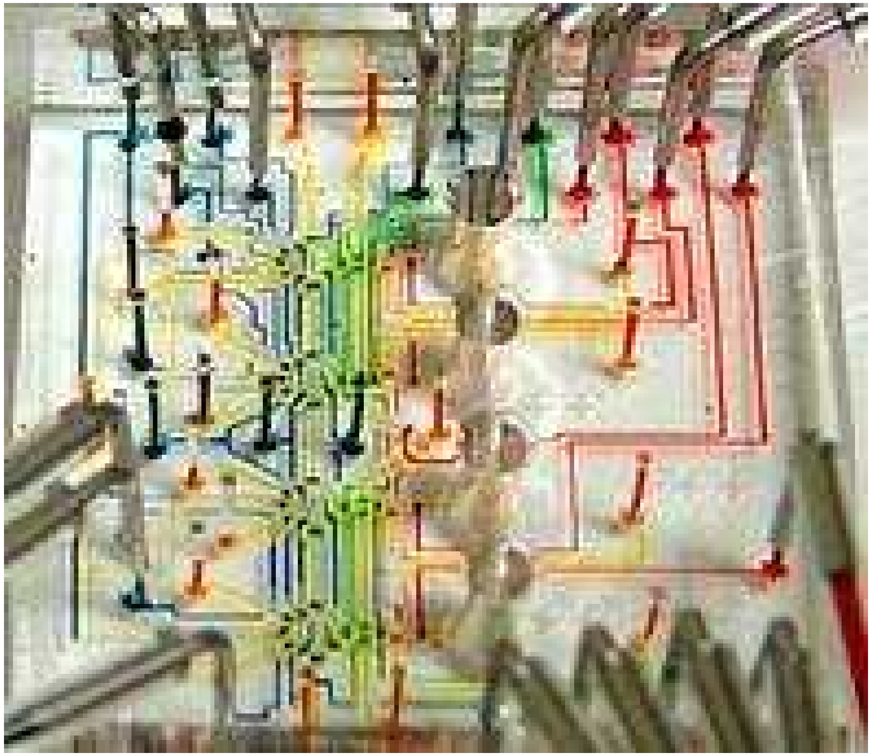
SAND2010-5216P

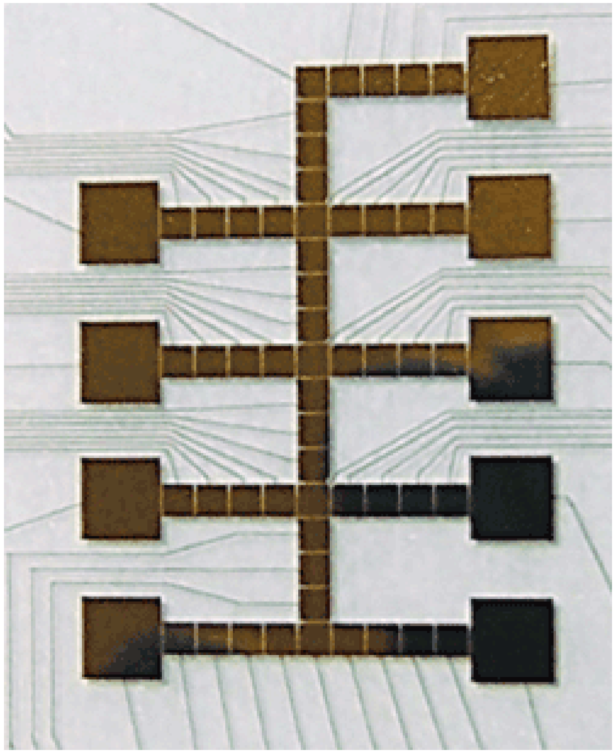
Developing a Digital Microfluidics Platform for Genetic Characterization of Pathogens

