

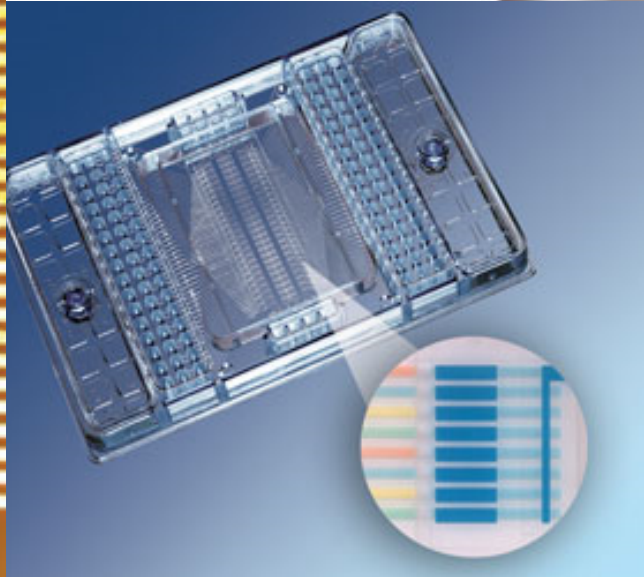
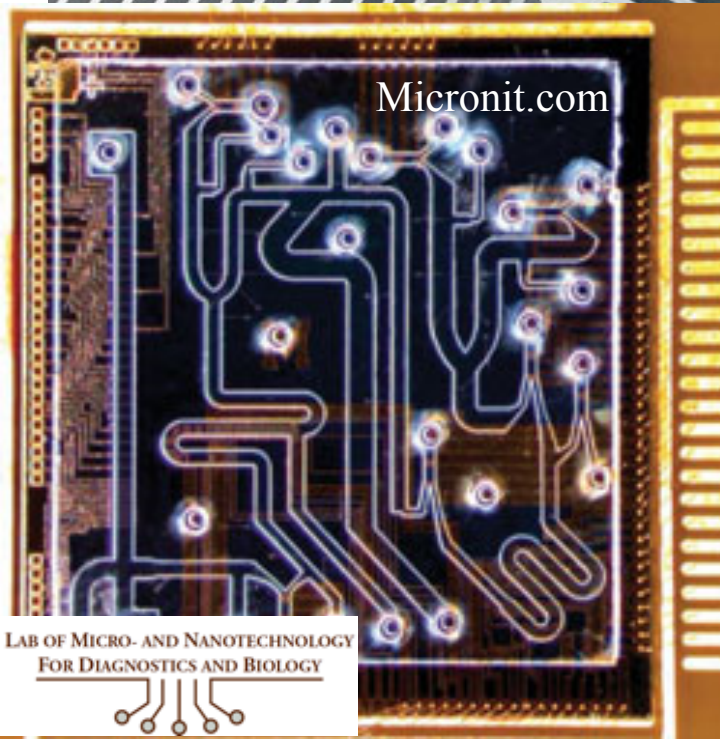
Microfluidics and Biosensors for Point-of-Care Diagnostics

Xuanhong Cheng

Materials Science and Engineering
Bioengineering
Lehigh University

November 24, 2014

Microfluidics for Medicine



Advantage of Microfluidic Systems

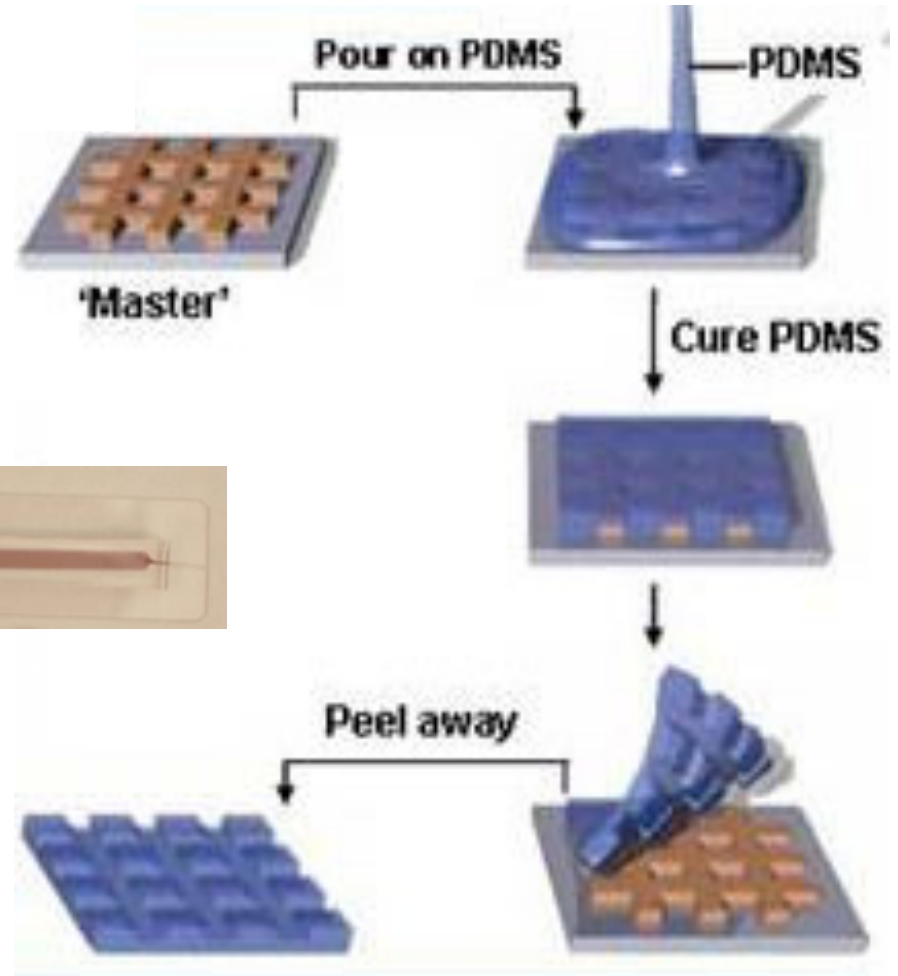
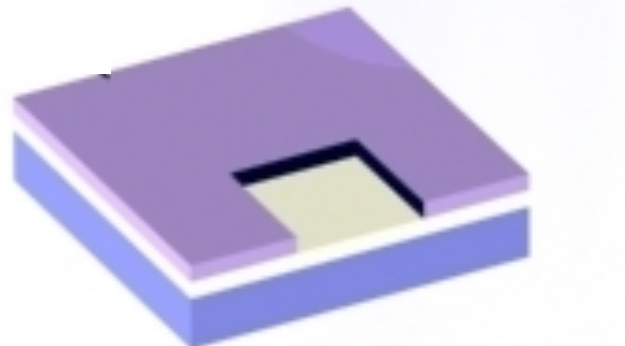
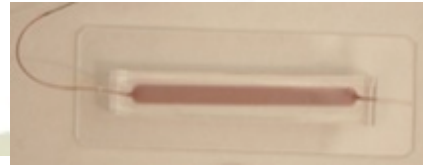
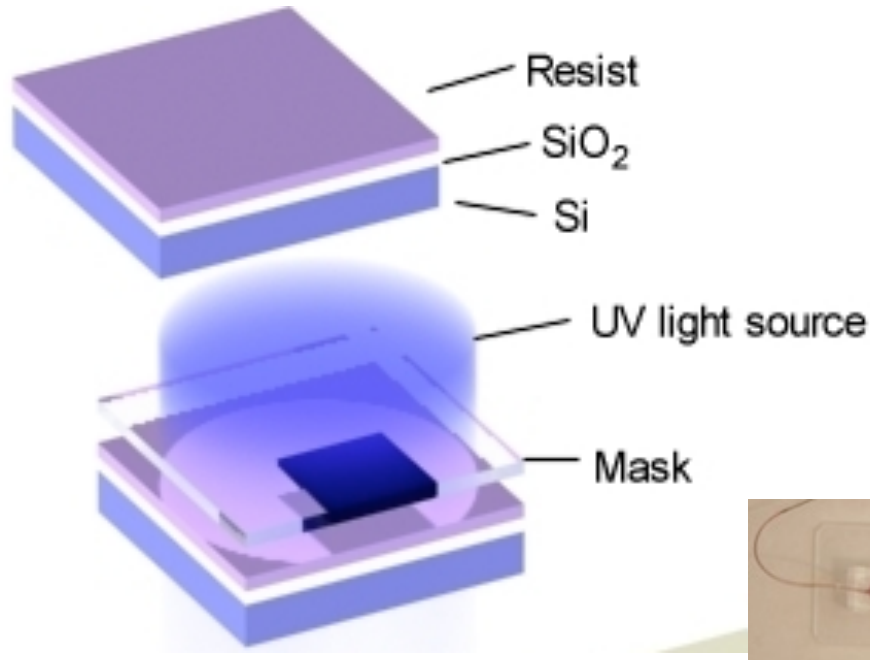
- Small sample volume
- Small reagent volume
- Low production cost
- Portable, potential for integration and automation
- High surface to volume ratio
- Laminar flow, predictable transport property

