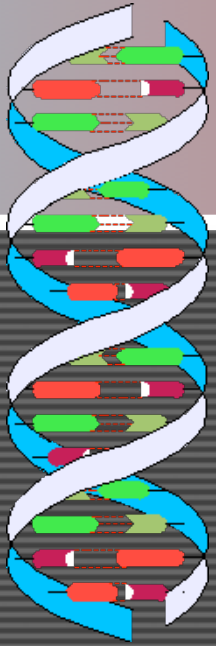


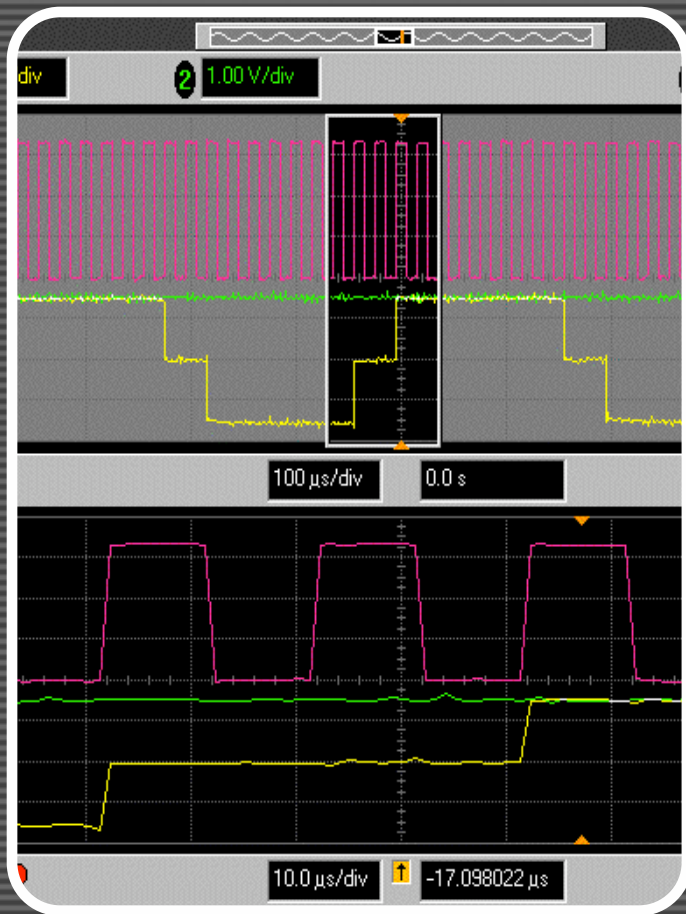
# CMOS Biochip



David Mathine: Optical Sciences, UA  
Ray Runyan: Cell Biology and Anatomy, UA  
Matt Scholz: Cell Biology and Anatomy, UA  
Ornella Selmin: Nutritional Sciences, UA  
Ruth Crawford: Physics, UA  
Gabriel Gray: Optical Engineering, UA  
Lynn LaRussa: Electrical and Computer Engineering, UA  
Tomoki Hoda: Electrical and Computer Engineering, UA  
Stacey Stanislaw: Cell Biology and Anatomy, UA  
Adam Morrietti: Electrical Engineering, LU  
Kiran Potluri: Electrical and Computer Engineering, UA  
David Fang: Electrical Engineering, UR



# Outline



- 1 Motivation
- 2 Biosystem Sensing
- 3 Multi-Sensor Integration
- 4 Microfabrication Techniques

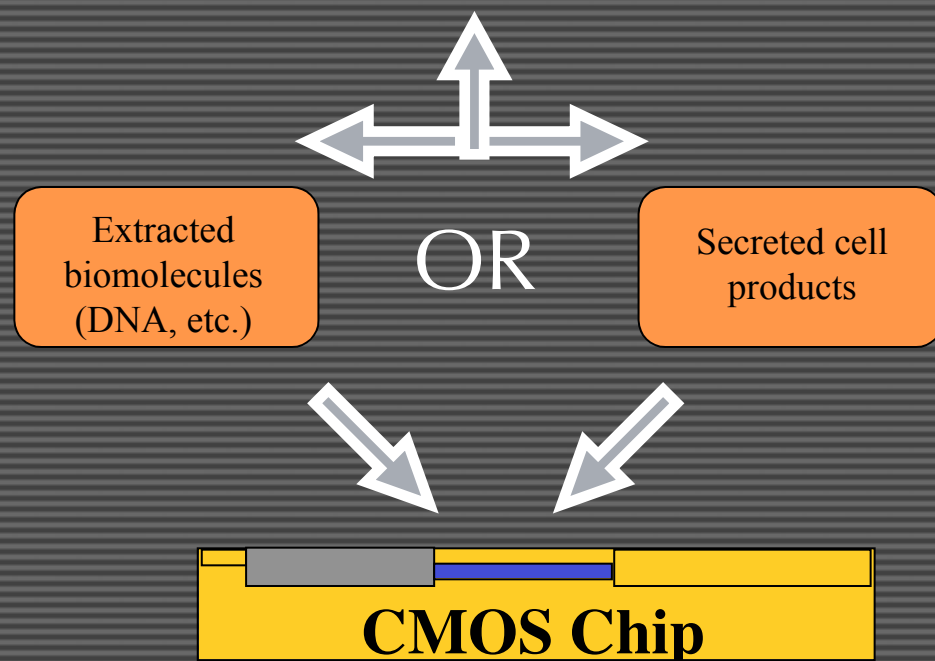
# Project Objectives and Impact



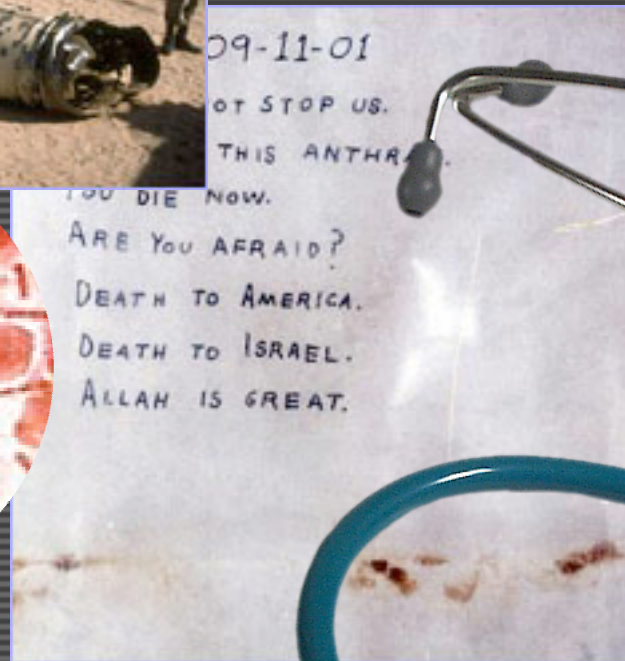
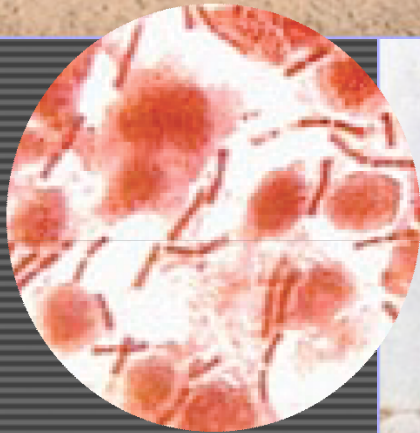
- Rapid Assessment of chemicals and process chemistries
- Important for both chemical suppliers and equipment suppliers
- A first step towards an on-line ESH monitor



