State of RACETE MRI

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INTRODUCTION:

In 2018, RACETE was demonstrated as a novel approach to visualize chemical exchange imaging[1]. RACETE is based on repeating the stimulated echo pathway to accumulate chemically exchanged excitation. By transferring excitation, the phase of the excitation pulses is retained in the resulting stimulated echo, giving rise to interesting possibilities[2]. Furthermore, the timing of the pulses allows for direct exchange rate quantification or spectroscopic analysis using the same principle as FLEX[3,4]. However in comparison to CEST, RACETE also adds complexity, introducing new challenges and limiting the total sensitivity.
In this abstract we want to share a few examples of the experience collected with optimizing and extending RACETE between 3T and 17.5T.

METHODS / RESULTS:

RACETE at "low field": In previous publications only ultra high field strengths devices (9.4 T-17.5 T) have been used. In Fig. 1 a pulseq based implementation using radial readout (spiral out) for RACETE and a subsequently refocused CEST weighted echo (spiral in – spiral out) was used to acquire phantom measurements on 3T scanner[5].

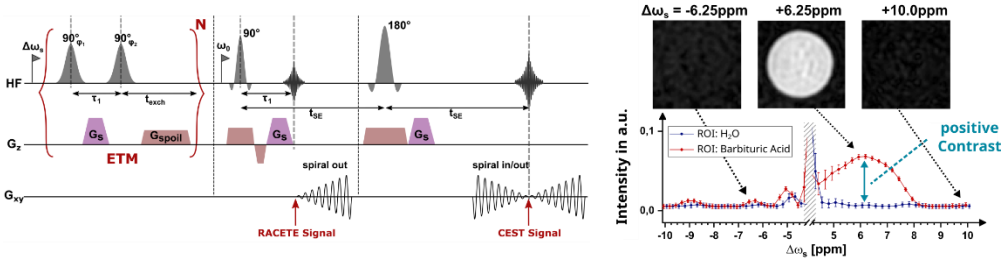

Fig 1 Spiral readout implementation of the RACETE-CEST experiment. Data acquired on a 3T medical imaging system (Siemens, Erlangen, Germany). Phantom: Inner: barbituric acid, Surrounding: H_2O. [5]

Phase Transfer: When several substances with different chemical shift are excited during the preparation, different phases *are accumulated* in the τ_1-interval (see Fig.1). By variation of this interval a signal evolution can be acquired. The resulting complex signal can be transformed directly to a spectrum of the contributing substances (see Fig. 2).

Optimizations: Several optimizations for acceleration have been regarded. One of the more interesting approaches is to interleave only a few preparations before magnetization is read out using an α-pulse[5]. In Fig. 3 the time normalized signal of steady state RACETE is shown to surpass normal RACETE by up to a factor of two for an optimal choice of α. Especially for multi-pool RACETE the sensitivity can be further optimized by choice of the excitation flip angle (not shown).

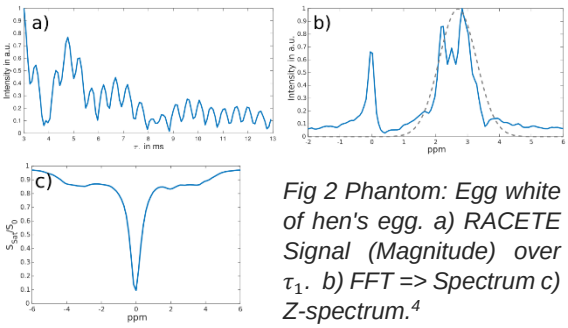

Fig 2 Phantom: Egg white of hen's egg. a) RACETE Signal (Magnitude) over τ_1. b) FFT => Spectrum c) Z-spectrum.[4]

DISCUSSION / CONCLUSION

RACETE has several interesting features however it has not found its way into any applications yet. The major challenges in RACETE imaging are its sensitivity towards B_0-inhomogeneities and the balancing between selectivity and efficiency in the preparation module, which limits the total sensitivity. In this work some of the features as well as some optimization to reduce the sensitivity limitation are shown.

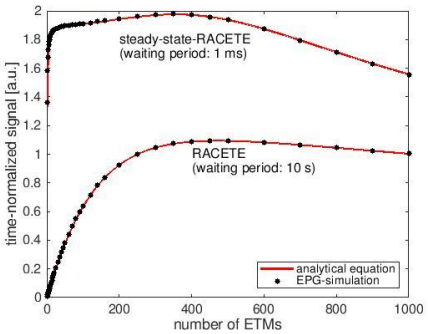

Fig 3 Time normalized signal intensity for RACETE (lower line) and steady-state-RACETE (upper line) using EPG simulation (dots) and a analytically derived description (red lines)[6]

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