Joint Department of
BIOMEDICAL ENGINEERING

UNC CHAPEL HILL | NC STATE UNIVERSITY

Special Rehabilitation Engineering Seminar

Noninvasive Neural Interfacing and Therapies

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Dr. Kubanek is a neural engineer at Stanford University, supported by a K99/R00 grant from the National Institute of Neurological Disorders and Stroke. Under this grant, he has been working on remote, noninvasive control of cellular excitability using focused ultrasound. He has investigated the molecular basis of the interaction of ultrasound with excitable cells, and has applied the approach to stimulate neurons in specific brain regions in macaque monkeys and this way influence their choice behavior. Prior to this research, he worked on developing electrocorticography-based neural interfaces in humans at the National Center for Adaptive Neurotechnologies, and conducted electrophysiological and pharmacological neuromodulation studies using macaque monkeys at Washington University School of Medicine. Dr. Kubanek's work has been covered in venues including *Scientific American* and *The Telegraph*. He serves as a frequent reviewer of articles published in the *Journal of Neural Engineering*, *Brain Stimulation*, and *Brain-Computer Interfaces*, and also reviews grants funded by the *Focused Ultrasound Foundation*.

ABSTRACT

The future of neural interfacing and therapies lies in minimally invasive approaches that can read and modify neural activity in specific circuits including circuits deep in the brain. Focused ultrasound has emerged as a unique theranostic modality that combines noninvasiveness, depth penetration, and sharp focus. The modality begins to be used for remote neurostimulation, for targeted delivery of neuromodulatory drugs, and for sensitive functional imaging of neural activity. The ability of FUS to remotely control neuronal activity has far-reaching implications for neural interfacing and for treatments of nervous system disorders. I have pursued this direction under a K99/R00 grant from the NIH. I will present our recent findings regarding the biophysical mechanism using which ultrasound stimulates excitable cells, show how that knowledge informs the design of stimulation protocols, and demonstrate an application of the method in noninvasive stimulation of neurons in specific brain regions in behaving primates. I will also introduce the future directions of my group. In addition to neurostimulation, we will use focused ultrasound to uncage drugs from nanoparticle carriers, and develop systems that enable stimulation and imaging of neural activity throughout the brain in awake behaving animals and humans.

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