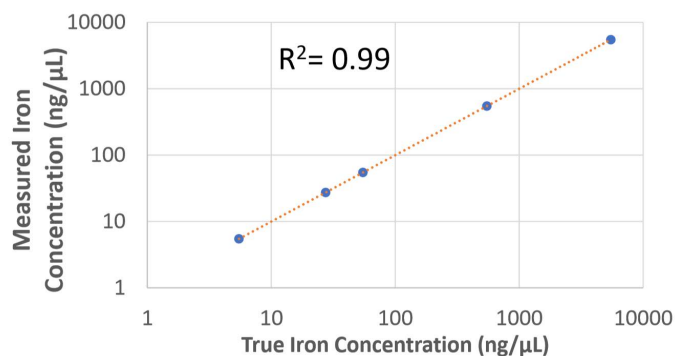


Groundbreaking Resolution and Sensitivity with Preclinical Magnetic Particle Imaging

Introduction to MPI

Magnetic Particle Imaging (MPI) is an emerging non-invasive, diagnostic imaging technique in the field of Molecular Imaging. Using super-paramagnetic iron oxide (SPIO) tracers, MPI generates positive contrast images with limited to no background. The technology has extensive applications for diagnostic imaging, such as: imaging cancer, inflammation, tracking cellular therapeutics, and visualizing vascular perfusion. Combining both high sensitivity and specificity, MPI does not suffer from signal attenuation due to tissue depth.¹ MPI is expected to provide a significant advancement for cellular and molecular research.

The MOMENTUM™ MPI System from Magnetic Insight produces the world's highest sensitivity and resolution MPI images. The technology is currently performing at picogram concentrations of tracer and micrometer spatial resolution. This is achieved from a fully self-shielded, high-field gradient main magnet and the proprietary x-space reconstruction process² and tracers with ideal properties³ and truly optimized for MPI relaxation dynamics⁴.



Quantitation & Linear Signal Range

The linear signal range of the MPI system extends over 4 orders of magnitude (Figure 1), and was measured with five serial dilutions from stock VivoTrax™ MPI tracer. The coefficient of determination ($R^2 = 0.99$), indicates a near perfectly linear system. The linearity of the system is an important requirement for accurate iron oxide quantification, allowing for calibration with a single fiducial tube.

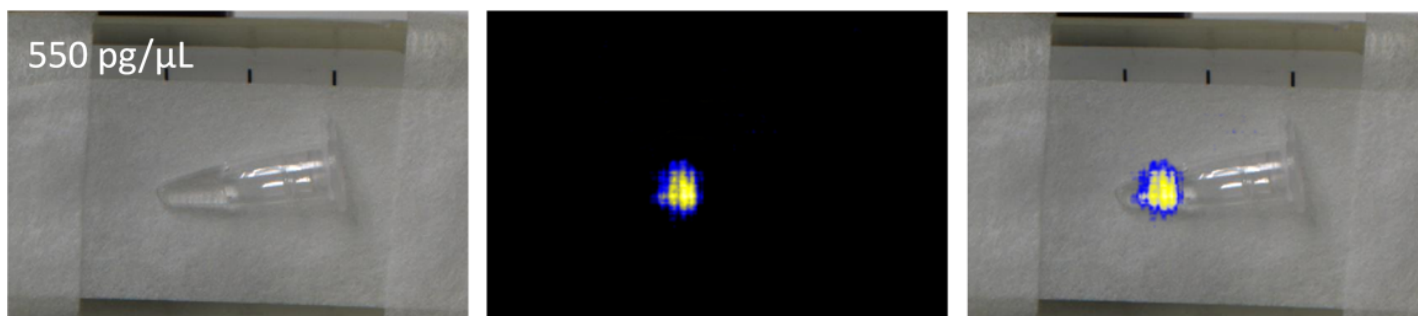
Sensitivity

The MOMENTUM™ scanner can quickly generate images from picogram concentrations of iron (Figure 2). Here a sample containing 550 pg Fe/μL is easily detected following a minute-long scan. With current sensitivity on the micromolar level (10μM) the system is well suited for cell tracking studies. Magnetic Insight looks forward to pushing the limits of sensitivity in the near future with increased imaging averages, additional software developments, and collaborative magnetic nanoparticle research. The further development of MPI tailored nanoparticles, will continue to enhance the detection limits while offering flexible targeting opportunities and theranostic prospects^{5,6}.

Photograph

MPI

Photograph/MPI

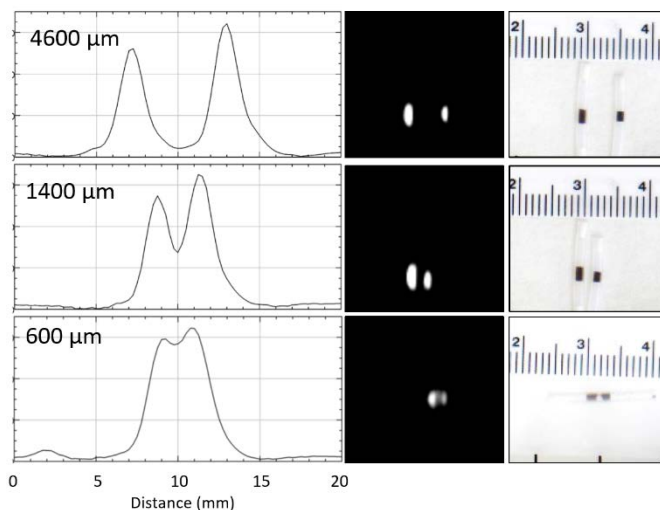


Resolution

In MPI, the resolution depends on both the imaging system hardware, as well as the properties of the nanoparticle tracer used⁴. To measure spatial resolution, two 1 μ L iron point source phantoms of MPI tailored nanoparticles³⁻⁶ were imaged at variable distances (Figure 3). With only 600 μ m separation, both points can be clearly distinguished in the MPI image and signal profile plot. No image post-processing or adjustments were performed besides window and leveling. Based on these results, the system resolution is expected to surpass 500 μ m with MPI tailored nanoparticles.

Conclusion

Magnetic Insight's MOMENTUM™ MPI system has demonstrated the highest sensitivity and resolution performance to date in the field of MPI. With submillimeter resolution, SPIO-tagged cells can be spatially localized and accurately quantified within tissue substructures of small animals. Combined with the detection of picogram quantities of iron oxide, applications extend from vascular leakage to arthritis induced inflammation. As the first diagnostic imaging technology to combine high sensitivity and resolution with positive contrast, MPI is expected to provide significant advances to molecular imaging.



Acknowledgments

Data was collected on the MOMENTUM™ MPI system located at Stanford University's SCi³ facility. Image analysis was performed with inviCRO's VivoQuant software. MPI-tailored nanoparticles were designed and provided by Dr. Krishnan's group⁷ at the University of Washington.

References:

1. Saritas et al. *J Mag Res*. 2013; 229: 116-126
2. Goodwill et al. *IEEE Trans Med Imaging*. 2012 May; 31(5): 1076-1085
3. Kemp et al, *RSC Advances*, 6, 77452 (2016).
4. Ferguson et al. *IEEE Trans Med Imaging*. 2015 May; 34(5): 1077-1084
5. Khandhar, et al, *Nanoscale* 9,1299-1306 (2017)
6. Yu et al, *Nano Letters* (in press)
7. <http://depts.washington.edu/kkgroup/>



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