By: Eric Kittlaus and Marielle Remillard

Overview of Microfluidic Devices



Continuous Flow Microfluidics



Digital Microfluidics

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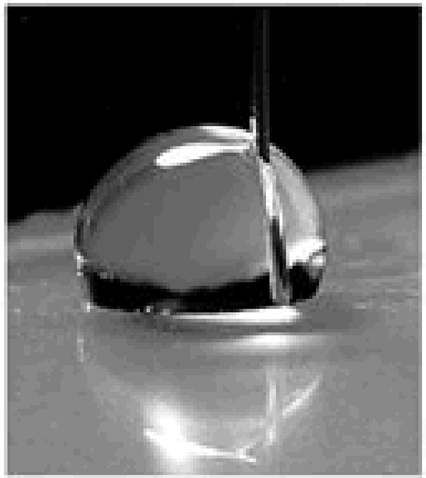
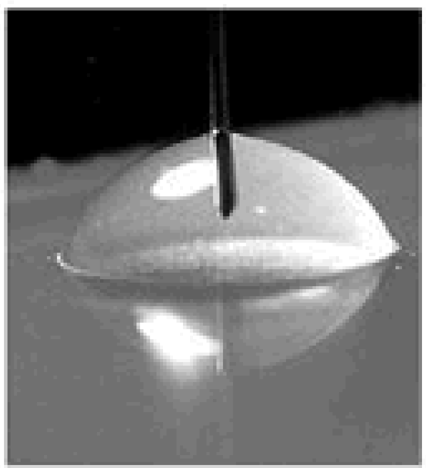
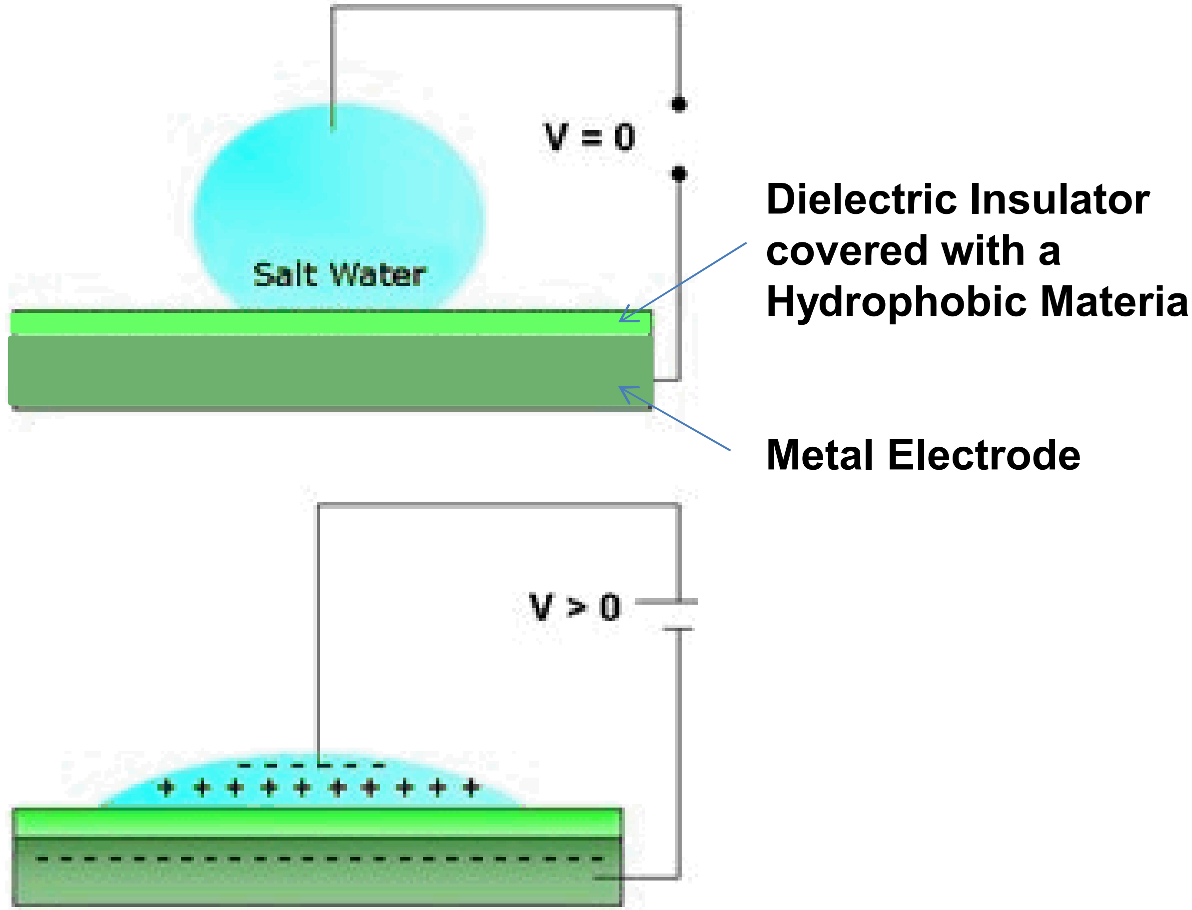
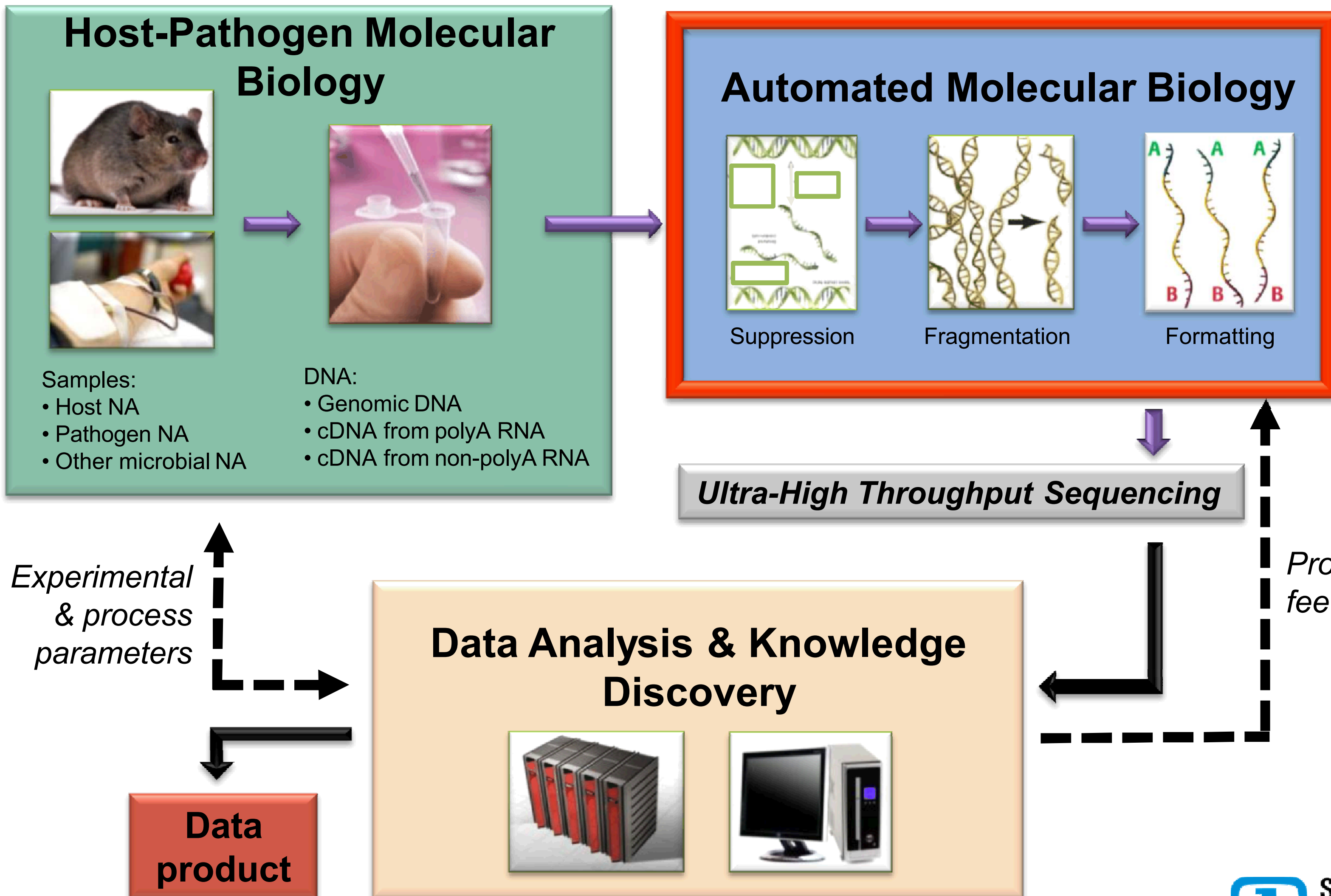
Basic Idea: Electrowetting