POC Diagnostics

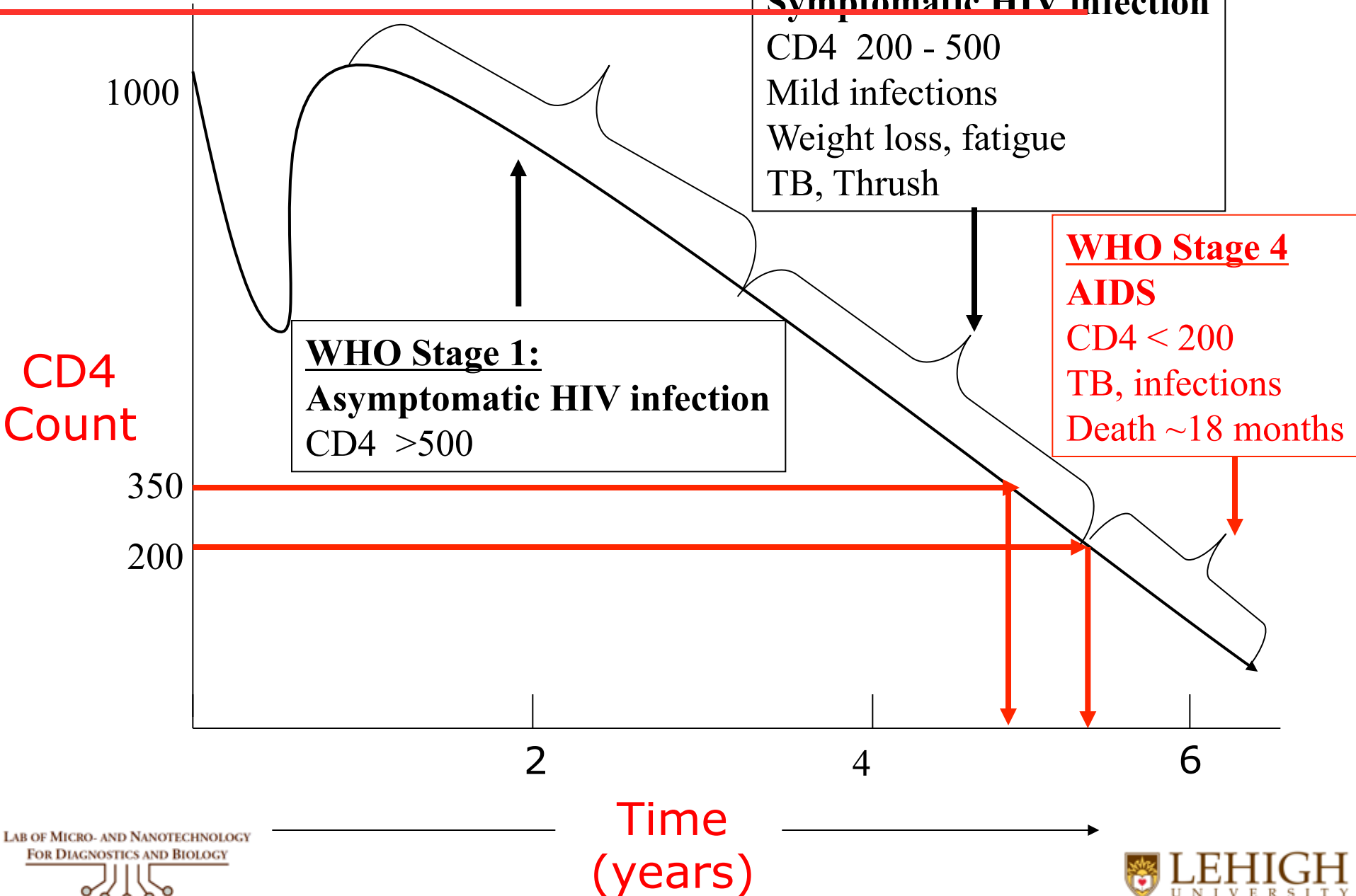




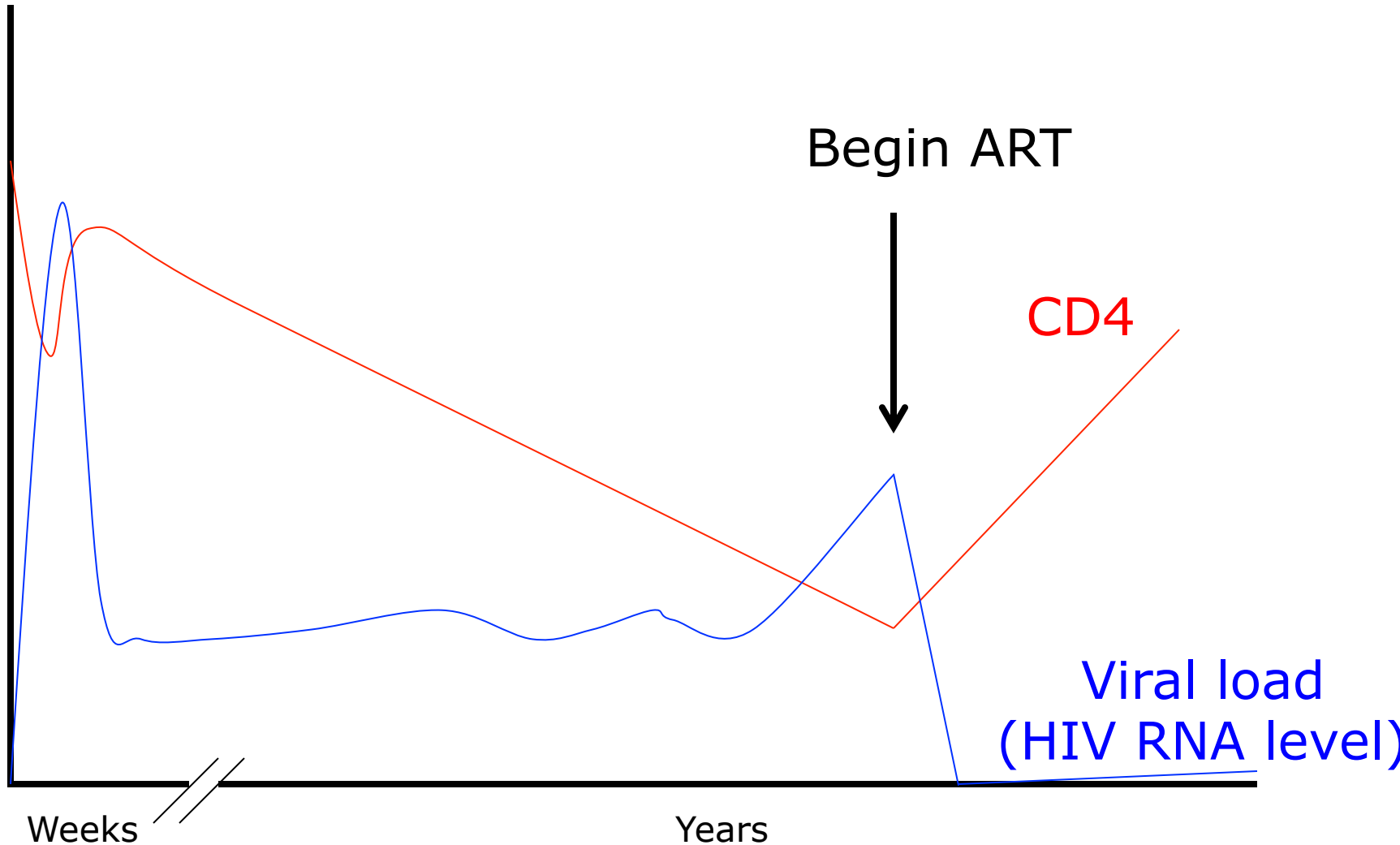
Micro-scale Fabrication



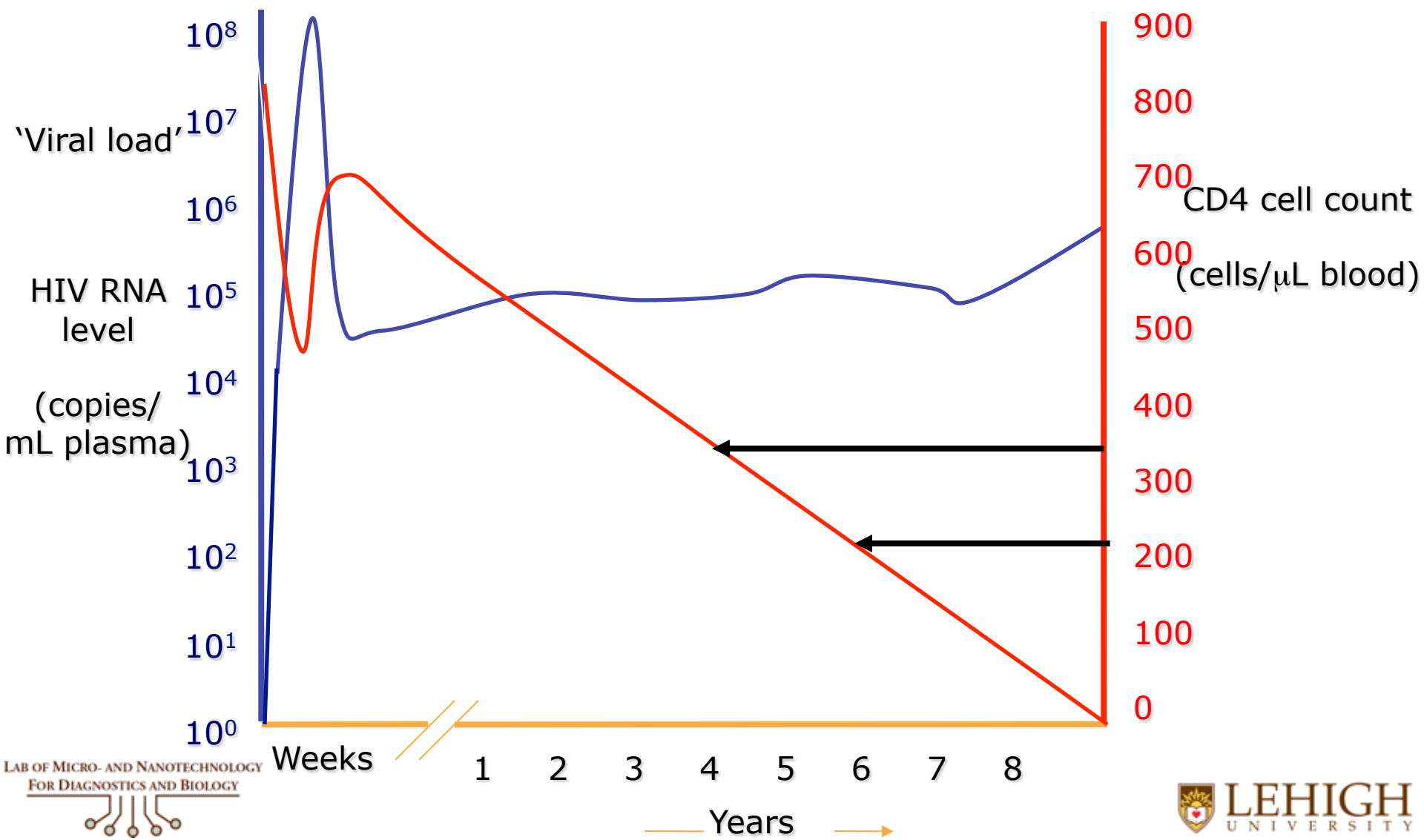
HIV Diagnostics



Impact of Treatment



Clinical Indicators



State of the Art Technologies

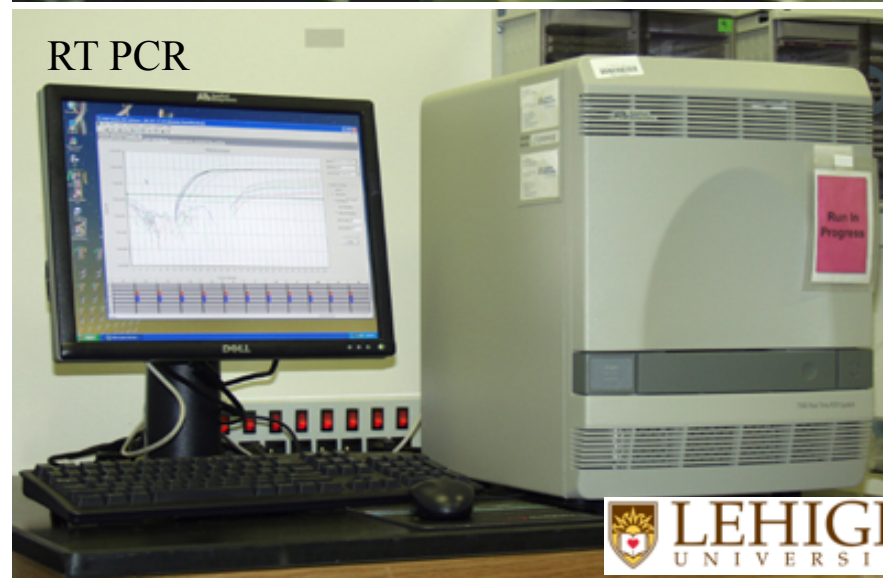
CD4-count

start treatment < 200 cells/ul



Viral load count

measure resistance to treatment



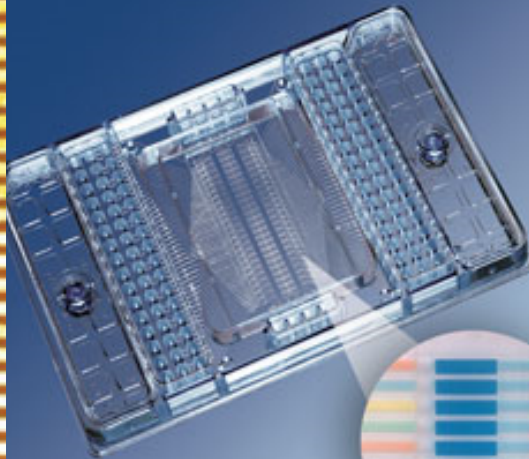
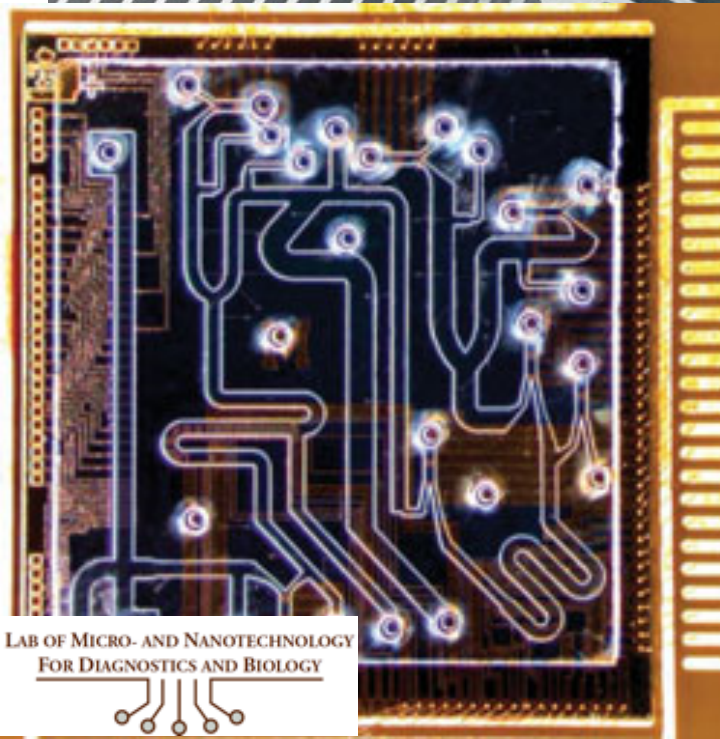
Lab Diagnostics in Resource Poor Settings