Reporter cells treated with chemicals of interest



# Other Applications



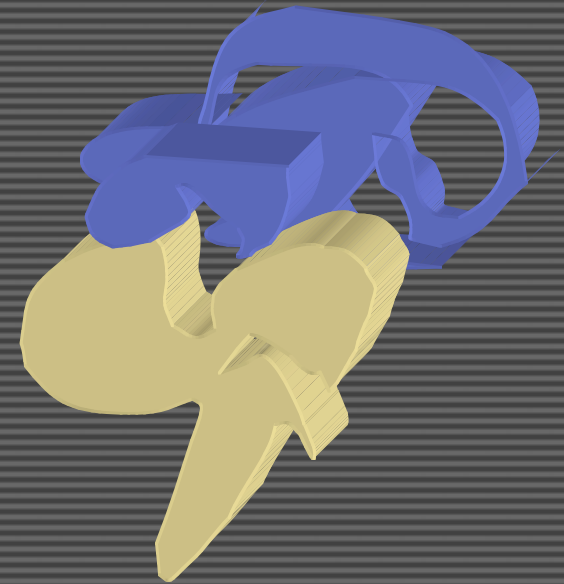
# Biological Interactions of Interest



Interactions  
between nucleic  
acids



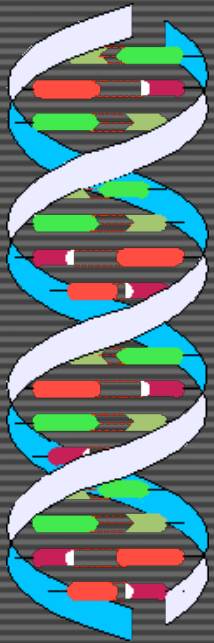
Interactions  
between proteins  
and nucleic acids



