UCSB MICROFLUIDICS LAB

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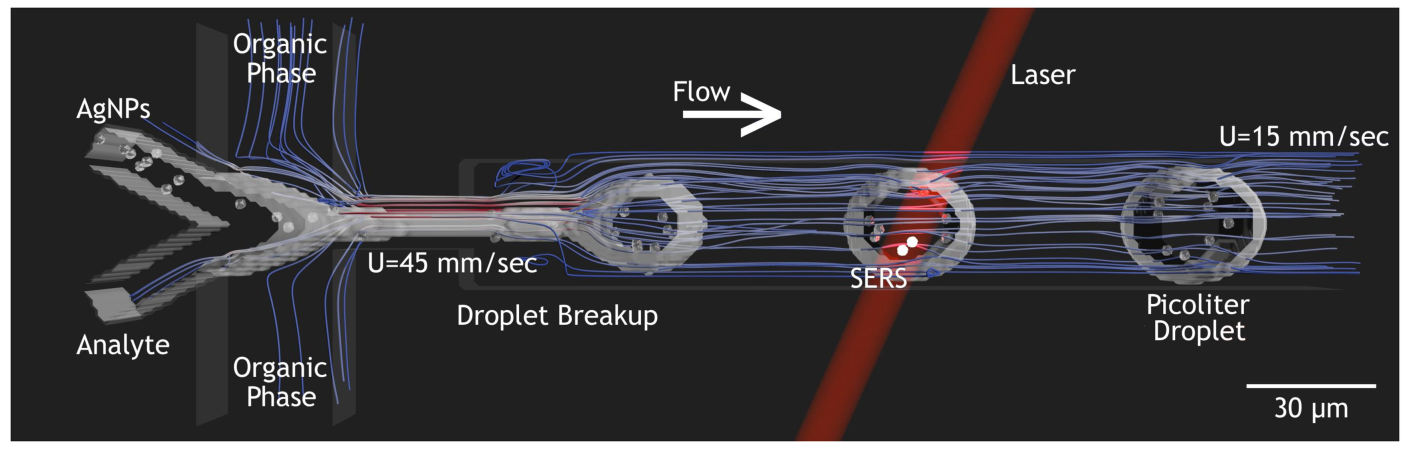
SERS in Microfluidic Droplets

Chrysafis Andreou

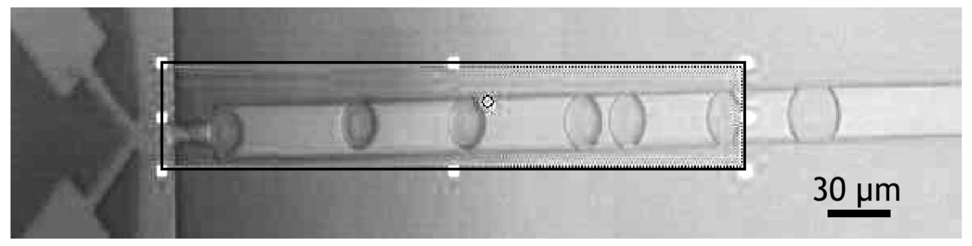
SERS + Microfluidics

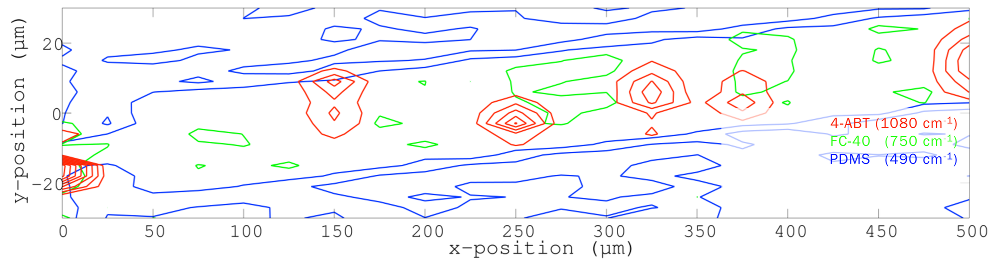
- Offer quick specific trace analyte detection.
- Enable the detection of a wide range of analytes.
- Operate in a variety of different contexts (airborne, biological[3], etc.)
- Are susceptible to fouling by Ag-nanoparticles (AgNPs).
- Benefit from single-use testing.
- Face challenges quantifying analyte concentration.



