

# Actuating Nanoparticles

A grayscale micrograph of a surface, possibly a polymer or biological material, showing a series of horizontal ridges on the left and a prominent, smooth, curved line that arcs from the center towards the right. The background is dark and textured.

Chris Axline

August 26, 2011  
Prof. Andrew Cleland

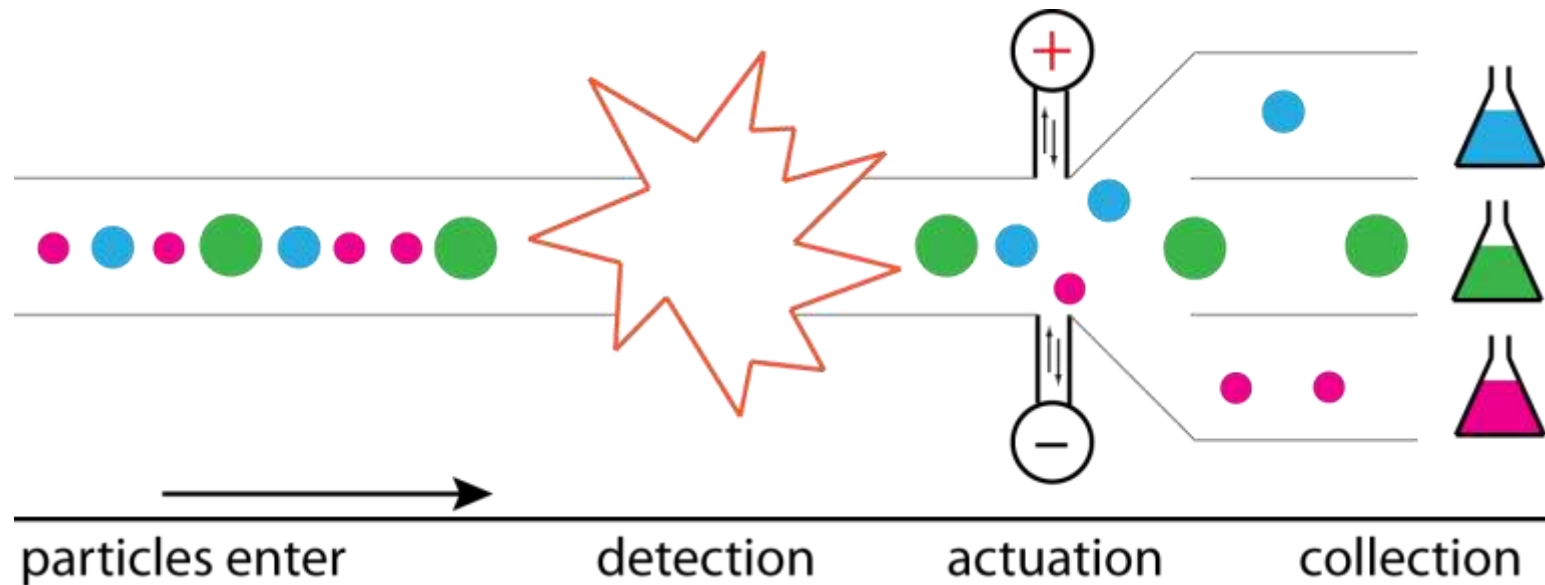
# Overview

## *Nanoparticle sorting scheme*

Nanoparticles in laminar flow in microfluidic device

Detector measures size or other characteristic

Detector triggers actuator: high-speed piezoelectric



# Background

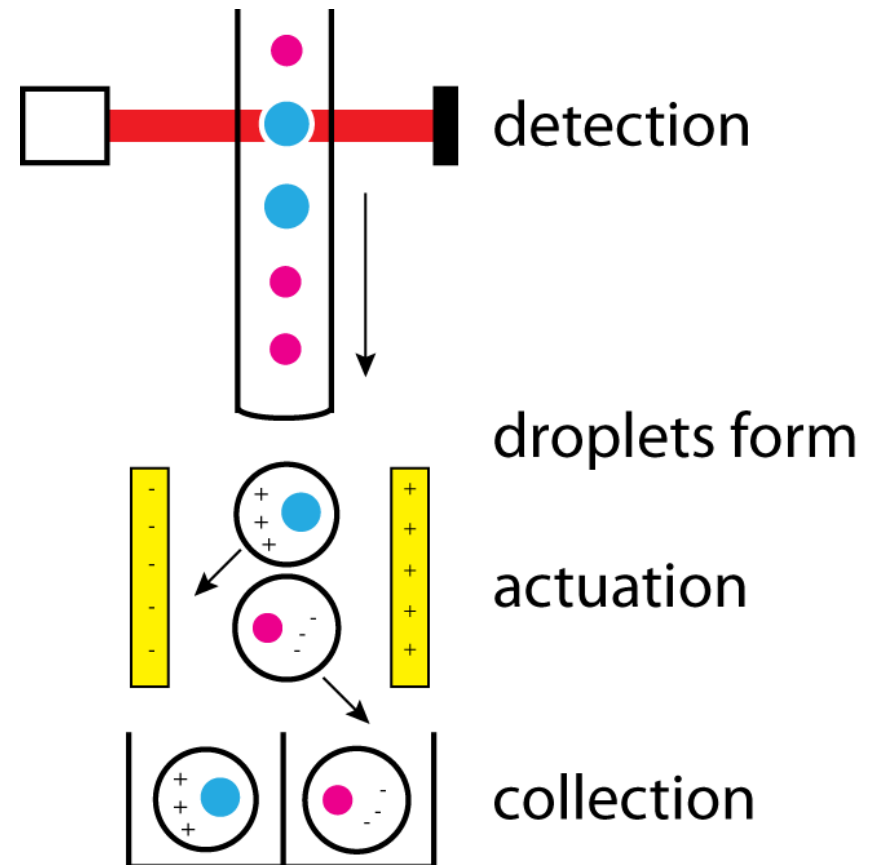
*A smaller FACS*