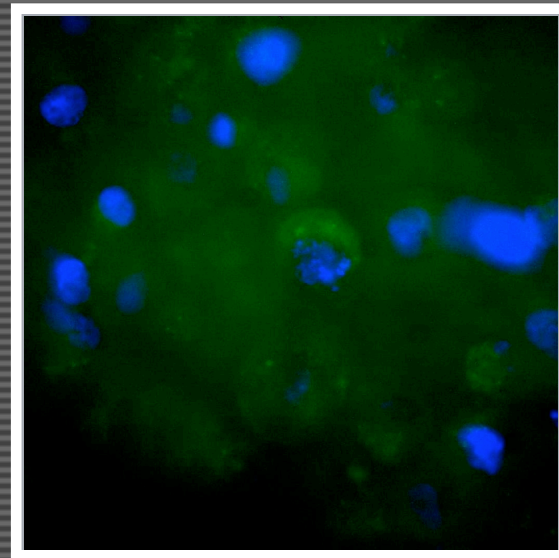
Interactions  
between  
proteins

# Biosystems of Interest

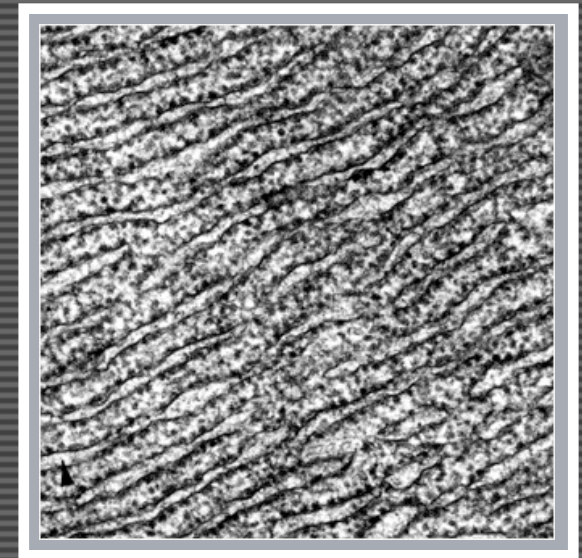
DNA



Cell

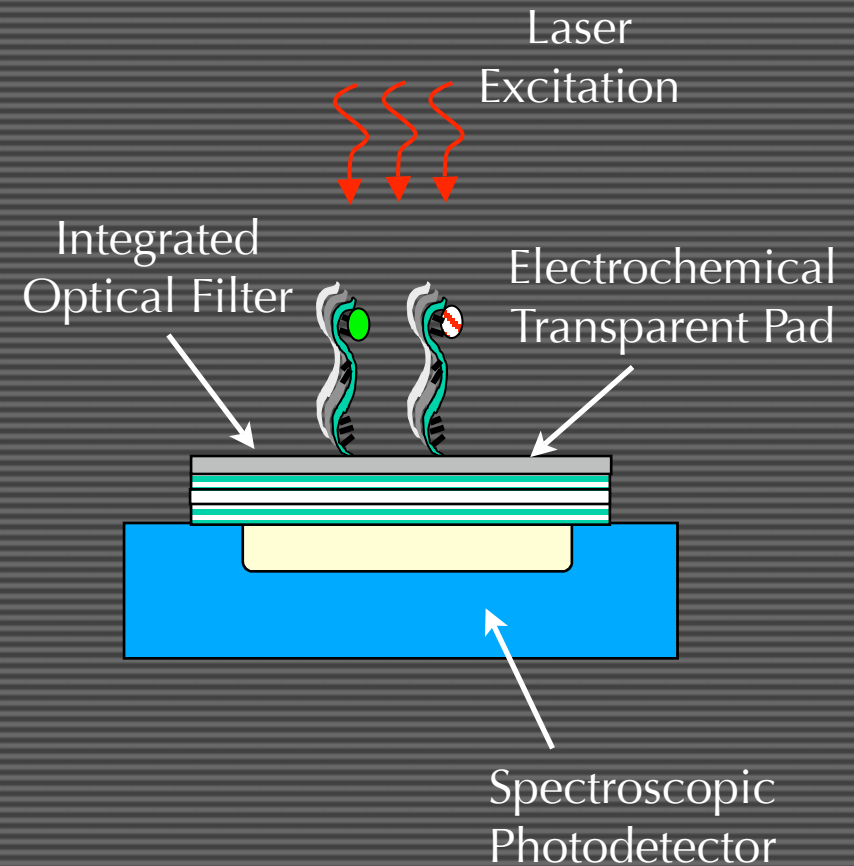


Tissue

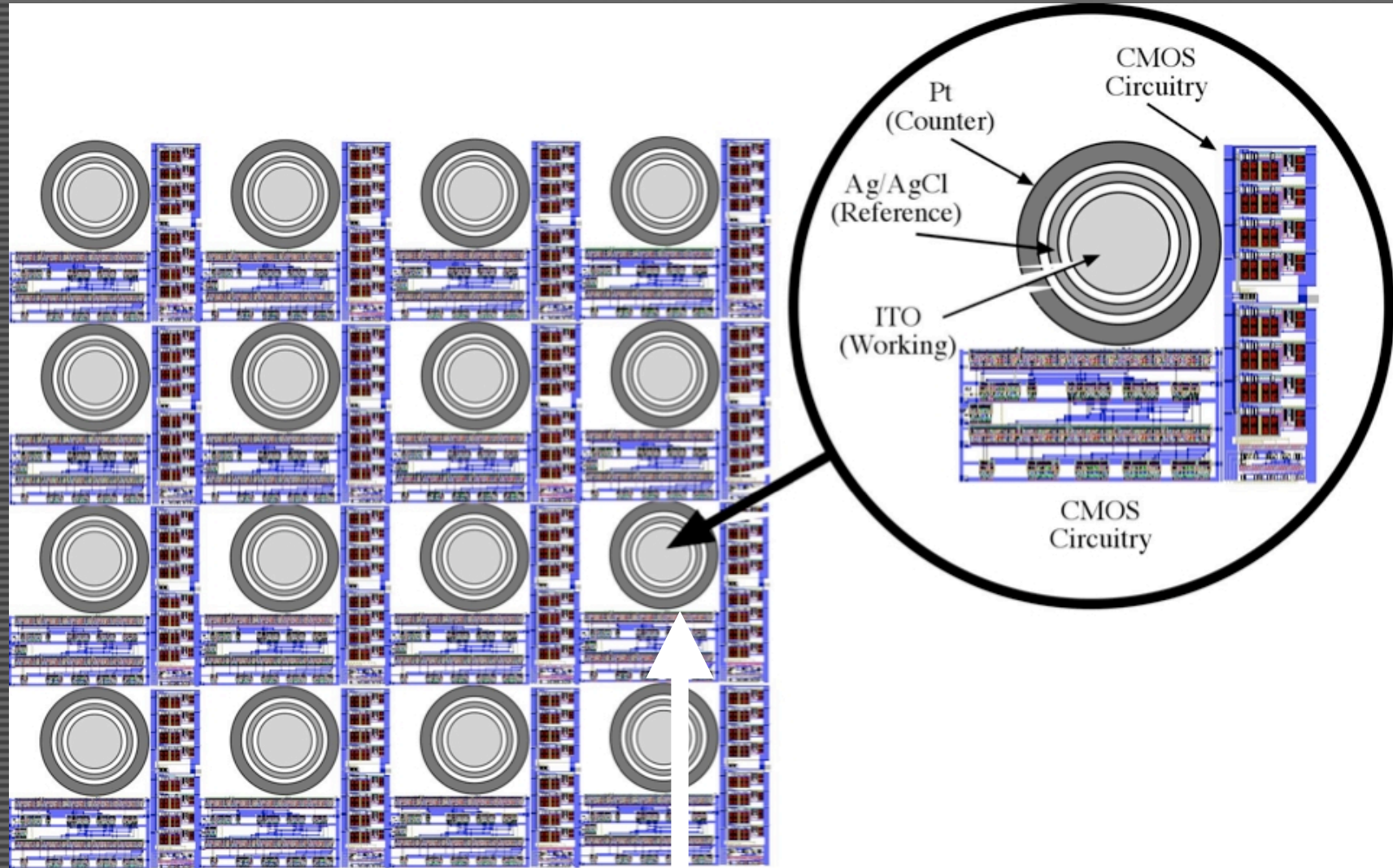


# Biosensor Fusion

- 1 Optical Sensing
- 2 Capacitance Sensing
- 3 Electrochemical
- 4 Electrical Sensors



# Biochip Array



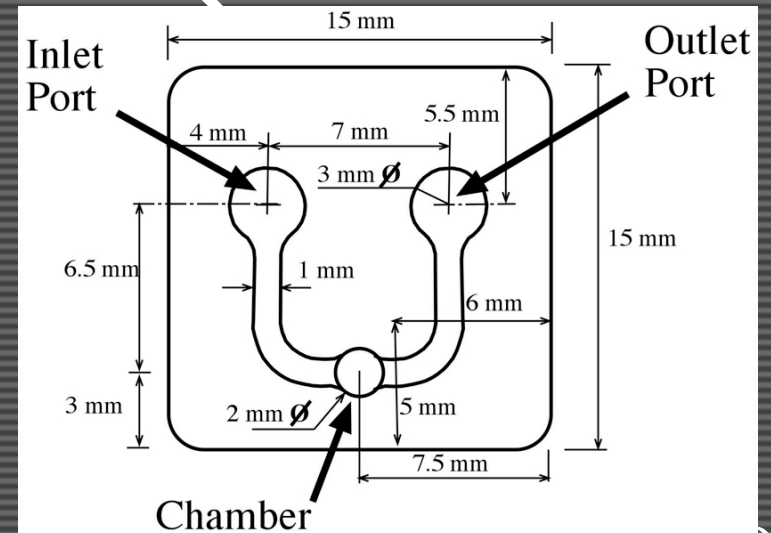
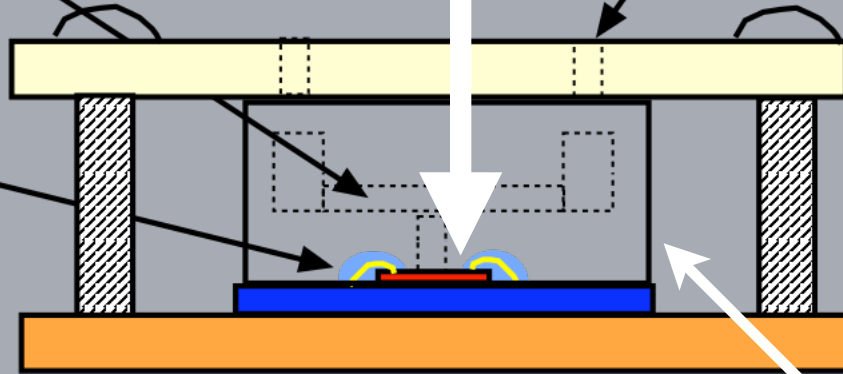


