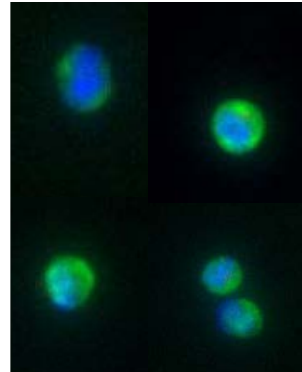
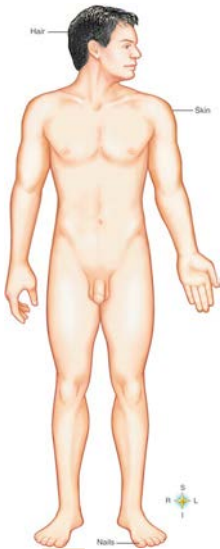
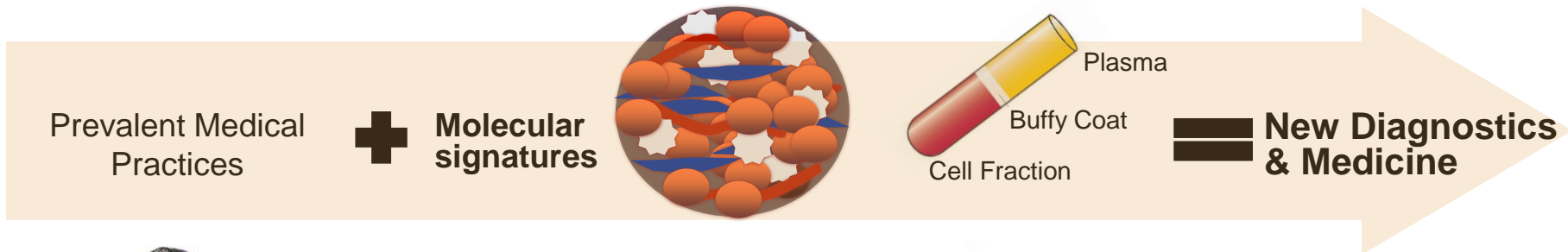


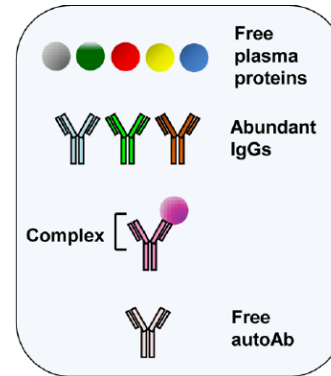
Bio Interface Focus Area Vision

Application pull: Aging population, exploding healthcare cost

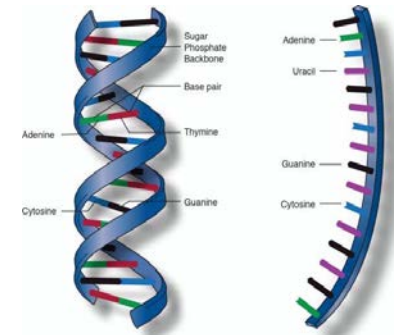
Technology push: Nanosensors, wearables, wireless, cloud, big data



Cells



Proteins & Antibodies



DNA

RNA

Biomedical instrumentation and sensors for minimally invasive diagnostics and monitoring of human diseases and wellness

Bio Interface Project Topics and Faculty

Implantable probes for brain, heart, and lung

Krishna Shenoy
Amin Arbabian
Ada Poon
Olav Solgaard
Jim Harris

In vitro biosensors for diagnostics of diseases and wellness

Audrey Ellerbee
Utkan Demirci
Roger Howe
Shan Wang
Reiner Dauskardt

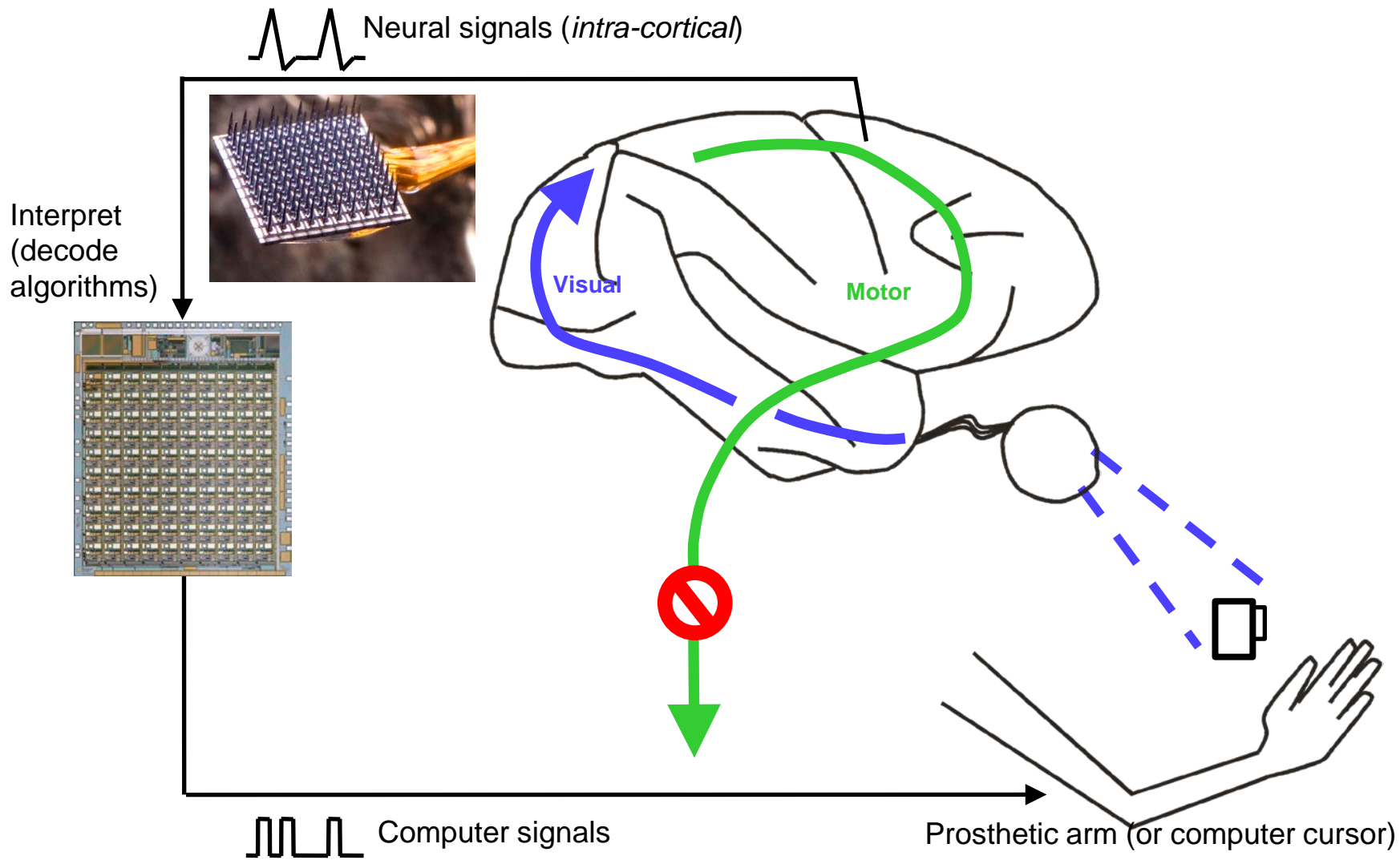
Nanosensors for cells

Nick Melosh
Jelena Vuckovic
Philip Wong

Affiliated Faculty: Pierre Khuri-Yakub, Greg Kovacs, Boris Murmann, Bert Hesselink