- Encapsulate AgNPs in discrete picoliter droplets.
- Prevent device fouling by AgNPs.
- Generate multiple discrete reaction volumes.
- Control the mean number of AgNPs in the droplets.
- Determine SERS enhancement vs. number of particles.
- Obtain quantifiable SERS measurements[4].

- Confocal Raman Spectrometer: LabRam Aramis, Horiba.
- 50X objective, spot size ~5 µm.
- Laser: 633 nm, 3.8 mW.
- Interrogate an area along the channel.





References

1 Piorek *et al.* Proceedings of the National Academy of Sciences **2007**, 104(48), 18898-18901.

2 Piorek *et al.* Analytical Chemistry **2014** 86 (2), 1061-1066.

3 Andreou *et al.* ACS Nano **2013** 7 (8), 7157-7164.

4. Guicheteau *et al.* Applied Spectroscopy, **2013** 67 (4), 396-403.

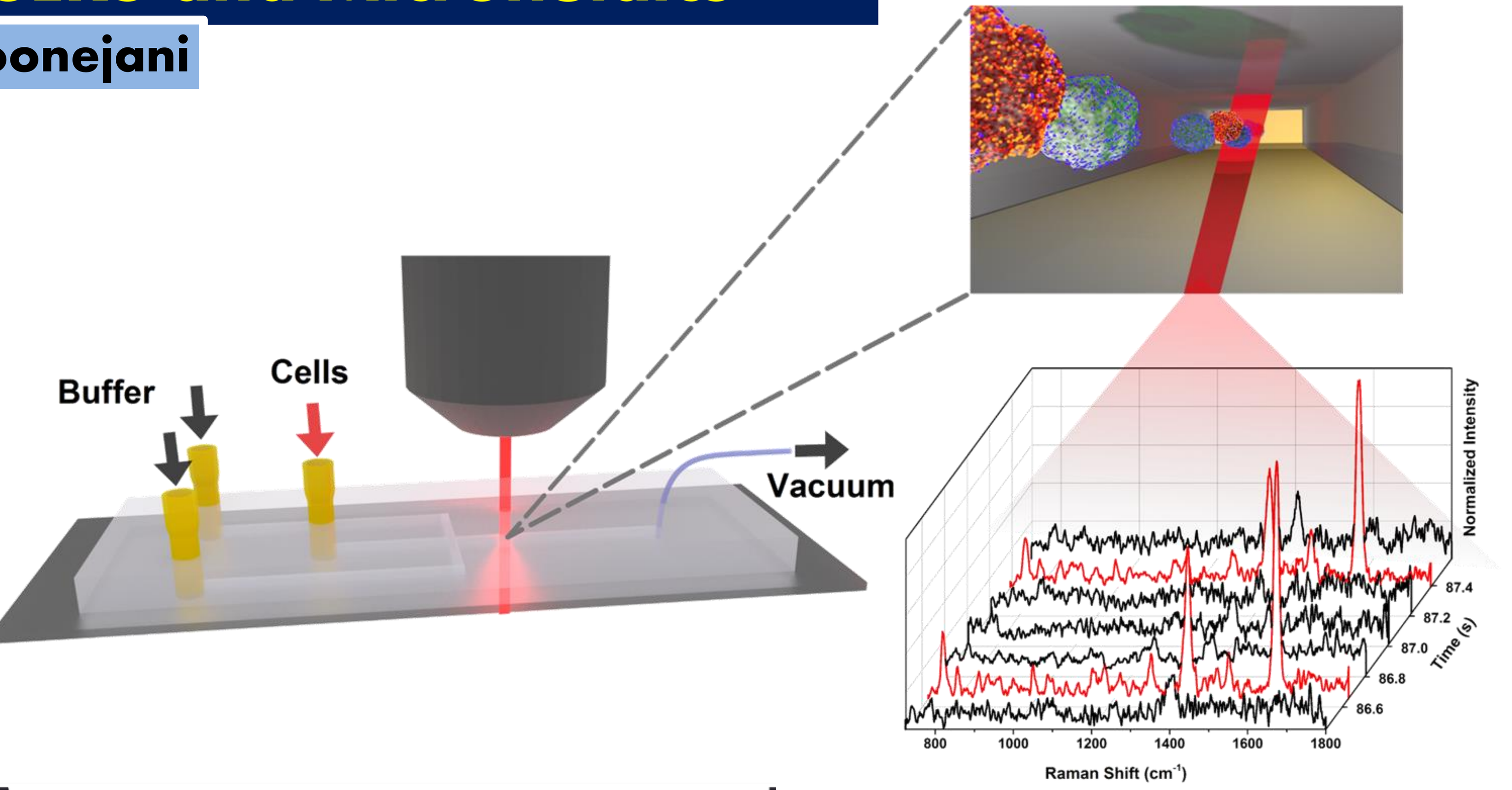
Rare Cell Detection Using SERS and Microfluidics