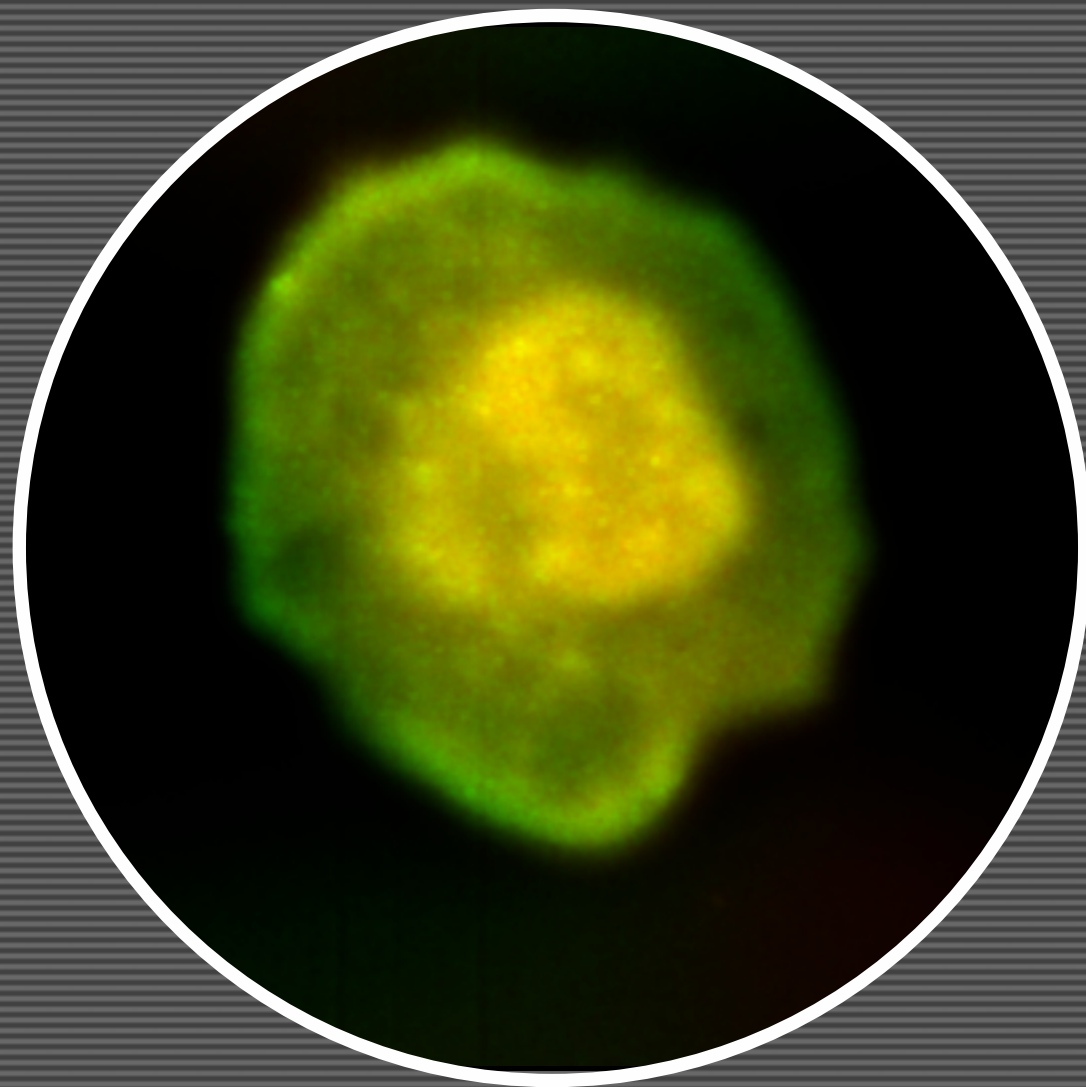
# Biochamber Design

PDMS Channels

Inlet Port

CMOS  
Smart Chip





Chamber Supports Cell Health

# Cell-Based Biosensing

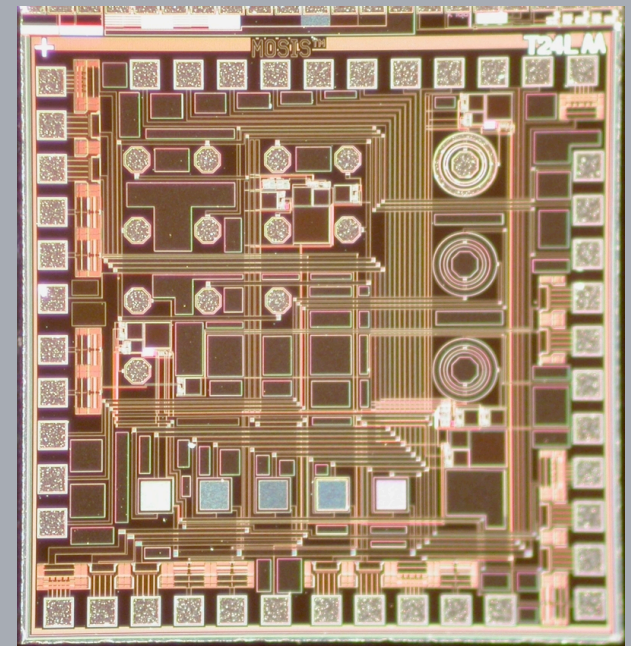
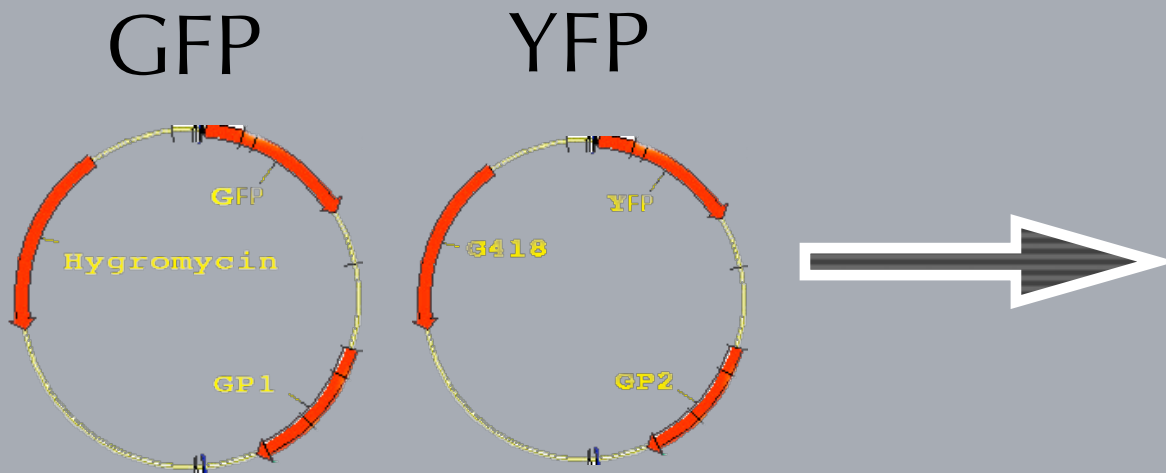
# Example: Protein Expression

Engineer two reporter constructs: one reports a protein of interest and the other a predetermined housekeeping protein for the system of interest

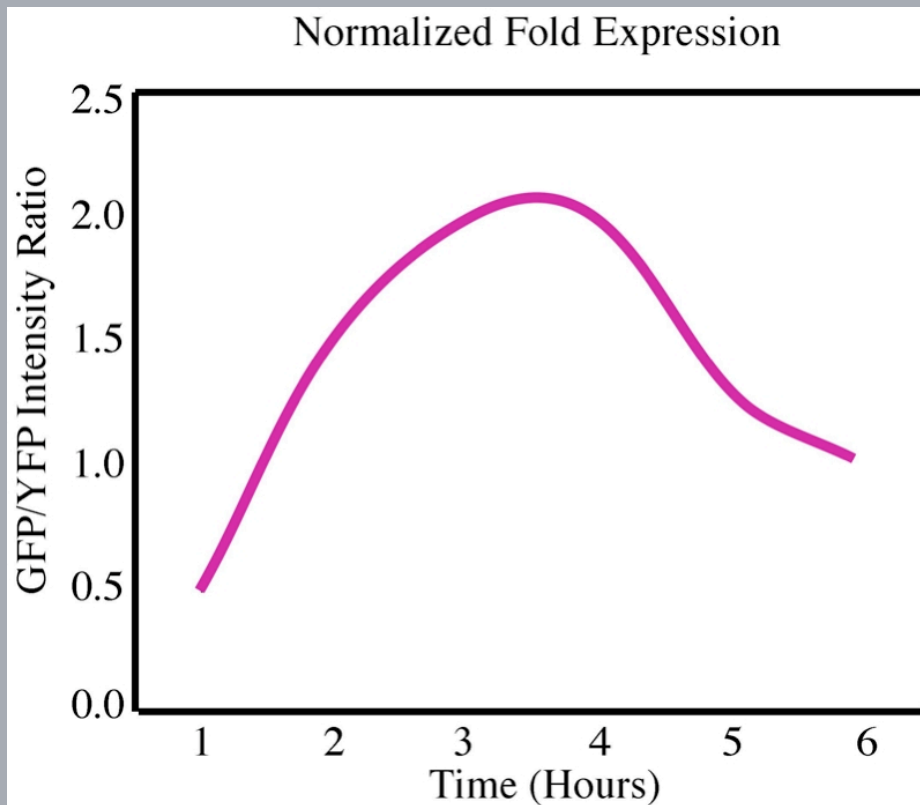
*Proposed*

# Protein Expression

Cotransfect host cells and select for stable transfectants to grow on a smart computer chip.

