

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## References

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