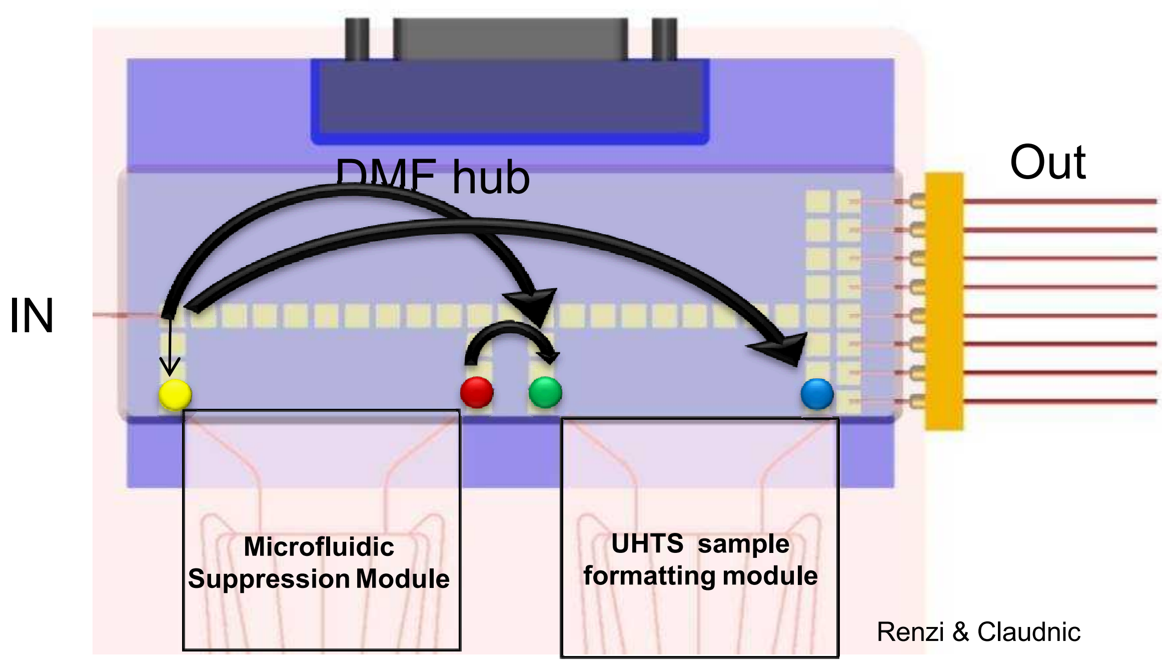


Background/RapTOR concept



Digital Microfluidic Array for Central Hub

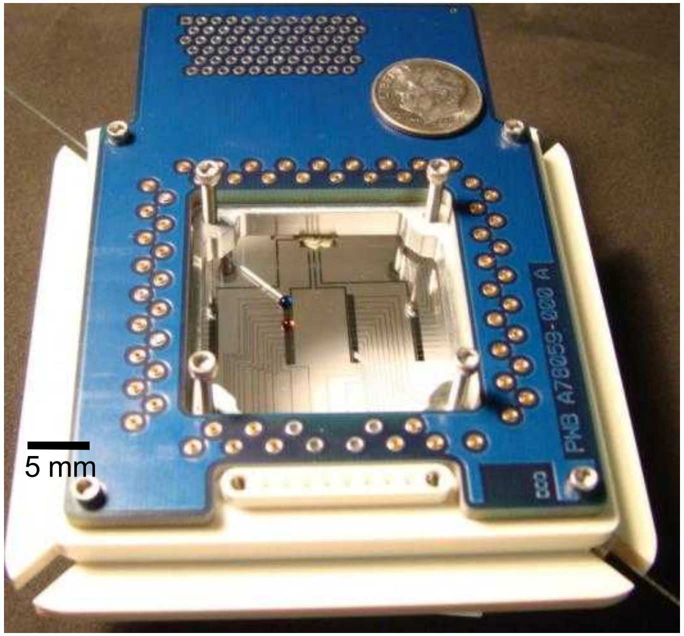
- **Central hub architecture with surface-bound microdroplets**
  - Input and output of suppression and formatting modules controlled through automated DMF hub
- **Flexible approach**
  - allows the efficient transfer of small quantities of DNA sample with precise temporal and spatial control



Renzi & Claudnic

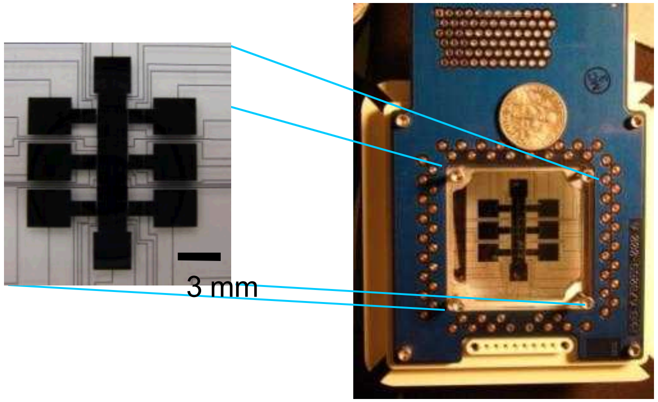
The DMF platform for manipulating of DNA samples

- **Sandia manufacturing abilities**
  - Fabricate DMF housing and devices for prototyping and testing
  - Programmable interface
  - Automatic fluid handling and routing

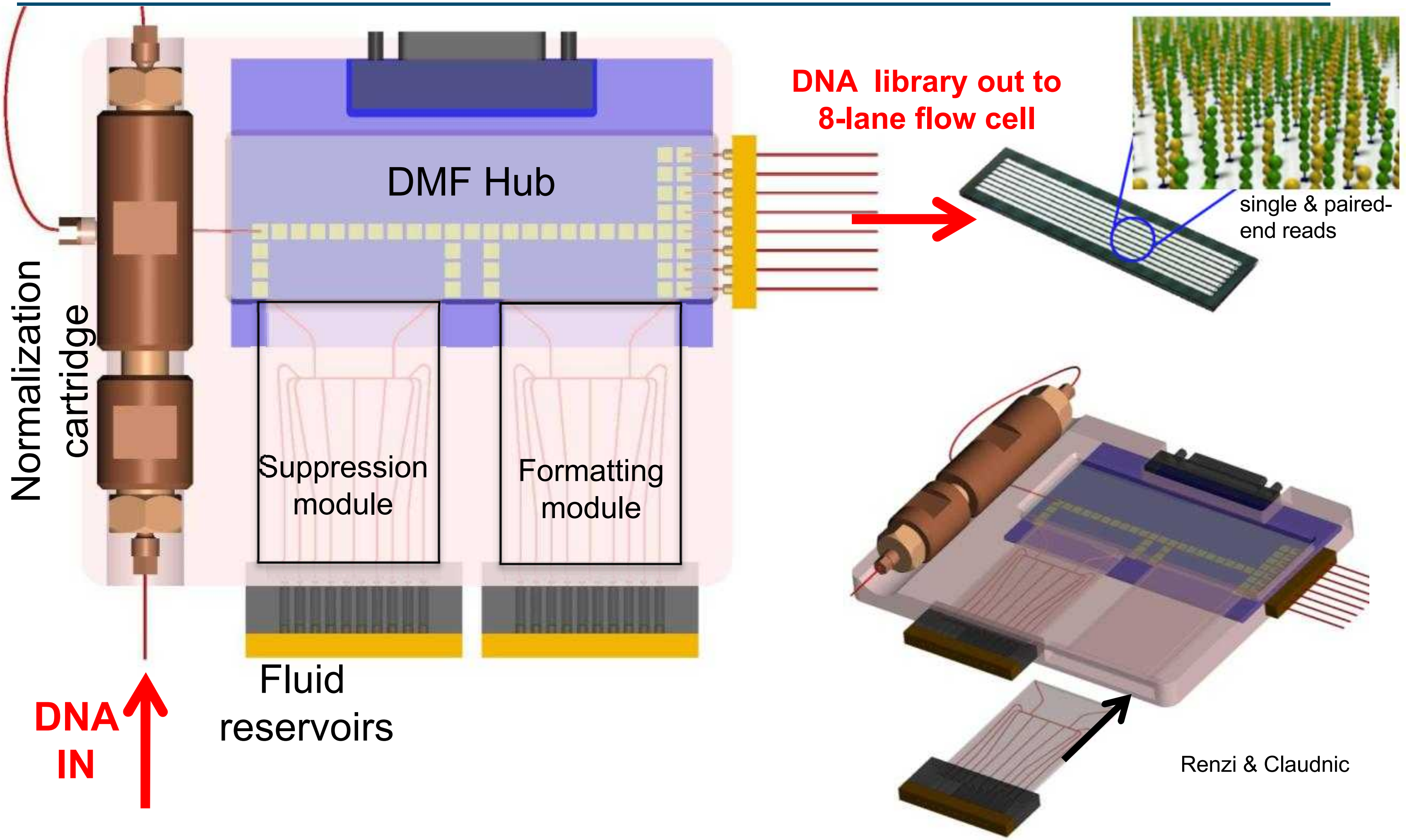


Renzi & Van De Vreugde

- **Demonstrated basic droplet operations** (splitting, mixing, merging, incubation)
  - 600 nL dispensing
  - Precise actuation and mixing



