NOTICE

Because my talk at the BioMagnetICs Workshop included many unpublished, preliminary results, what follows is a *very* abbreviated overview. At the end is a list of relevant publications. Thank you for your understanding.

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A Micromagnetic Gene Chip: Magnetic Labeling and GMR Detection of DNA

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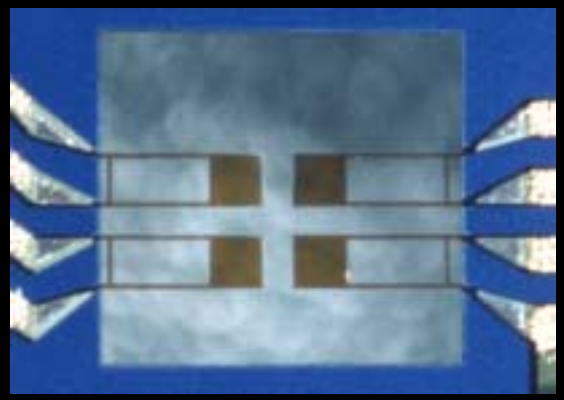
Initial development funded by DARPA-DSO

BioMagnetICs Workshop, 12 December 2001

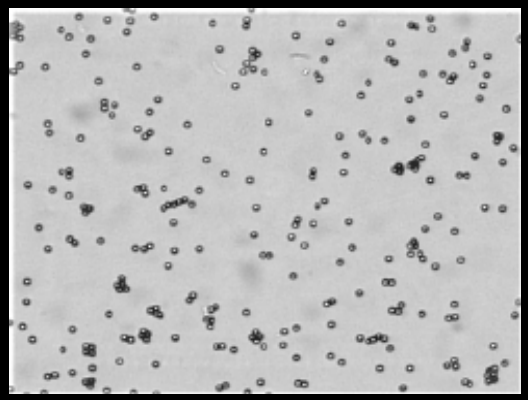
Magnetic Microbead Detection

Three detection methods (after force discrimination)



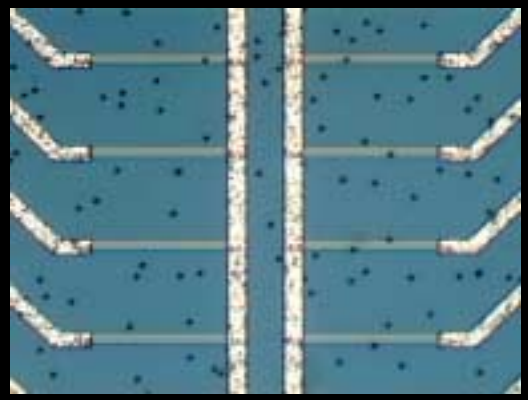
Piezoresistive cantilevers
aka
FABS

JVST B **14**, 789 (1996)



Optical Microscopy
aka
FDB

Anal. Biochem. **287**, 261 (2000)