Brain-Machine Interfaces (BMIs)

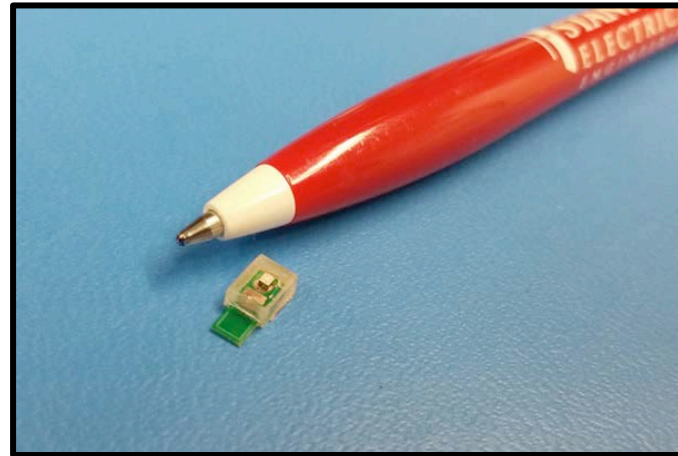
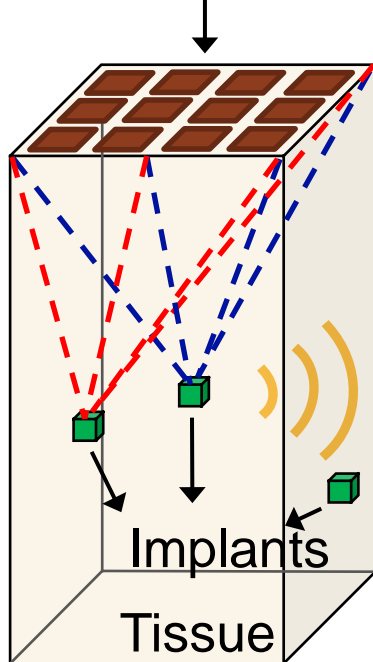
Interpreting neural signals to guide prostheses



Ultrasonic-Powered Miniaturized Wireless Implants

- MONITORING AND MODULATING LOCAL PHYSIOLOGY IN CLOSED-LOOP
- NEURO-MODULATION
- “ELECTROCEUTICALS”

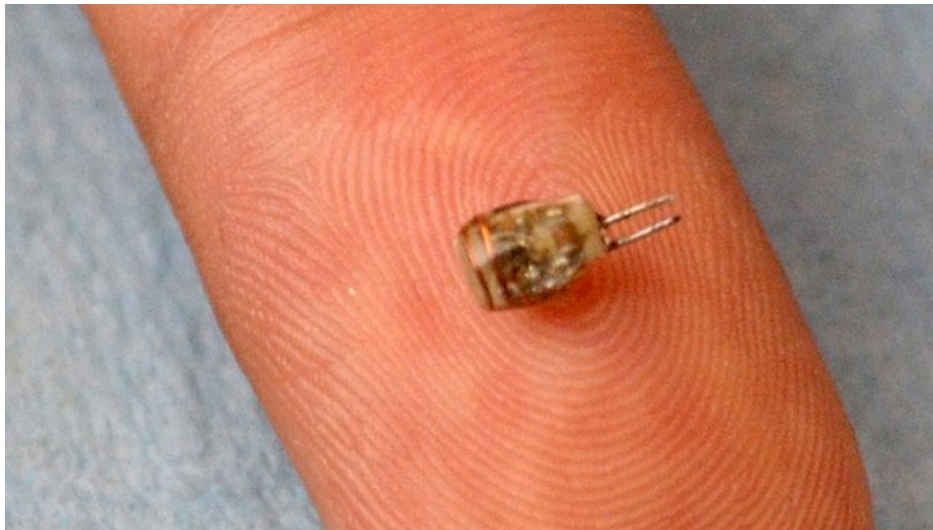
Acoustic transducer array



Miniaturized Wireless Medical Implants

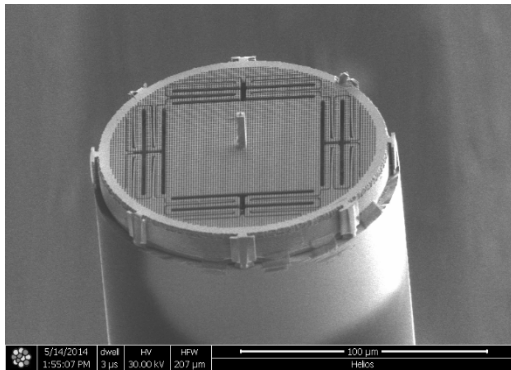


Battery-less
electrostimulator

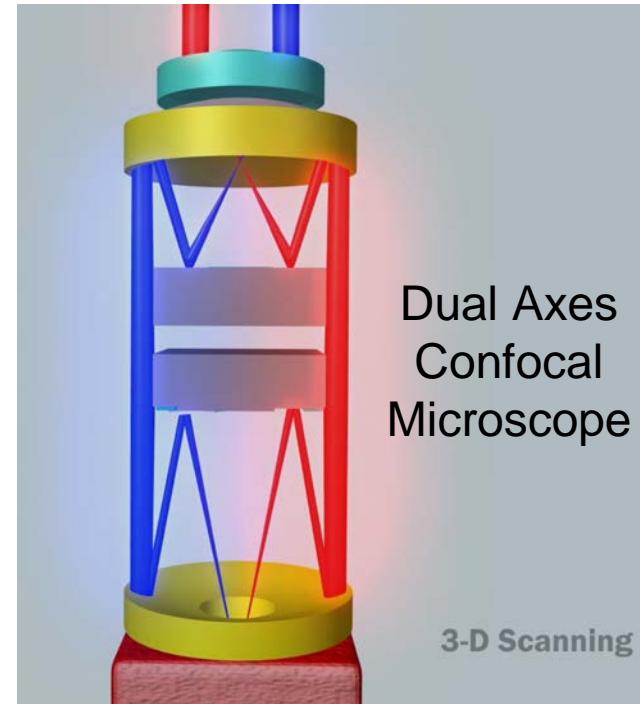


“Wireless
pacemaker”