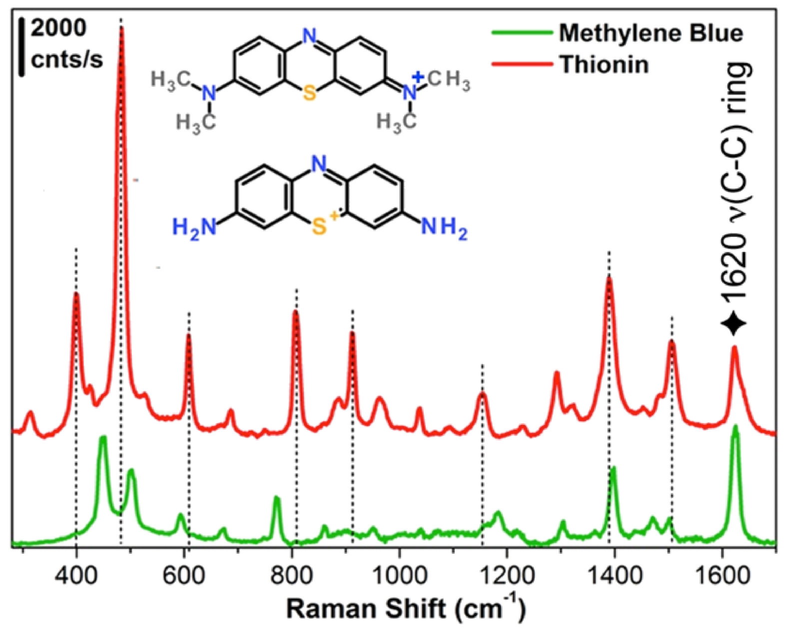
Mehran Hoonejani

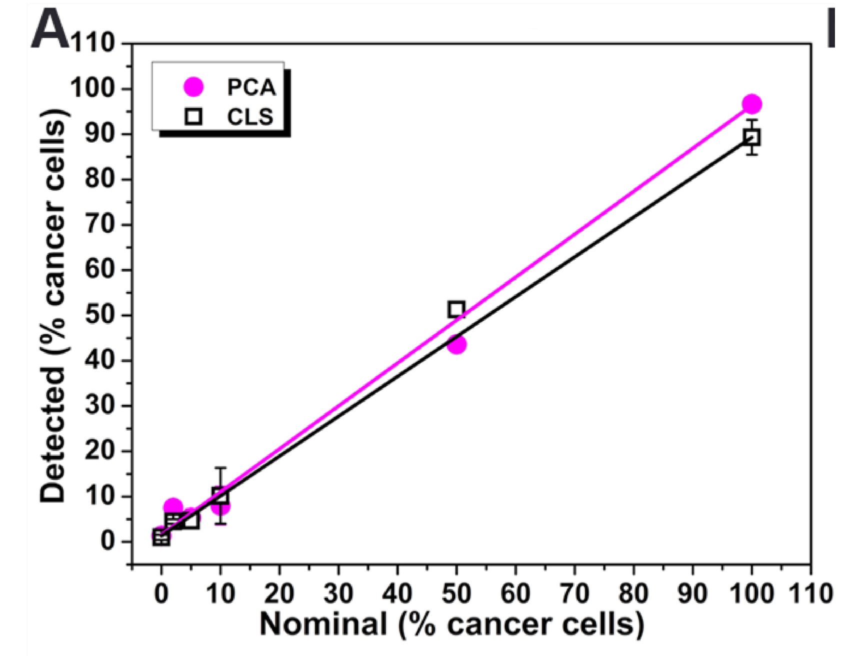
Why SERS:

- Single bio-friendly laser source
- Very low laser intensities
- Extremely good multiplexing capabilities
- Ratiometric approach

- Normal and cancer cells incubated with SERS biotags engineered for specific cell surface expressions.
- SERS interrogation in a flow-focusing device
- Chemometric analysis: PCA and CLS







