Imaging with Optimized Magnetite MPI Tracers

R. Matthew Ferguson[1], Amit P. Khandhar[2], Patrick W. Goodwill[3], Steven M. Conolly[3], and Kannan M. Krishnan[1]

[1] Materials Science & Engineering, University of Washington, Box 352120 Seattle, WA 98195-2120, USA
mferg47@uw.edu, kannanmk@uw.edu
[2] LodeSpin Labs LLC, PO Box 95632 Seattle, WA 98145-2632, USA
amit.khandhar@gmail.com
[3] Bioengineering, University of California, Berkeley Berkeley, CA 94720-1762
goodwill@berkeley.edu, sconolly@berkeley.edu

Magnetite nanoparticle (MNP) tracers can be optimized for Magnetic Particle Imaging (MPI) by tuning their magnetic core size and size distribution. In previous work, our group showed that ~15 nm MNPs were optimal at 250 khz by synthesizing a series of tracers with tuned size and narrow size distributions. This optimization approach is general, and here we present experimental results that demonstrate that the same principles apply at 25 khz excitation. The key result of this work is that MPI spatial resolution can be improved by the appropriate selection of MNPs.

We synthesized MNP tracers in our labs with median diameters of 20-25 nm and narrow size distributions. Each tracer consisted of magnetite cores that were synthesized in organic solvents to ensure uniform size and subsequently coated with an amphiphilic polymer and dispersed in water. Tracer performance was characterized using a home-built MPI magnetometer that excites tracer magnetization with a field of up to 36 $mT\mu_0^{-1}$ (peak to peak) and measures the signal induced in a receive coil by the derivative of tracer magnetization, *M'(H(t))*. In preliminary results, our tuned tracers showed 30% better spatial resolution compared to Resovist, determined from the point-spread function: the full-width-half-maximum of *M'(H(t))*. The tuned tracers also yield harmonic spectra with greater intensity than Resovist, when normalized by iron concentration, for all of the 40 harmonics measured by our device.

In addition to measurements of the point spread function we present preliminary results of phantom imaging experiments using the tuned tracers. These results highlight the improved performance of our tracers compared with Resovist, the current standard tracer for MPI.

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