Reduced Peak Power Dualband VSS Pulse Design

A. B. Kerr\textsuperscript{1}, P. E. Larson\textsuperscript{2}, D. B. Vigneron\textsuperscript{3}, and J. M. Pauly\textsuperscript{1}

\textsuperscript{1}Electrical Engineering, Stanford University, Stanford, CA, United States, \textsuperscript{2}Radiology and Biomedical Imaging, UCSF, San Francisco, CA, United States

Introduction: Spectroscopic imaging based on conventional 3D PRESS localization is improved by using very selective suppression (VSS) pulses for outer volume suppression [1]. Cosine-modulated VSS pulses can be used to simultaneously suppress two parallel bands [2] but doubles the required peak RF amplitude. This abstract presents an efficient method for designing a dualband VSS pulse that requires only a $\sqrt{2}$ increase in peak RF amplitude.

Methods: RF saturation pulses with nonlinear phase profiles have reduced peak RF amplitudes. These phase profiles can be specified analytically as for quadratic-phase VSS pulses [3,4], or can be arrived at by manipulating the roots of the $B_{\delta}(z)$ polynomial [5,6] that describes the slice profile in an SLR-based RF design [7]. We will use the root-manipulation approach for calculation efficiency and also because the quadratic-phase profile will degrade to approximately linear phase in the dualband case.

Figure 1a shows the profile of a $B_{\delta}(z)$ polynomial designed to excite a single band using a minimum-phase FIR filter design method based on convex optimization and spectral factorization [8]. The filter has a ratio of passband to stopband using a minimum-phase FIR filter design method based on convex optimization. The filter has a ratio of passband to stopband using a minimum-phase FIR filter design method based on convex optimization and spectral factorization [8].

The peak amplitude increase over a single-band reduced peak power VSS pulse is only 41%, which can be exploited to suppress more complex geometries. Zeros unchanged from the reference $B_{\delta}(z)$ are circles while flipped roots are crosses.

Figure 1b demonstrates the excellent saturation achieved using the RF pulse. Though the peak ripple is approximately 3-4% compared to a design of 2%. The increased ripple is likely due to RF system nonlinearity.

Discussion: An efficient root-manipulation based approach was developed to design reduced peak power dualband VSS pulses for clinical MRSI studies. The peak amplitude increase over a single-band reduced peak power VSS pulse is only 41%, which can be exploited to suppress more complex geometries or increase $B_{\delta}$ and $T_{\text{ref}}$ insensitivity. The design method is appropriate for incorporation during scan prescription to allow for variable specification of band thickness, separation and tip-angle.


[Acknowledgement: This work partly supported by NIH R01 EB007588 & CA111291]