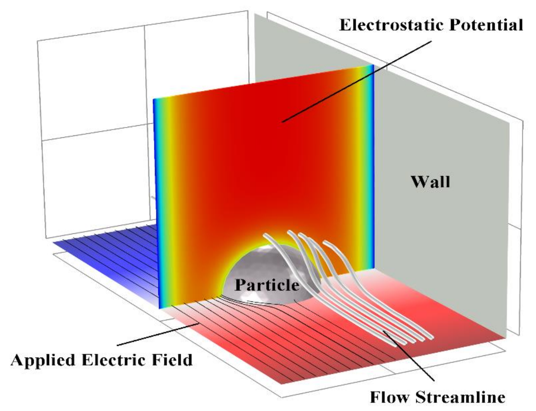
References

- Pallaoro et al. *Proc Natl Acad Sci U S A* 108:16559–16564.
- Stiles T et al. (2005) Hydrodynamic focusing for vacuum-pumped microfluidics. *Microfluid Nanofluid* 1:280–283.

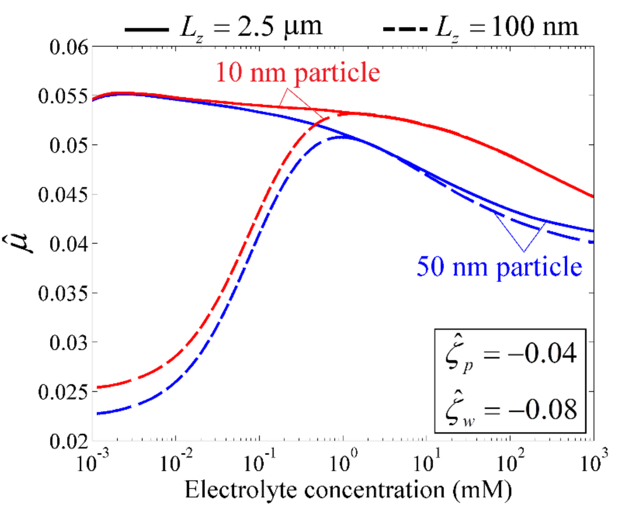
Electrophoresis of Nanoparticles in Nanochannels

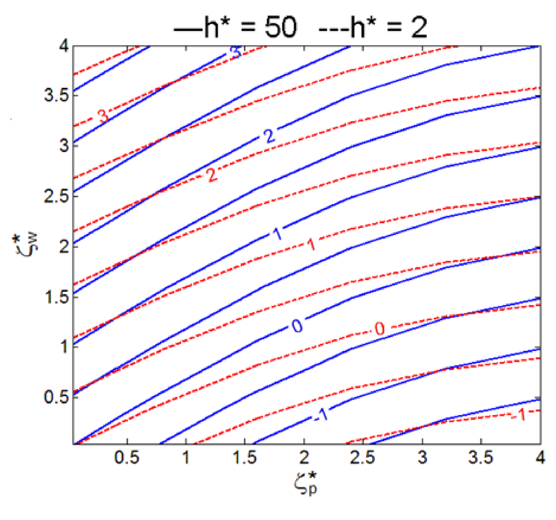
Yu Wei Liu

- Calculate mobility of nanoparticles in nanochannels
  - We Solve coupled Poisson, Stokes, and Nernst-Planck equations by COMSOL.
  - Refined mesh is used near the surfaces to capture the influence of electric double layers.
  - Confinement effect is investigated with different zeta potentials, electrolyte concentrations.



- Use nanochannels to separate nanoparticles or measure zeta potentials





AC Electrokinetic Micromixer

Marin Sigurdson

A 3D micromixer is developed for improving bioassays. Numerical smodeling is combined with experimental measurement to evaluate the mixer.

