SIMULTANEOUS IMAGING OF NEURAL ACTIVITY AND ANATOMY BY MAGNETIC RESONANT TECHNIQUES AT ULTRA-LOW FIELD

Robert .H. Kraus, Jr., Ph.D.
Los Alamos National Laboratory, Los Alamos, New Mexico (USA)

A variety of techniques have been developed to noninvasively image human brain function that are central to research and clinical applications endeavoring to understand how the brain works and to detect pathology (e.g. epilepsy, schizophrenia, etc.). Current methods can be broadly divided into those that rely on hemodynamic responses as indicators of neural activity (e.g. fMRI, PET) and methods that measure neural activity directly (e.g. MEG and EEG). The approaches all suffer from either poor temporal resolution, poor spatial localization, or indirectly measuring neural activity.

The Los Alamos "SQUID Team" has been investigating instrumentation and modeling approaches to improve the quality and reliability of MEG for more than a decade. Recently we have begun investigating ultra-low field (ULF, microtesla fields) NMR and MRI, the signals for which can be acquired by the same SQUID sensors that acquire the MEG signal. I will review advances we have made in MEG and examine the strengths and weaknesses of MEG as a functional brain imaging modality. I will then transition to reviewing our work to integrate MEG, anatomical ULF-MRI, and an entirely new idea of direct neural imaging (DNI) based on ULF-MRI techniques. I will present the physical basis and experimental evidence for a technique for tomographically imaging the direct consequences of neural activity with high spatio-temporal resolution.