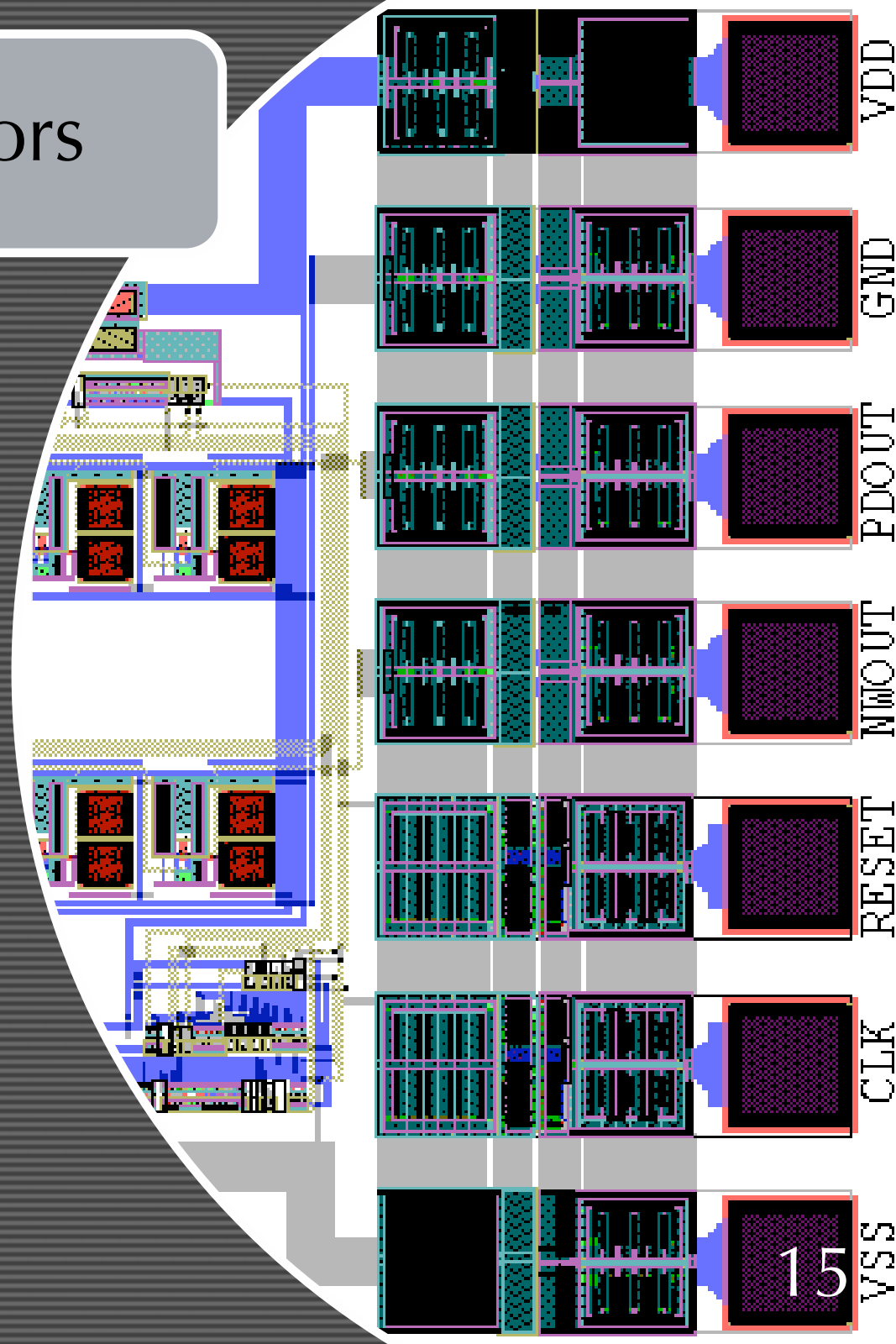
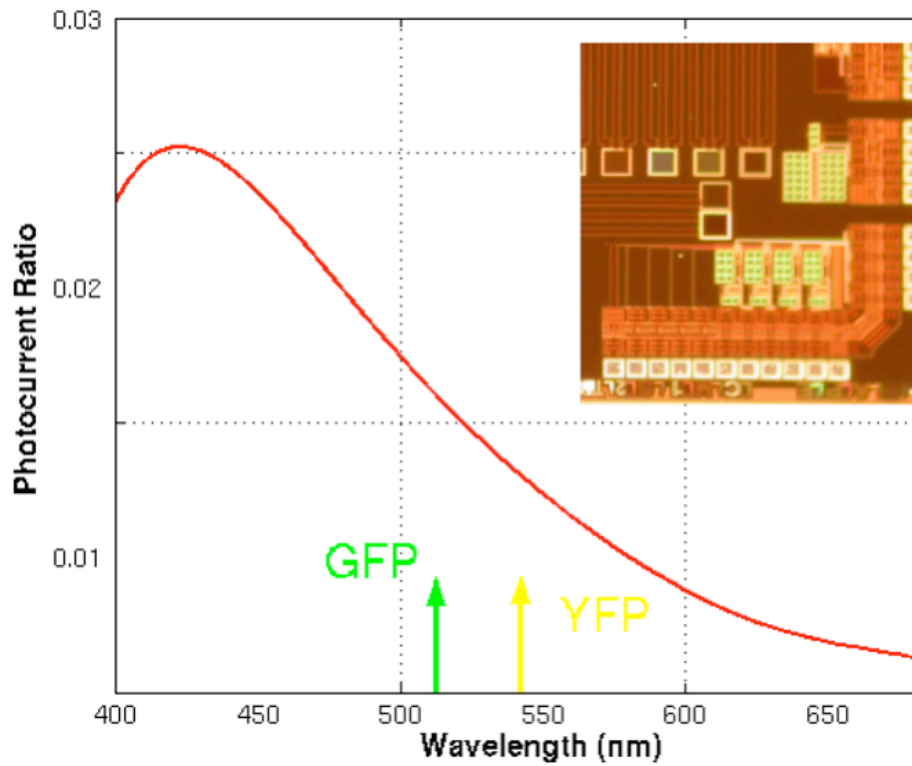


# Normalized Fold Expression



Treat cells with chemical or stimulus of interest and measure relative intensity emitted by reporter-tagged proteins over time upon laser excitation.