## Fluorescence-Activated Cell Sorting (cells: $\sim 10\ \mu\text{m}$ )

- Single file, spaced
- Measures fluorescence
- Applies charge to divert



uwa.edu.au



# Background

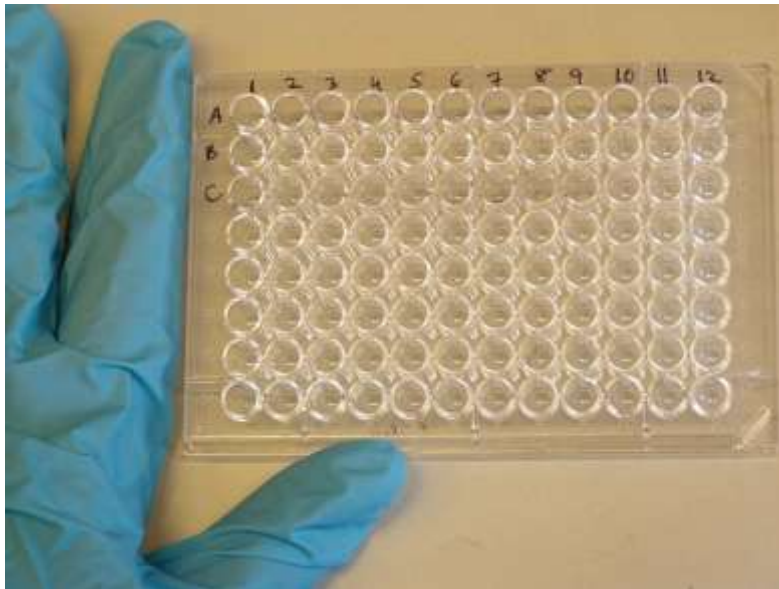
## *Applications*

Fill role of FACS at smaller scale ( $\sim 100$  nm)

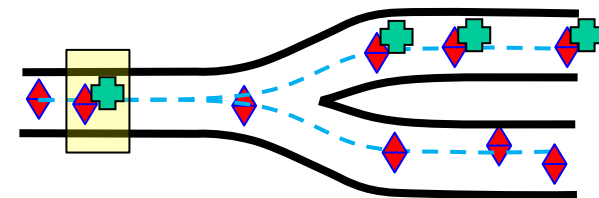
Rapid medical diagnosis, drug delivery

Secondary analysis and processing

Nanoparticle characterization



Jeffrey M. Vinocur



A. N. Cleland

# Background

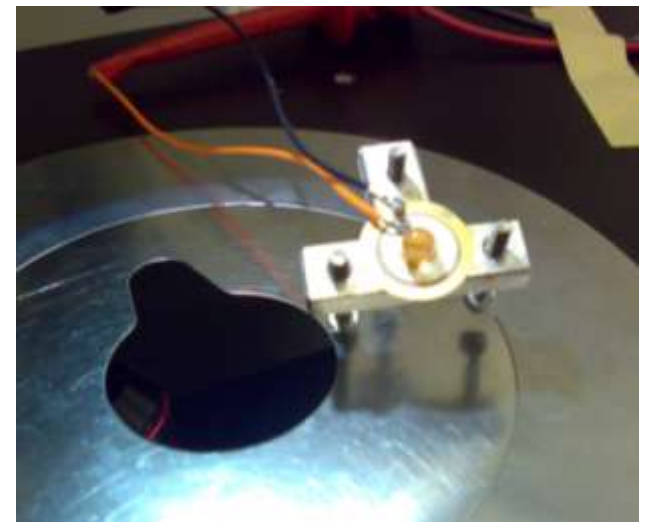
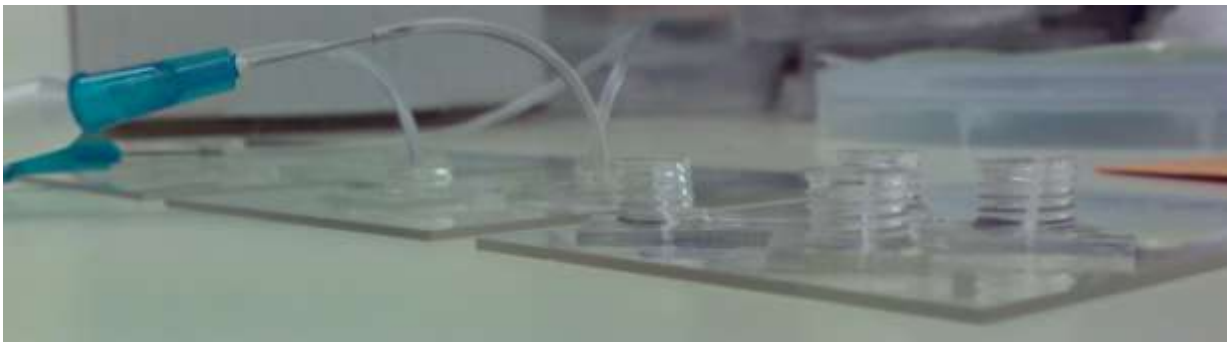
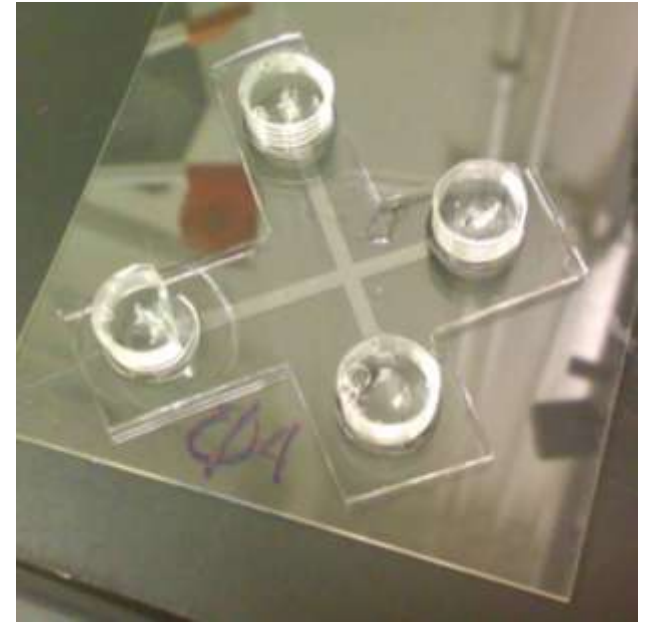
## *Microfluidics as a platform*

