

## Neural Prosthesis Seminar

# “Simultaneous Neurochemical Sensing, Stimulation, and fMRI Studies Using WINCS Harmoni During Deep Brain Stimulation”

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### Abstract

Despite its clinical success in variety of neurologic and psychiatric disorders, there is a limited understanding of the therapeutic mechanism behind Deep Brain Stimulation (DBS). To fully understand the neurochemical and neural circuit effects of DBS, we developed the WINCS (Wireless Instantaneous Neurochemical Concentration Sensing system), MINCS (Mayo Investigational Neuromodulation Control System), and fMRI monitoring during DBS. WINCS employs fast scan cyclic voltammetry (FSCV) to characterize the neurochemical interactions events during DBS and MINCS allows wirelessly controlled electrical stimulation. Presently, we have developed a second-generation electrochemical monitoring and stimulation system called WINCS Harmoni. WINCS Harmoni incorporates a wirelessly controlled synchronizable neurostimulator, and four-channel integrated circuit for simultaneous neurochemical and electrophysiological measurements. PC based software provides real-time control of stimulation, neurotransmitter detection, data acquisition, and data visualization. We demonstrate Harmoni's 4-channel capability to accurately detect disease-relevant analytes. Additionally, we also examined Harmoni's efficacy in vivo using a bipolar stimulation electrodes placed in the medial forebrain bundle (MFB). Harmoni successfully evoked and detected striatal dopamine release by DBS. Notably, the synchronization of stimulation with interleaved FSCV scans eliminated the stimulus artifact that would have otherwise obscured the neurochemical measurements. In addition, the stereotactic targeting of the recording electrode was identified by fMRI BOLD activation during DBS in the pig, monkey, and human. Taken together, our results suggest the activation during DBS corresponds to neurotransmitter release in distant sites of the neural circuit. In future work, we anticipate the use of feedback loop smart DBS system that incorporates electrochemical sensing.

For more information, please contact Cheryl Dudek at (216) 231-3257.

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