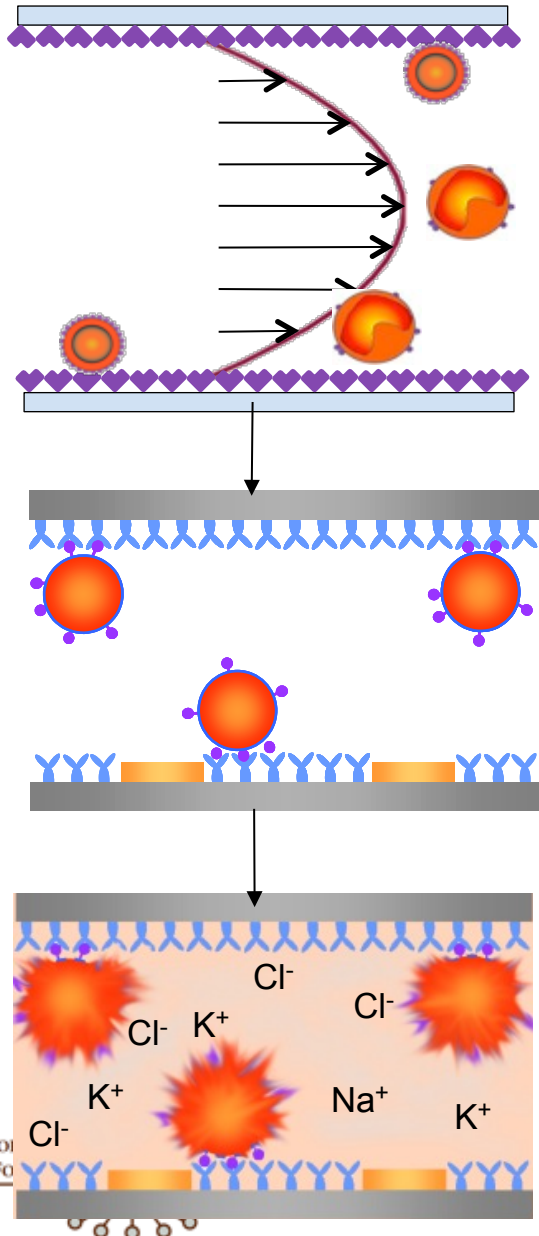
What is Needed

- Low cost
- Easy to use
- Rapid and Robust
- Portable
- Sensitive and specific

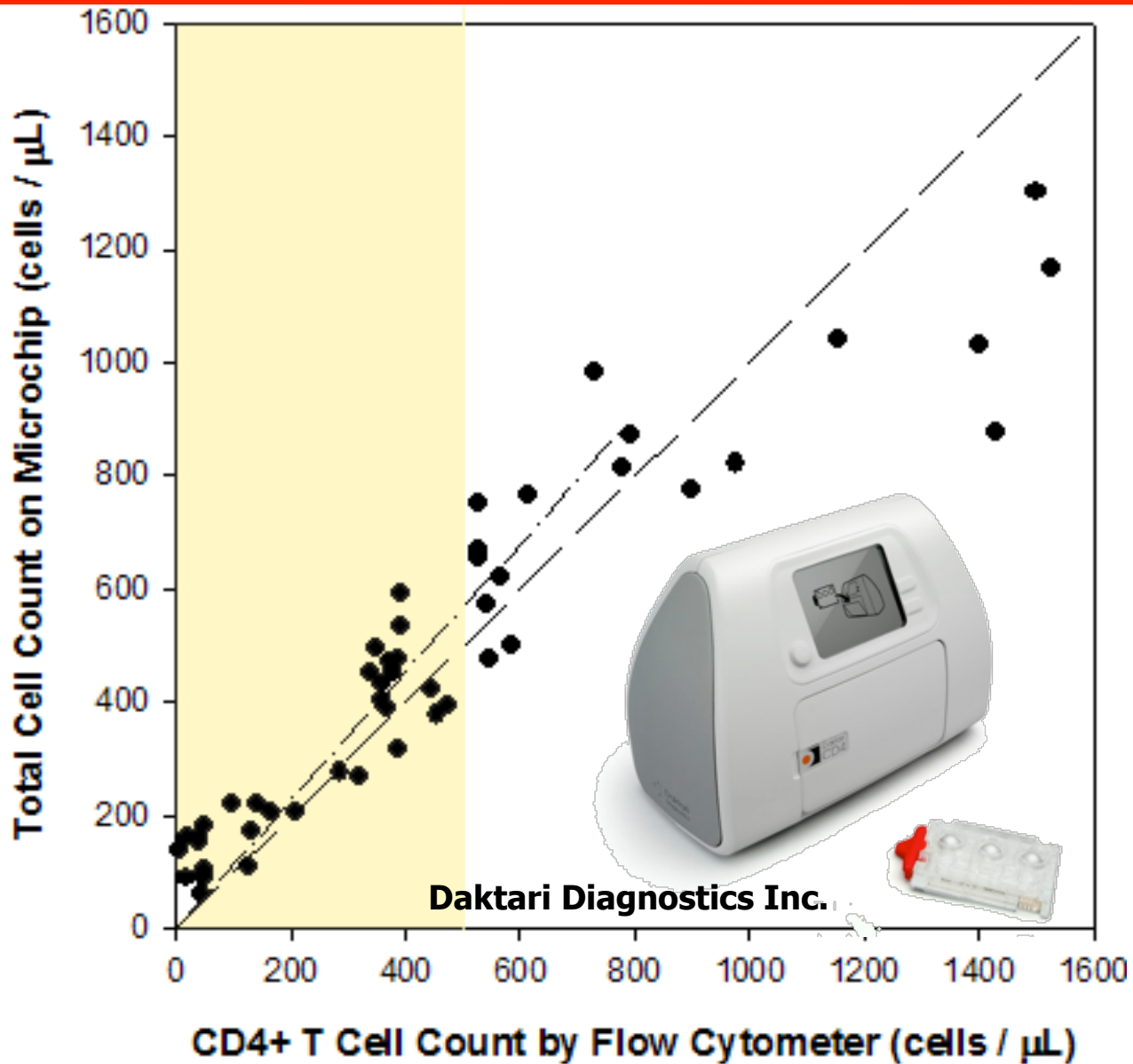
Microchip Technology for Medicine



Portable CD4 Counter

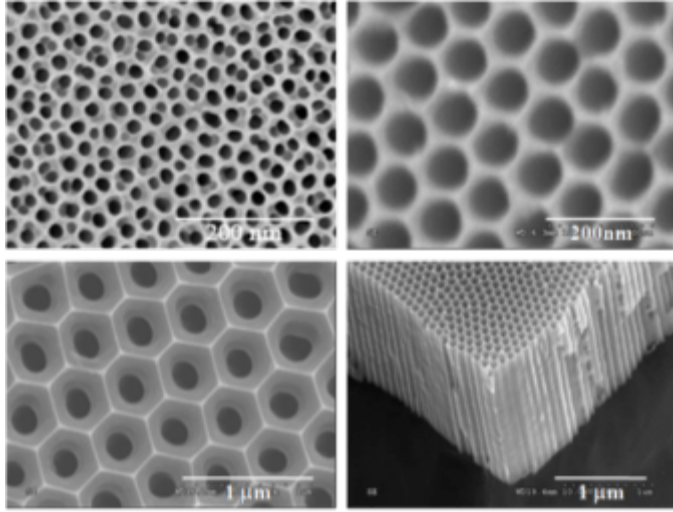
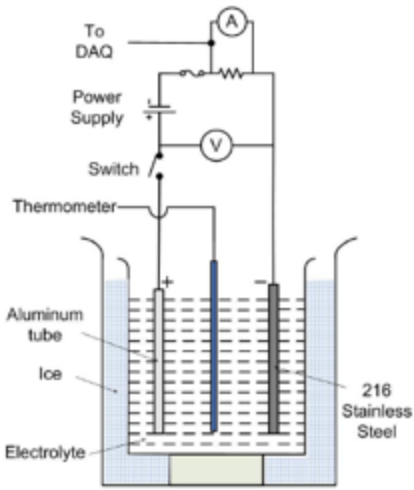
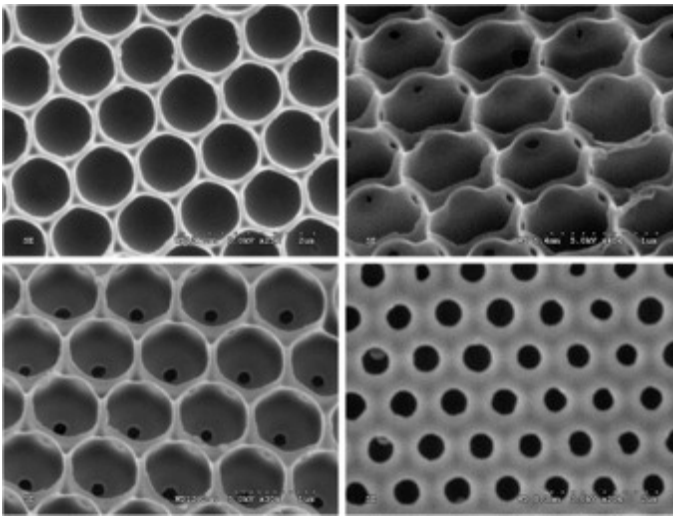
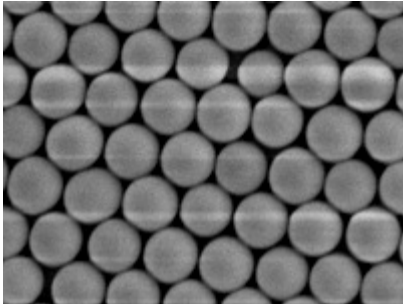


CD4 counting microchip

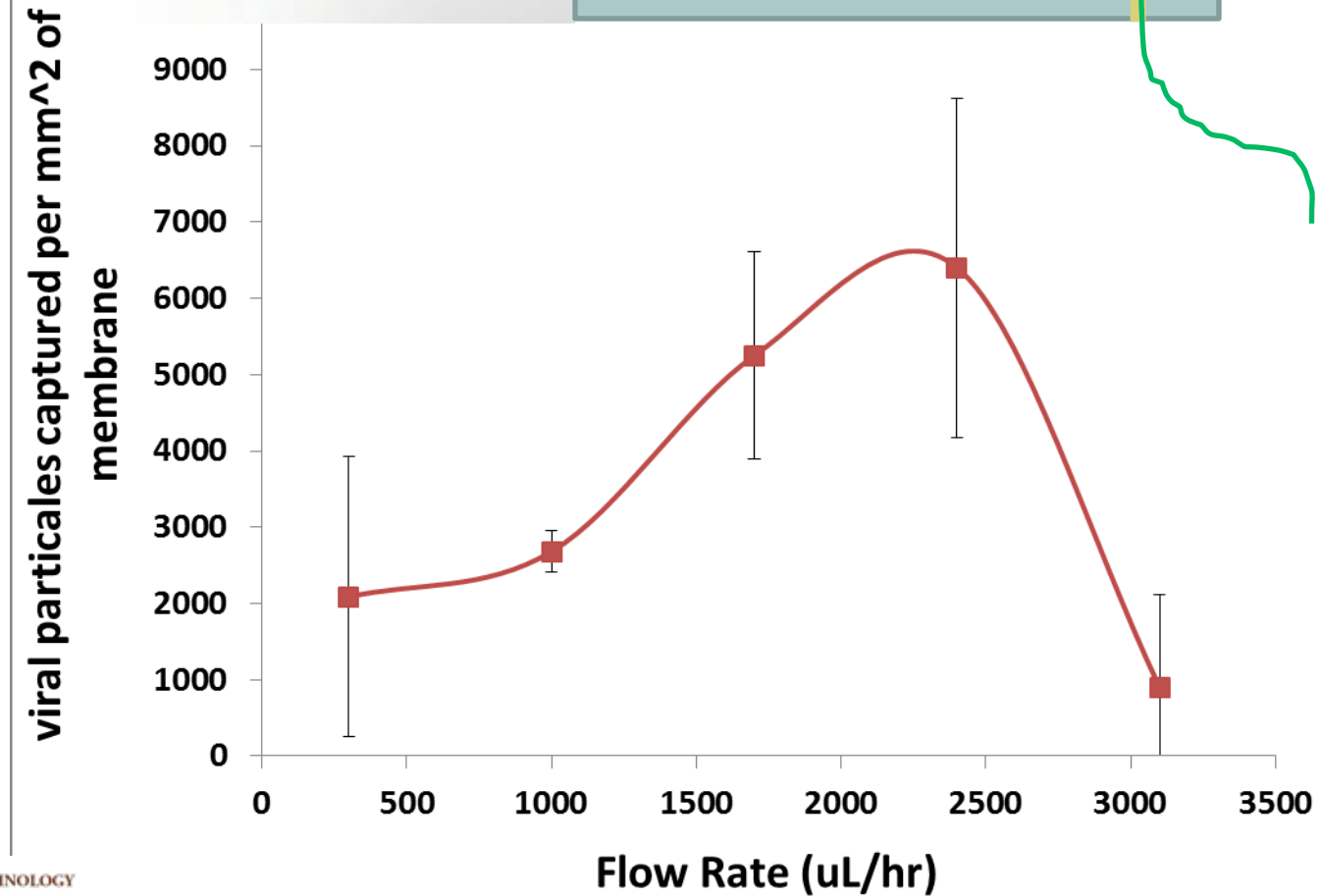
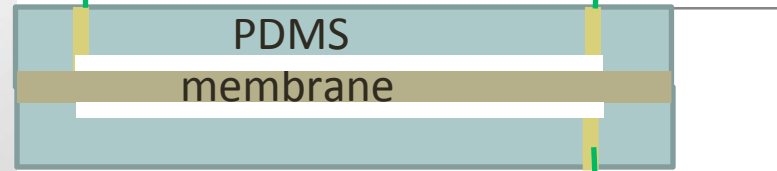


Nanoporous Membrane for Viral Processing and Sensing

- Controllable pore size
- High porosity
- Bio-functionality
- Tight pore size distribution
- Thin membranes