Implanted microscopic biosensors



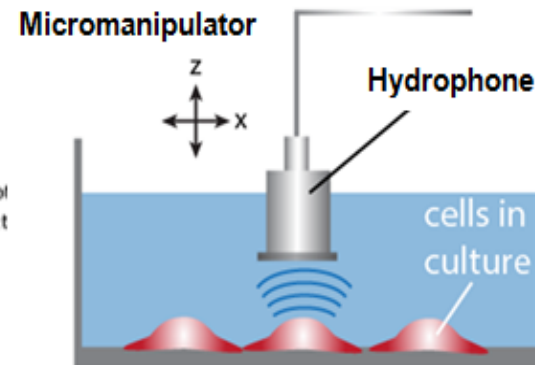
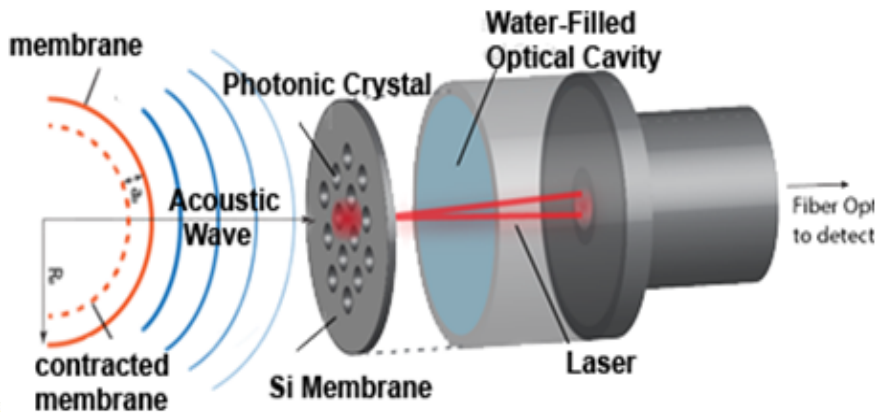
High-Frequency Force-Sensing AFM Probes



Acoustic Wave On Action Potential

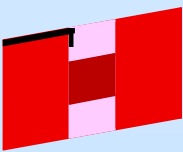
Single-Cell Photonic Stethoscope (SCS)

Single Cell Acoustic Physiology



Cell stethoscope

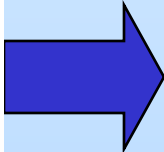
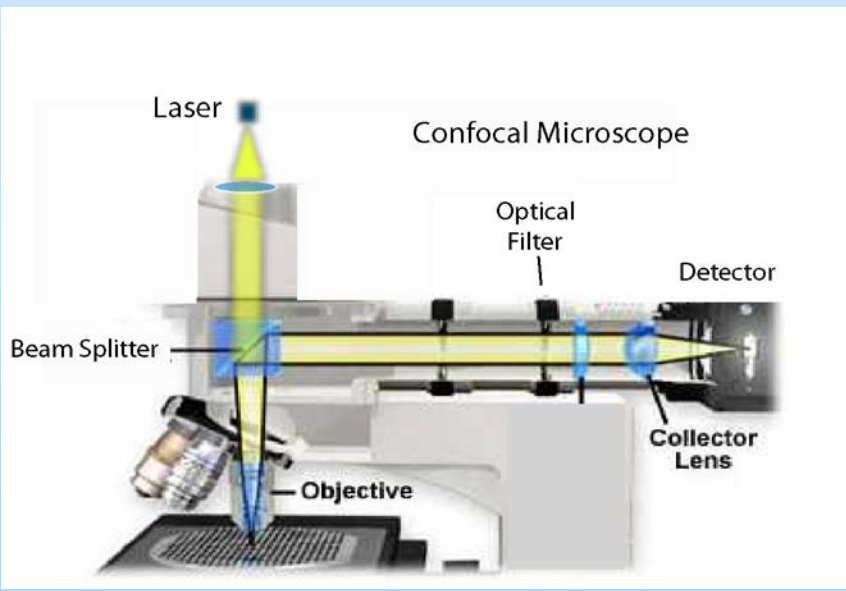




Multi-functional Integrated Fluorescent Bio-sensor

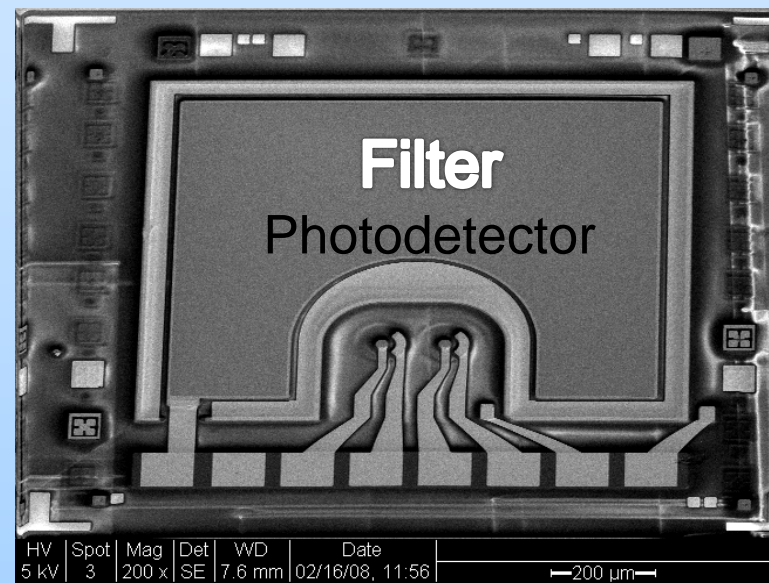


Today



Future

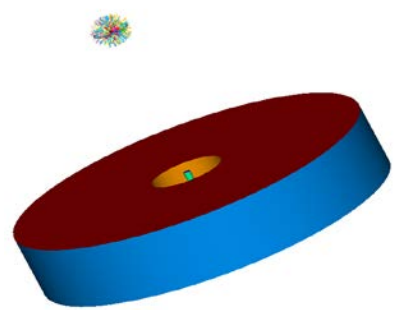
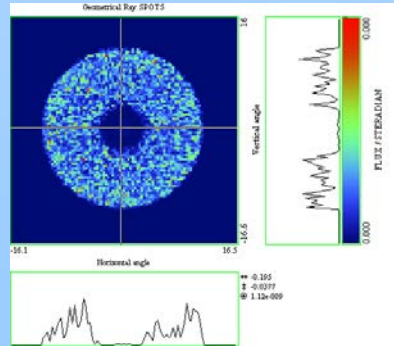
Integrated VCSEL/ Photodetector



| | | | | | |
|------|------|-------|-----|--------|-----------------|
| HV | Spot | Mag | Det | WD | Date |
| 5 kV | 3 | 200 x | SE | 7.6 mm | 02/16/08, 11:56 |

