

Advancing Coil Design in Micromagnetic Brain Stimulation

Principal Investigator: Giorgio Bonmassar, PhD, Massachusetts General Hospital

Micromagnetic stimulation (μ MS) has several advantages over electrical stimulation. First, μ MS does not require charge-balanced stimulation waveforms as in electrical stimulation. In μ MS, neither sinks nor sources are present when a current is induced by the time-varying magnetic field, thus μ MS does not suffer from charge buildup as can occur with electrical stimulation. Second, magnetic stimulation via μ MS is capable of activating neurons with specific axonal orientations. Moreover, as the probes can be completely insulated from the brain tissue, we expect to significantly reduce the problem of excessive power deposition into the tissue during magnetic resonance imaging (MRI). μ MS technology was first developed in our laboratory and is entirely based on commercial components off the shelf, which are readily available to researchers. However, commercially available inductors are designed to maximize efficiency (Q-factor), which consists in trapping the generated magnetic field to minimize its losses. Furthermore, such coils do not allow for multiple coil design in small and complex 3D geometries as it is often needed in neuroscience applications. In this application we propose to acquire new thin-film technology at the Center for Nanoscale Systems (CNS) Harvard University to acquire the know-how and expertise to design, fabricate and test nanoscale coil structures for next generation of μ MS devices. Such devices could become potentially the pacemakers and brain stimulators of the future with their contactless ability to deliver the neuronal stimulation needed for therapeutic efficacy for patients in need of implantable cardioverter-defibrillators or pace-makers, or in patients with Parkinson's disease, epilepsy, and major depression.