Inexpensive

Quick prototyping

Final device can be miniature

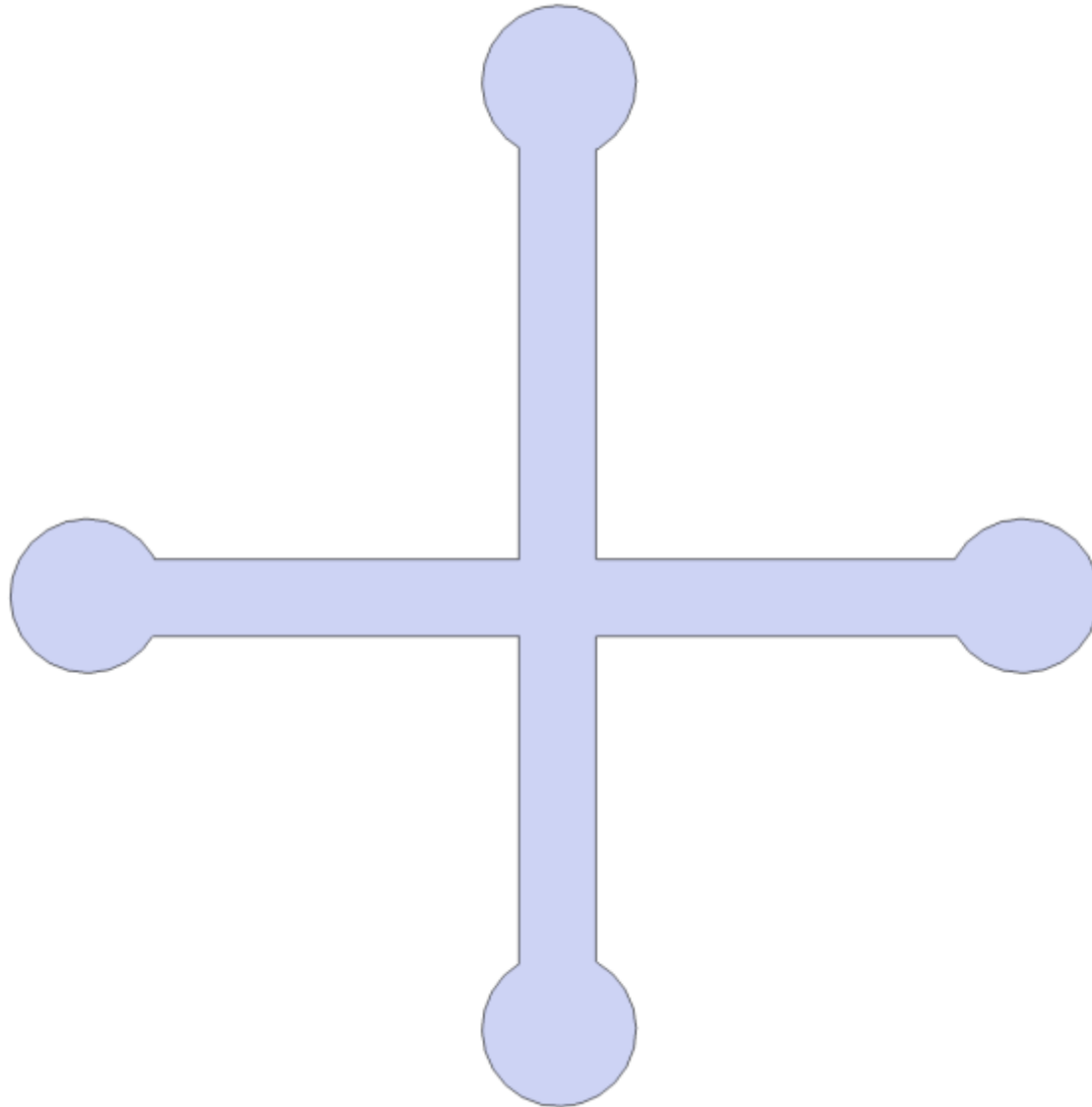
Small volumes, high throughput



# Channel design

*Crossing geometry*

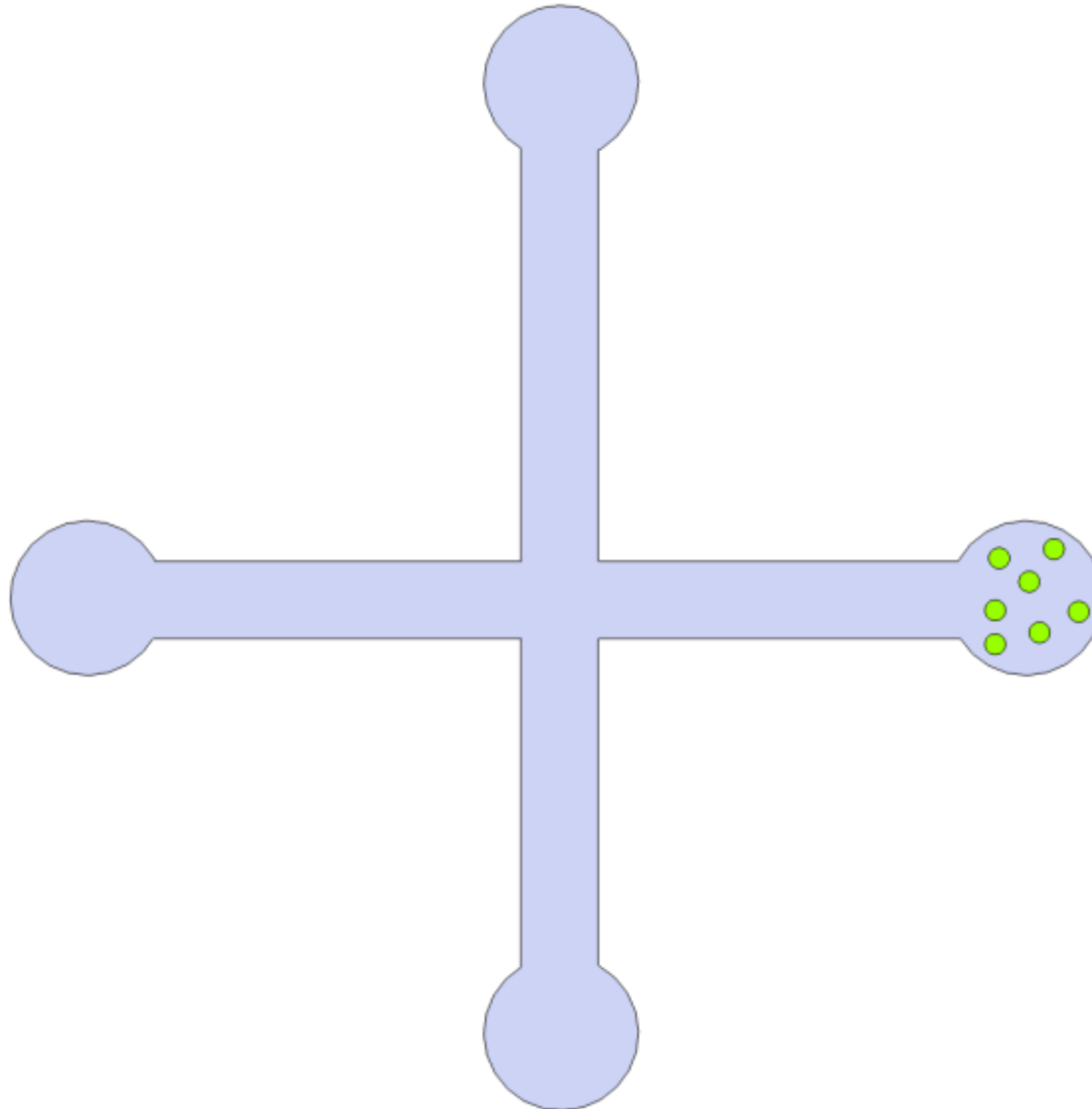
Actuation transverse to flow