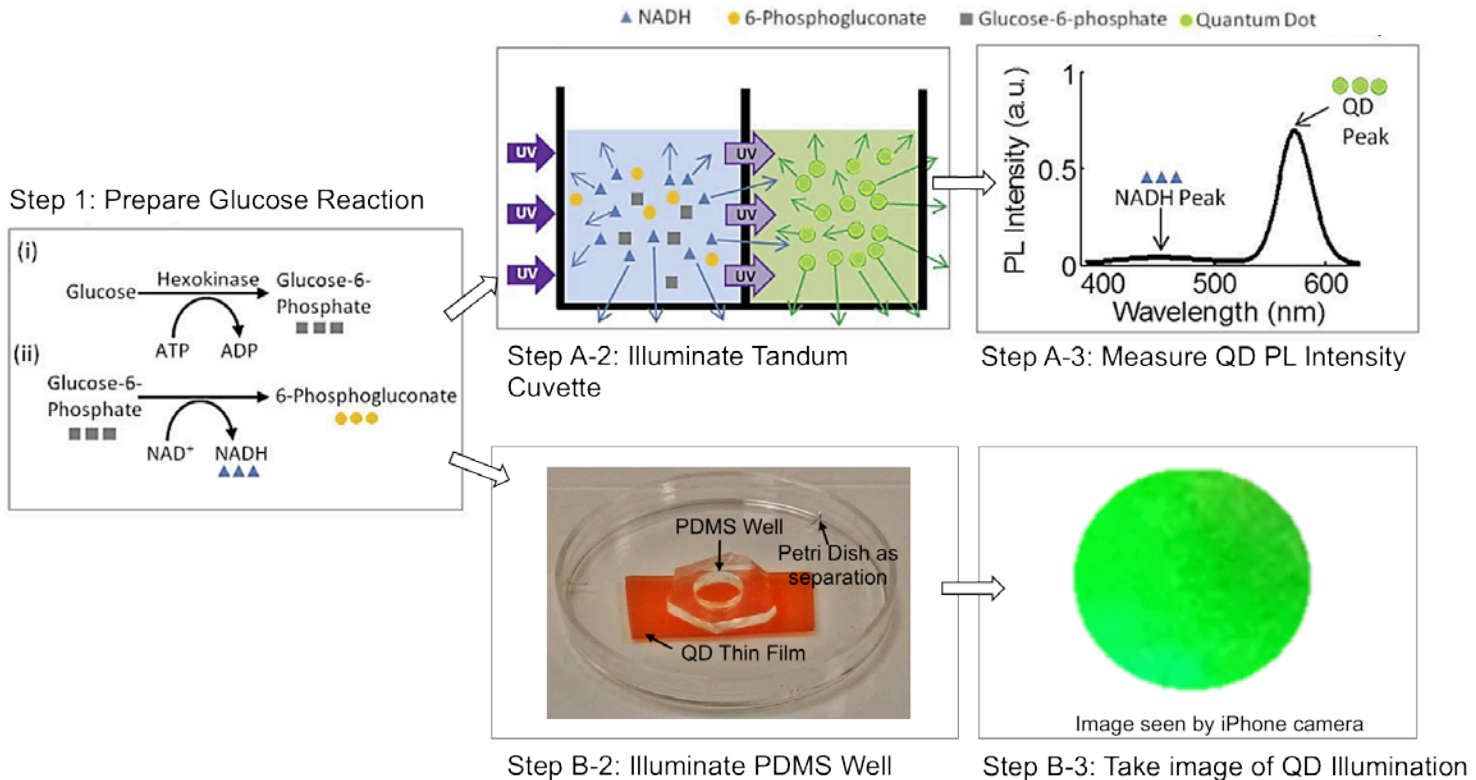
200 μm

- Application of integration of micro and nano structures from electronics to biotechnology
- Development of simulation tools is critical to enable sensor design and evaluation prior to fabrication.