RapTOR platform for processing nucleic acids samples



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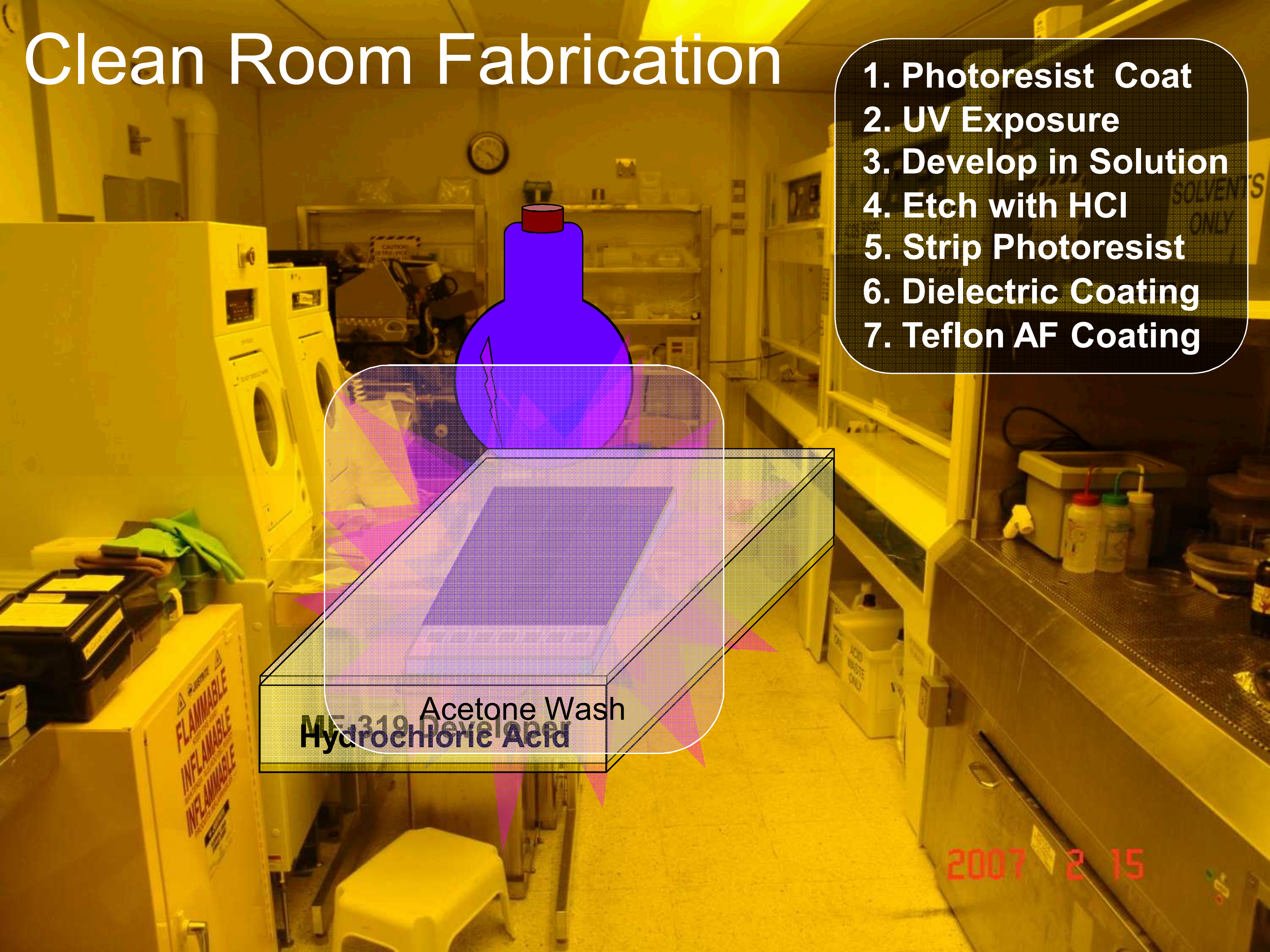
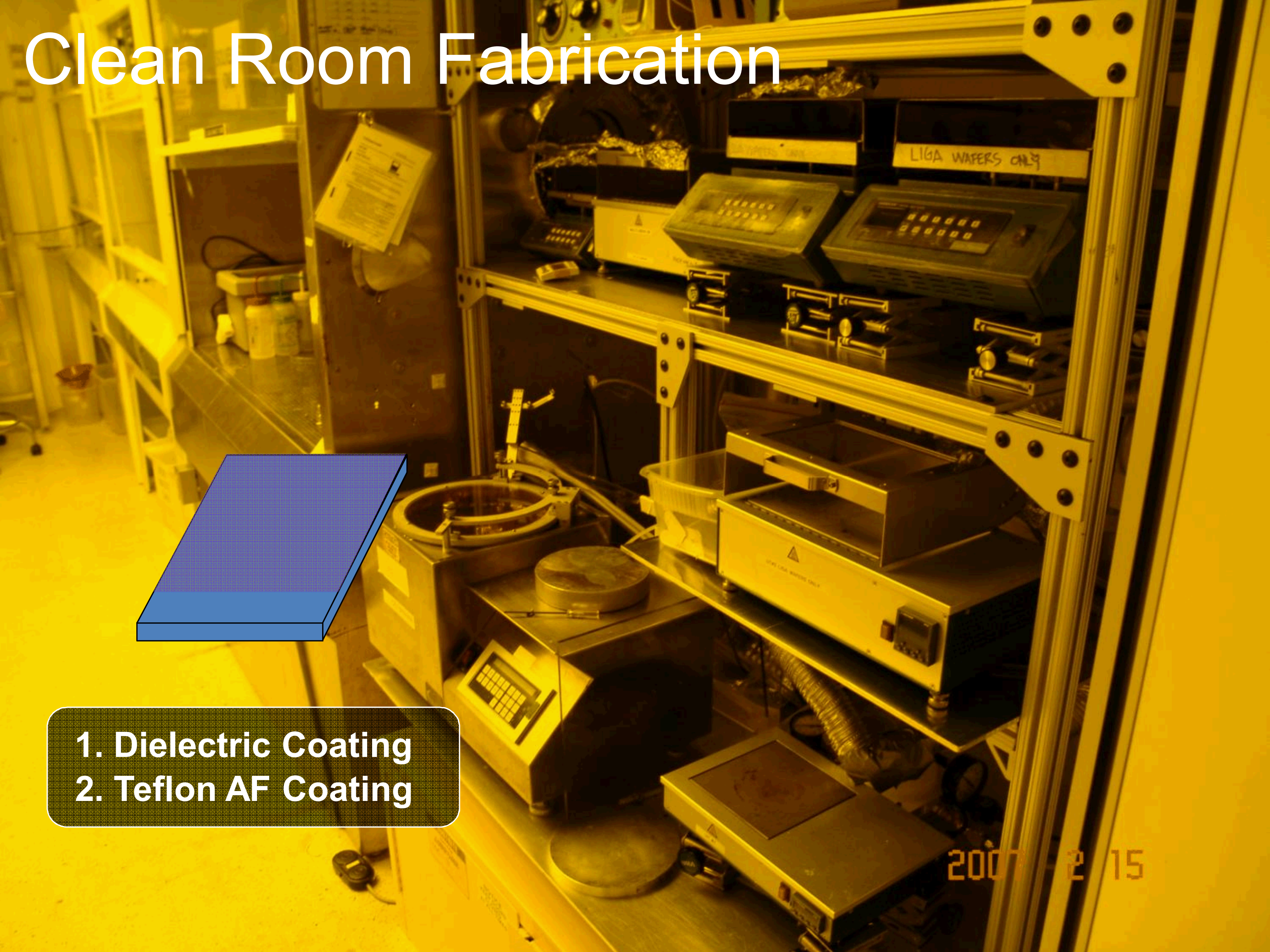
Clean Room Fabrication

1. Photoresist Coat
2. UV Exposure
3. Develop in Solution
4. Etch with HCl
5. Strip Photoresist
6. Dielectric Coating
7. Teflon AF Coating