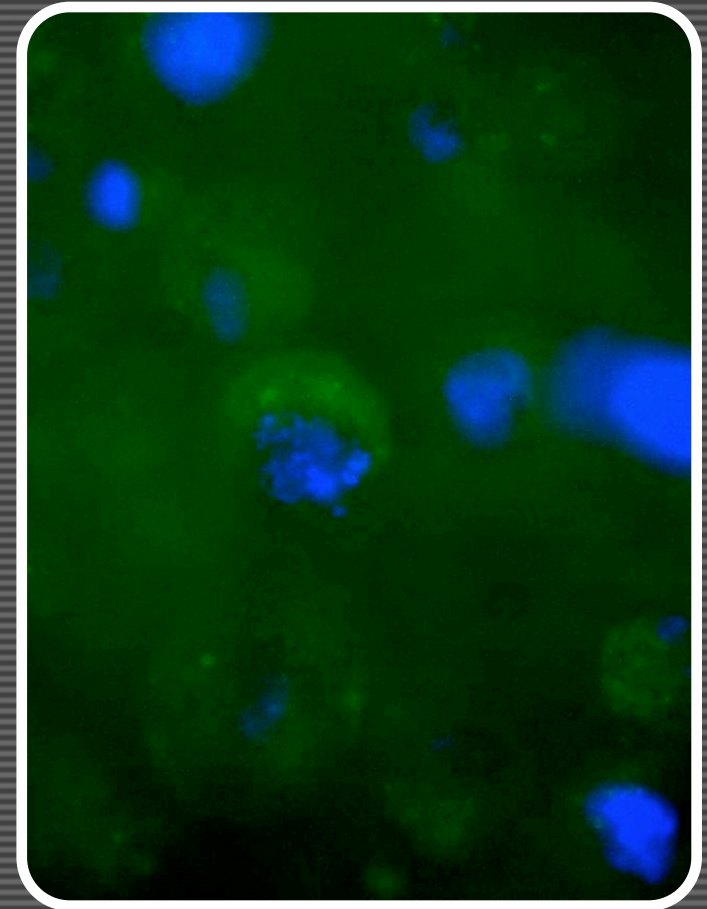
# Spectroscopic Detectors



# Cell-Based Biosensing

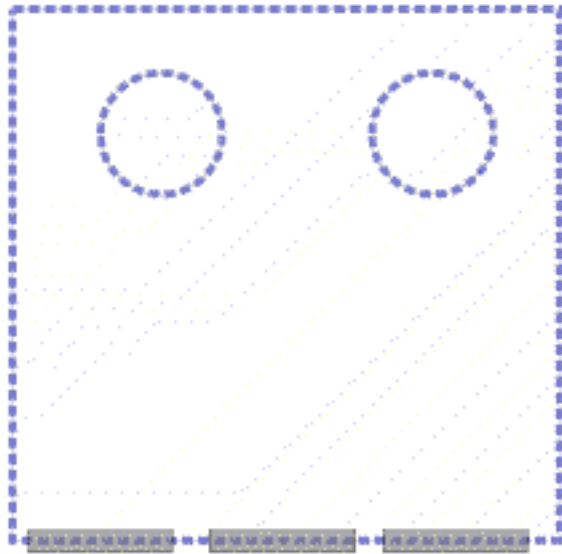
Real-time measurements of:

- 1 normalized protein expression
- 2 cellular action potentials
- 3 cell spreading and cell death
- 4 electroactive analyte concentrations
- 5 autoluminescent and fluorescent reporters