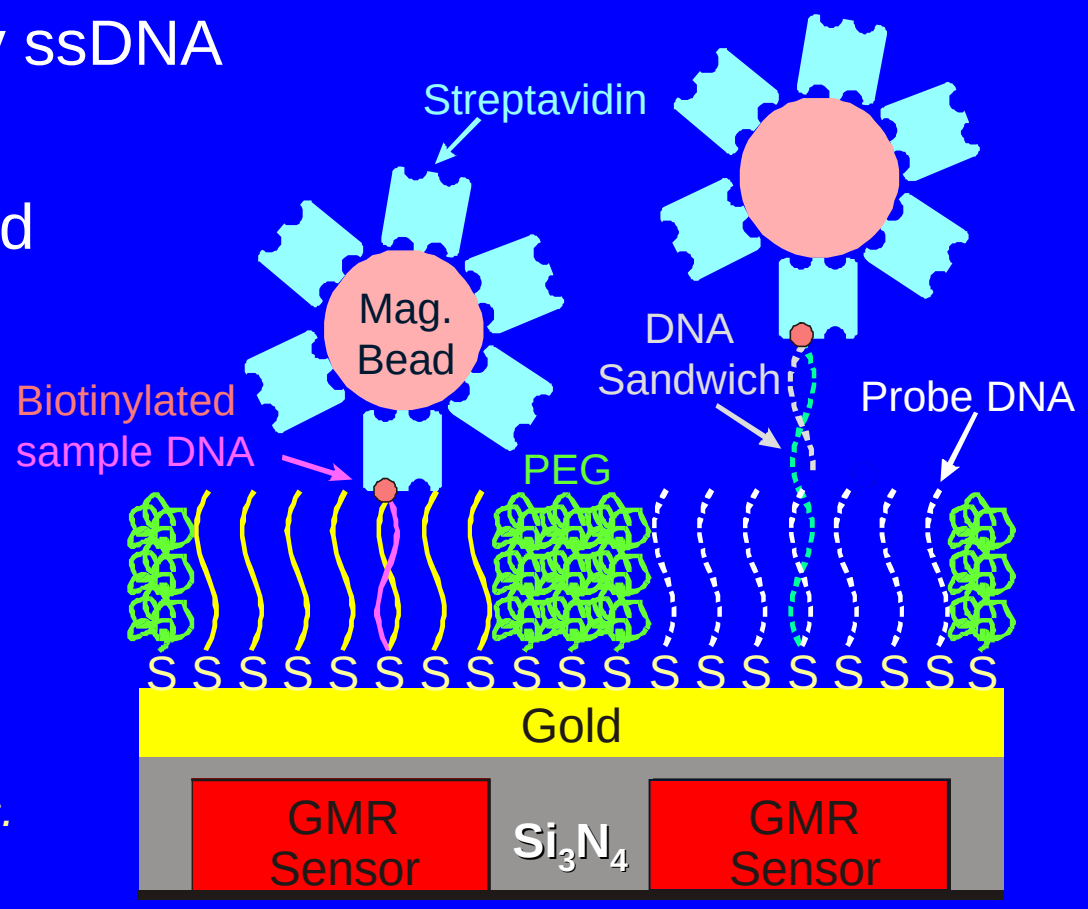
Magnetoresistive Sensors
aka
BARC

JMMM **225**, 138 (2001)

BARC: The Bead ARray Counter

A microchip with an array of GMR field sensors.

1. Array ssDNA probes on chip
2. Protect with nonfouling PEG film
3. Capture complementary ssDNA in sample (biotinylated)
4. Inject streptavidin-coated beads
5. Pull off non-specifically bound beads
6. Detect remaining beads with GMR sensors