# Channel design

*Crossing geometry*

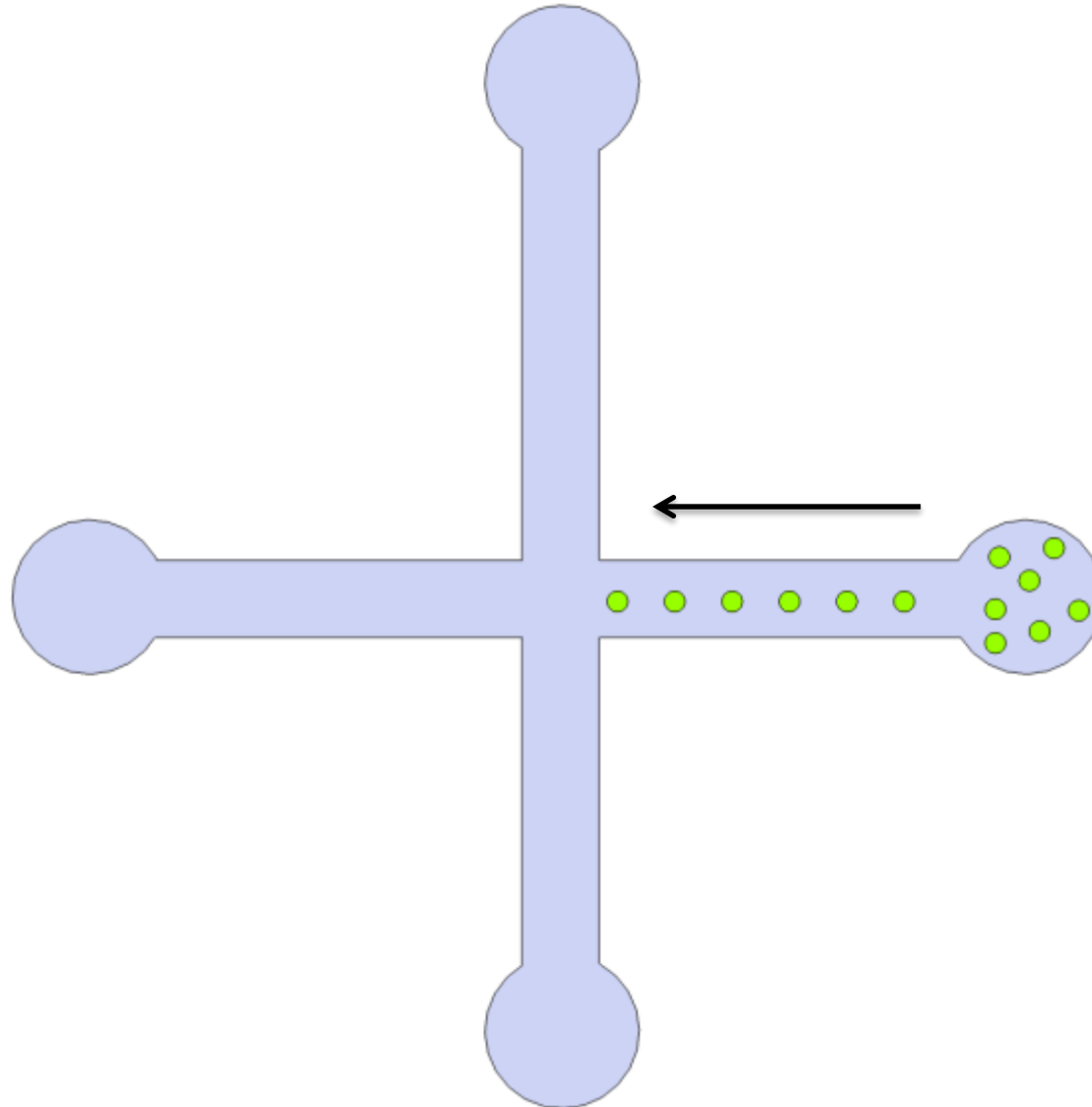
Actuation transverse to flow



# Channel design

*Crossing geometry*

Actuation transverse to flow

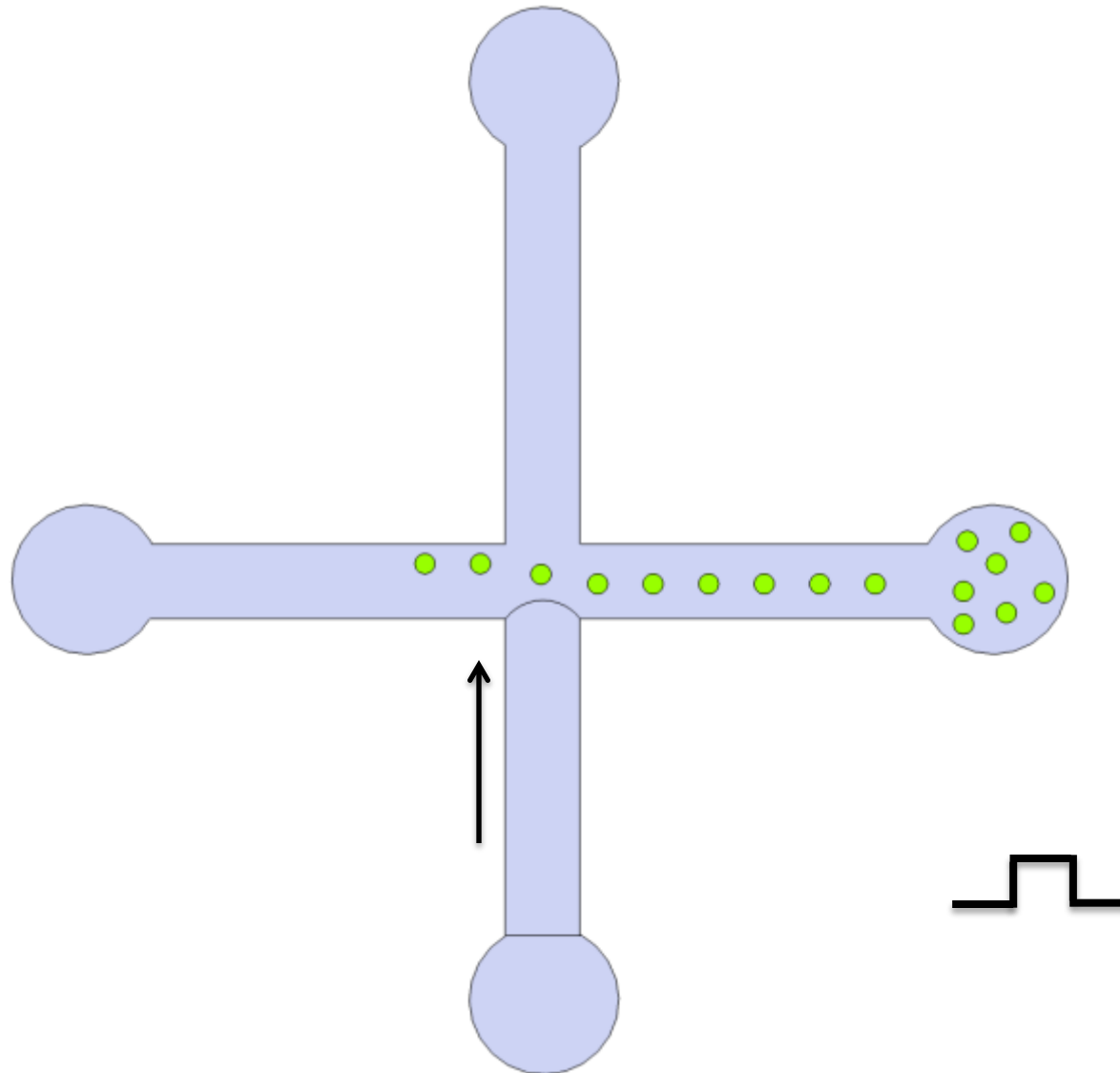