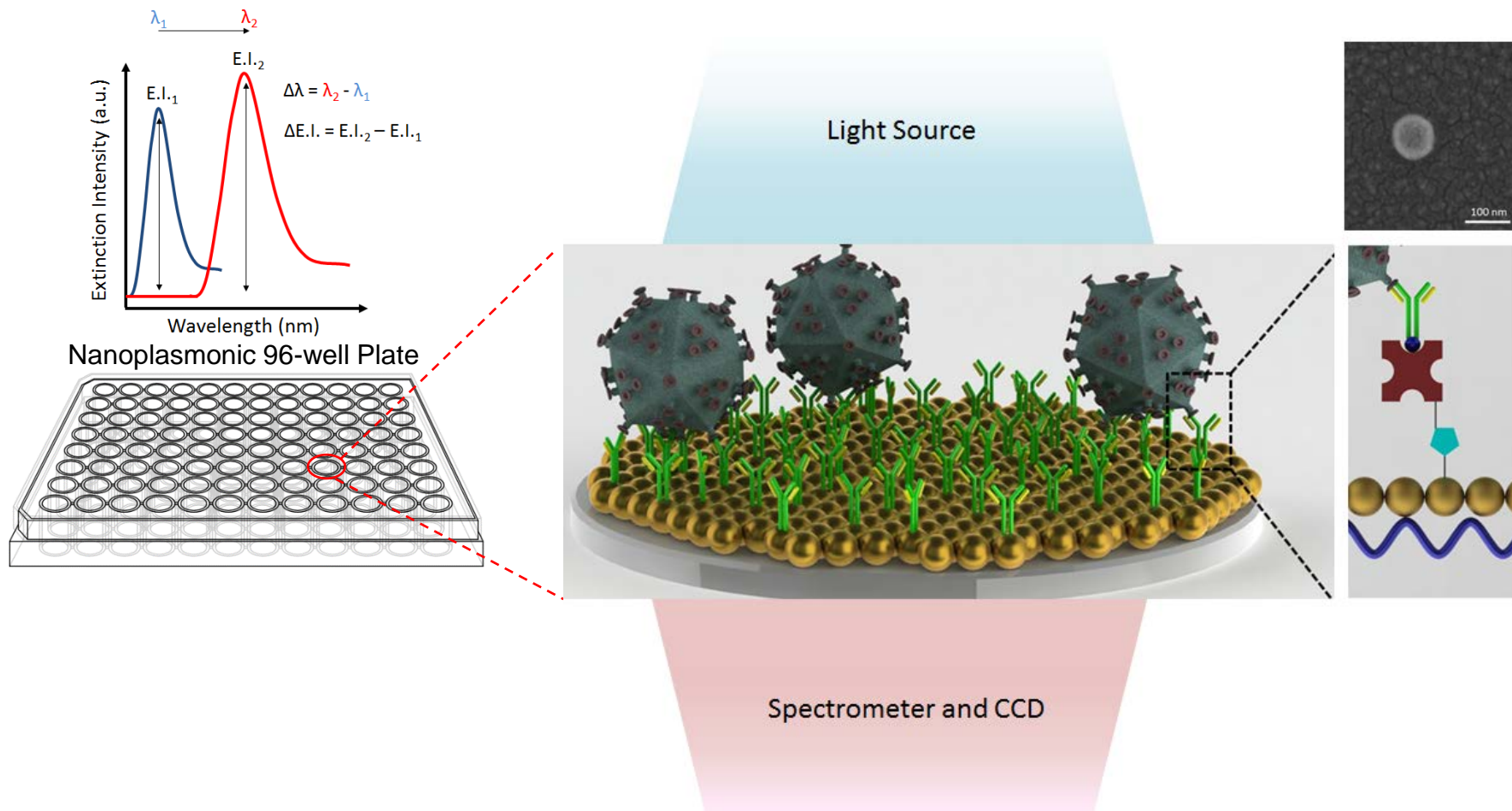


Non-contact optical measurement of blood glucose

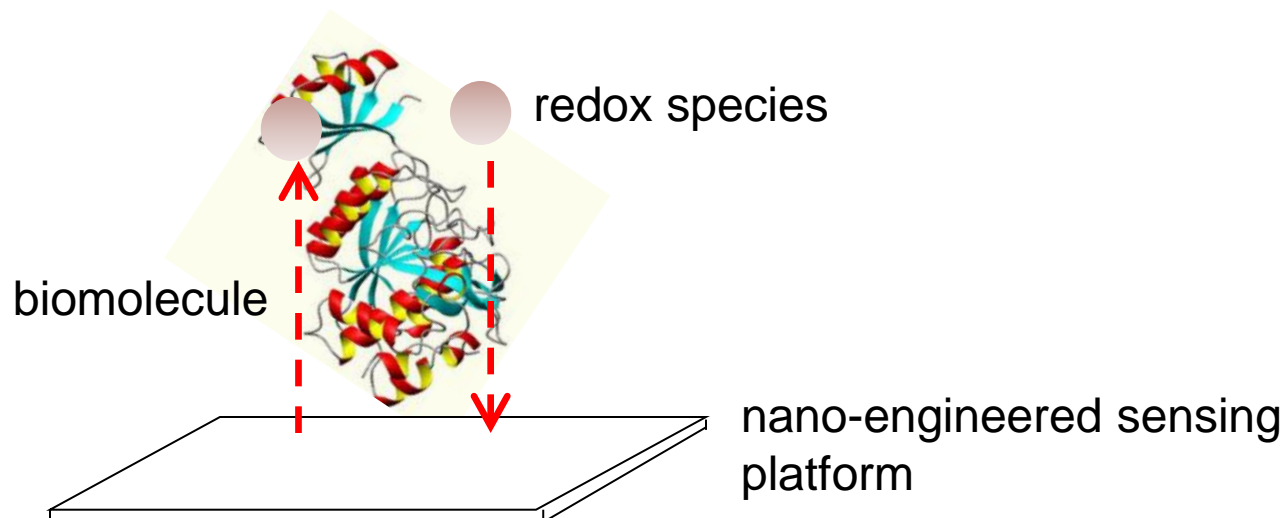
- **REUSABLE** QUANTUM DOT-EMBEDDED IN FILM QUANTIFIES CONCENTRATION OF GLUCOSE IN **WHOLE BLOOD AND URINE**
- MEASUREMENTS OBTAINED BY **DIRECT CONTACT** OF FILM WITH CELL PHONE (**LOW-COST, SIMPLE**), WITHOUT ADDITIONAL LENSES OR COMPONENTS
- EQUIVALENT SENSITIVITY TO COSTLY, UV-VIS SPECTROPHOTOMETER



Nanoplasmonic Quantitative Biosensors for Pathogen



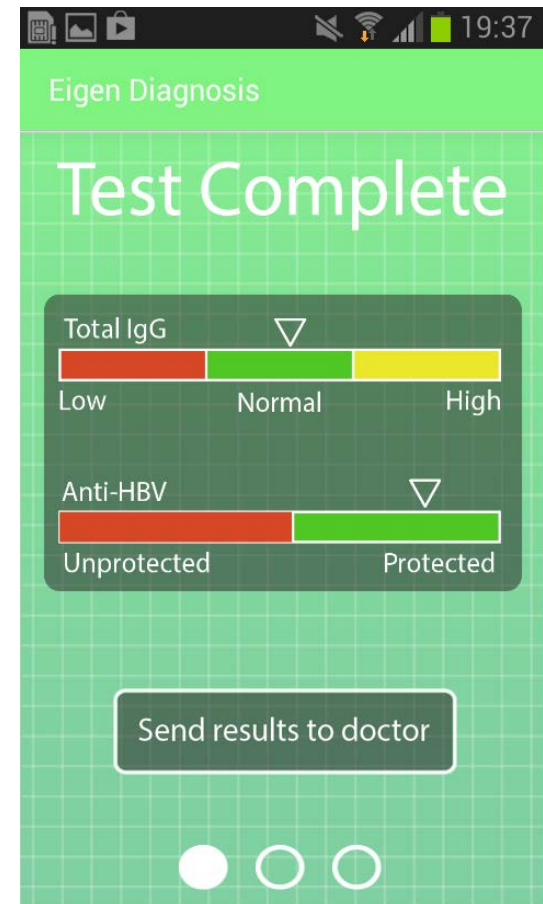
Label Free Electronic Spectroscopy Probes



- **Complexity of sensing front-end is minimized** → inexpensive to manufacture; complexity shifted to data analysis, which can be done at centralized back-end
- **Multi-resolution data** → more information per experiment
- **Higher sensitivity** → assays at pM concentrations and below amidst high background
- **Reduced sample volume** (10s of nL) → inexpensive, less invasive
- **No complex surface chemistry** → barrier for assay development goes down