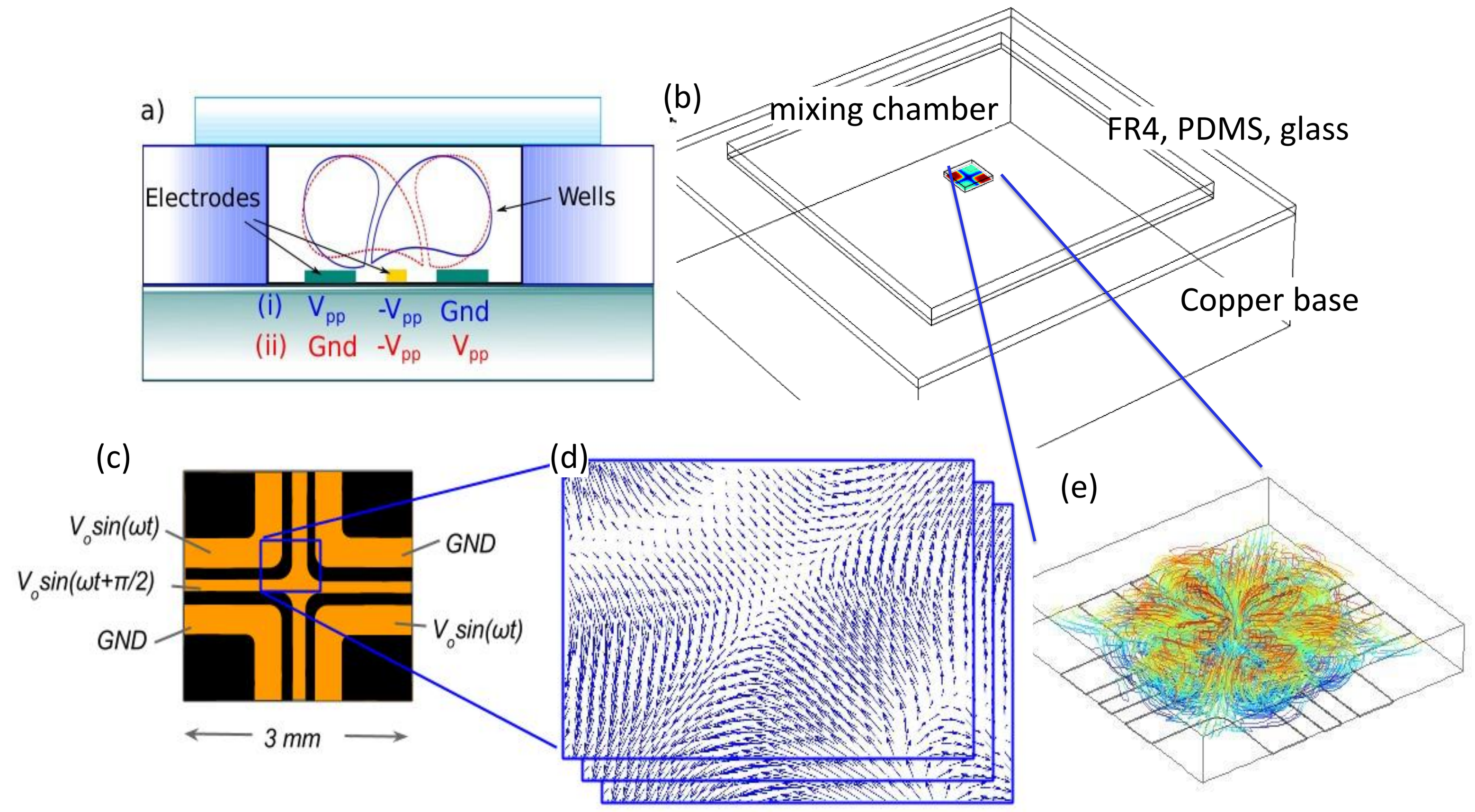
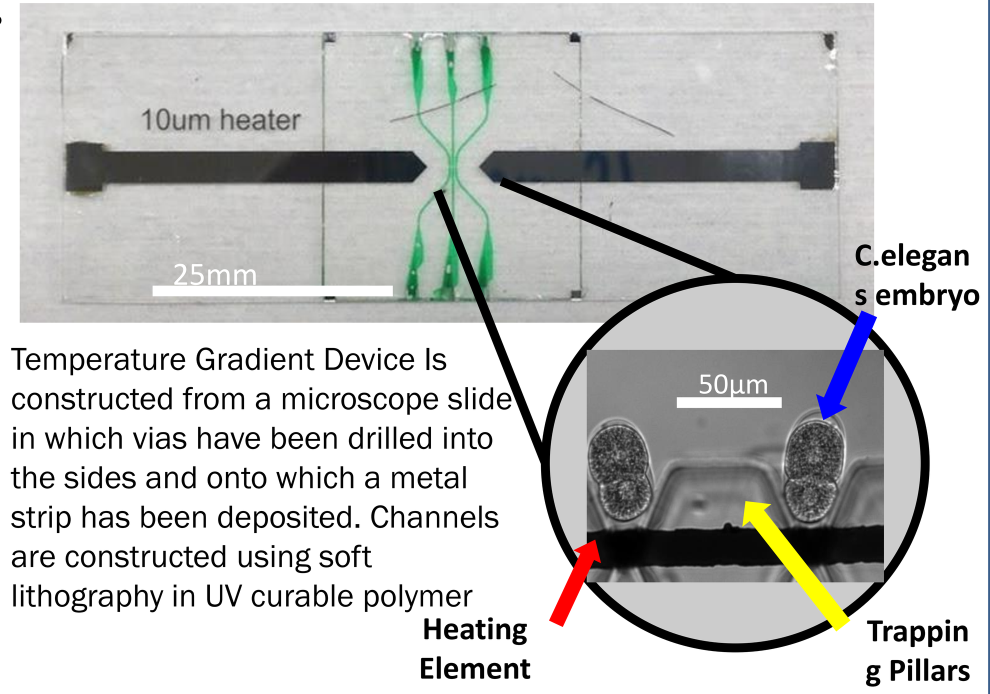