# Channel design

*Crossing geometry*

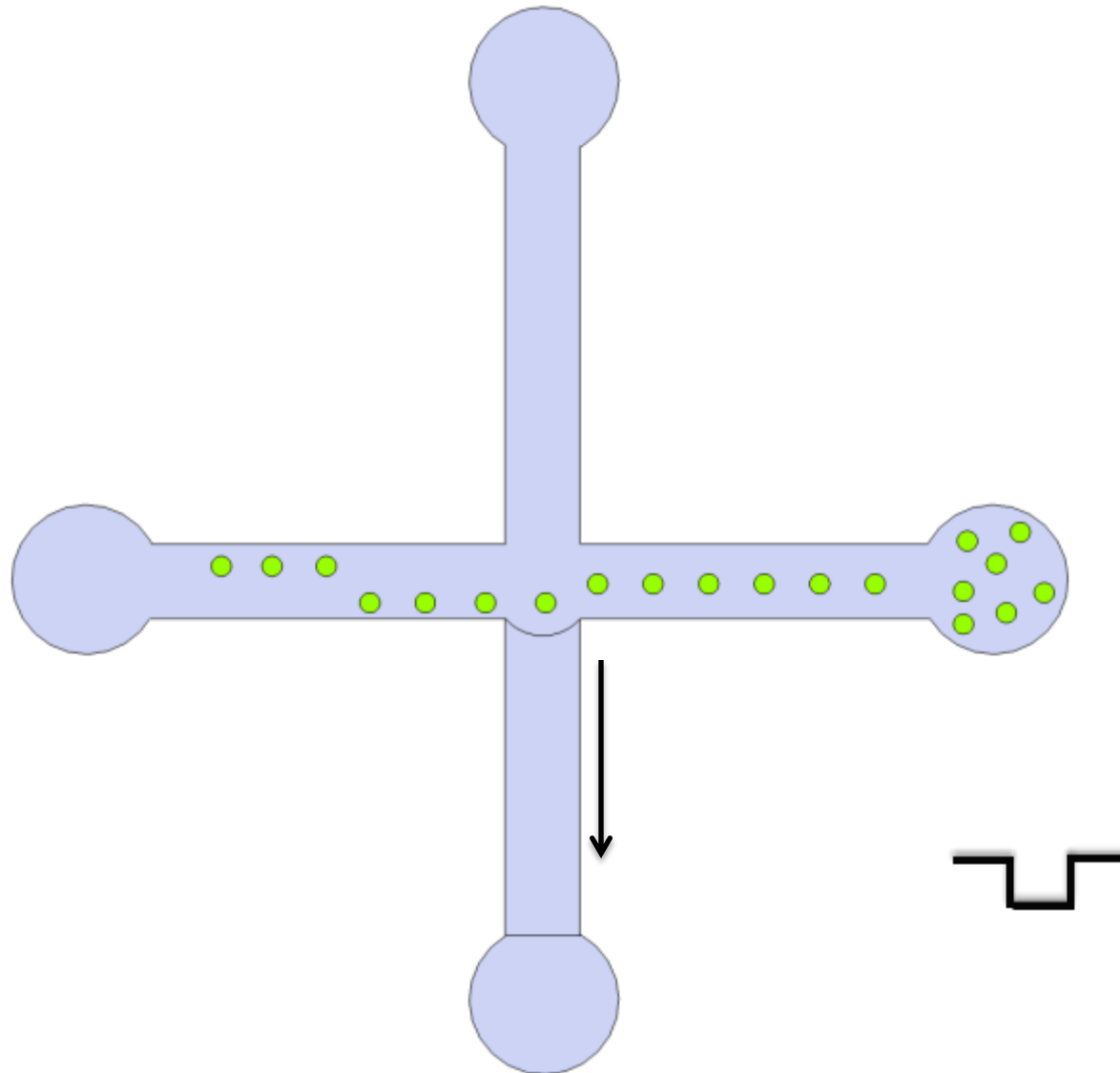
Actuation transverse to flow



# Channel design

*Crossing geometry*

Actuation transverse to flow

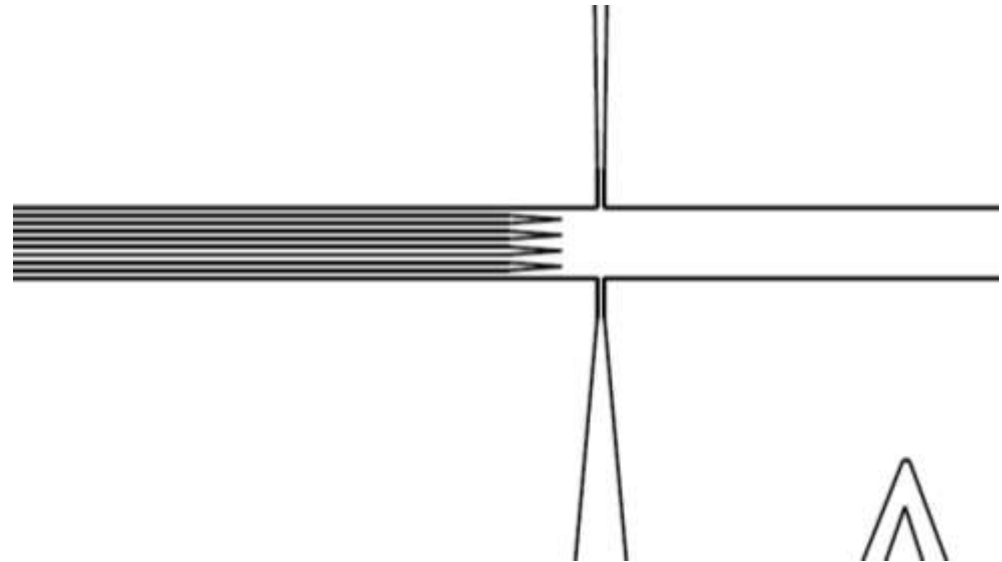
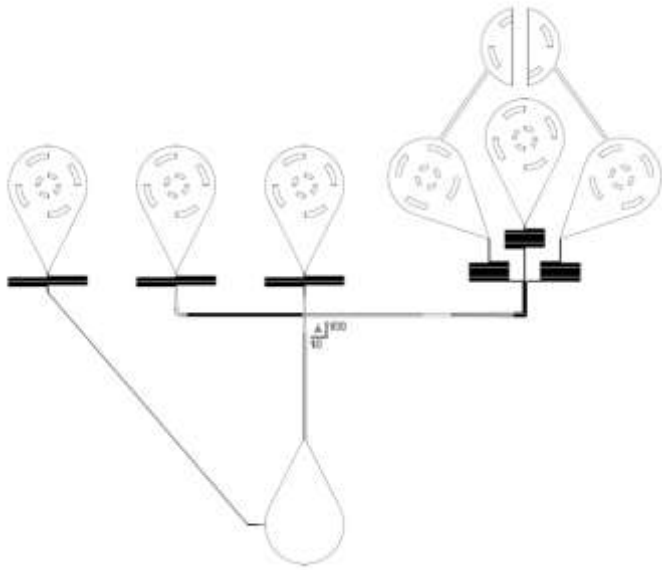