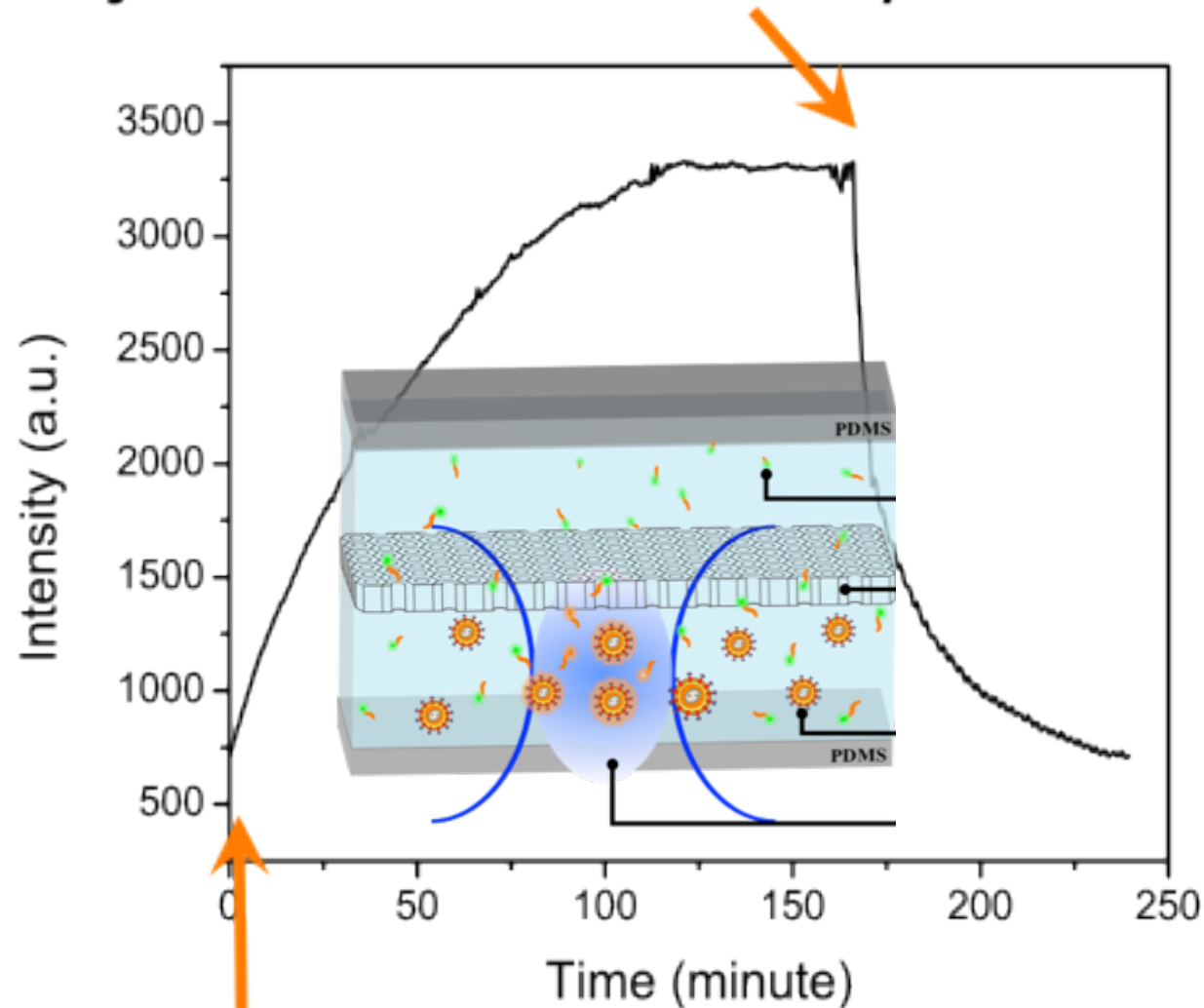


Embedded Nanoporous Membranes for Virus Capture



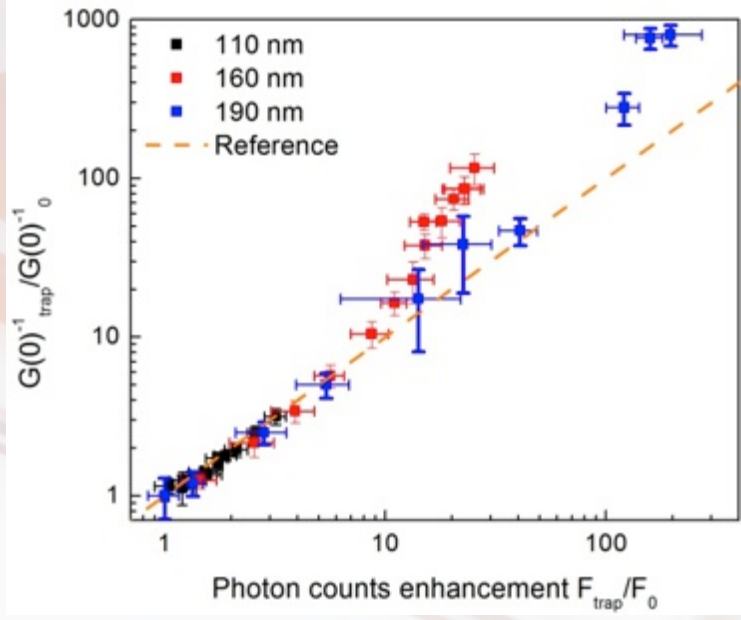
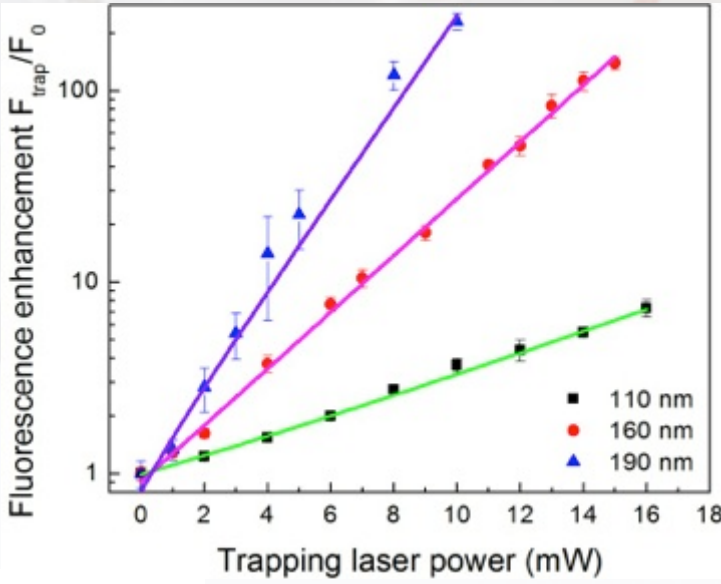
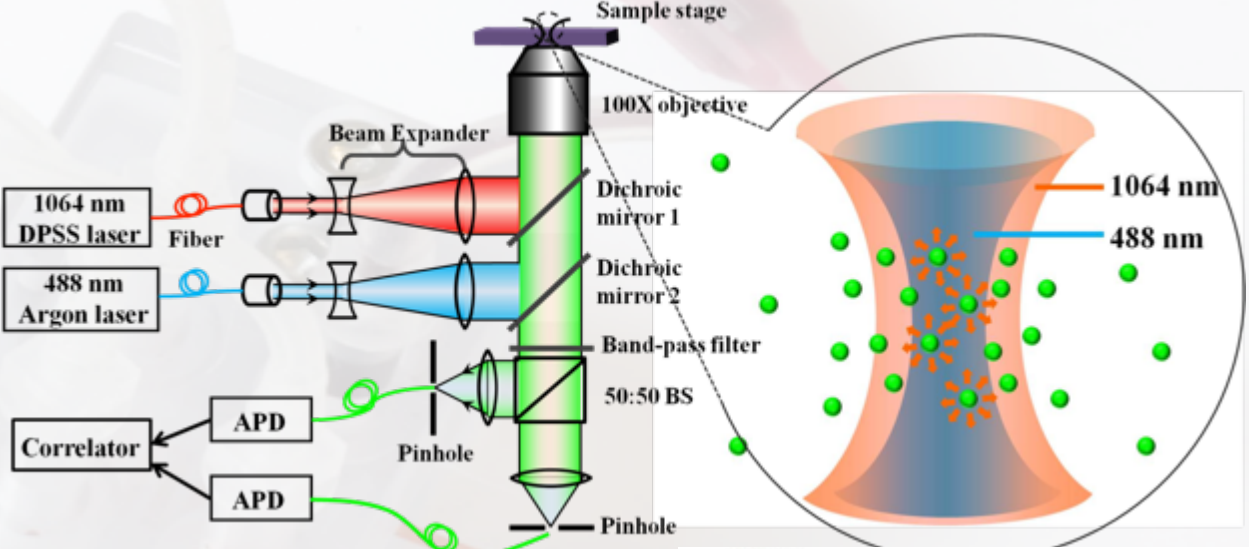
Embedded Nanoporous Membranes for Virus Staining

