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Abstract must fit on one 1 page

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Next generation CEST MRI: Optimal Control comprehensive CEST at 7T

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Introduction CEST imaging experiments typically benefit from long continuous wave (cw) saturation in order to achieve high labelling¹. In clinical settings, cw irradiation is not possible due to SAR and hardware safety limits. Optimal control (OC) pulses² are an emerging technique, which promise high CEST labeling while still accounting for hardware and software limitations of in-vivo scanners. In this work, pulses were optimized for the complete 7T comprehensive CEST (cCEST) protocol of three B1 regimes³ and compared to the conventional pulses.

Methods Data is acquired from a healthy subject at a Siemens MAGNETOM Terra.X 7 Tesla scanner (Siemens Healthcare GmbH, Erlangen, Germany) with a 32ch Rx and 8ch Tx head coil. Pre-saturation was realized in Pulseseq-CEST⁴ using the three B1 regimes of 7T cCEST at $B_{1rms}=1\ \mu T$, $2\ \mu T$ and $4\ \mu T$ ³ including higher and lower B1 for B1 correction. Image readout was a centric 3D snapshot GRE⁵. GRAPPA 2 was applied in the first phase encoding direction.

Results Compared to conventional pulses (Figure 1a, $6.25\ \mu T$ adiabatic spin lock pulses) the respective optimal control pulses look very different (Figure 1b), but create very similar Z-spectra data for all B1 regimes (Figure 1c-e). Direct comparison of CEST maps (Figure 2A-F) and optimal control pulses (Figure 2G-L) show very similar outcome with slightly more homogeneous outcome for the optimal control cCEST especially in the frontal area.

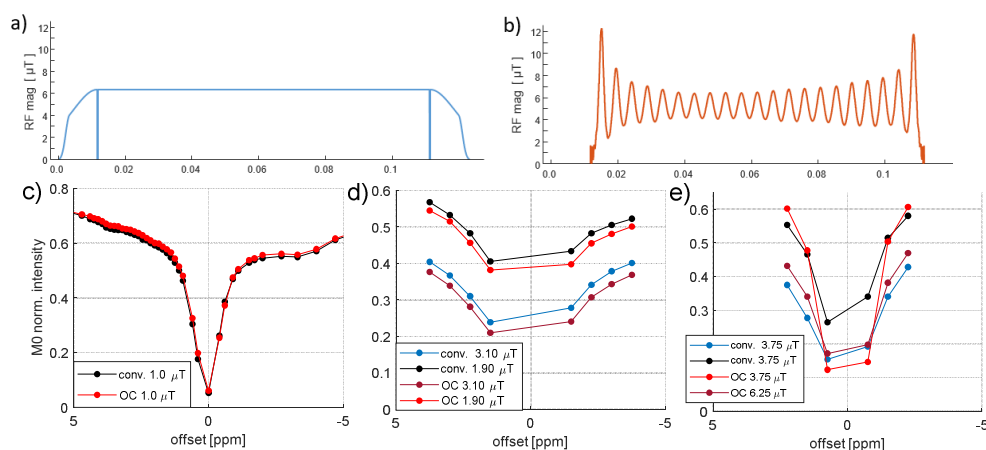


Figure 1: pulses (Figure 1a, $6.25\ \mu T$ adiabatic spin lock pulses) the respective optimal control pulses look very different (Figure 1b), but create very similar Z-spectra data for all B1 regimes (Figure 1c-e).

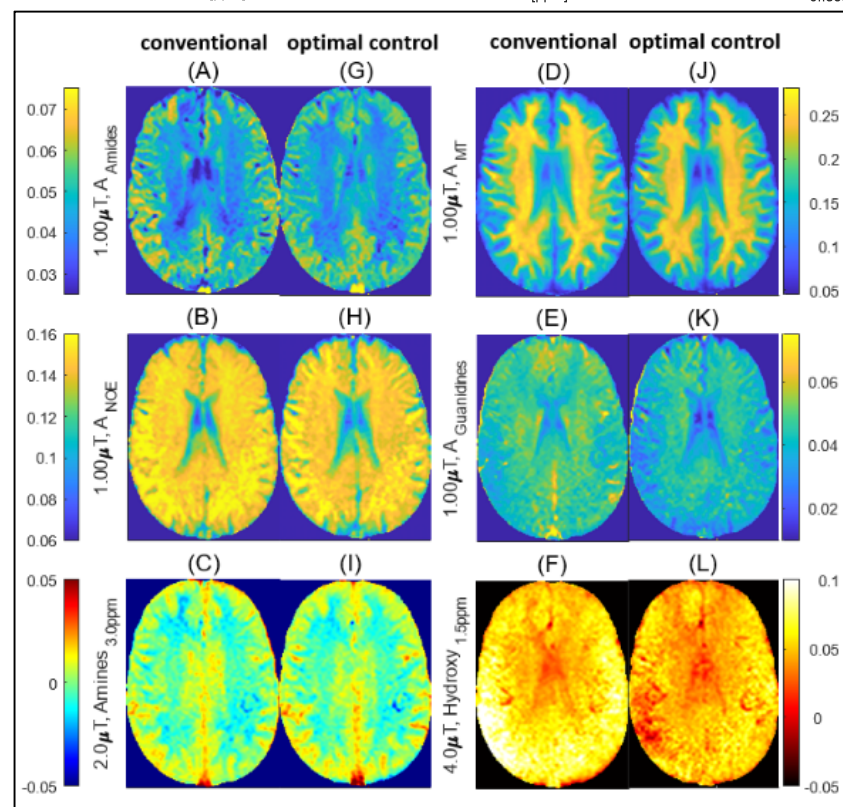


Figure 2: Comprehensive CEST maps for conventional pulses (A-F) and optimal control pulses (G-L).

Discussion In the course of this work, optimal control pulses in a healthy male subject showed comparable Z-spectra and CEST effects with improved robustness against B0/B1 inhomogeneity, as proposed by Stillianu et al.² CEST saturation with optimal control pulses is estimated to yield improved CEST labelling in all exchange regimes, while being optimizable for different targets, e.g. minimizing spillover or SAR.

Conclusion Optimal Control pulses can be used as drop-in replacement in the cCEST protocol generating 6 CEST contrast with improved field inhomogeneity robustness that can successfully be applied in human subjects.

References

1. Zaiss et al. *NeuroImage*(2022):Clinical,32,1
2. Stillianu et al. *MRM* (2024)
3. Fabian et al., *NBM* (2024), e5096.
4. Herz et al., *MRM*(2019), 81(1), 275-290.
5. Zaiss et al., *NBM* 31.4 (2018), e3879.