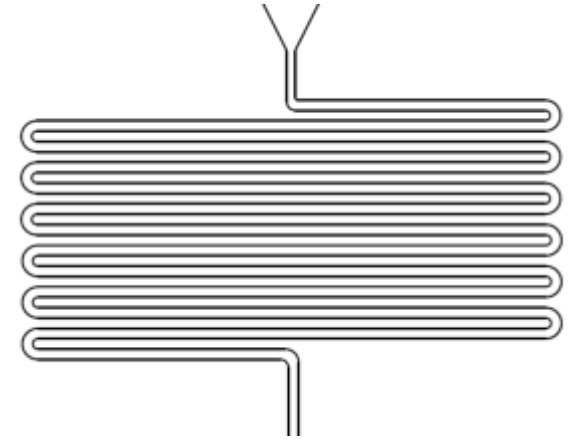


# Channel design

## *Features*

Geometry allows measurement,  
air removal, variable impedance

Central, symmetric flow; can bias

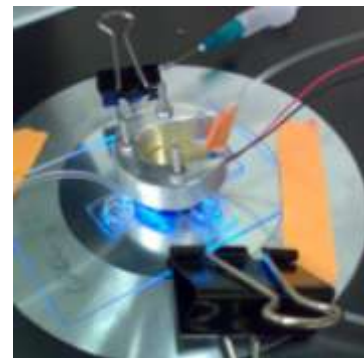