Inject buffer into the top channel



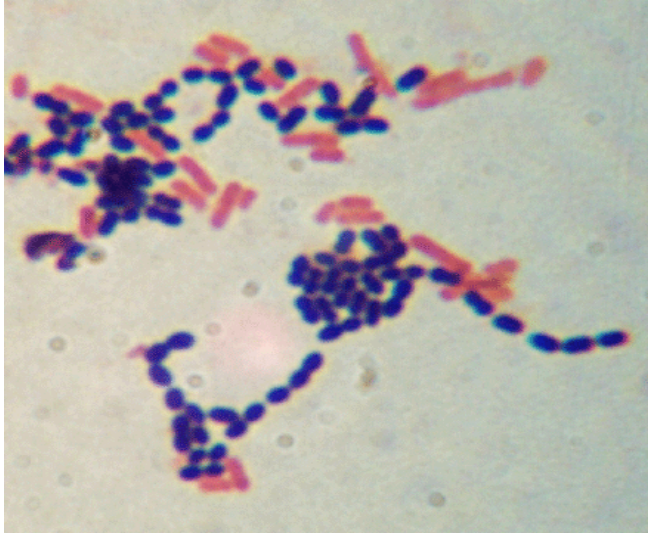
Inject dye into the top channel

Optically Forced Cytometry for Nanoparticle Counting

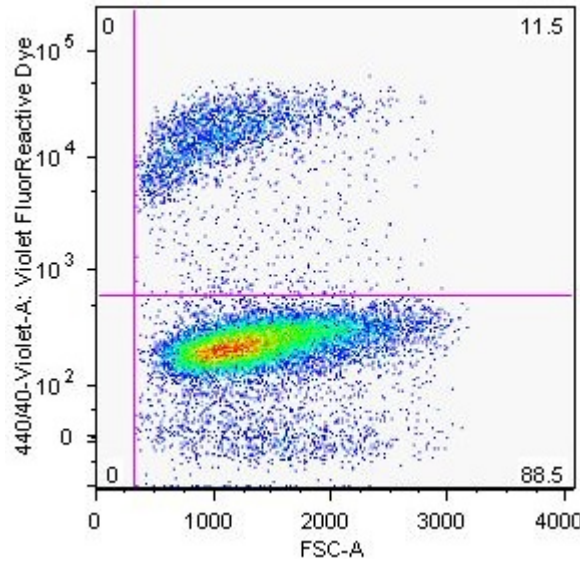


Detection of Bacteria Viability

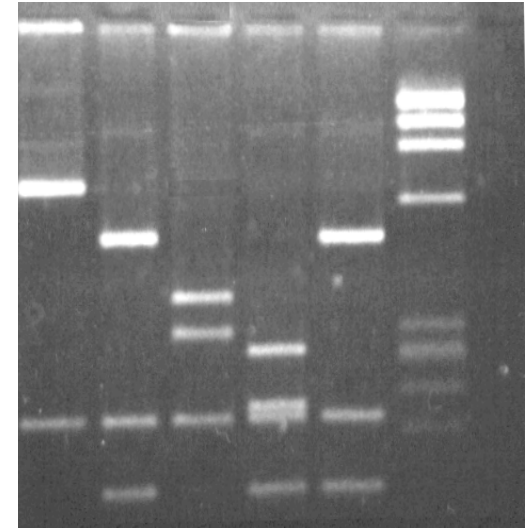
Cell Staining



Flow Cytometer

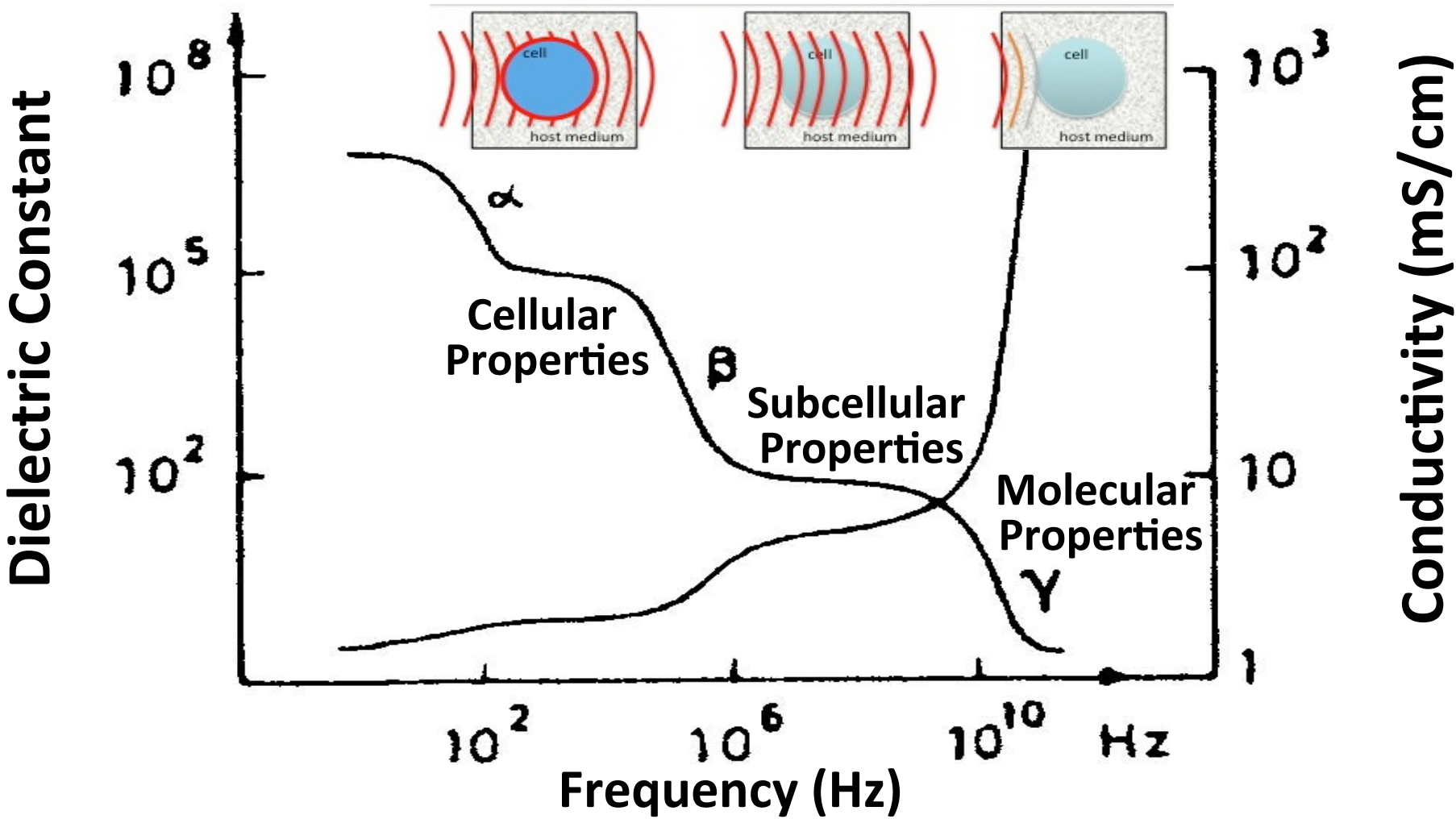


Molecular Markers



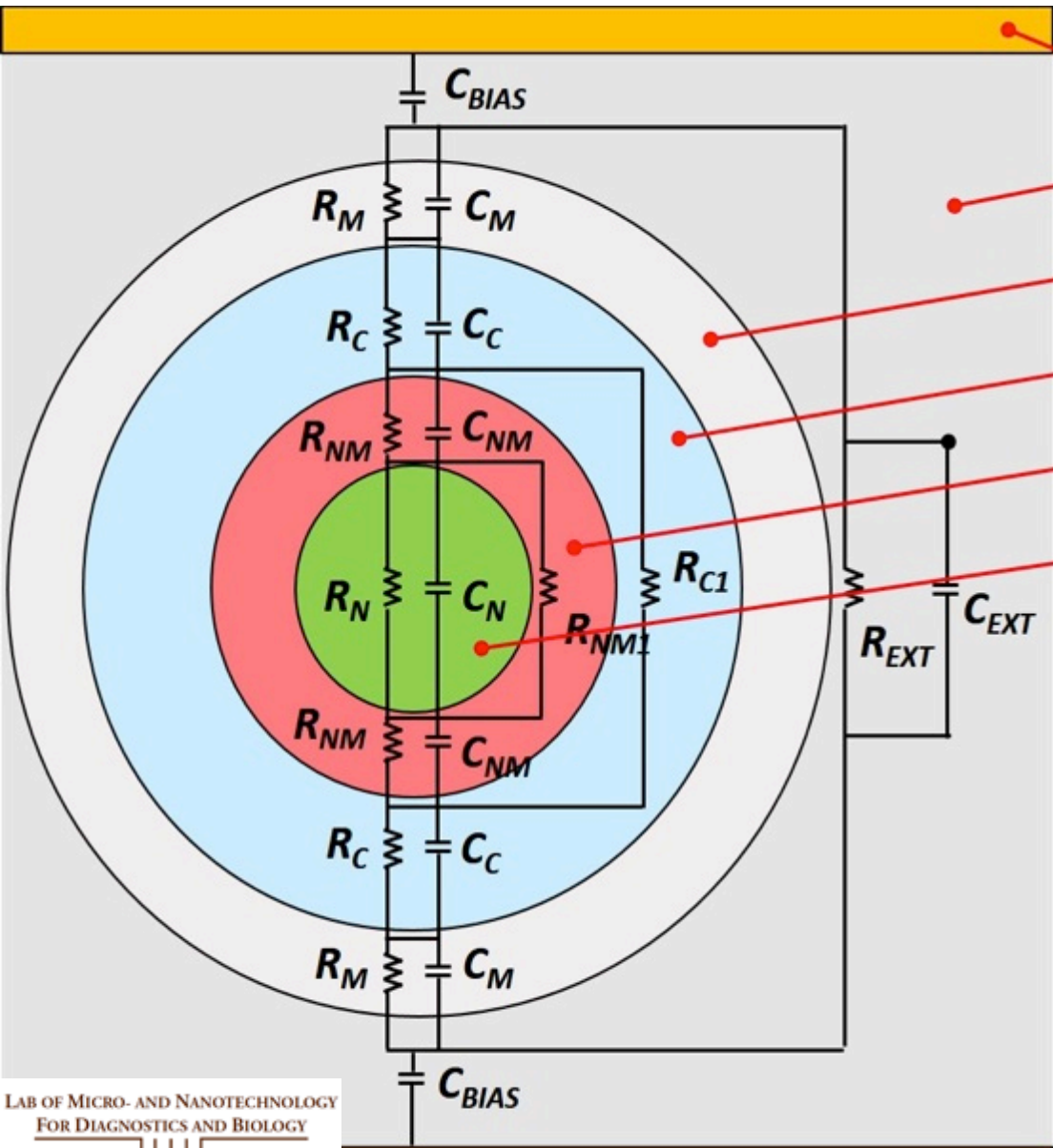
- Significant in clinical diagnosis, biohazard surveillance, food safety monitoring, etc.
- Contemporary approaches require laboratory access
- Electrical test can be fast, compact, sensitive and label free

Broadband Electrical Sensing



HP Schwan (1985): Hypothesis based on tissue measurement

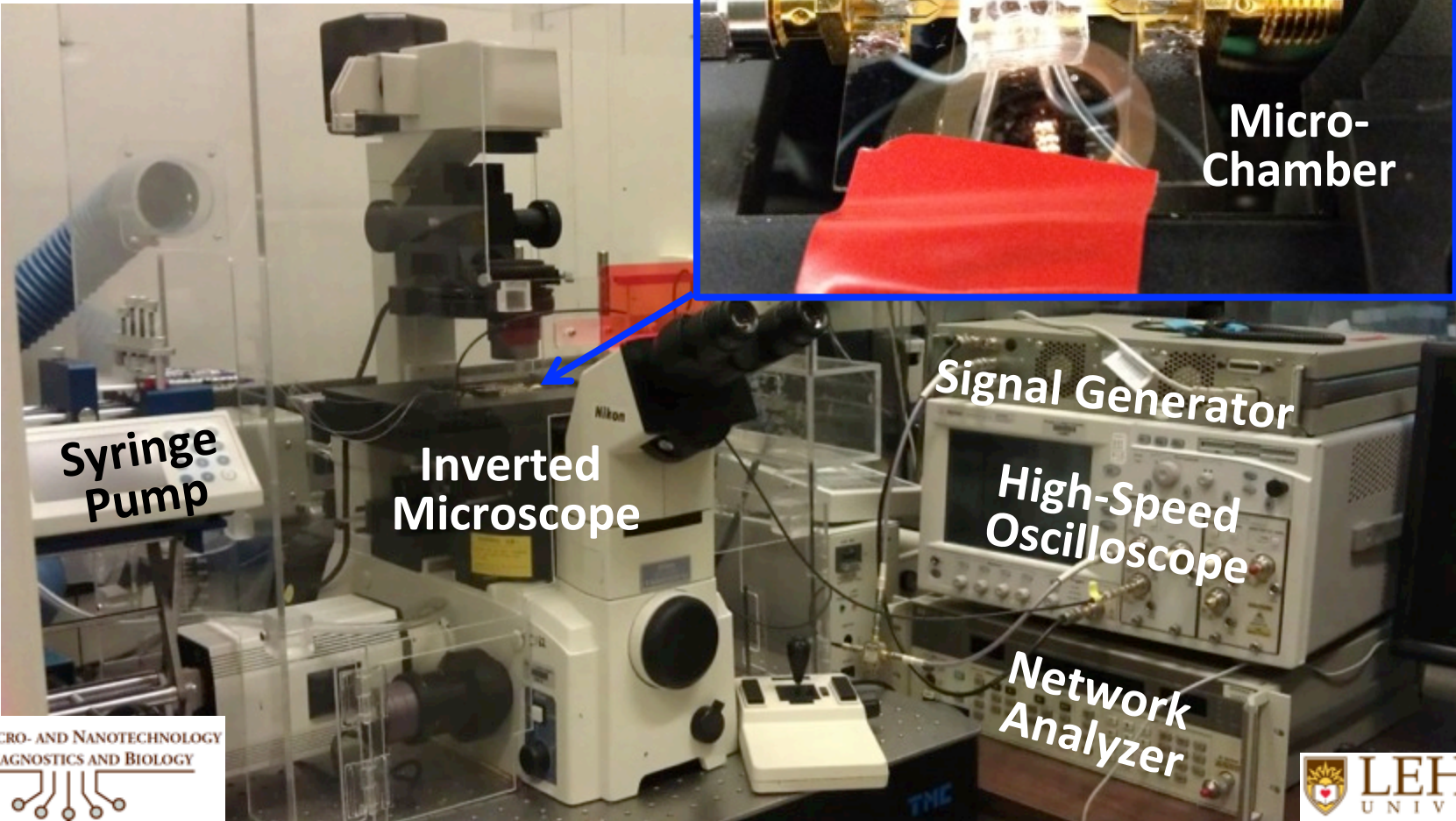
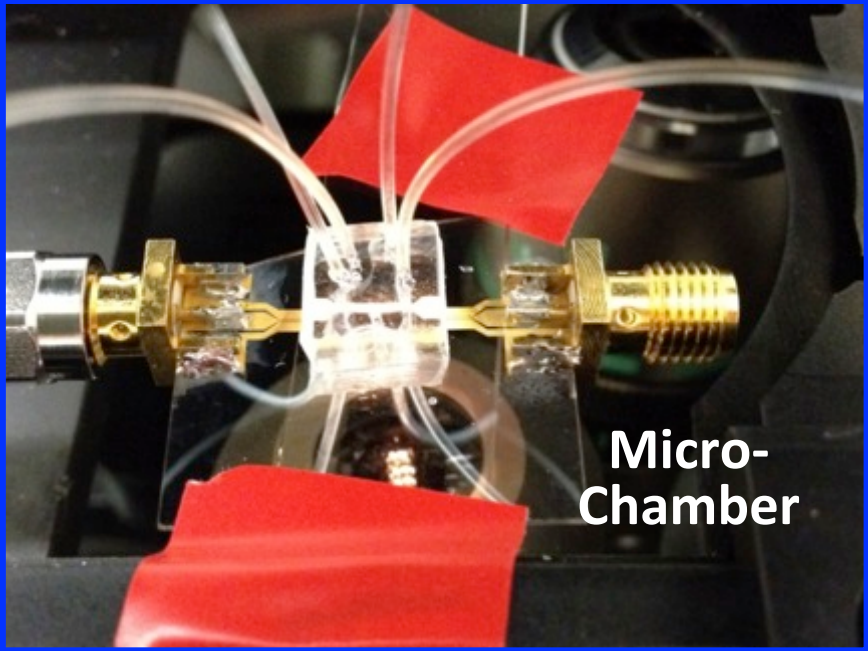
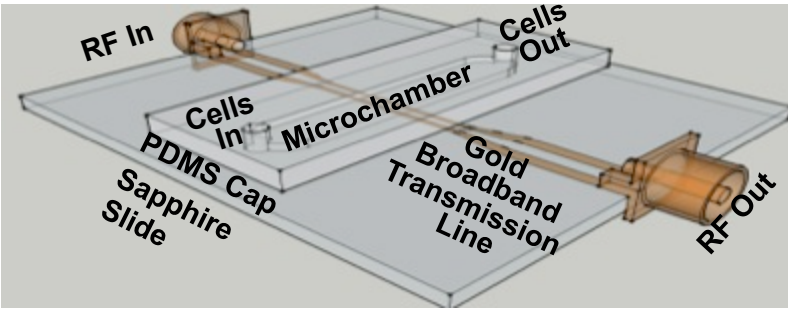
Broad Band Electrical Sensing