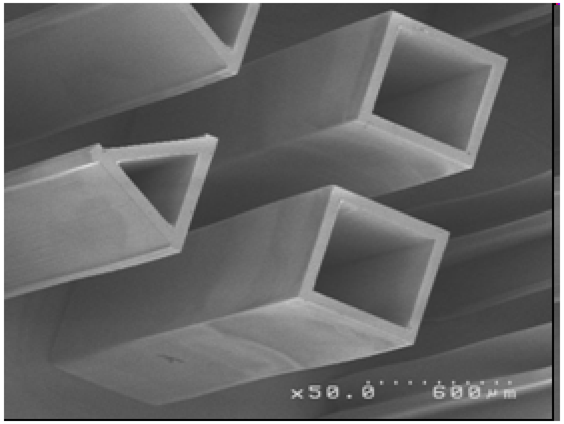
Clean Room Fabrication

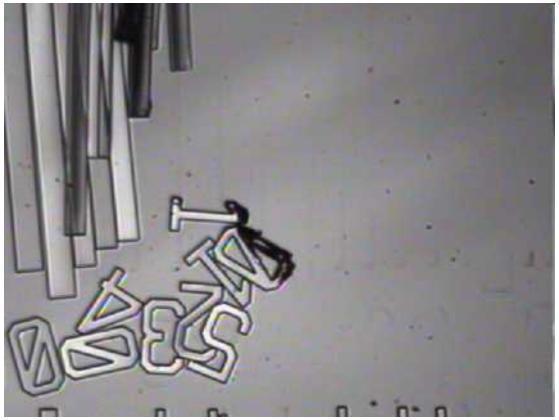


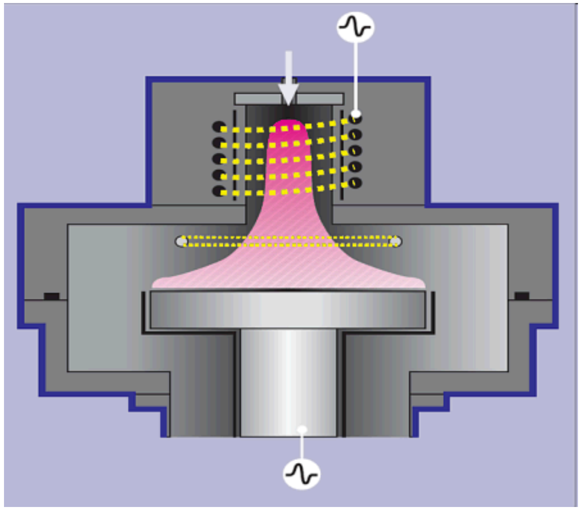
1. Dielectric Coating
2. Teflon AF Coating

Fabrication Modifications

- Exposure time
- Etching time
- Plasma Etching
- Dielectric (SU-8 vs. Parylene)







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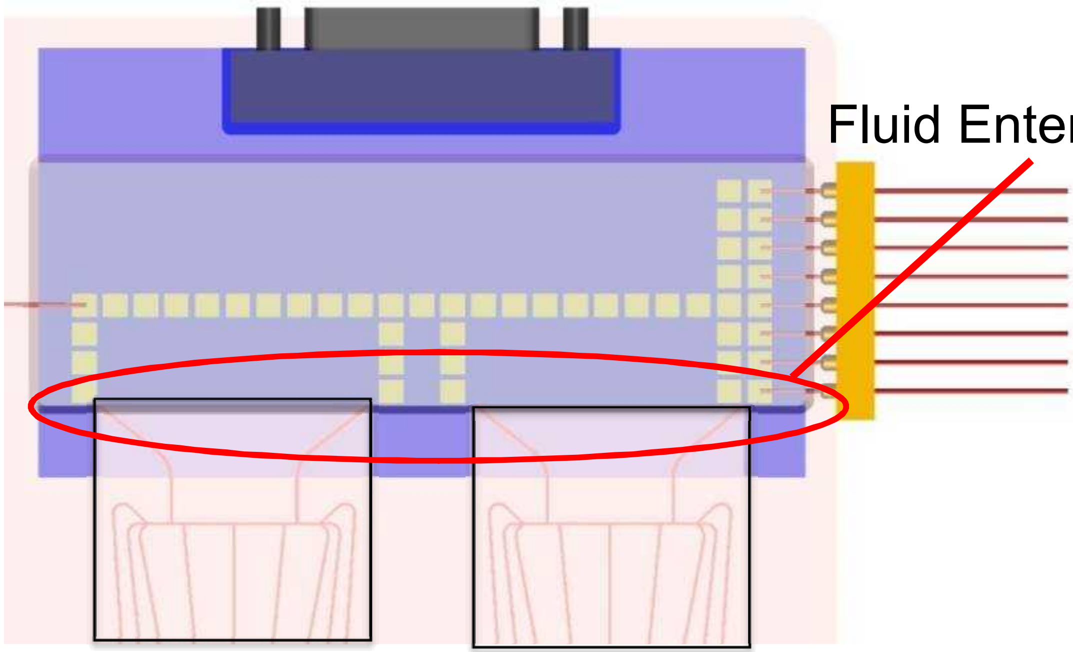
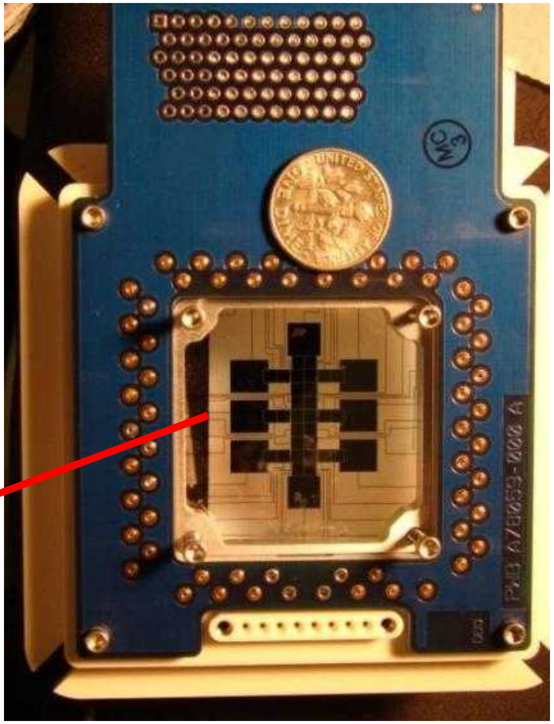
Mechanical Stage

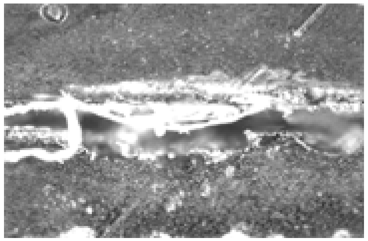


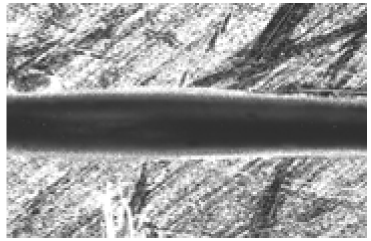
Fluid Enters DMF Hub from Side



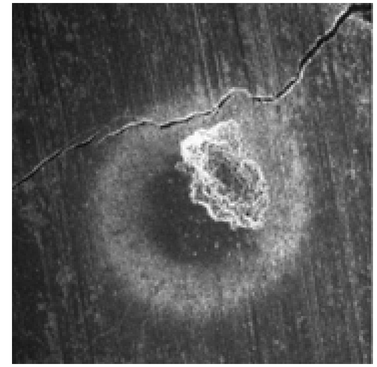
What about injecting fluid through top?