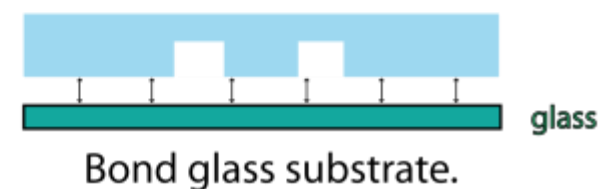
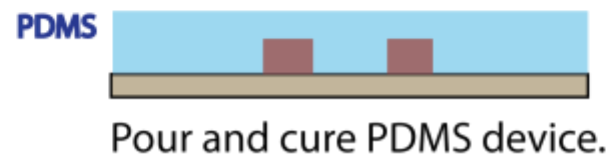
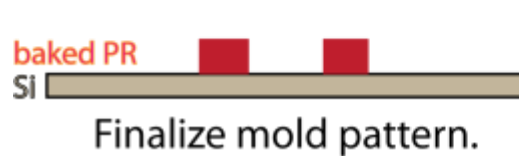
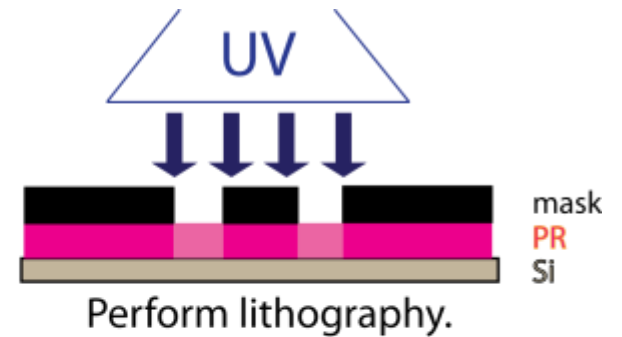
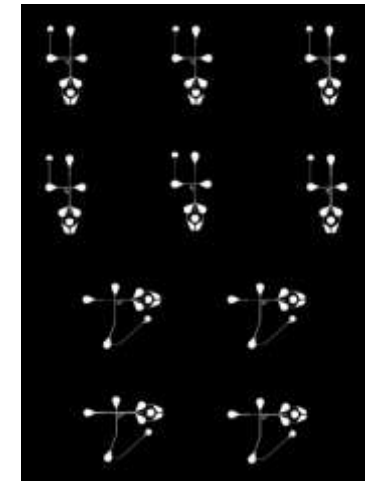
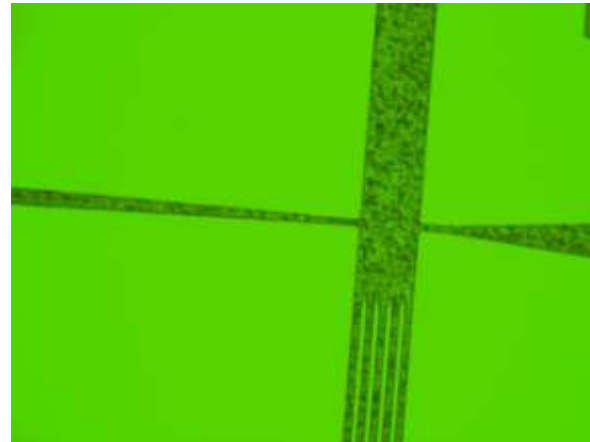


