



A GMR-based Magnetic Flow Cytometer Using Matched Filtering

Chih-Cheng Huang, Xiahan Zhou, Da Ying, and **Drew A. Hall** University of California, San Diego



Optical Flow Cytometer



- Quantitative cellular analysis in hematology
- Identifying prognostic indicators:
 - Cancer, HIV, and other time-dependent biomarkers
- Gold standard for multi-parametric analysis
- Sophisticated instrumentation

Challenge: Hard to translate to a PoC setting!



Magnetic Flow Cytometer



MNP-coated cells evoke change of sensor resistance



Optical- vs. Magnetic-FCM

Optical FCM

- Complex optics, lasers, and photodetectors
- Extensive sample preparation
- Long turnaround times and out of reach for routine monitoring



Magnetic FCM

- Biological samples have no magnetic background
- Sample preparation can largely be eliminated
- Can be miniaturized, which also improves their sensitivity





Multi-stripe Layout



Unique signature improves matched filtering



- Commonly used inside hard disk drives
- Key enabler for higher areal density (larger HDD)
- Nobel prize in 2007 awarded to Fert and Grünberg





R.S. Gaster, D.A. Hall, S.X. Wang nanoLetters 2011 (cover art)



GMR Spin-Valves (GMR SV)



D.A. Hall, R.S. Gaster, et al. - Biosensors and Bioelectronics 2010



System Architecture





Micromagnetic Simulations

Random distribution of MNPs on a cell





Simulations closely match with our measurement results!

Hydrodynamic Analysis

V OF C



Micromagnetic Simulation of MNPs

OF





ToF Measurement Results



Detection of individual magnetic bead (M-450)



Matched Filtering



Improve detection of signal events and reject false alarms Minimum detectable SNR:14 dB → 4.5 dB



Flow Rate Optimization



Tradeoff between signal and flow rate for a given H_z



Complex Detection





Measurement of Real Cells





- <u>Multi-stripe layout</u>: enables distinct magnetic signature used for matched filtering
- <u>Matched filter</u>: reduces minimum detectable SNR from 14 dB to 4.5 dB, and improves detection efficiency
- <u>ToF measurements</u>: offers multi-parametric analysis of flowing analytes
- <u>GMR-based FCMs</u>: increases portability and rapid "sample-to-answer" measurement capability



Thanks!



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