Faculty: Roger Howe, Boris Murmann,
and Shan Wang

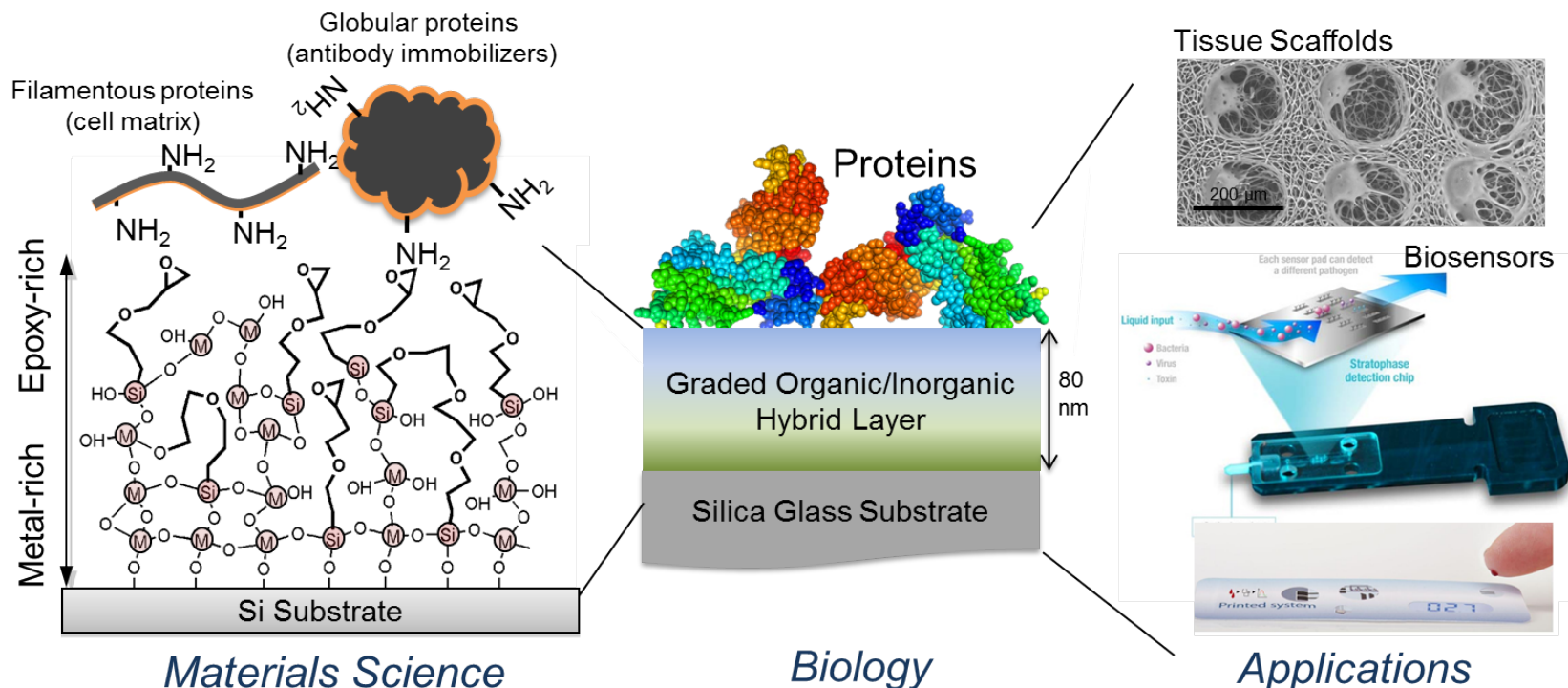
Sensors and Interfaces for Mobile Health



Handheld diagnostic device & app for immunity, infectious diseases, risks of heart diseases and cancer, all fully controlled by a cell phone.

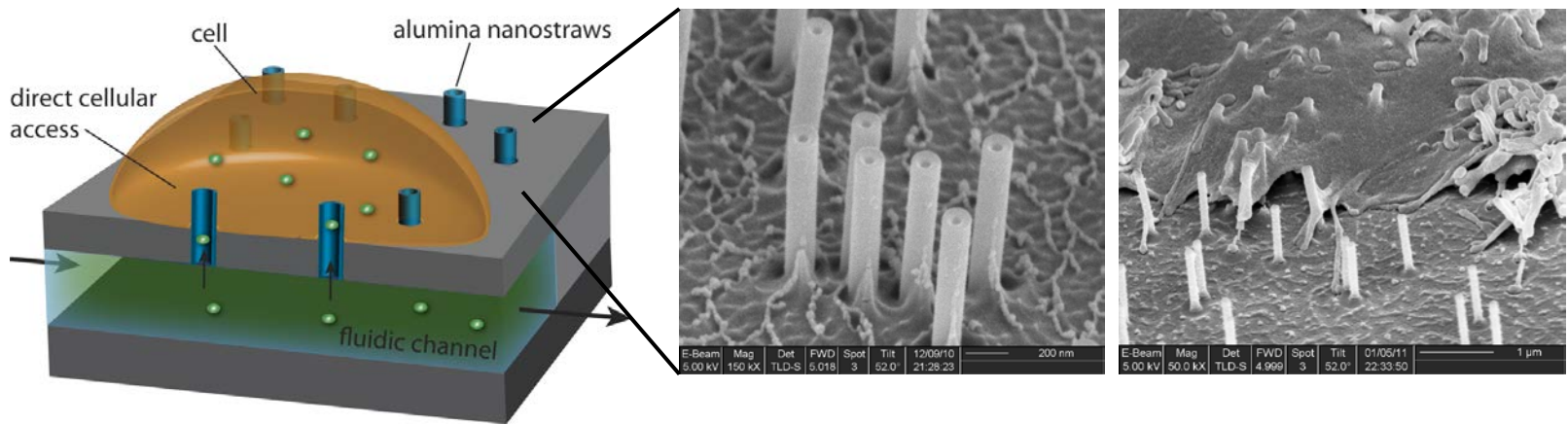
From Semiconductors to Cells: Enabling Bioactive Surfaces with Hybrid Films

- CONTEMPORARY BIOTECHNOLOGIES (POINT-OF-CARE DIAGNOSTICS, GENOME MICROARRAYS, ...) RELY ON COUPLING PROTEINS TO SYNTHETIC SURFACES
- CURRENT BI-FUNCTIONAL SILANES TO COUPLE BIOTIC AND ABIOTIC MATERIALS TO SYNTHETIC SURFACES ARE UNRELIABLE AND UNSTABLE IN AQUEOUS ENVIRONMENTS

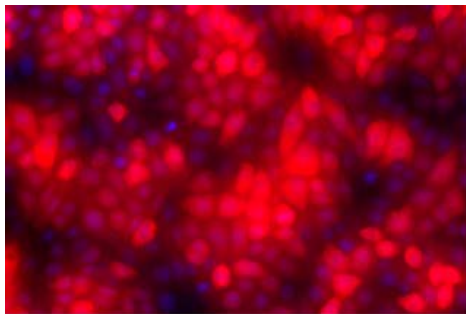


- USING HYBRID MOLECULAR MATERIALS, WE CAN RELIABLY BOND PROTEINS TO SYNTHETIC SURFACES EVEN IN WET BIOLOGICAL ENVIRONMENTS