Cross Section

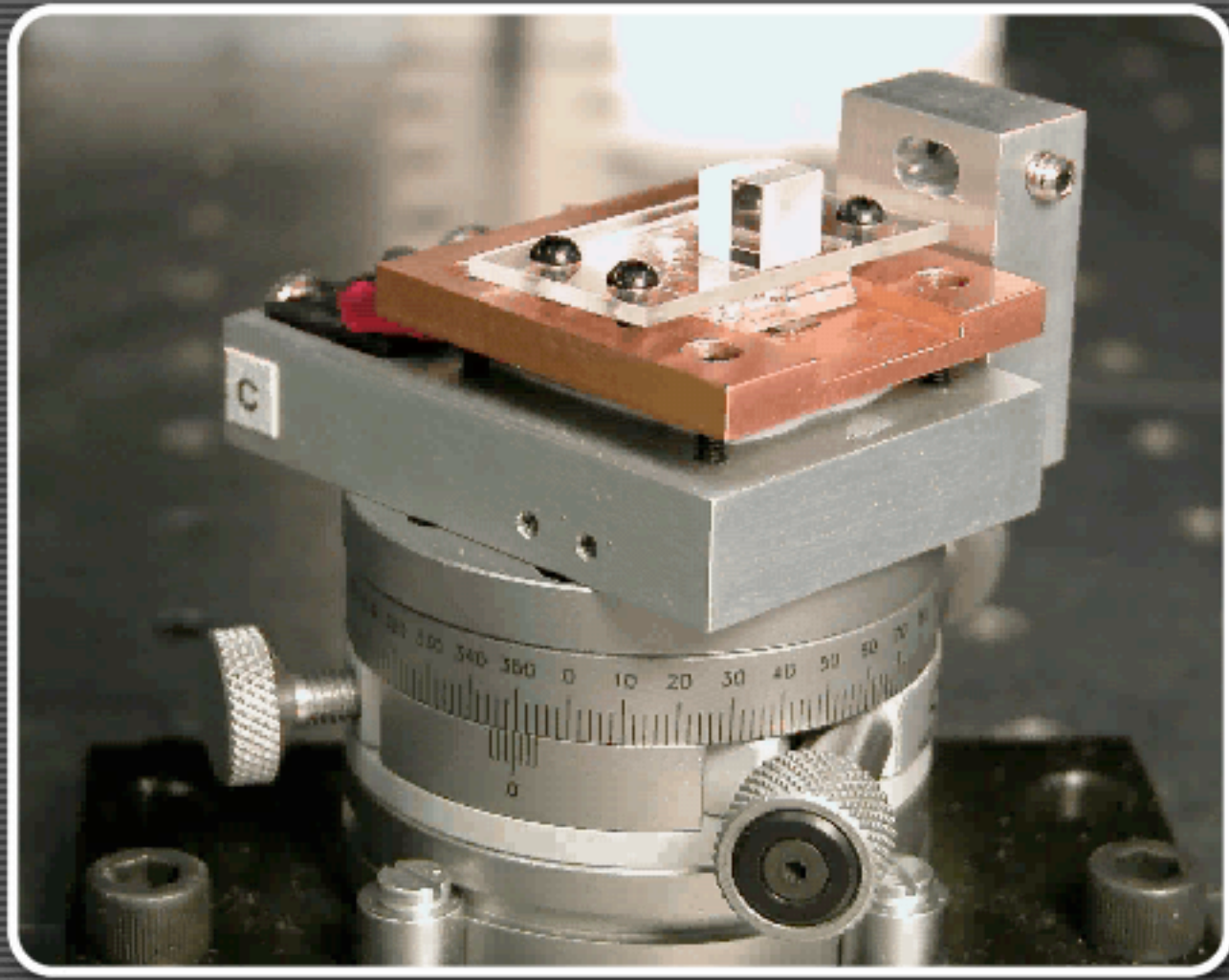


m Splitter Cube

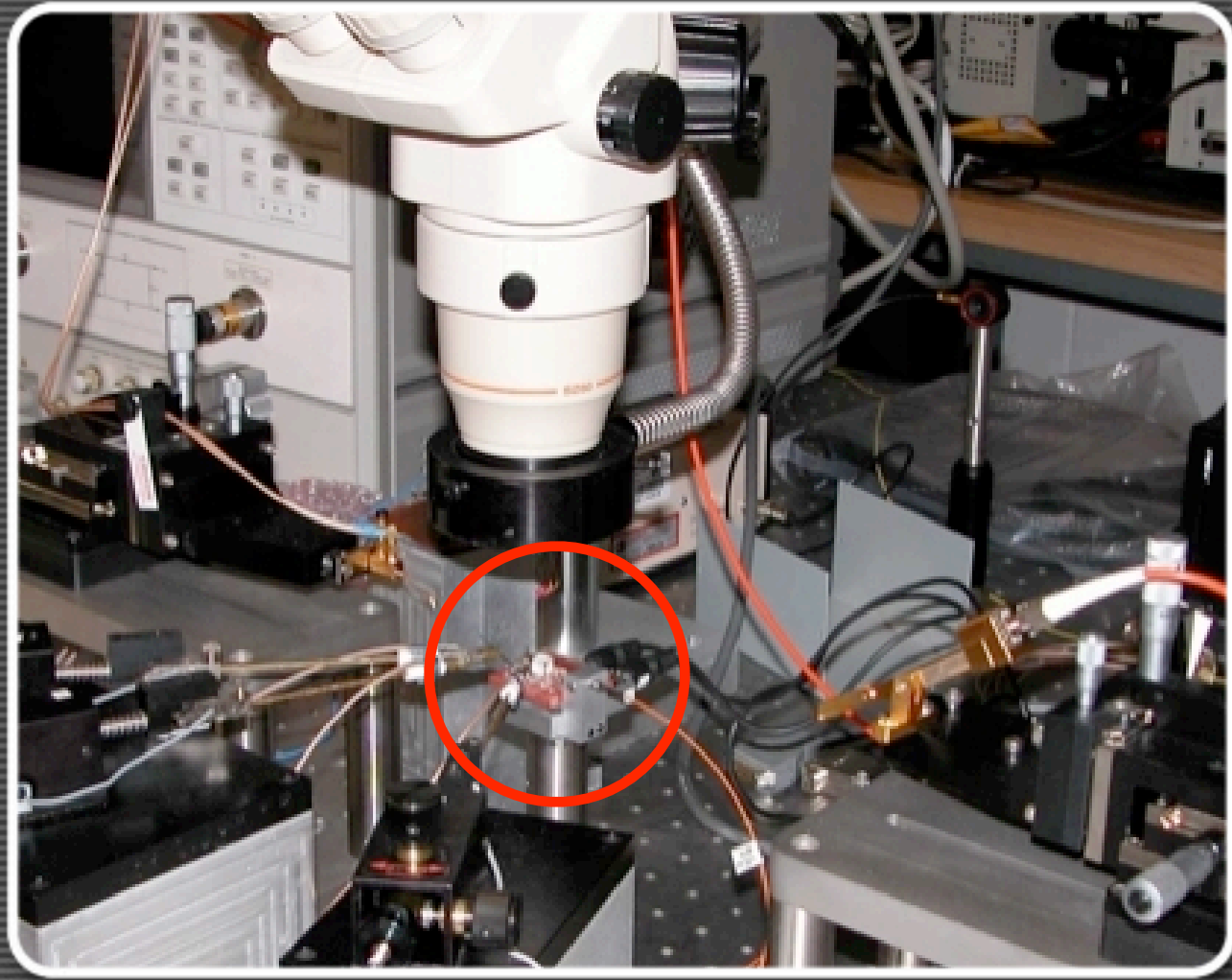
PDMS

Silicon  
Sample

# Cell Based Biochamber



# Biochamber Rotation



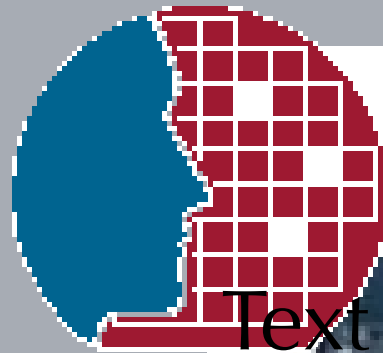
# Biochamber Test

# CMOS Prototyping

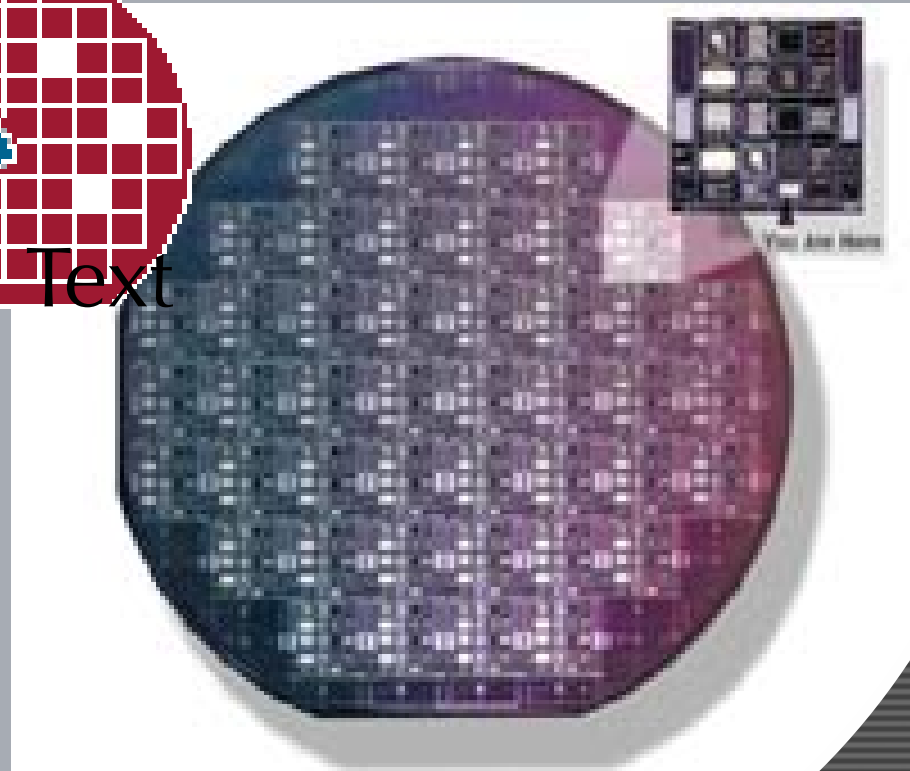