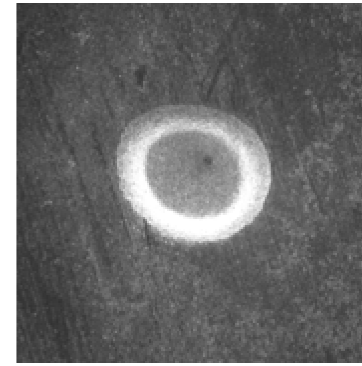
Femtosecond Laser Machining


Conventional Laser


Femtosecond Laser

LLNL


Conventional Laser

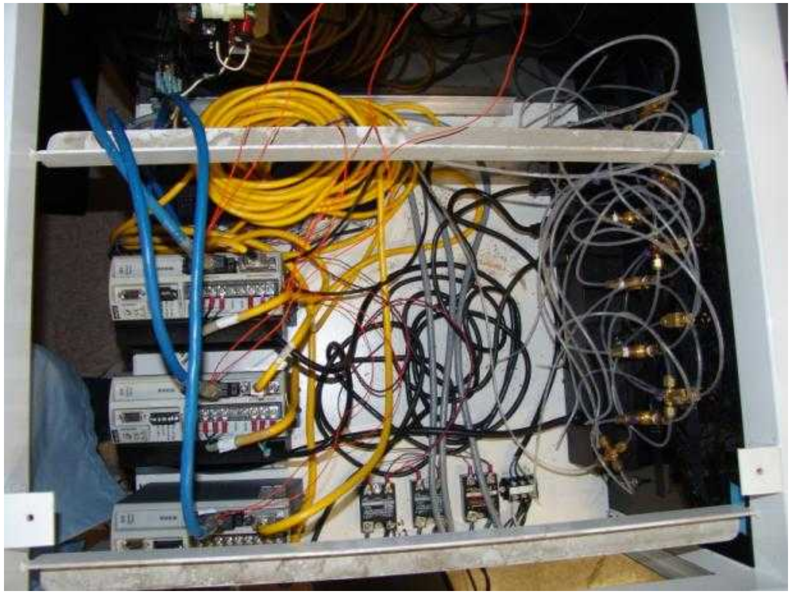

Femtosecond Laser

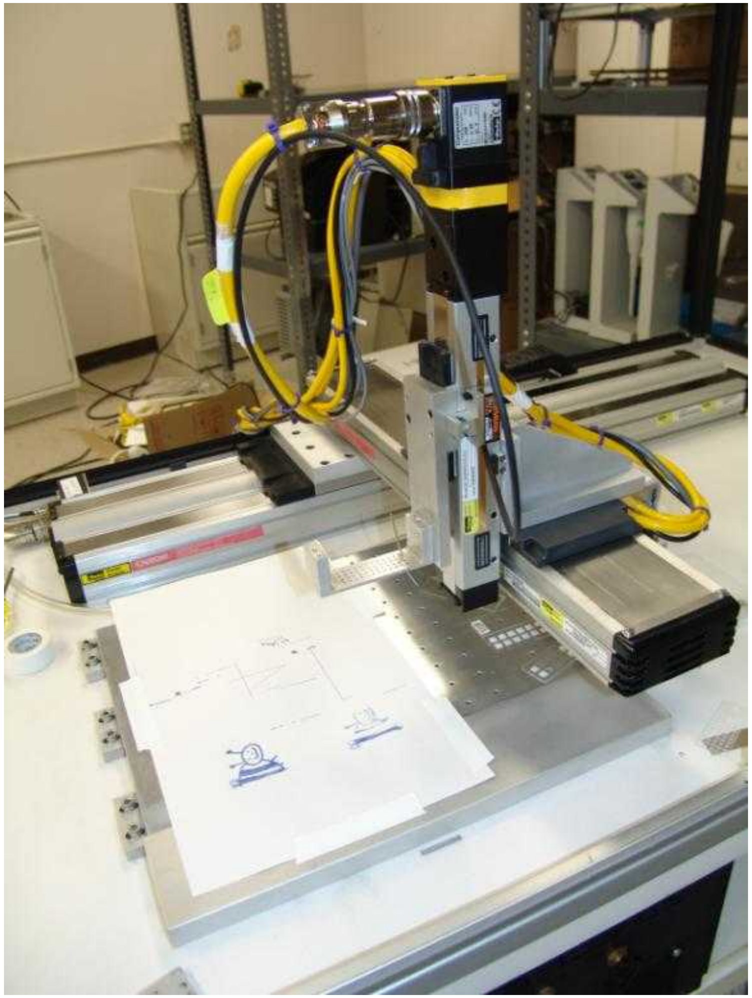
LLNL

- Photons absorbed on femtosecond timescale
- Complete resolidification after 1μs elapsed
- Result Is cleaner machining
- No slag, cracking

Machining: Mechanical Stage

- Concept: used to move DMF platform for hole drilling
- <1 micron resolution





Mechanical Stage

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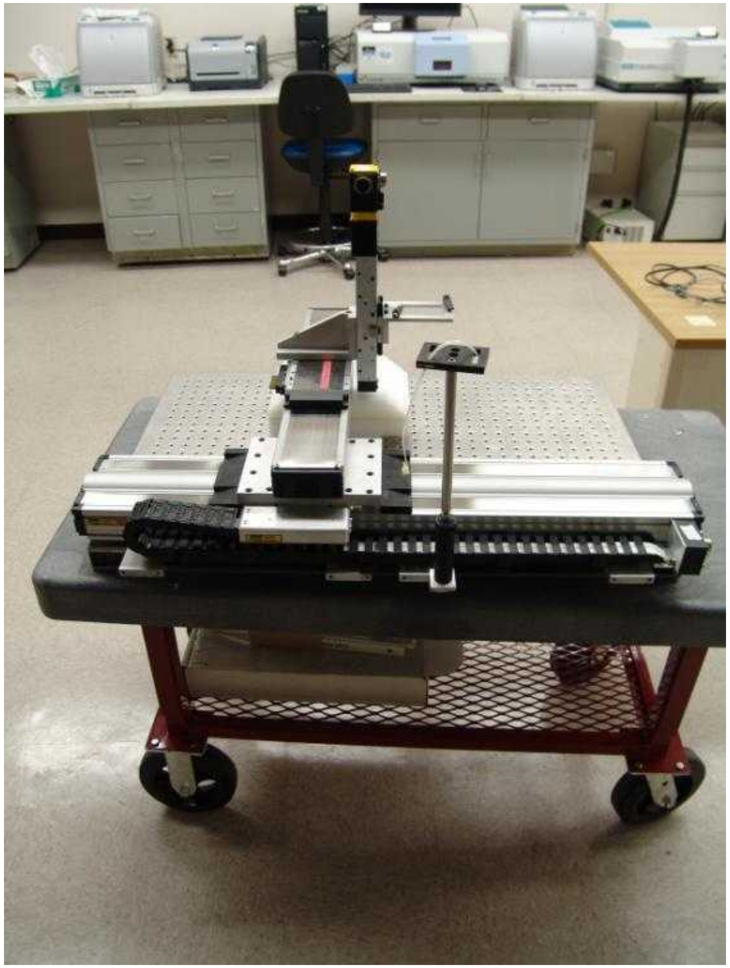
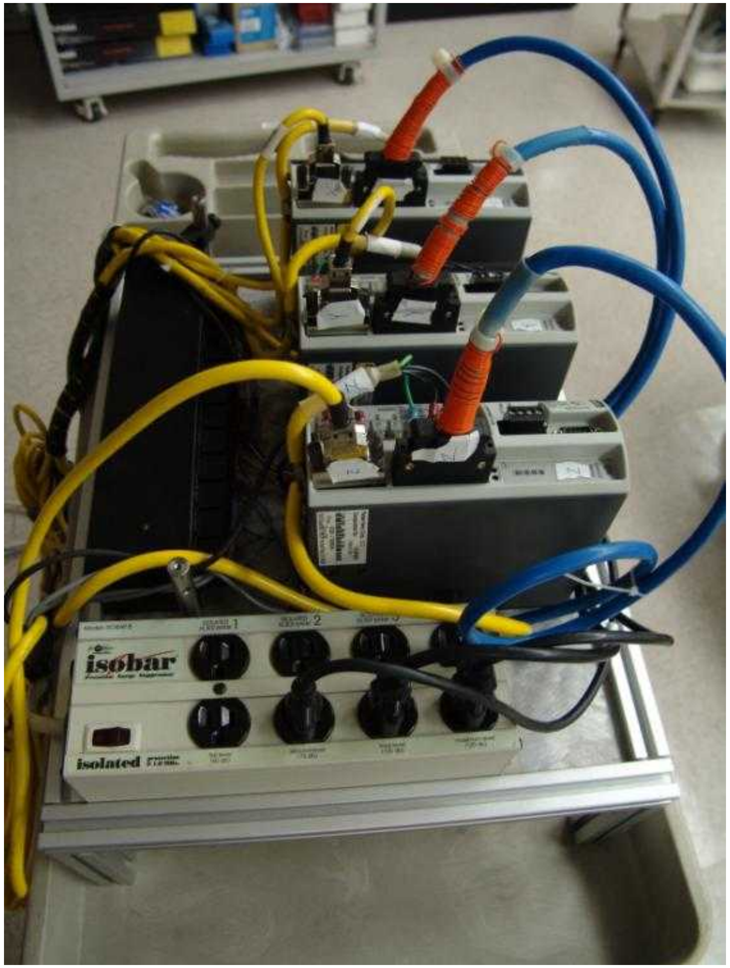
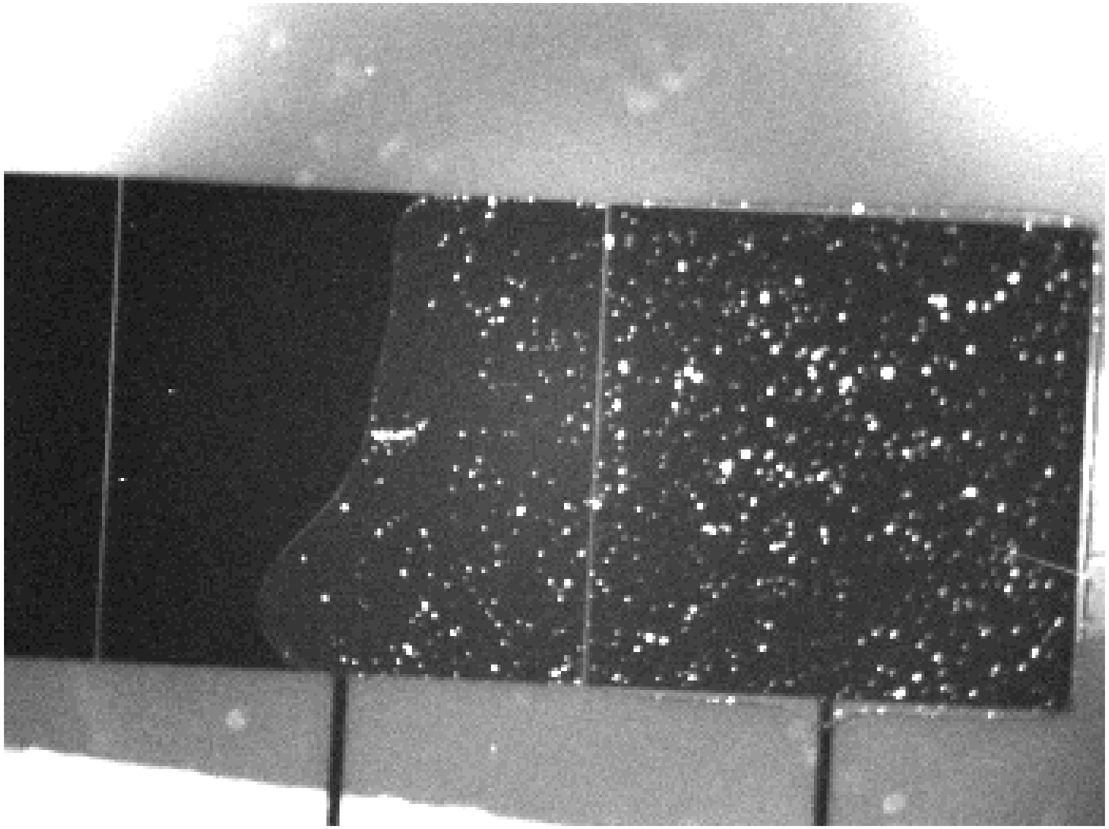
Mechanical Stage: Finished Product