Figure. (a) AC electrothermal flow is created when voltage applied to electrodes produces localized heating. Switching the voltage breaks up the vortices and results in mixing.(b) Experimental Mixing testbed: programmable, blinking AC electrothermal flow. (c) Voltage is applied to electrodes (orange), which produces fluid circulation in mixing chamber. (d) PIV: sequential images are taken of fluorescent tracer particles in the flow; cross correlation yields 2D, 2 component velocity field. (e) Finally, these are combined with a numerical model to produce flow trajectories, which are used to evaluate the mixer.

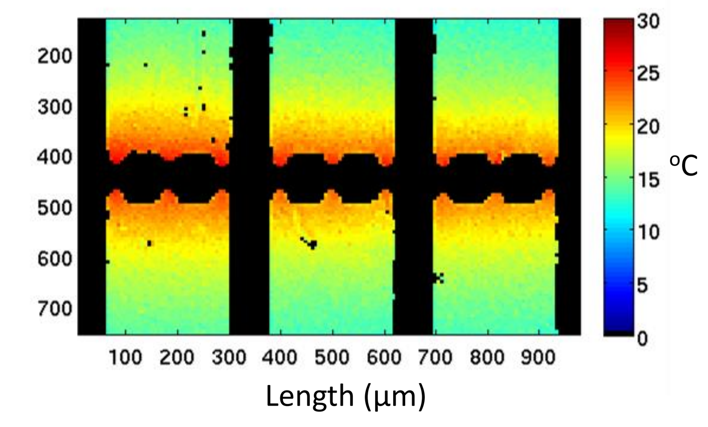
Microfluidics for Fundamental Biological Research

Eric terry

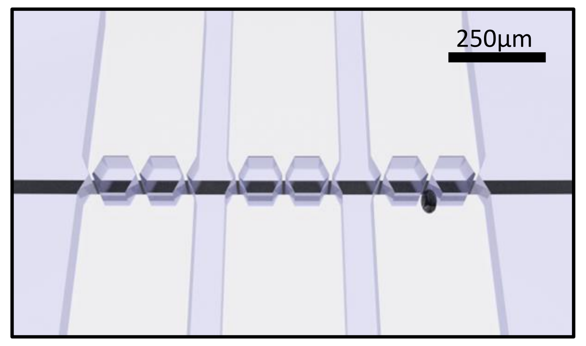
The Meinhart lab enjoys an on going collaboration with the Rothman Lab in the department of Molecular Cellular and Developmental Biology at UCSB. This collaboration is working on creating microfluidic devices to enable biological experiments that would be impossible with current tools available to biology researchers. The current focus of this collaboration is a temperature gradient device in which the 50 µm long embryos of the nematode C. elegans can be delivered to and oriented in a temperature gradient of >5ºC across their 50um length.



Temperature Gradient Device Is constructed from a microscope slide in which vias have been drilled into the sides and onto which a metal strip has been deposited. Channels are constructed using soft lithography in UV curable polymer



False coloring image of temperature measurements in the channel during operation.



Internal capture region of the microfluidic device The embryos are captured and oriented by the pillars which are on top of the dark strip shown. The dark strip is a platinum electrode that heats the immediate surroundings when current flows, which creates a tunable temperature gradient.