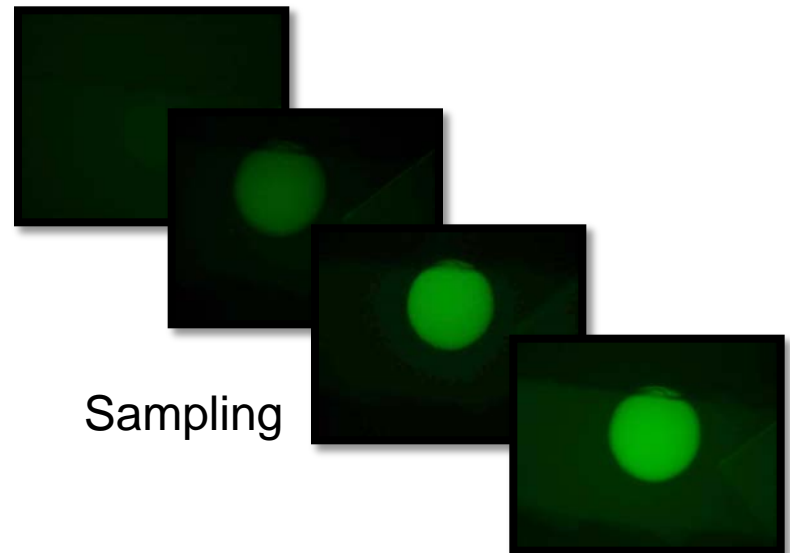
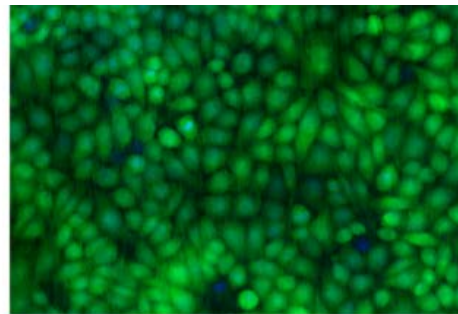
Real-time Cell Monitoring



Nanoscale pipelines into and out of the cell

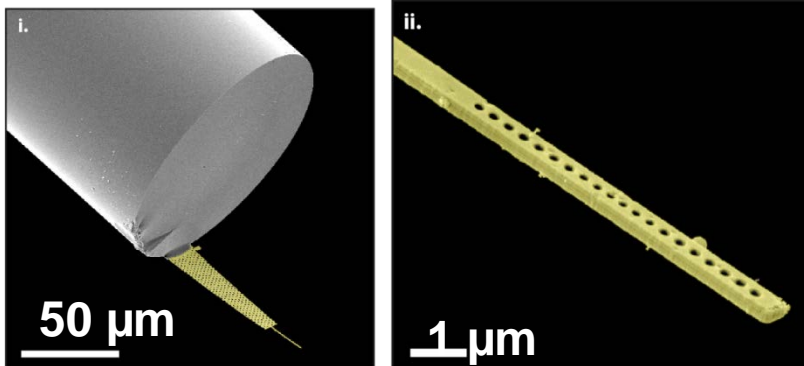


Efficient Delivery



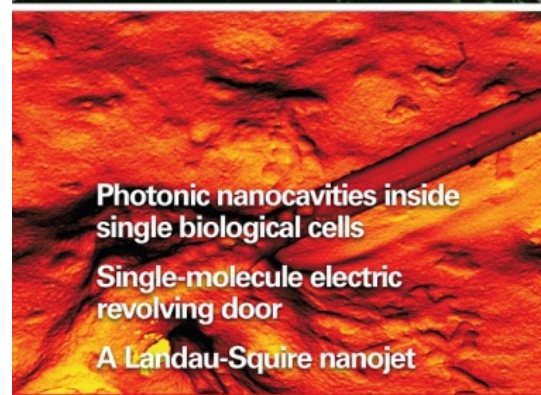
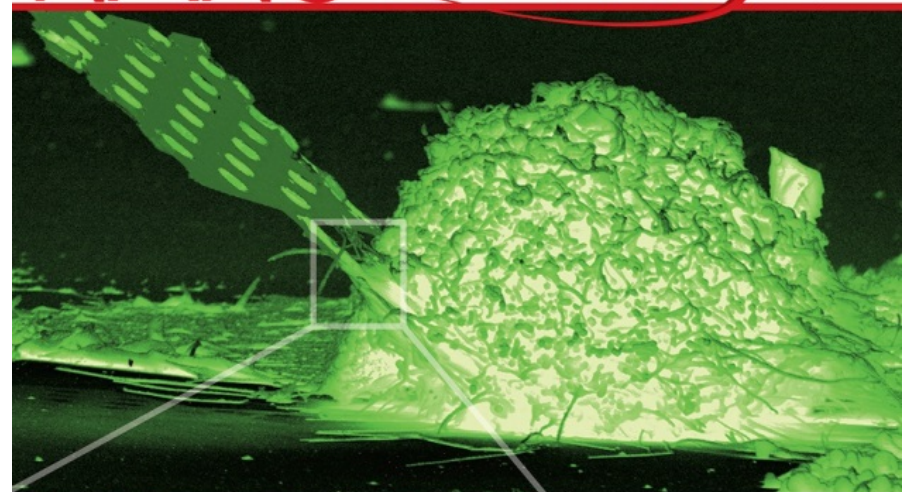
Sampling

Single cell photonic nanocavity probe



NANO LETTERS

November 2013
Volume 13, Number 11
pubs.acs.org/NanoLett



ACS Publications
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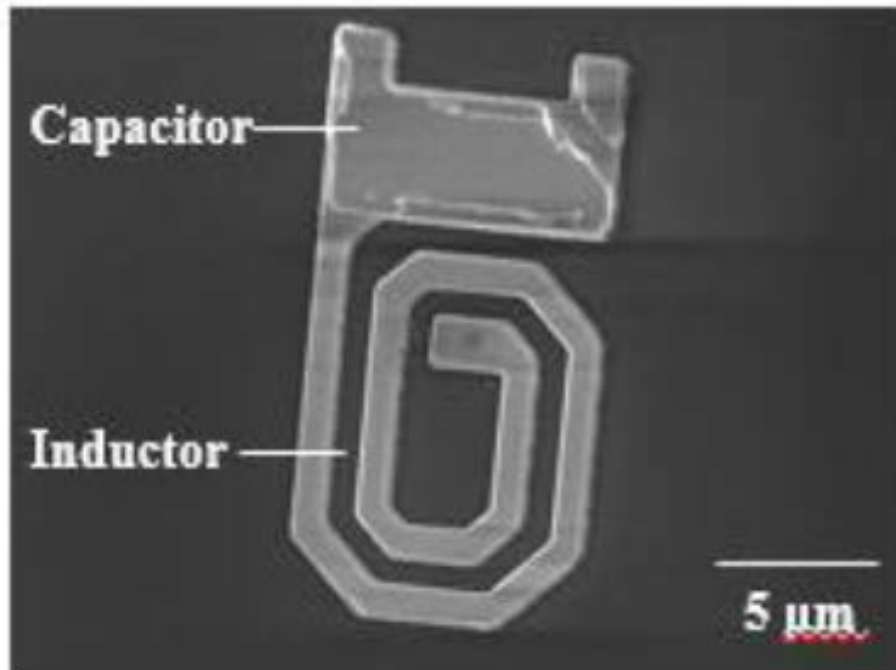
www.acs.org

