

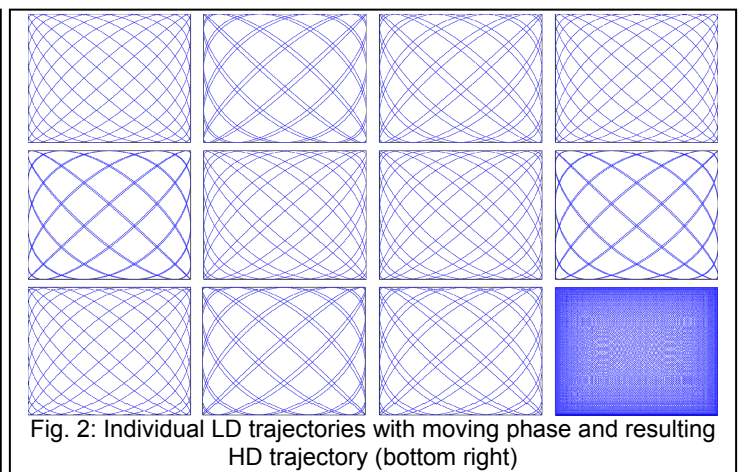
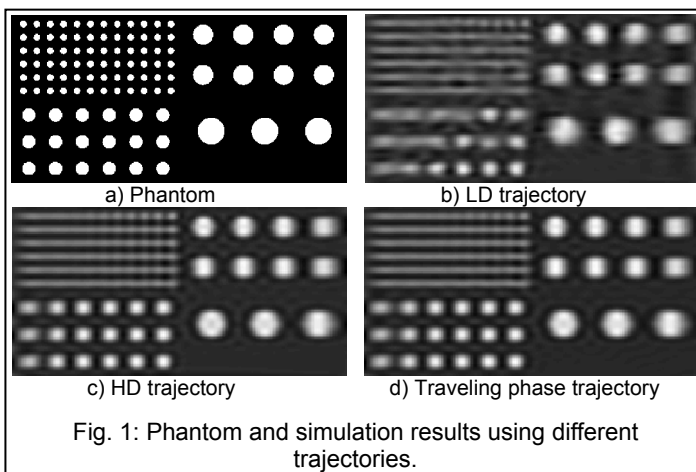
# Improving the Imaging Quality in Magnetic Particle Imaging by a Traveling Phase Trajectory

S. Biederer<sup>1</sup>, T. F. Sattel<sup>1</sup>, T. Knopp<sup>1</sup>, M. Erbe<sup>1</sup>, and T. M. Buzug<sup>1</sup>  
<sup>1</sup>Institute of Medical Engineering, University of Luebeck, Luebeck, Germany

**Introduction:** Magnetic particle imaging (MPI) is a new quantitative tomographic imaging method for measuring the spatial distribution of super-paramagnetic iron-oxide nanoparticles (SPIOs) in real-time [1, 2, 3, 4]. MPI takes advantage of the nonlinear magnetization behavior of the SPIOs. Spatial encoding is achieved by moving a field-free point (FFP) through the field of interest. For moving the FFP, different trajectories were analyzed [5]. The Lissajous curve was evaluated as an adequate trajectory and is used in actual scanners. In these scanner implementations, the different transmit frequencies cannot be varied due to resonance matching of the transmit coils. This results in a fixed sampling trajectory as well as in fixed resolution and repetition time. In this contribution, we present a new method, which allows for changing the sampling trajectory and the resulting resolution.

**Methods:** A 2D Lissajous curve evolves from two slightly different frequencies. Thereby, two almost equal frequencies result in a high density (HD) trajectory and in high spatial resolution, but also in a long repetition time. Increasing the distance of these frequencies results in a lower density (LD) trajectory, a lower resolution as well as a shorter repetition time. As mentioned above, the frequencies cannot be changed easily to allow for trajectories with different densities. However, a HD trajectory can also be obtained by choosing an LD trajectory with a phase change introduced to after each repetition. When the LD trajectory is  $k$  times shorter than the HD trajectory, the same density is accomplished by acquiring  $k$  different LD trajectories.

**Results:** In Fig. 1, a) a bubble phantom is shown as used for simulation. Results for an LD trajectory with a frequency ratio of 10/9 and a HD trajectory with a ratio of 100/99 are shown in Fig. 1 b) and c), respectively. As expected, the LD trajectory results in a poor resolution. The resolution was improved (see Fig. 1 d)) to the same density as for the HD trajectory by varying one phase stepwise by  $2\pi/11$ . The trajectories for the individual phases and the resulting HD trajectory are shown in Fig. 2.



**Discussion/Conclusion:** The new method allows for selecting a small base repetition time and generating almost arbitrary dense trajectories by acquiring multiple repetitions with a traveling phase. As a result even two identical frequencies could be chosen for setting up a MPI system. The freedom of choice of application adapted densities can, for example, be used to have a fast orientation scan and subsequently a slower high resolution scan.

## References:

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