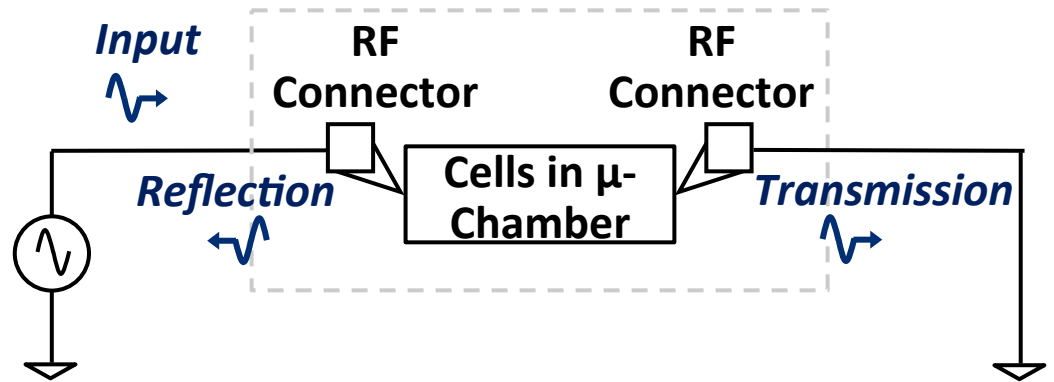
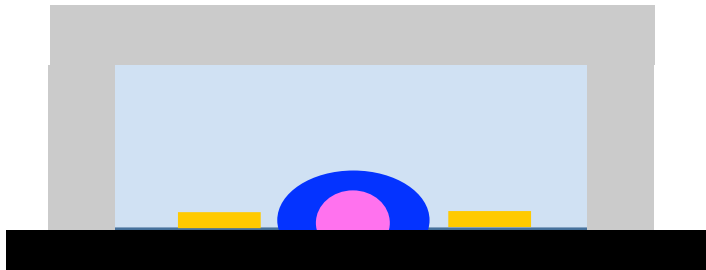
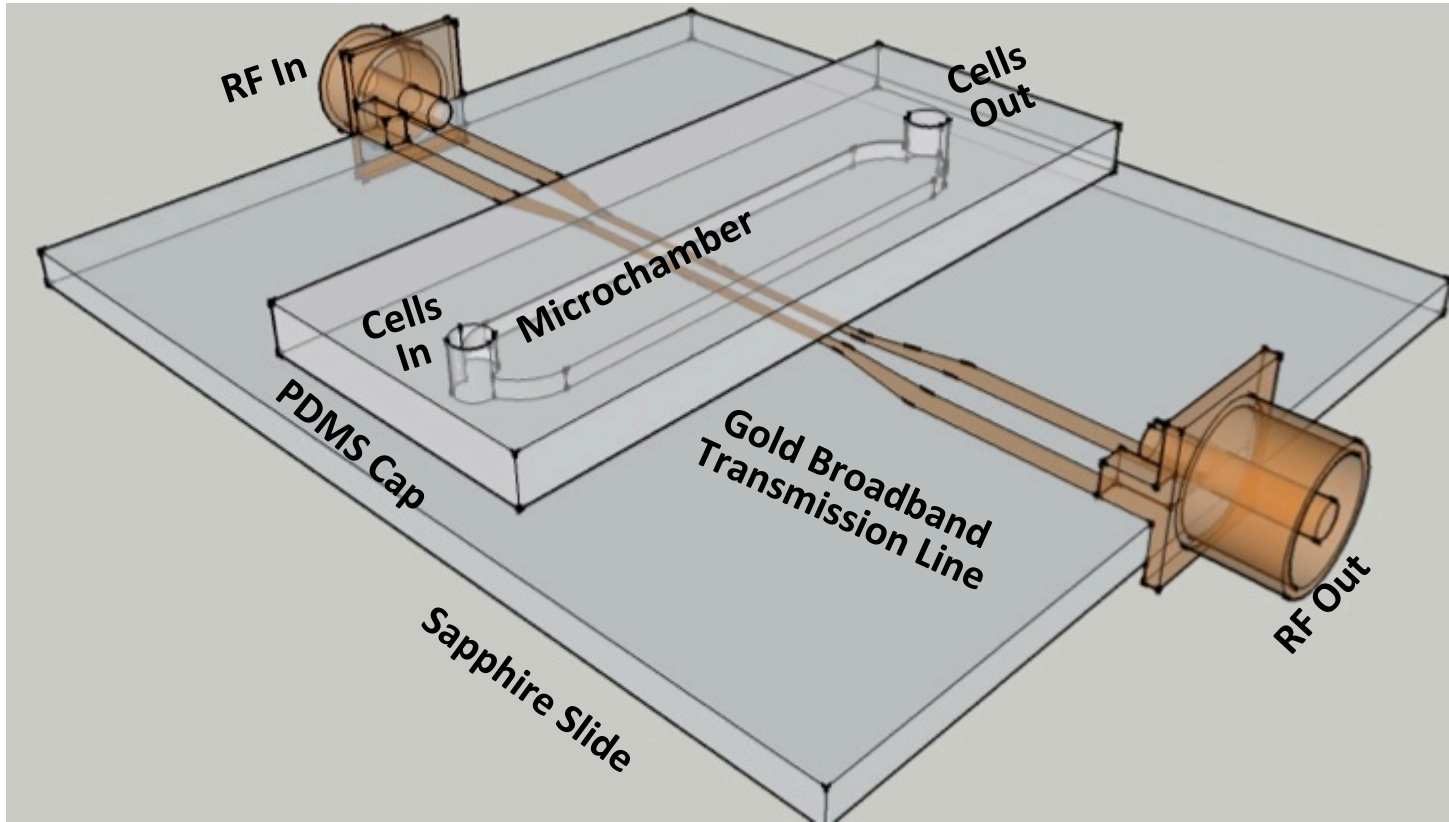


- Electrode
- Solution
- Plasma Membrane
- Cytoplasm
- Organelle/Nucleus Membrane
- Organelle/Nucleus