Vuckovic & Gambhir groups (*Nano Lett.*, 2013)

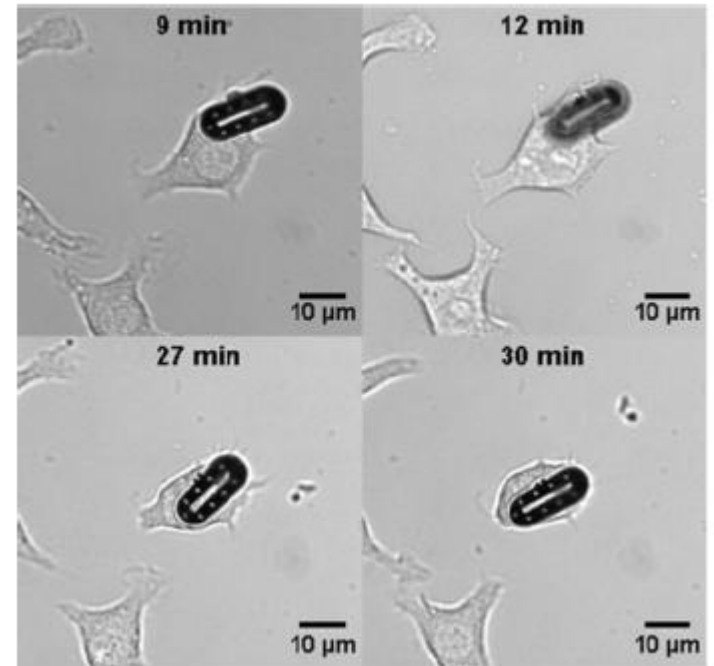
Stanford | ENGINEERING

Faculty: Jelena Vuckovic, Sam Gambhir

Miniaturized RFID Cell-Tags for Wireless Cell Monitoring



SEM image of RFID cell-tag under fabrication



Selected time-elapsd bright field microscopy images of cellular uptake of cell-tag

Faculty: Philip Wong, Ada Poon,
Demir Akin, Michael McConnell

Hepatitis B – A Case Study



Annual deaths from infectious diseases

HIV/AIDS



Tuberculosis



Hepatitis B



Malaria



World Health Organization (WHO)

Hepatitis B Prevention



\$ 100

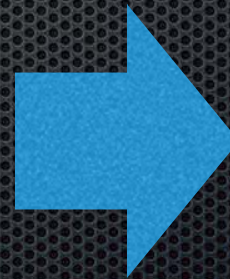


birth

12 h



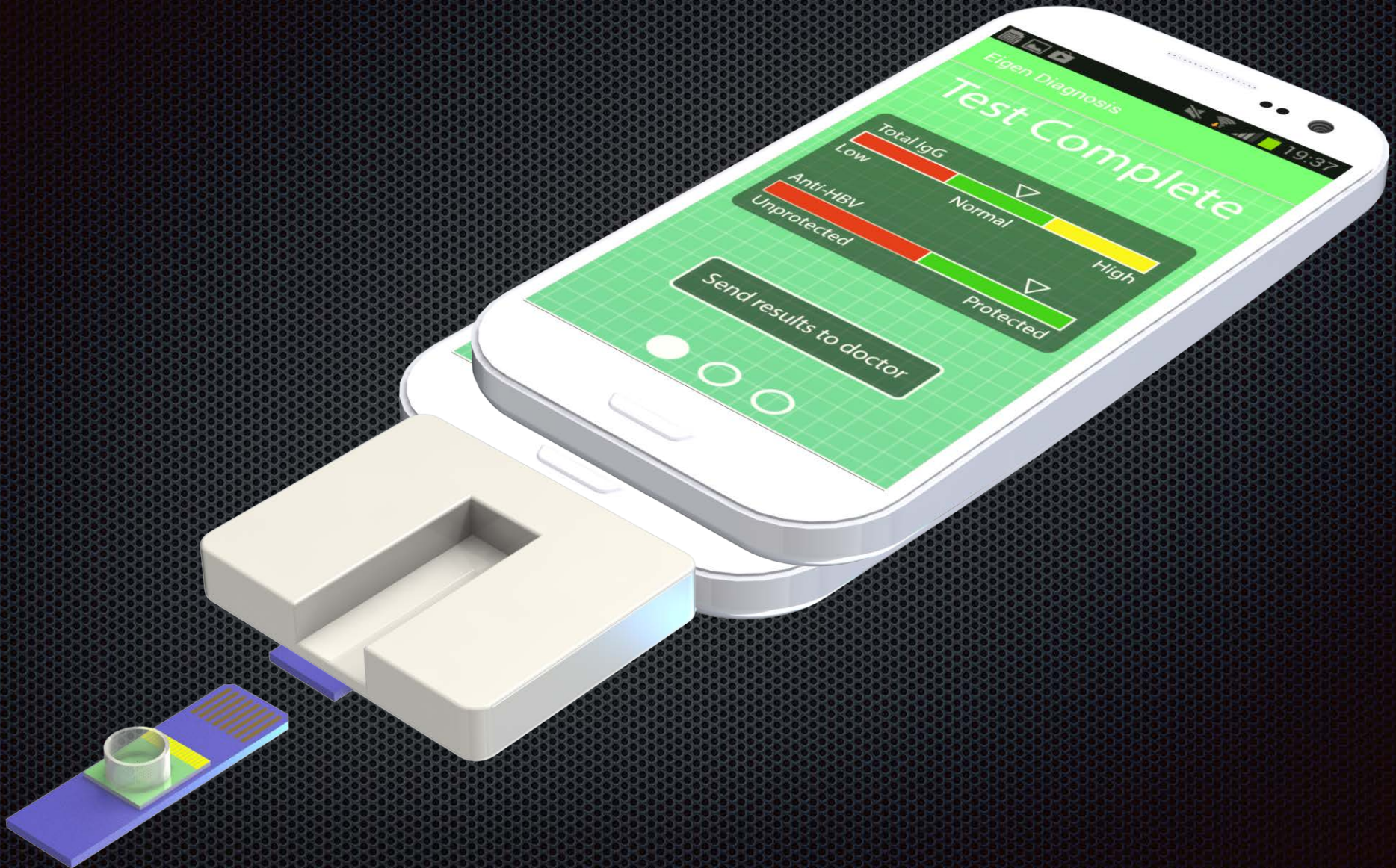
9 months



\$ 100



Vision



A Cell Phone “Doctor”



Bio Interface: Transformative technologies for healthcare!

Implantable probes for brain, heart, and lung

Krishna Shenoy
Amin Arbabian
Ada Poon
Olav Solgaard
Jim Harris

In vitro biosensors for diagnostics of diseases and wellness

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Affiliated Faculty: Pierre Khuri-Yakub, Greg Kovacs,
Boris Murmann, Bert Hesselink