

From Lab to Clinic: Automating Nanoparticle Purification and Coating for Magnetic Particle Imaging

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What is Magnetic Particle Imaging?

A next-generation scanner that tracks and images iron oxide nanoparticle tracers inside the body in real time, with no radiation and no tissue interference.

Detects injected **iron oxide tracers** with **zero** background signal, unlike MRI or PET

Demonstrated pre-clinical applications include **GI bleeding** detection, **stroke**, and **traumatic brain injury**

No ionizing radiation, **no toxic** contrast agents, and signal strength scales directly with how much tracer is present

The Tracer Problem

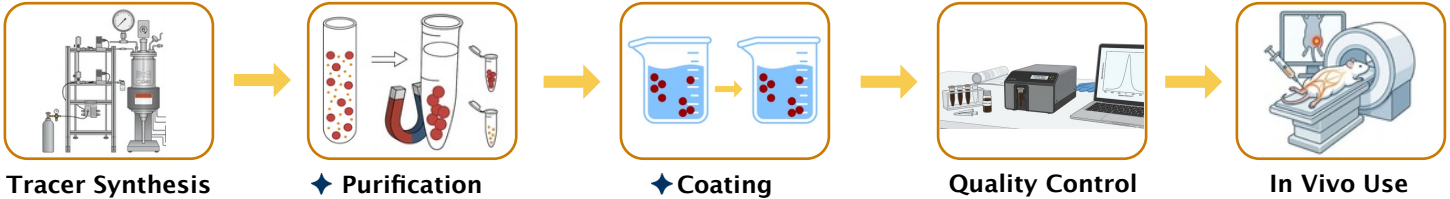
MPI resolution is only as good as the nanoparticles used, and today's tracer synthesis produces inconsistent batches that blur the image.

Variations in **particle size**, **magnetic moment**, and **chain length** degrade the resolution, **reducing image sharpness**

Existing purification methods are too **slow** and **unreliable** to consistently produce High Resolution MPI Tracer (<1mT)

Without **better purification**, clinical-grade resolution remains out of reach

Current MPI Tracer Synthesis Pipeline ♦ Denotes areas of focus for this Capstone Project



OUR SOLUTION



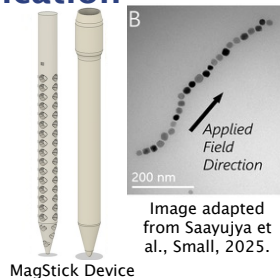
MPI resolution is **bottlenecked** by **tracer quality**, limiting its potential as a next-generation imaging tool. We developed **MagStick**, a geometry-controlled device that separates high-quality SFMIO tracers from conventional SPIOs, followed by a **Silica encapsulation** process that locks purified tracers into controlled chain formations.

Together they form the first end-to-end automated purification and encapsulation pipeline for MPI tracers, achieving a **2x** improvement in resolution compared to existing methods.

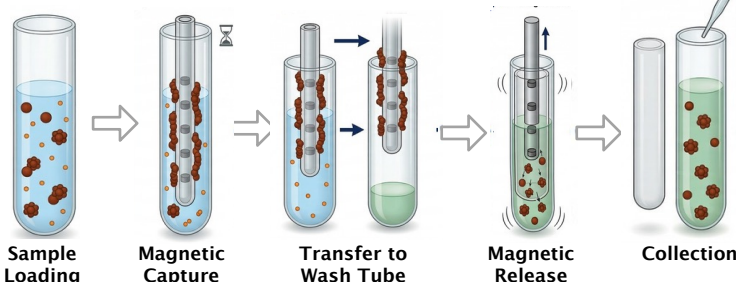
MagStick: SFMIO (Tracer) Purification

A geometry-controlled magnetic device that selectively isolates superferromagnetic (SFMIO) tracers from conventional superparamagnetic (SPIO) nanoparticles to get high resolution tracer.

High-magnetic-moment SFMIOs chain along the device and are captured; low-moment SPIOs remain in suspension and are discarded



Novel MagStick System



Silica Encapsulation (Coating)

Purified SFMIOs are coated and assembled into controlled chain structures that optimize and improve their magnetic behavior for MPI. The process is outlined below.

