COLLOQUIUM

# Novel Tools for Rational Design and Assessment of Radiofrequency Coils for Magnetic Resonance Imaging

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At high and ultra-high field magnetic resonance imaging (MRI), understanding the interactions between the dielectric sample and the electromagnetic fields associated with radiofrequency coils becomes crucial for safe and effective coil design as well as for insight into limits of performance. We developed a rigorous framework, using dyadic Green's functions, to calculate ideal current patterns that result in the highest possible signal-to-noise ratio (ultimate intrinsic SNR) compatible with electrodynamic principles. We identified familiar coil designs within ideal current patterns at low to moderate field strength, thereby establishing and explaining graphically the near-optimality of traditional surface and volume quadrature designs. We also documented the emergence of less familiar patterns, e.g., involving substantial curl-free as well as divergence-free current contributions, at high field strength. Our method can serve as a tool for the evaluation of coil designs against absolute references, as well as a tool to guide the development of original designs that may begin to approach the optimal performance.