Fully Transient 3D Model Based CEST

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INTRODUCTION:

Steady state CEST methods have been introduced to shorten acquisition time by removing any recovery time (Trec), which can lead to speedups of over half the measurement time [1]. One downside of steady state methods is the influence of the incomplete recovery on the resulting Z-spectra. Some methods try to limit the severity of these influences by optimizing the sequence design [1][2], while others try to apply correction factors to the Z-spectra afterwards [3]. We propose a method to account for the influence of the transient state by incorporating the transition between offsets into the signal model. Therefore, shortening the acquisition time, while accounting for the transient state. To accomplish this, the proposed method uses interleaved saturation and readout blocks combined with a model based reconstruction.

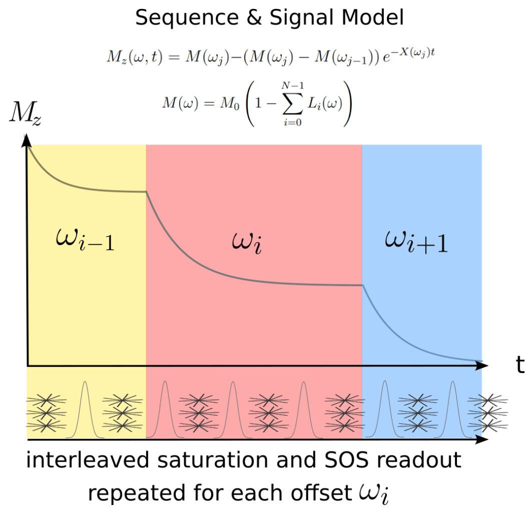

Figure 1: Signal model, magnetization change over different offsets and schematic sequence diagram.

METHODS:

The signal model consists of a sum of Lorentzian line shapes and exponential transition from one offset to the next, as shown in Figure 1.
The sequence was implemented in pulseq-cest, using a golden angle increment stack of stars readout between saturation pulses. Saturation consisted of fifteen Gaussian pulses with a duration of 100ms and B1rms of 1.5µT. Between pulses the stack of stars readout acquired four spokes each for six slices, which resulted in a DC of ~50%. The sequence was tested on a phantom of nine falcon tubes containing water and varying concentrations of Nicotinamide in a 3T scanner. The signal model was implemented in the Python reconstruction toolbox PyQMRI [3], which was used to solve the non-linear problem using an iteratively regularized Gauss-Newton method with primal-dual splitting.

RESULTS:

Figure 2 shows the amplitude maps for the Amide pool compared to the conventional measurement. Good agreement was found for all nine tubes over the six slices. Parameter maps for water amplitude and offset also show similar results.

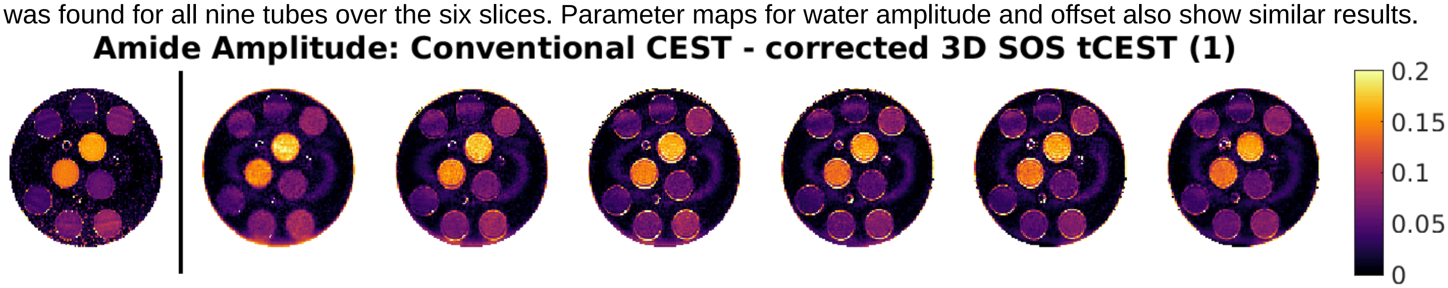

Figure 2: Results for the Amide amplitude of the reference measurement (left) and the six slices acquired in the tCEST measurement corrected for the readout influence.

DISCUSSION and CONCLUSION:

Slight deviations were found between slices, which are probably caused by the influence of the slice profile for the 3D readout, which is not considered in the signal model. This was solved by a correction, which uses the fitted equilibrium magnetization for each slice. Overall, the results show the possibilities given by the tCEST method. The whole spectrum is acquired in 3D in only 180 seconds. This abstract presents a proof of concept for CEST contrast images in half of the time compared to the conventional sequence, while accounting for, and encoding information about the transient state via the time constant X.

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