Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **4210** Type: **Oral Competition (Graduate Student) / Compétition orale (Étudiant(e) du 2e ou 3e cycle)**

# (G*) Assessing magnetic particle imaging parameters for improved sensitivity in cellular tracking applications

*Monday 27 May 2024 15:15 (15 minutes)*

Magnetic particle imaging (MPI) is an emerging tracer-based imaging modality that employs the use of magnetic excitation to detect superparamagnetic iron oxide (SPIO) particles. MPI signal is only generated from SPIO and thus there is no signal from tissue. As well, the signal is linearly quantitative with SPIO concentration so the number of SPIO-labeled cells can be calculated from images. The sensitivity and resolution of MPI depend heavily on the type of SPIO used and the imaging parameters. Lower gradient field strength, higher drive (excitation) field amplitude and signal averaging are known to increase the MPI signal, however, the degree to which these changes improve SPIO and cellular sensitivity has not been tested experimentally. Our goal was to test the effects of changing various MPI imaging parameters on the MPI signal strength and cellular detection limits.

Experiments were performed on a MomentumTM MPI scanner (Magnetic Insight Inc.). SPIO (ProMag) samples were imaged using an advanced user interface which allows editing of pulse sequences to change the parameters. 2D images were acquired to compare 2 gradient field strengths, 2 drive field amplitudes, and signal averaging. Stem cells were labeled by overnight incubation with ProMag and collected to create samples of 100K to 1K cells. 2D images were acquired to compare the 2 gradient field strengths and the 2 drive field amplitudes. An in vivo pilot experiment was performed where cell pellets of 50K, 25K, 10K, and 5K cells were injected subcutaneously into the back of nude mice. MPI was performed using the optimal parameters as determined from the in vitro cell sample experiments.

The mean MPI signal of the SPIO samples was 1.7 times higher using the low gradient field strength compared to the high strength and 4.2 times higher for the high drive field strength compared to low showing improved sensitivity but also lower resolution. As well, a low gradient field strength and a high drive field amplitude produced higher signal from SPIO-labeled cells. The highest cellular sensitivity (1K cells) was achieved using a low gradient field strength and a high drive field amplitude. Signal averaging increased the signal-to-noise ratio by approximately the square-root of the number of averages. When using a 12cm FOV to image the whole mouse the 25K and 5K cells could be clearly visualized but the lower cell numbers were faint. This is the result of the known dynamic range limitation in MPI. With a 3D acquisition (35 projections) the 10K and 5K cell injections could also be detected.

To conclude, in this study we showed that MPI imaging parameters can be adjusted to improve cell detection limits in vitro and in vivo. Further improvements to our in vivo detection limit are expected as MPI-tailored SPIOs are developed.

## Keyword-1

Magnetic particle imaging

## Keyword-2

Cell tracking

## Keyword-3

Sensitivity

**Primary author:** FLOOD, Samantha

**Co-author:** FOSTER, Paula (Department of Medical Biophysics at Western University, Robarts Research Institute)

**Presenter:** FLOOD, Samantha

**Session Classification:** (DPMB) M2-3 Low-field Magnetic Resonance Imaging | Imagerie par résonance magnétique à bas champ (DPMB)

**Track Classification:** Symposia Day (Wed May 29) / Journée de symposiums (Mercredi 29 mai): Symposia Day (DPMB/DAPI - DPMB/DPAI) - Medical Imaging / Imagerie médicale