

# Dual Band Water and Lipid Suppression for Multi-slice MRSI of Human Brain at 3T

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## Purpose:

Multi-slice Magnetic Resonance Spectroscopic Imaging (MRSI) [1] can measure the spatial distributions of metabolites such as NAA, Cr and Cho in the brain. Recent advancements in phased array coils and SENSE reconstruction have reduced the scan time of conventional lengthy MRSI scans to the order of a few minutes. However, fold-over artifacts, typical in parallel imaging, are particularly problematic in SENSE-MRSI because the signals of extra-cranial lipid overwhelm the metabolic signals by a factor of hundred or more. This abstract describes an approach to address lipid contamination by combining  $B_1$  and  $T_1$ -optimized dual band lipid and water suppression pulses with outer volume suppression (OVS).

## Materials and Methods

Five dual band, frequency modulated suppression pulses were generated using hyper geometric functions [2] with parameters shown in Table 1. All pulse parameters including (target) flip angles and delay times were optimized with computer simulations to cover a  $T_1$  range of 250ms to 1.2s and an up to fourfold  $B_1$  variations. The 95ms delay between the 4<sup>th</sup> and 5<sup>th</sup> suppression pulses was intended for 8 optional OVS pulses of 95° flip angles (Fig.1). The center of the OVS pulses was 80ms before signal excitation. Crusher gradients of 3ms followed each suppression pulse. The total length of this sequence was 220ms. A VAPOR [3] water suppression sequence with 8 OVS pulses was used for comparison. The OVS pulses were between the 5<sup>th</sup> and the 6<sup>th</sup> suppression pulses with flip angles of 120°, limited by maximum  $B_1$ . The center of OVS pulses in VAPOR was 215ms before signal excitation and the total length of VAPOR was 738ms. A slice selective spin echo MRSI sequence succeeded the suppression pulses with TE/TR of 144ms/2.5s for dual band and 144ms/3s with VAPOR. Three 15 mm thick axial slices were recorded. A FOV of 190x240mm was sampled with an MRSI matrix of 27x33. Experiments were performed on 3 normal volunteers on a 3T Achieva system (Philips Healthcare), equipped with an 8-channel phased array receiver coil. Sense factor was 2. Prior to data acquisition, a rapid dual-field mapping technique was used to optimize  $B_0$  homogeneity and determine transmit  $B_1$  level.

## Results

Figure 2(a&b) shows a comparison of residual lipid maps using two methods. The two spectra at the marked voxel location (Fig.2c) show significantly less lipid contamination with dual band + OVS suppression (black line). To quantify the performance of the two suppression methods, the same slice selective spin echo sequence was applied without phase encoding gradients. The resulting spectra (Fig.3) show the sums of the signals from the entire slice: (1) no suppression at all with purple line, (2) VAPOR only with black line, (3) VAPOR + OVS with green line, (4) dual band only with blue line, (5) dual band + OVS with red line. The residual lipid signals from scans (2-5) were integrated and normalized by the lipid signals in scan (1) to produce lipid suppression factors: 1.0: 1.0: 0.36: 0.18: 0.15.

## Conclusion

The dual band sequence shows comparable in water suppression to VAPOR, while lipid suppression performance is 2 to 3 times better than VAPOR with OVS. Total length of the dual band sequence is also significantly less than VAPOR, so it allows a shorter TR to be used in the multi slice sequence.

## Reference:

[1] Duyn et al. Radiology 188, 277-282 (1993) [2] Rosenfeld et al. MRM 37: 793-801 (1997) [3] Tkac et al. MRM 41: 649-656 (1999). Supported in part by P41RR15241.

Table 1: Pulse Parameters

Pulse	Length (ms)	Delay (ms)	Pass BW(Hz)	Sweep (Hz)	Water Flip	Lipid Flip
1	30	35	329	6009	85.6 °	32.5 °
2	30	95	321	1364	69.3 °	99.4 °
3	30	35	330	3205	51.2 °	20.3 °
4	30	95	327	1299	113.4 °	128.1 °
5	30	18	326	1620	127.7 °	135.9 °

Figure 1: Pulse Diagram