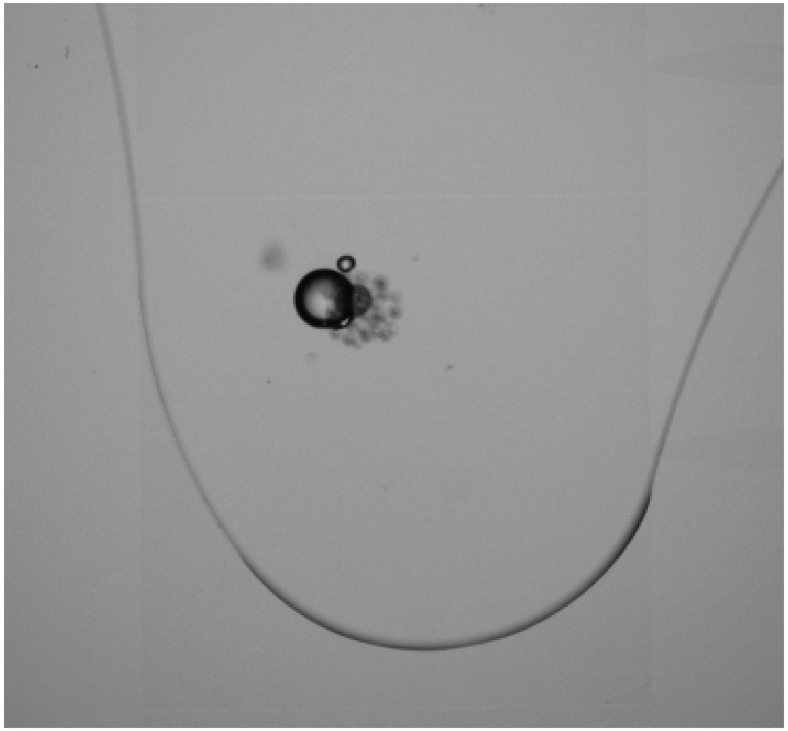


1st Attempt at Moving Cells

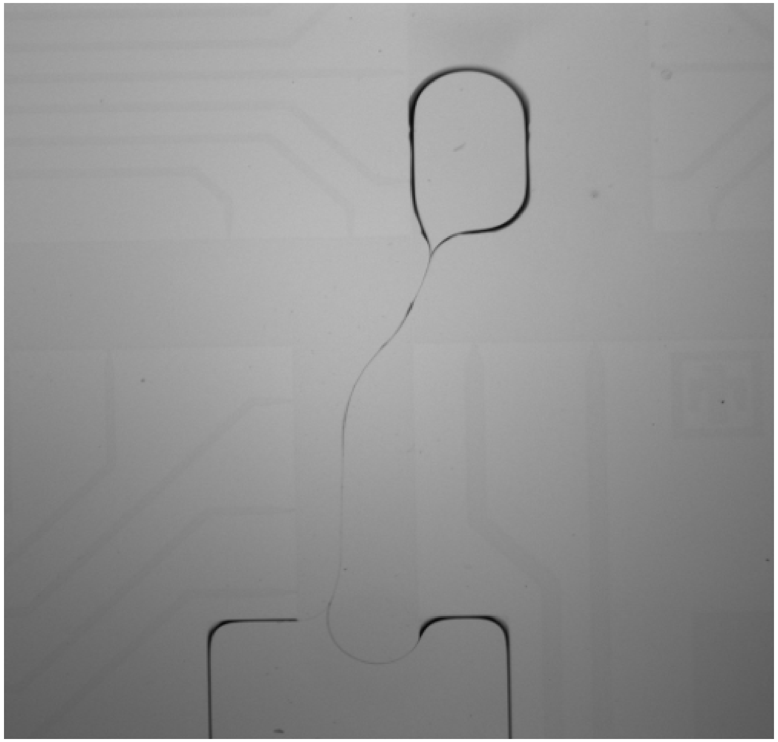
- Fluorescent P388D.1 Cells
- Chrome
- Parylene dielectric
- HIGH VOLTAGE (160 Vrms)



