Cardiac phase-resolved myocardial T1 quantification at ultra-high fields using machine-learning based transmit field calibration

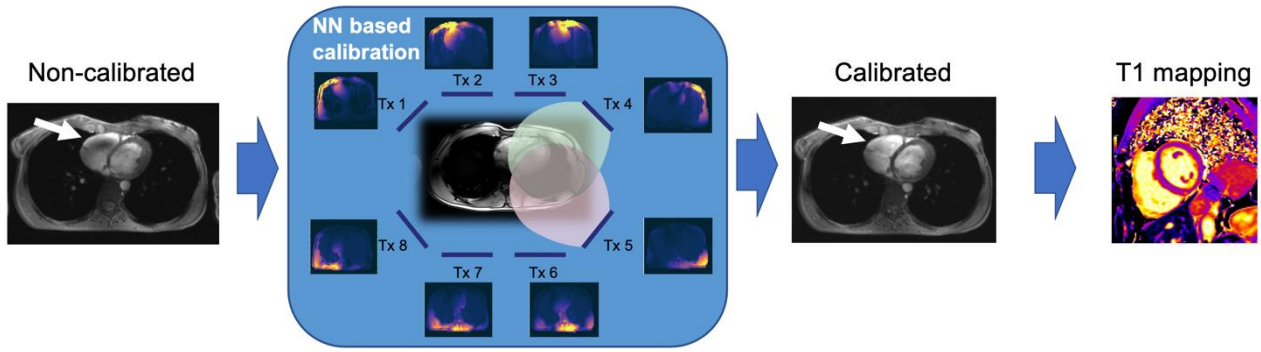
PIs: Jeanette Schulz-Menger, Sebastian Schmitter, Tobias Schäffter

Theme: Tissue structure

Background: T1 relaxation time mapping is an established technique in clinical cardiovascular MRI. T1 mapping allows a quantitative myocardial tissue differentiation to detect fibrosis as well as other infiltration. That makes it crucial for therapeutic decision making. Ultra-high field (UHF) MRI operating at 7 Tesla has high potential for T1 mapping as it offers higher resolution and more accurate quantification. However, its diagnostic benefit for patients has not been investigated so far and patient studies are urgently needed. The reason for this gap is that UHF T1 mapping is challenging due to RF power limitations and heterogeneous excitation fields at UHF, which need to be calibrated.

Hypothesis: 7 Tesla cardiac MRI allows higher resolution as well as more accurate quantification for the detection of myocardial injury and cardiomyopathies.

Methods: In this project we will develop a neural network-based calibration technique for UHF transmit RF field mapping (1) and parallel transmission (2) to enable high-resolution, multi-slice T1 mapping performed in a breath-hold at 7 Tesla. The imaging method will be derived from a cardiac phase-resolved 3 Tesla T1 mapping technique developed within a previous Bioqic project (3) that will be integrated into the 7 Tesla framework. The novel 7 Tesla method will be investigated and tested in healthy volunteers at 7T. Subsequently 10 patients with cardiomyopathies and known myocardial injury will undergo the scans at 7T and 3T and the results will be compared to matched healthy controls.



Collaborations: The project will be performed in close collaboration between Prof. Schulz-Menger and her group at Charité hospital and Dr. Schmitter and his group at PTB. The students will join our joint project meetings as well as our regular joint group meetings for discussions, presentations, and feedback. Furthermore, the project will be strongly linked to the group of Dr. Kolbitsch at PTB, particularly concerning the image reconstruction.

Impact: The work will enable the application of T1 mapping at 7 Tesla in patients, which allows future investigations in various cardiac diseases such as fibrosis or other infiltrations.

References:

1. Dietrich S, Aigner CS, Kolbitsch C, Ludwig J, Mayer J, Schmidt S, Schaeffter T and Schmitter S. “3D Free-breathing Multi-channel absolute B1+ Mapping in the Human Body at 7T”, Magn Reson Med. 2021 May;85(5):2552-2567.
2. Aigner CS, Dietrich D, Schmitter S. "Three-dimensional static and dynamic parallel transmission of the human heart at 7T", NMR Biomed. 2021 Mar;34(3):e4450
3. Becker KM, Schulz-Menger J, Schaeffter T, Kolbitsch C. " Simultaneous high-resolution cardiac T1 mapping and cine imaging using model-based iterative image reconstruction" Magn Reson Med. 2019 Feb;81(2):1080-1091.

Please contact Sebastian Schmitter (sebastian.schmitter@ptb.de) for any further questions on this project.