# Elimination of Extracranial Lipid Leakage Effect in Brain CSI by SLIM Reconstruction

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**Introduction:** *In vivo* magnetic resonance spectroscopy provides unique information on tissue biochemistry and is used to study biochemical basis of disease and therapy. Chemical Shift Imaging (CSI) [1] combines spectroscopy with spatial phase encoding and allows simultaneous acquisition of spectroscopic information from different regions. However, due to the low density of metabolites and scan time restrictions only a small central portion of k-space can be covered in a CSI experiment. This leads to substantial inter-voxel signal contamination due to the point spread function effects. It is particularly harmful in the brain CSI since the intense extracranial lipid signal can detrimentally contaminate the spectroscopic signal from the brain regions. Several promising attempts have been made to overcome this problem [2 – 4]. Spatial Localization by Imaging (SLIM) offers mathematically consistent approach to deal with this problem [5]. Indeed, SLIM reconstruction algorithm of CSI data takes advantage of additionally acquired anatomic images and allows reconstruction of arbitrarily-shaped voxels selected according to identified anatomical structures. Herein we report implementation of SLIM technique at 3T MRI scanner and demonstrate effective elimination of contaminating extracranial lipid signal from brain regions.

**Methods:** We implemented a 1D CSI sequence on Siemens 3T Magnetom Allegra system and the data were collected using a circularly polarized head coil. To demonstrate the feasibility of SLIM reconstruction initial experiments were done on a phantom containing tubes filled with water and oil. Sequence parameters were: Fourier voxel size of 1.6 x 2.0 x 4.0 $cm^3$, TR/TE = 1500/40 ms and spectral bandwidth = 2000Hz with 1 average. Single voxel spectra was also obtained from the two tubes as a reference. *In vivo* experiments were performed on 7 subjects. Data was collected with and without outer volume suppression, Fourier voxel size = 1.6 x 1.6 x 1.6 $cm^3$, TR/TE = 1500/40 ms, 16 averages and spectral bandwidth 2000Hz. High resolution reference images were also obtained from the same location as the spectroscopy section and used as anatomical marker for SLIM reconstruction. Brain was divided into sections to obtain spectra from different regions. Additional compartments chosen for SLIM reconstruction were skull, scalp and muscle.

**Results and Discussions:** Figure 1 shows the spectra from the tube containing oil obtained via single voxel spectroscopy (SVS), Fourier reconstruction of CSI data and SLIM reconstruction of CSI data. Even though water- and oil-filled tubes are substantially spatially separated, water signal leakage is prominent with the Fourier reconstruction, The SLIM reconstruction shows significant reduction of water leakage as compared to Fourier reconstruction. Figure 2 shows the representative spectrum from one subject. Spectra shown are for two adjacent voxels near the left side of the brain. It is obvious from the Fourier reconstructed spectra that even with outer volume suppression there is still a significant lipid signal left which contaminates the signal from brain thus making it very difficult to evaluate the metabolite signal. With the SLIM reconstruction, we were able to eliminate the lipid signal resulting in pure signal from the brain regions. Same results were obtained for all subjects. For experiments where outer volume suppression was not used the lipid signal completely dominates the metabolite signal with the Fourier reconstruction (data not shown) but with the SLIM reconstruction we were able to eliminate the lipid signal from brain voxels

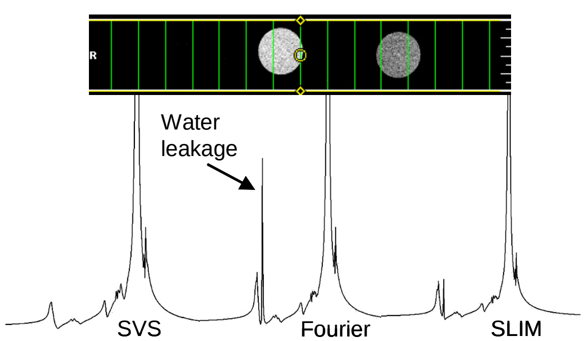


**Figure 1:** Image shows the location of the water and oil tubes. Only spectra from oil are shown. Spectra from Fourier reconstruction show significantly higher water leakge signal than SLIM reocnstruction

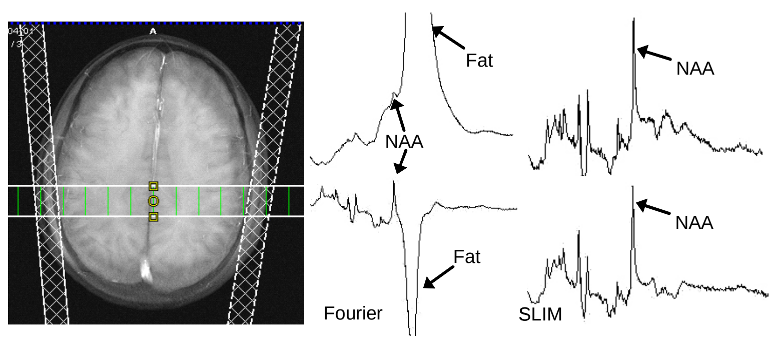


**Figure 2.** Image shows location of 1D spectroscopy section with outer volume suppression bands. Spectra are shown for two voxels in brain adjacent to the left side of brain. Fourier spectra (left column) shows large leackage of lipid signal while SLIM reconstruction was completely able to get rid of the lipid contamination.

**Conclusions:** It is demonstrated here that the leakage of extracranial lipid signal can be eliminated in brain CSI using SLIM reconstruction. In addition to removal of contaminating lipid signal the other advantage of SLIM is that the regions in brain can be of arbitrary shape e.g. if there is a tumor in brain it can be chosen as a compartment resulting in true signal from the tumor, also gray and white matters can be chosen as individual compartments. 2D SLIM reconstruction of head CSI data is in progress.

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**References:** 1. Brown T.R. et. al. *Proceedings National Academy of Sciences* (1982); 2. Plevritis S. K. et. al. *Magnetic Resonance in Medicine* (1995); 3. Kienlin M. V. et. al. *Journal of Magnetic Resonance* (1991); 4. Archibald R. et. al. *IEEE Transactions on Medical Imaging* (2002); 5. Hu X. et. al. *Magnetic Resonance in Medicine* (1998)