SOLVING THE RADIOFREQUENCY FIELD INHOMOGENEITY PROBLEM IN HEAD MRI FOR FULL EXPLOITATION OF ULTRA-HIGH FIELD SCANNERS

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BIO
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ABSTRACT
Although MRI activities at ultra-high field (UHF) have been blooming for the last two decades due to promises and hopes for achieving higher spatiotemporal resolution, the discipline has not yet lived to its full potential. Within this context, the radiofrequency (RF) field inhomogeneity problem was voted at the ISMRM UHF workshop in 2019 in Dubrovnik by the community as the most important obstacle for UHF scanner exploitation. By increasing field strength, the wavelength of the RF wave used to excite the water magnetization indeed decreases and becomes comparable to the dimensions of the object to be imaged. Wave interferences thus arise and can yield highly inhomogeneous RF field intensity patterns, leading at the very least to suboptimal signal-to-noise ratio in some areas and in the worst case to extreme signal voids making the images merely unusable. Traditional NMR methods (e.g. composite and adiabatic pulses) fail to compensate for these inhomogeneities due to their power needs inapplicable in vivo. The advent of parallel transmission in 2003 was a breakthrough to address this issue. It consists of placing around the subject several RF transmitters that can be controlled independently (amplitude and phase). By interference, and via sophisticated optimization routines, as one can modulate the spin’s response to return effectively a spatially quasi-uniform excitation profile. But despite the progress made over the years by the community, the technique has also failed to be embraced in routine due to its complexity and cumbersome procedures. After an introduction of the context, this talk will present how this step can be bypassed by the so-called Universal Pulse approach. This calibration-free technique has been applied so far exclusively at 7T for head imaging and has proved to reestablish a flip angle homogeneity better than at 3T in the standard (CP) mode of excitation, where RF field inhomogeneity is not deemed a serious problem. This solution comes at zero cost for the user and has been demonstrated experimentally for many foundational sequences (3D, 2D, anatomy, fMRI) and across different sites.