SQUID-based Systems for Co-registration of Ultra-Low Field Nuclear Magnetic Resonance Images and Magnetoencephalography

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Abstract - The ability to perform MRI in ultra-low magnetic fields (ULF) of ~100 μT, using superconducting quantum interference device (SQUID) detection, has enabled a new class of magnetoencephalography (MEG) instrumentation capable of recording both anatomical (via the ULF MRI) and functional (biomagnetic) information about the brain. The combined ULF MRI/MEG instrument allows both structural and functional information to be co-registered to a single coordinate system and acquired in a single device. In this paper we discuss the considerations and challenges required to develop a combined ULF MRI/MEG device, including pulse sequence development, magnetic field generation, SQUID operation in an environment of pulsed pre-polarization, and optimization of pick-up coil geometries for MRI in different noise environments. We also discuss the design of a "hybrid" ULF MRI/MEG system under development in our laboratory that uses SQUID pick-up coils separately optimized for MEG and ULF MRI.

Keywords – SQUID, magnetoencephalograpgy, MEG, Nuclear magnetic resonance imaging, MRI, co-registration

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