Electronic Supplementary Information

Spinning Magnetic Trap for Automated Microfluidic Assay Systems

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ESI 1: Choosing the optimal location of channel along the length of magnets

When using strip magnets, it becomes important to place the channel at the best position along the length of the magnets to obtain both capture and release of beads. When the channel is located closer to the center of the magnet holder, the beads are continuously exposed to a significant field gradient due to the frequency of magnets travelling along the channel at any point in time. While increasing the number of magnets available aids in the capture, it presents a problem in the release of the beads. The opposite is true when the channel is placed further away from the center of magnet holder, in which case fewer magnets are passing below the channel at any point in time, thus reducing the capture efficiency, but increasing the release of beads. The best placement of channel was determined to be at the center of the strip magnets, where the spacing between magnets provided for optimized capture and release.

ESI 2: Visualization of bead capture and release

The visualization of bead movement in the microchannel was recorded for both the capture and release of the beads. Supplementary Video 1 shows the beads entrapped in the top third of the channel, with the magnets rotating below it. The rotation of magnets opposite to the flow shows that while the beads move laterally and horizontally in the channel, with the changing positions of the magnets, they also remain in the channel. In the second part of the Supplementary Video 1, the bottom of the channel is shown and the rotational direction of the magnets matches that of the flow inside the microchannel. The beads are shown to be pulled to the side of the microchannel by the magnets. As the magnets move away from the microchannel, the beads remain at the edge and continue to move towards the exit, showing that drag is dominating the dynamics.

ESI 3: Simulation of moving magnetic field gradient

Post-processing of the COMSOL model in MatLab was used to visualize the moving magnetic field gradient along the microchannel, as shown in Supplementary Video 2. In the video, the magnets rotate over the microchannel (depicted as a white line). The graph on the bottom of the video shows the strengths of magnetic flux density gradient, of both the parallel and anti-parallel orientations, directly corresponding to the location of magnets with respect to the channel in the magnet animations in the top of the video. Four groups of peaks are seen with the passing of each magnet pair, demonstrating that the magnet edges are responsible for holding the beads against the flow.