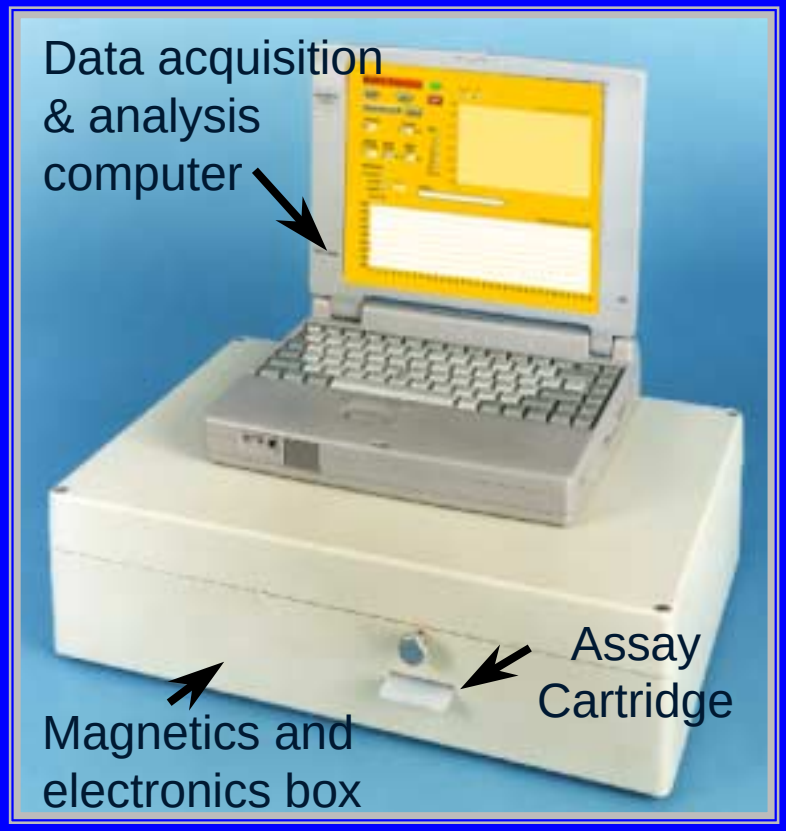


Edelstein, et al., Biosens. & Bioelec. ***14****, 805 (2000)*

The BARC Biosensor System

Goal: A biosensor for bacterial & viral pathogens that is:

- ***Multi-analyte***
- ***Quick***
- ***Specific***
- ***Fieldable (size, power)***



Subsystems:

- DNA hybridization assay and probe arrays
- Instrumentation/software
- GMR sensor chip
- Microbead and sensor magnetics
- Fluidics

High-Sensitivity, *Optics-free* Sensing

Next Generation Development:

- Further assay optimization
- Immunoassay implementation
- High-magnetization microbeads
- More complete, robust fluidics
- On-chip CMOS electronics

Next Generation System? (simulated image)

Major Technical Issues:

- Functional beads
- Integrated magnetics
- Better GMR response
- Getting sample to sensor

Requires integrated development of beads, sensors, magnetics, fluidics, and biochemistry.

Publication List

- "Biosensor Based on Force Microscope Technology," D. R. Baselt, G. U Lee, and R. J. Colton, J. Vac. Sci. Technol. B **14**, 78–793 (1996)
- "A High-Sensitivity Micromachined Biosensor," D. R. Baselt, G. U Lee, K. M. Hansen, L. A. Chrisey, and R. J. Colton, Proc. IEEE **85**, 672–680 (1997)
- "A Biosensor Based on Magnetoresistance Technology," D. R. Baselt, G. U Lee, M. Natesan, S. W. Metzger, P. E. Sheehan, and R. J. Colton, Biosensors & Bioelectronics **13**, 731–739 (1998)
- "Development and characterization of surface chemistries for microfabricated biosensors," S. W. Metzger, M. Natesan, C. Yanavich, J. Schneider, and Gil U Lee, J. Vac. Sci. Technol. A **17**, 2623–2628, (1999)
- "The BARC Biosensor Applied to the Detection of Biological Warfare Agents," R. L. Edelstein, C. R. Tamanaha, P. E. Sheehan, M. M. Miller, D. R. Baselt, L. J. Whitman, and R. J. Colton, Biosensors & Bioelectronics, **14**, 805–813 (2000)
- "Implementation of Force Differentiation in the Immunoassay," G. U Lee, S. Metzger, M. Natesan, C. Yanavich, and Y. F. Dufrêne, Anal. Biochem. **287**, 261–271 (2000)
- "A DNA Array Sensor Utilizing Magnetic Microbeads and Magnetoelectronic Detection," M. M. Miller, P. E. Sheehan, R. L. Edelstein, C. R. Tamanaha, L. Zhong, S. Bonnak, L. J. Whitman, R. J. Colton, and G. Prinz, J. Mag. and Mag. Mat. **225**, 138–144 (2001)
- "Magnetic Method for DNA Detection on an Arrayed Solid State Device," C. R. Tamanaha, R. J. Colton, M. M. Miller, M. A. Piani, J. C. Rife, P. E. Sheehan, and L. J. Whitman, in *Micro Total Analysis Systems 2001*, edited by J. M. Ramsey and A. van den Berg (Kluwer Academic Publishers, Boston, 2001, pp. 444–446)
- "Hybrid Micro-Macro Fluidics System for a Chip-Based Biosensor," C. R. Tamanaha, L. J. Whitman, and R. J. Colton, submitted to J. Micromech. Microeng.