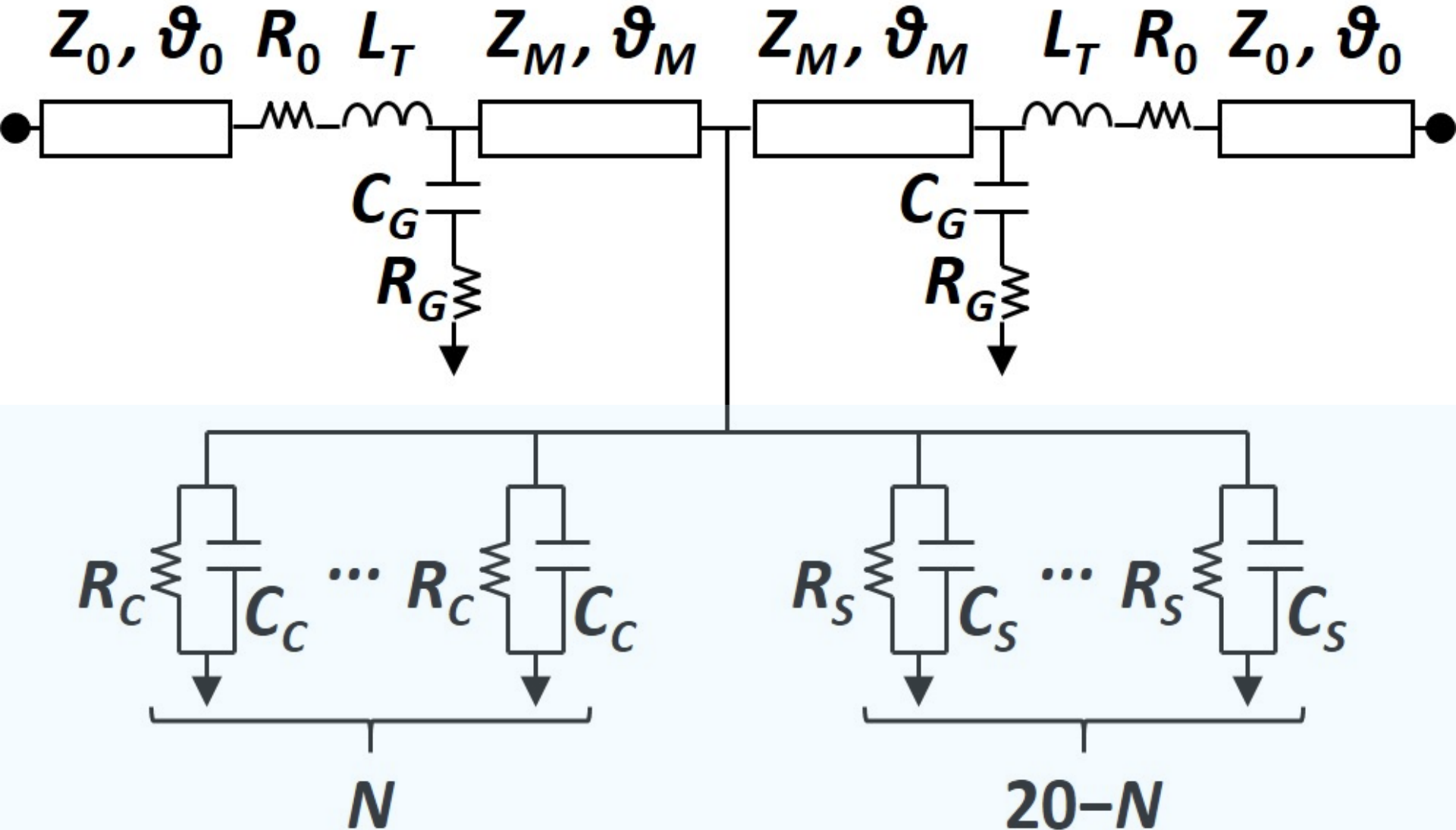


Experimental Setup

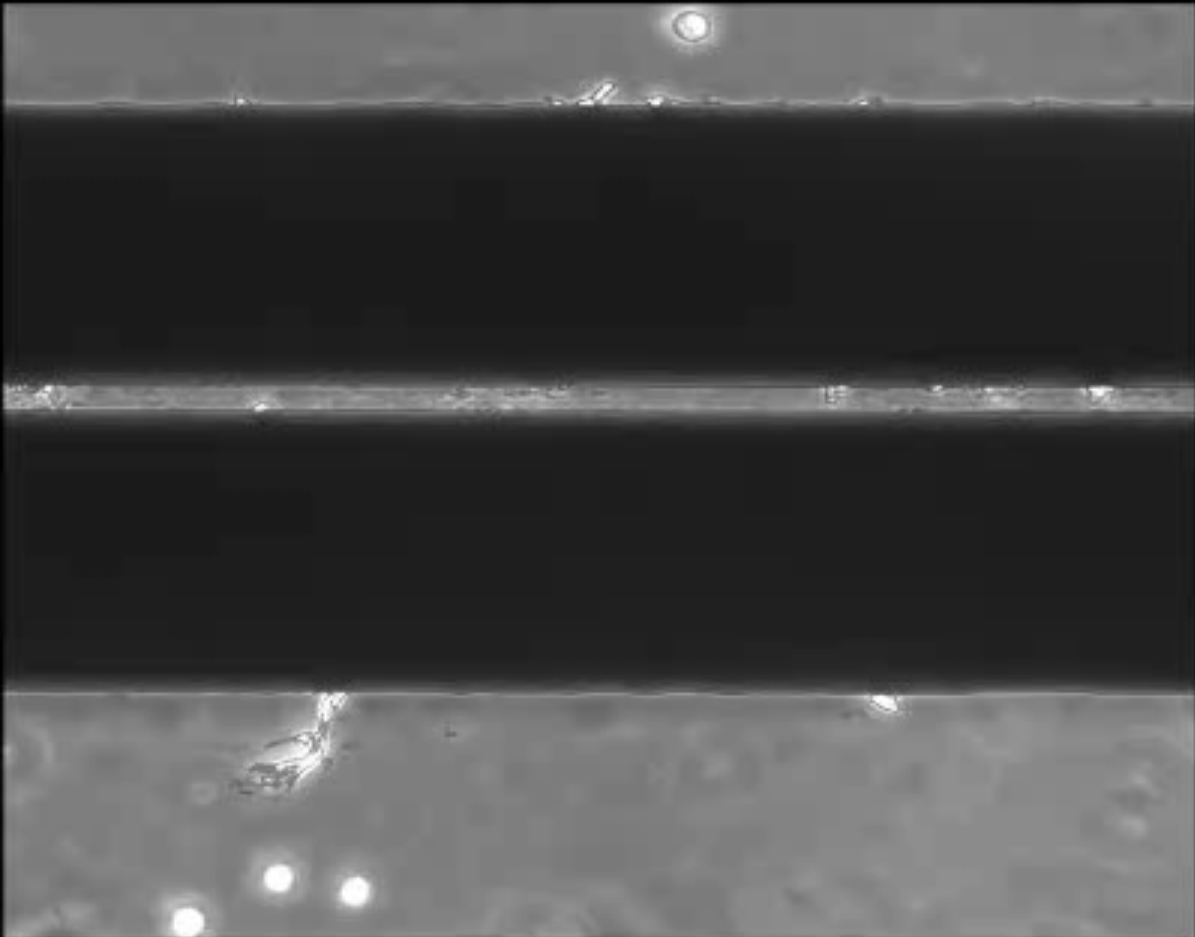




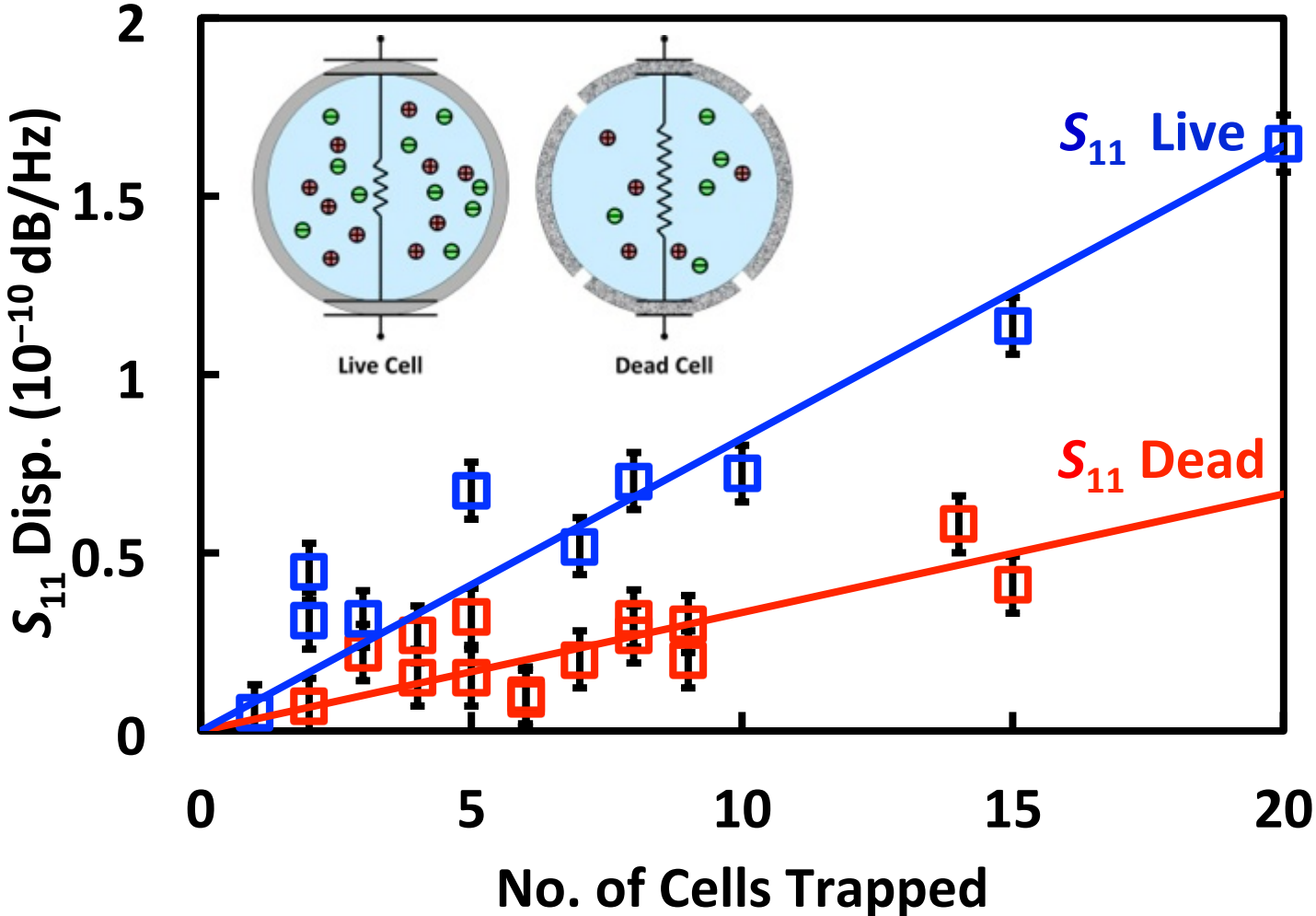
Modeling to Extract Cell Information



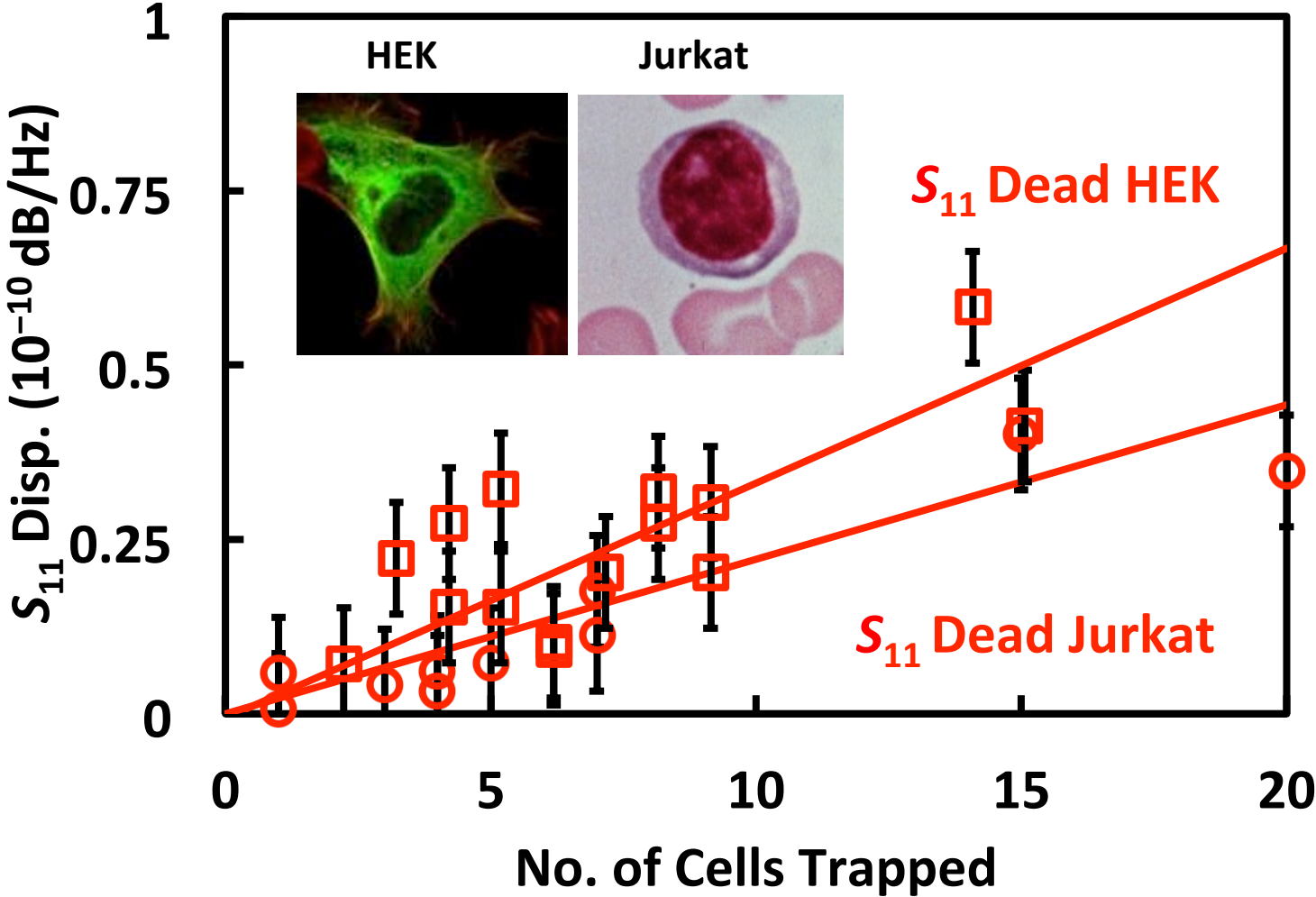
Cell Immobilized by Dielectrophoresis



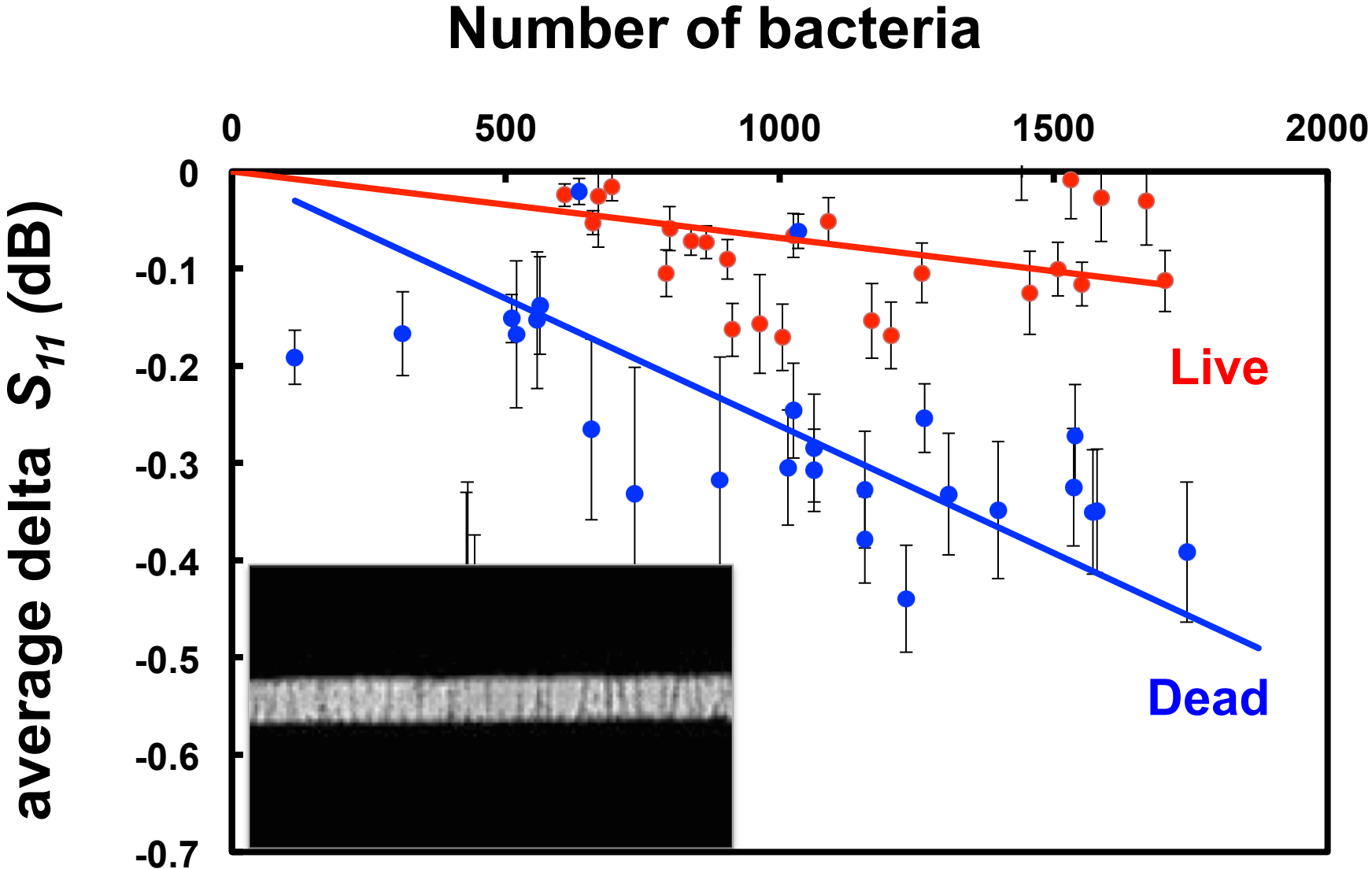
Differentiating Live vs Dead HEK Cells



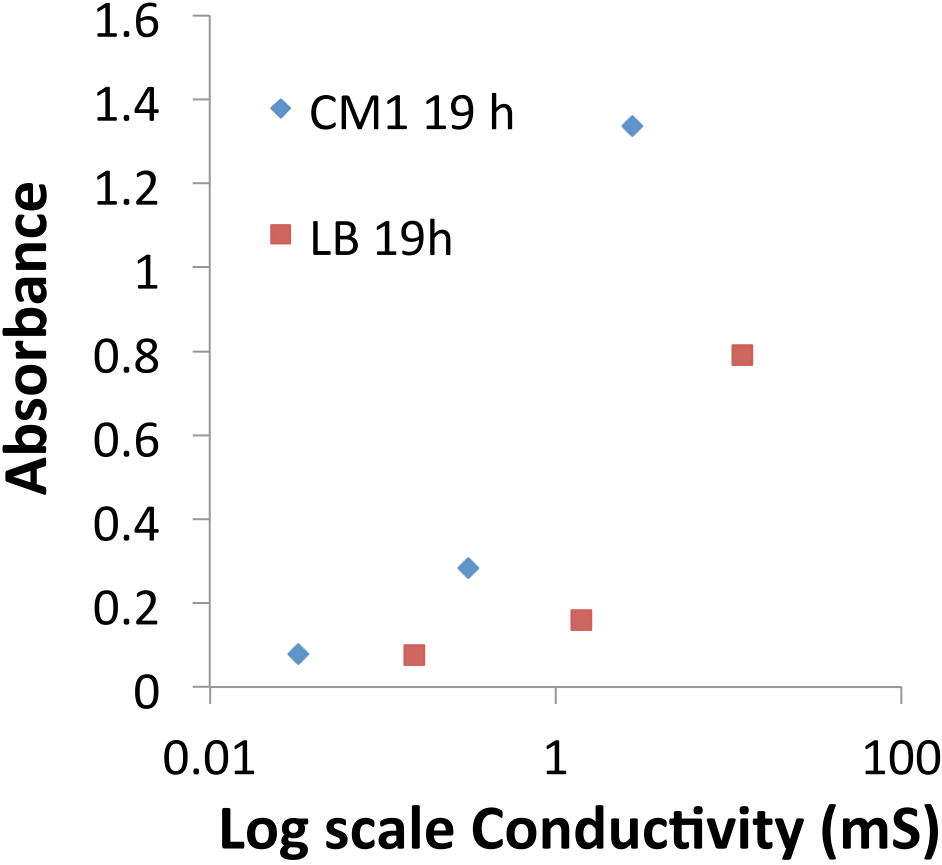
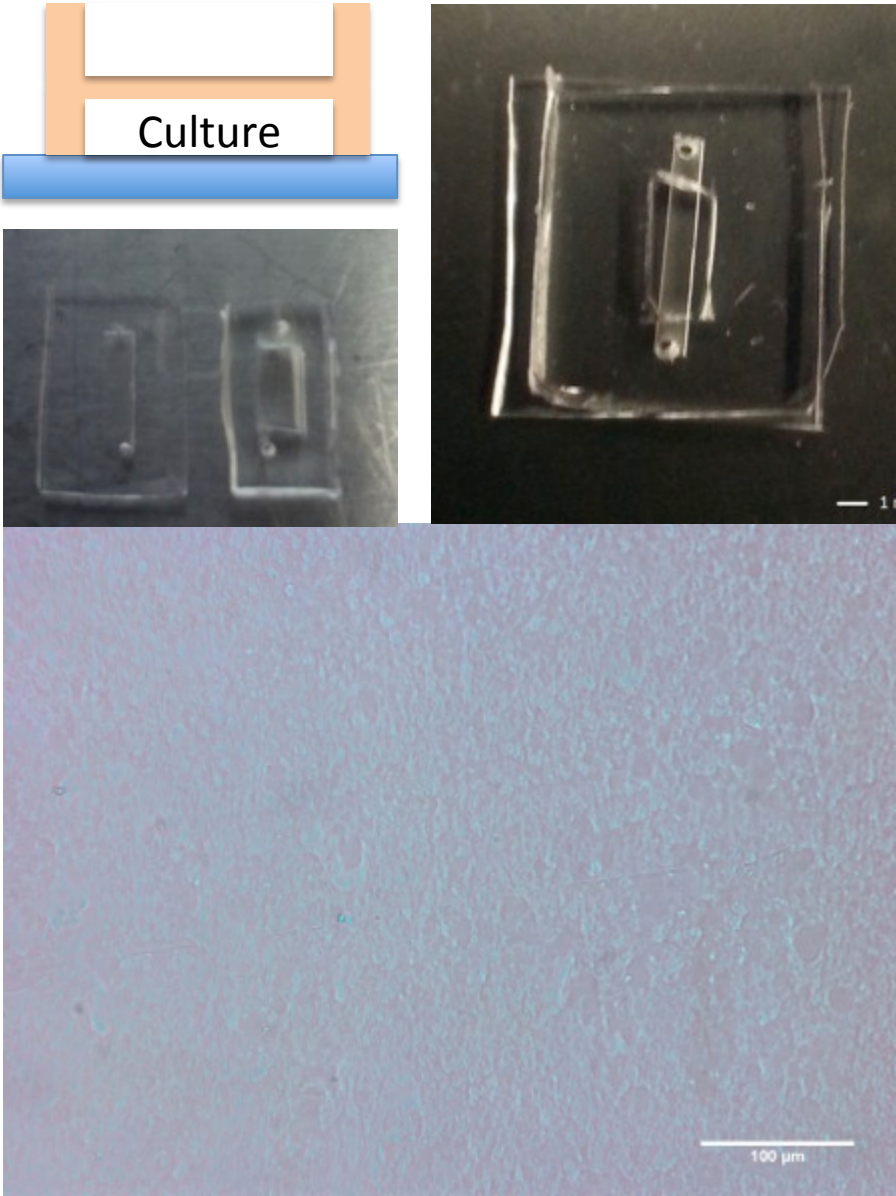
Differentiating Dead HEK and Jurkat Cells



Differentiating Live and Dead E. coli



Biofilm Monitoring on a Chip



Next Steps

- Monitor biofilm growth on chip
- Screen anti-biofilm reagents

Acknowledgments

Collaborators

Fil Bartoli
Arthur Chiou (Yangming U, Taiwan)
Tim Friel (LVHN)
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Alp Oztakin
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William Rodriguez (MGH)
Olga Latinovic (IHV)
Peikuen Wei (Academia Sinica, Taiwan)
Frank Zhang