Challenges with PBS and F127

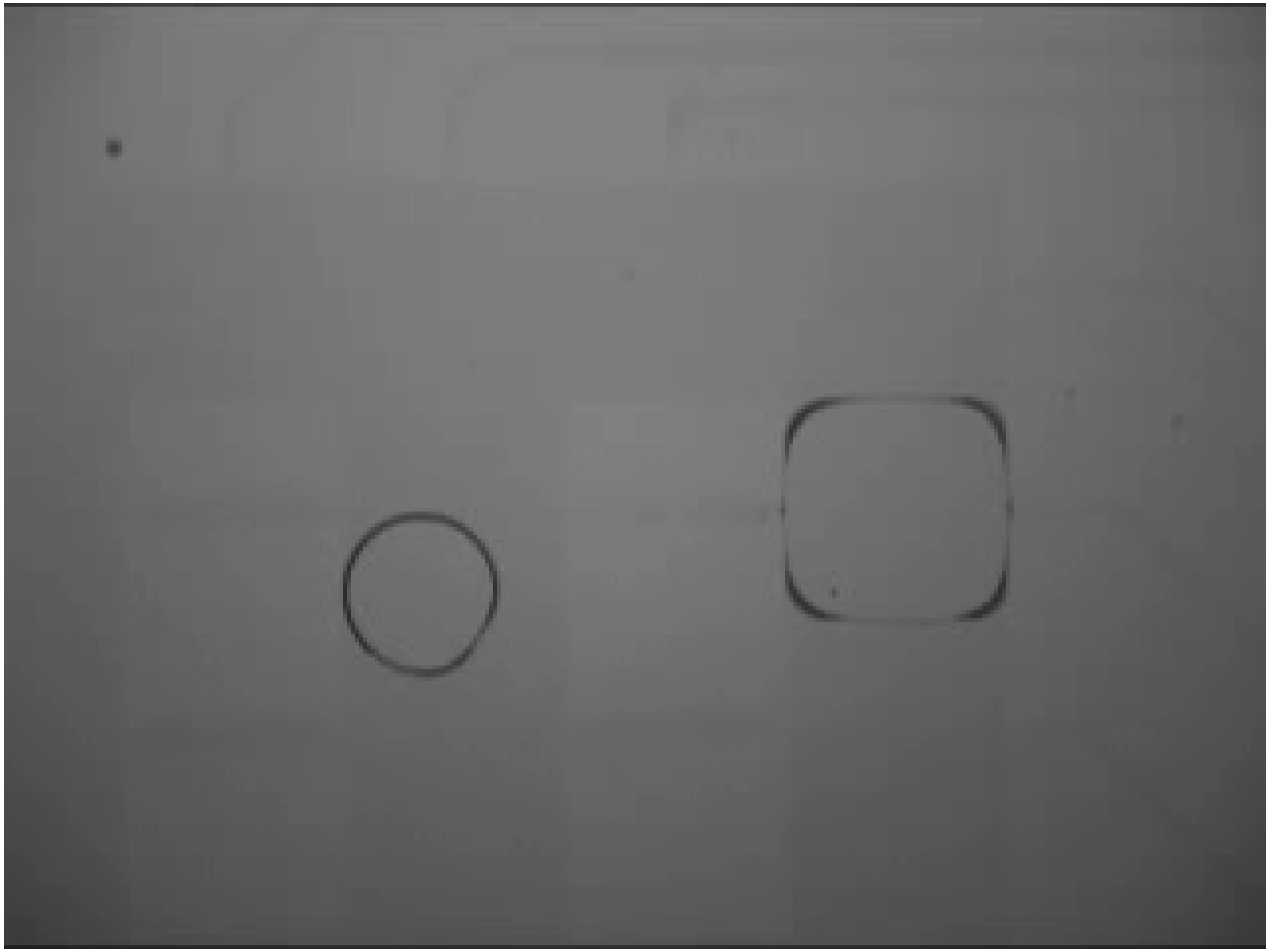


1% Pluronic F127 in 1X PBS,
SU8 dielectric

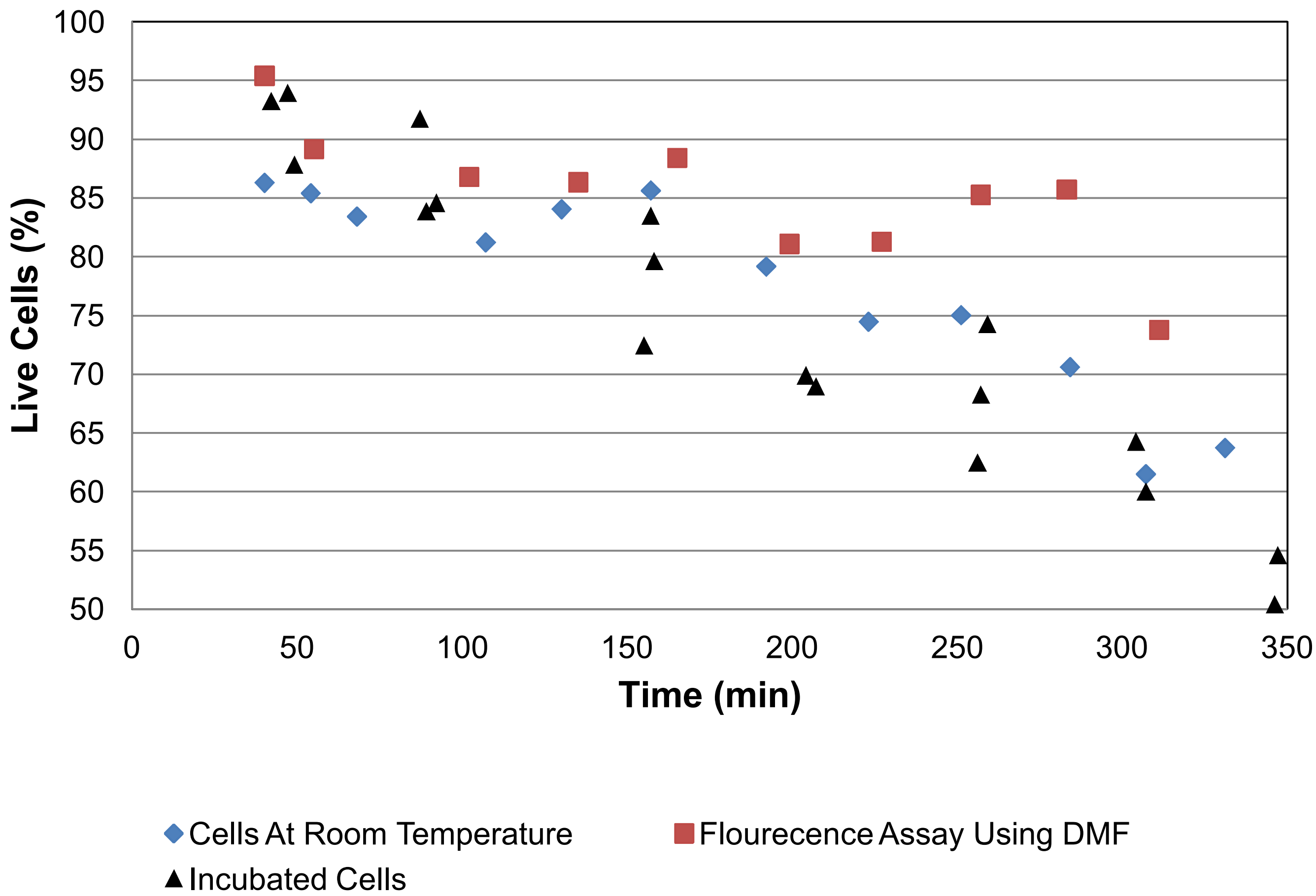


2% Pluronic F127 in 1X PBS,
SU8 dielectric

Live Dead Assay Using DMF



How long will the cells survive?



Acknowledgements

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- Sandia National Labs

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Sources

- http://www.niherst.gov.tt/scipop/sci-bits/microfluidics.htm
- **Fusayo Saeki, Jean Baum, Hyejin Moon, Jeong-Yeol Yoon, Chang-Jin "CJ" Kim and Robin L. Garrell. "Electrowetting on Dielectrics (EWOD): Reducing Voltage Requirements for Microfluidics" http://ag.arizona.edu/research/biosensors/acs01b.pdf**
- http://pubs.acs.org/cen/_img/87/i29/8729scon_microfluidic.gif