# Circuit Design



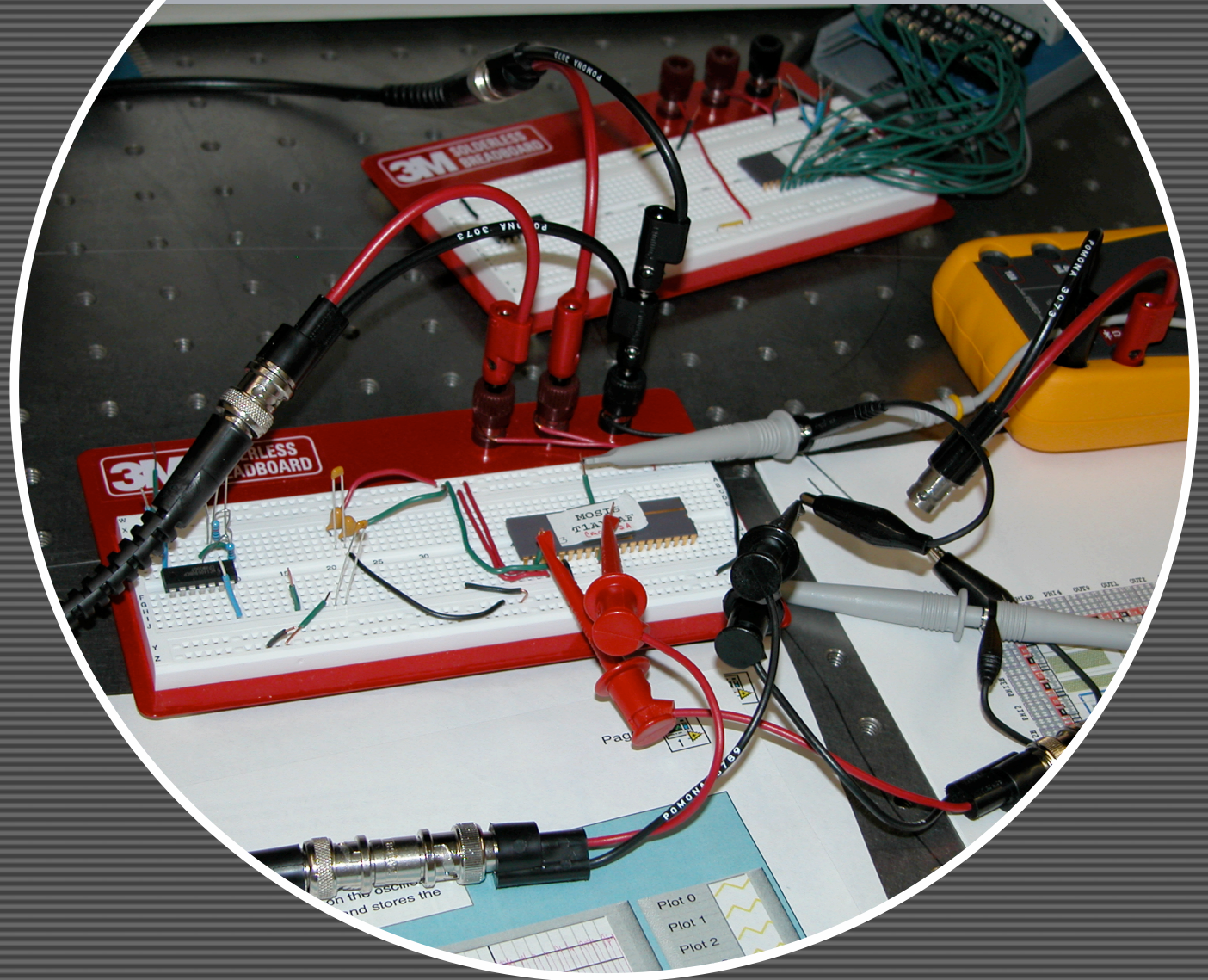
# Prototyping Through Foundary Service



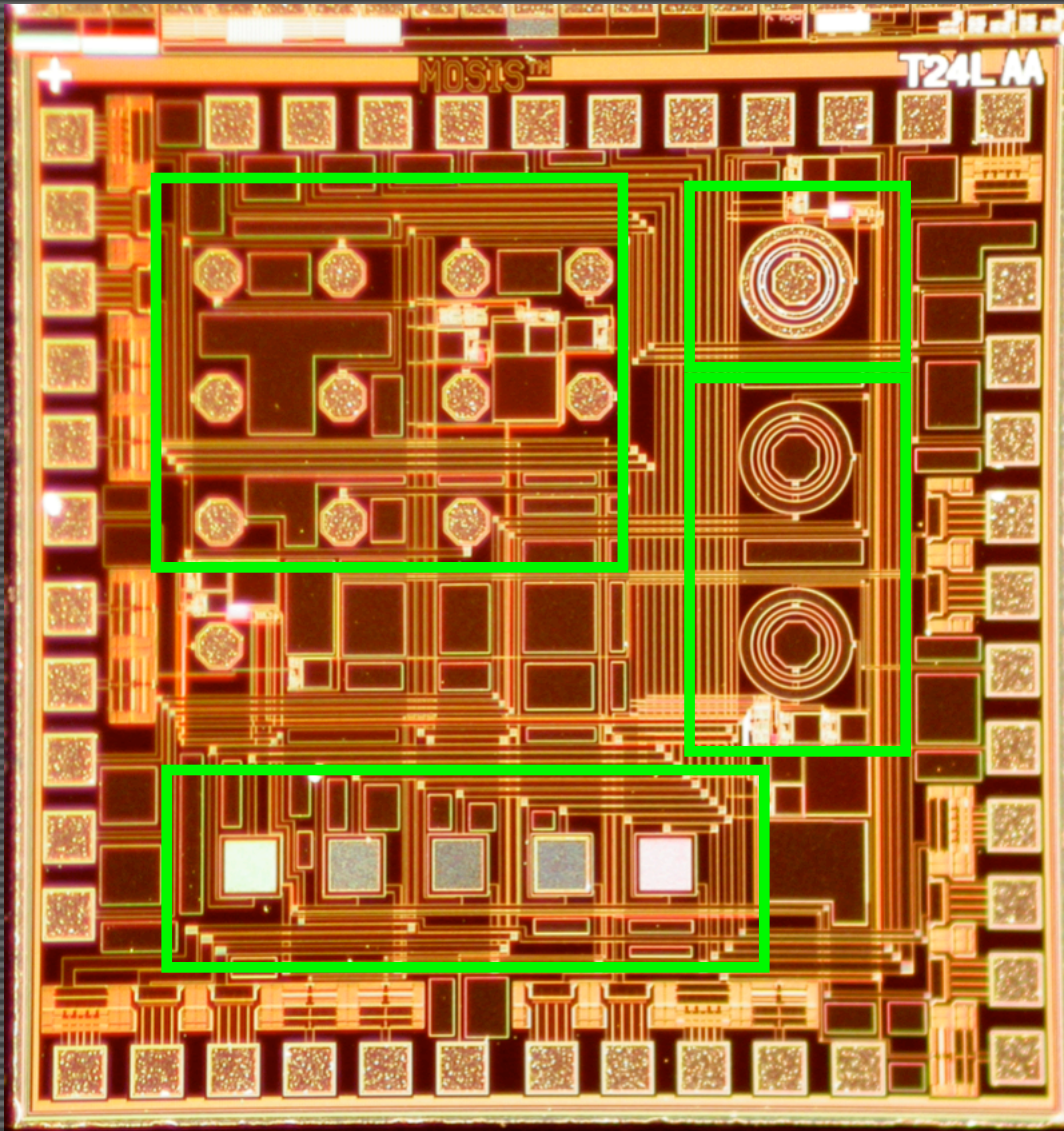
Text



# Circuit Characterization



# CMOS Biochip



- 1 Nucleic Acid Binding
- 2 Photodetectors
- 3 Cyclic Voltammetry
- 4 Capacitance