Students

Caroline Multari
Krissada Surawathanawises
Bu Wang
Chao Zhao



National Institute of Allergy and Infectious Diseases
Leading research to understand, treat, and prevent infectious, immunologic, and allergic diseases.

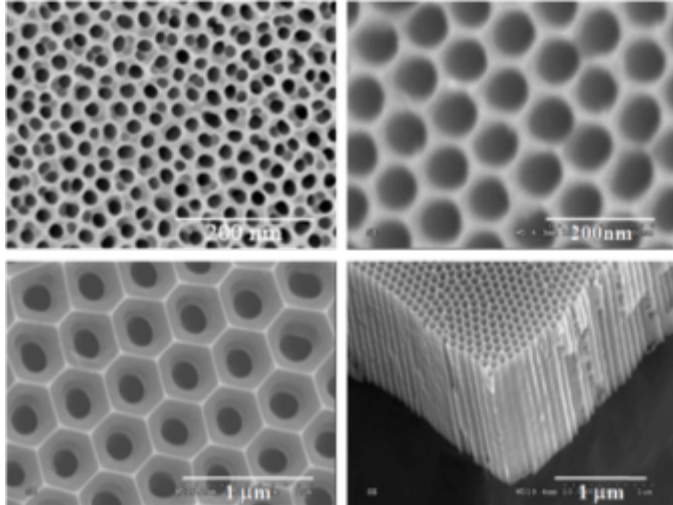
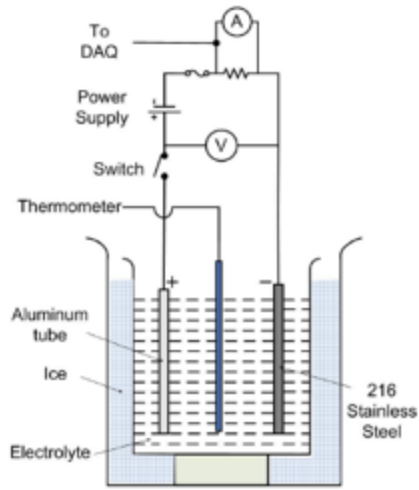
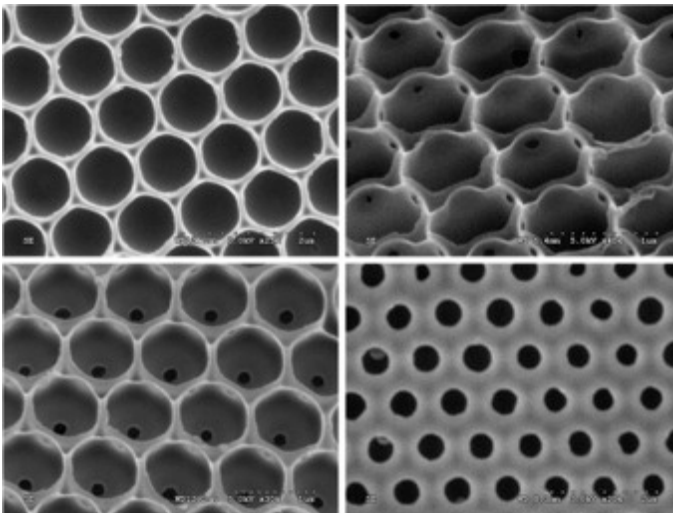
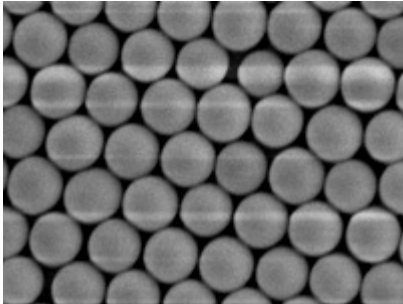
DEPARTMENT OF
HEALTH



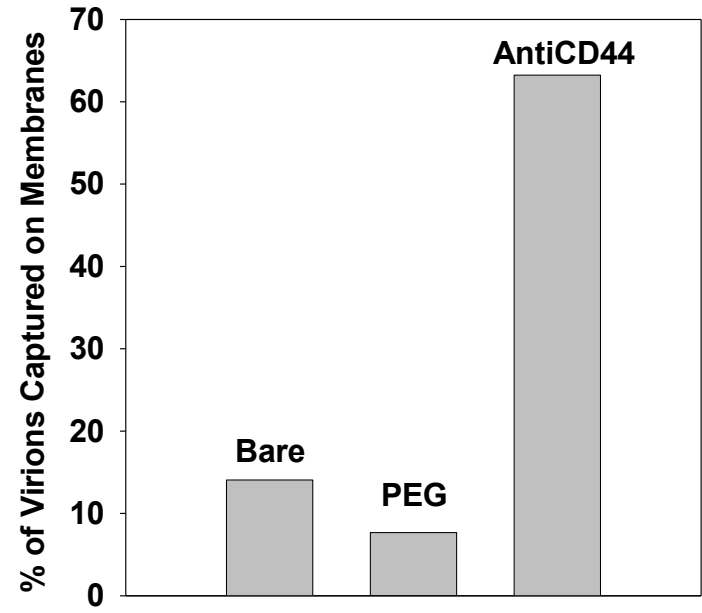
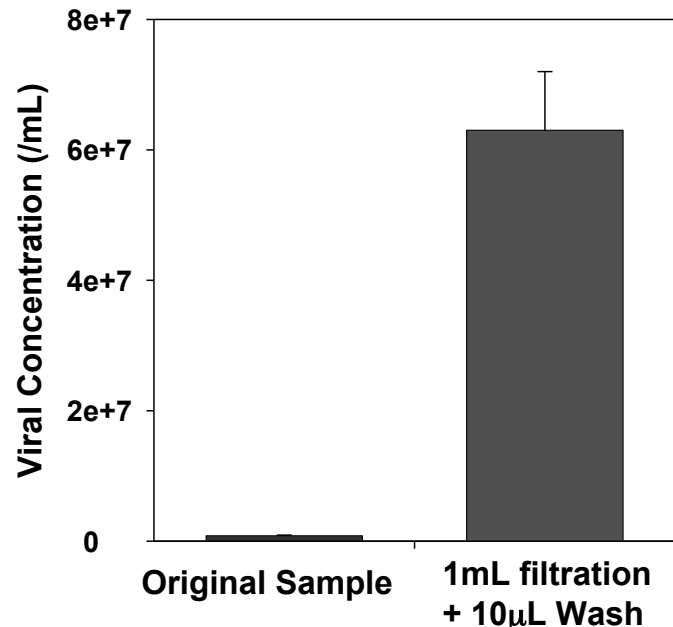
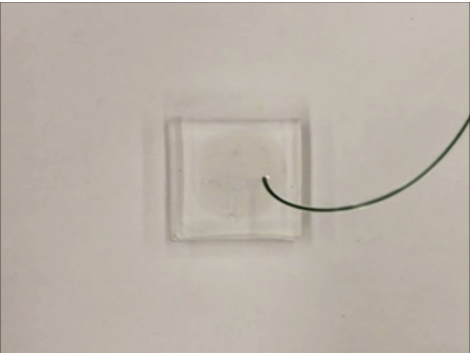
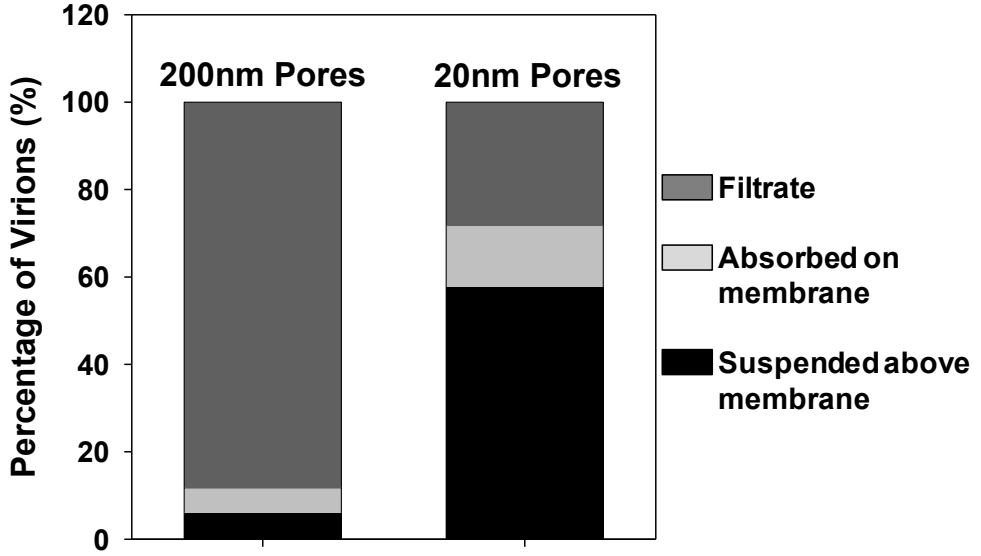
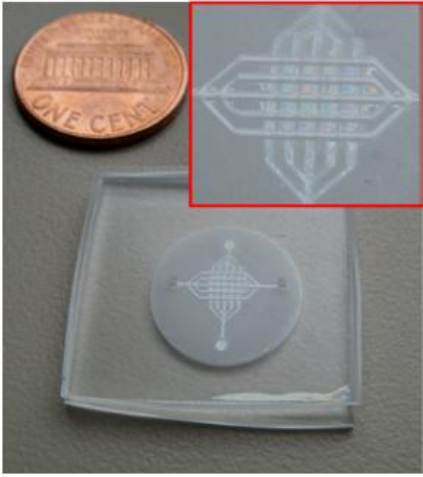
THANK YOU!
QUESTIONS?

Nanoporous Membrane for Viral Processing and Sensing

- Controllable pore size
- High porosity
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Embedded Nanoporous Membranes for Viral Processing



Community-based Care



*Care takes place
in the community.
Reinforced in the
clinic.*