# Fabrication

## Method

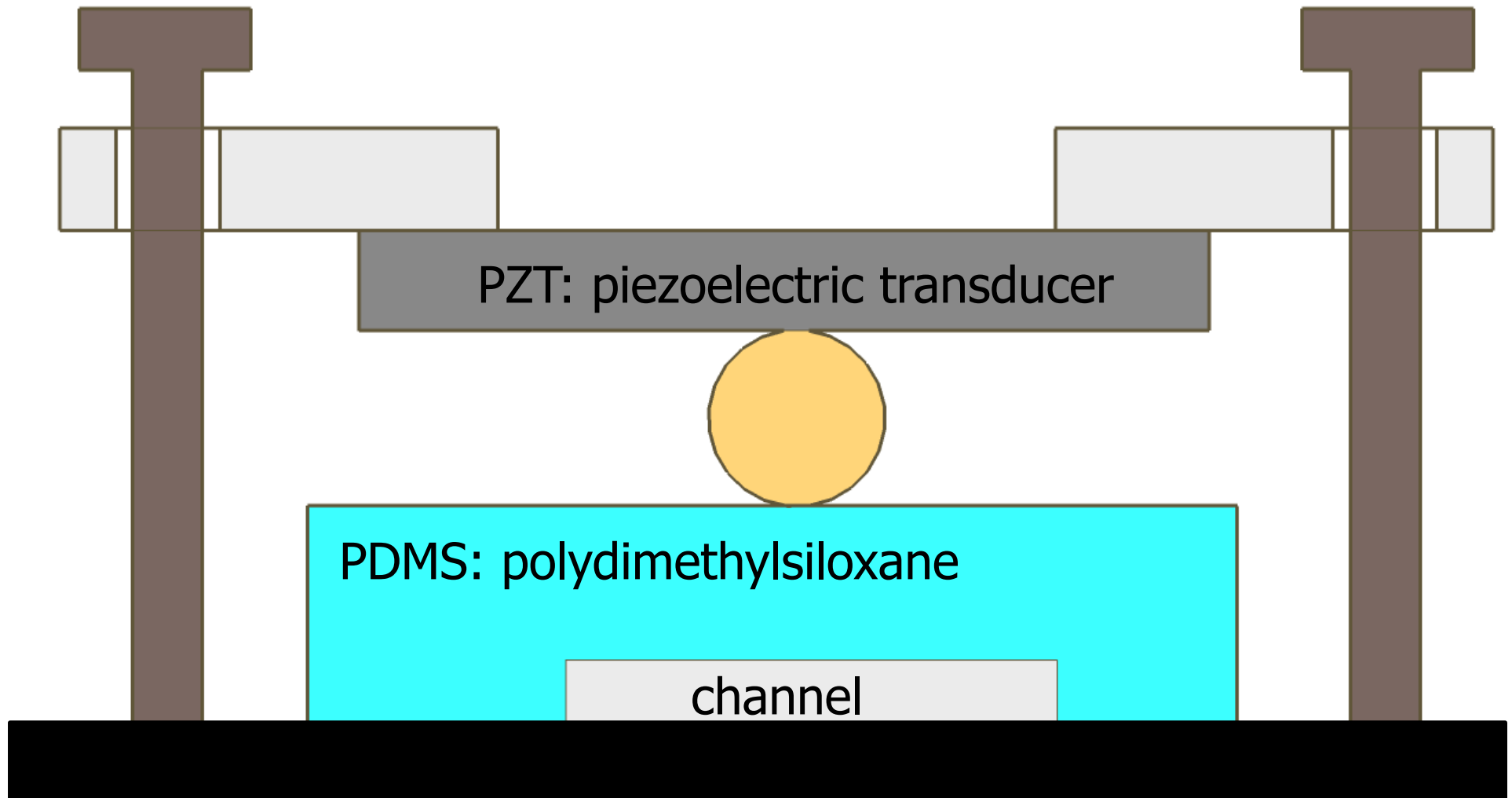


cqstech.com



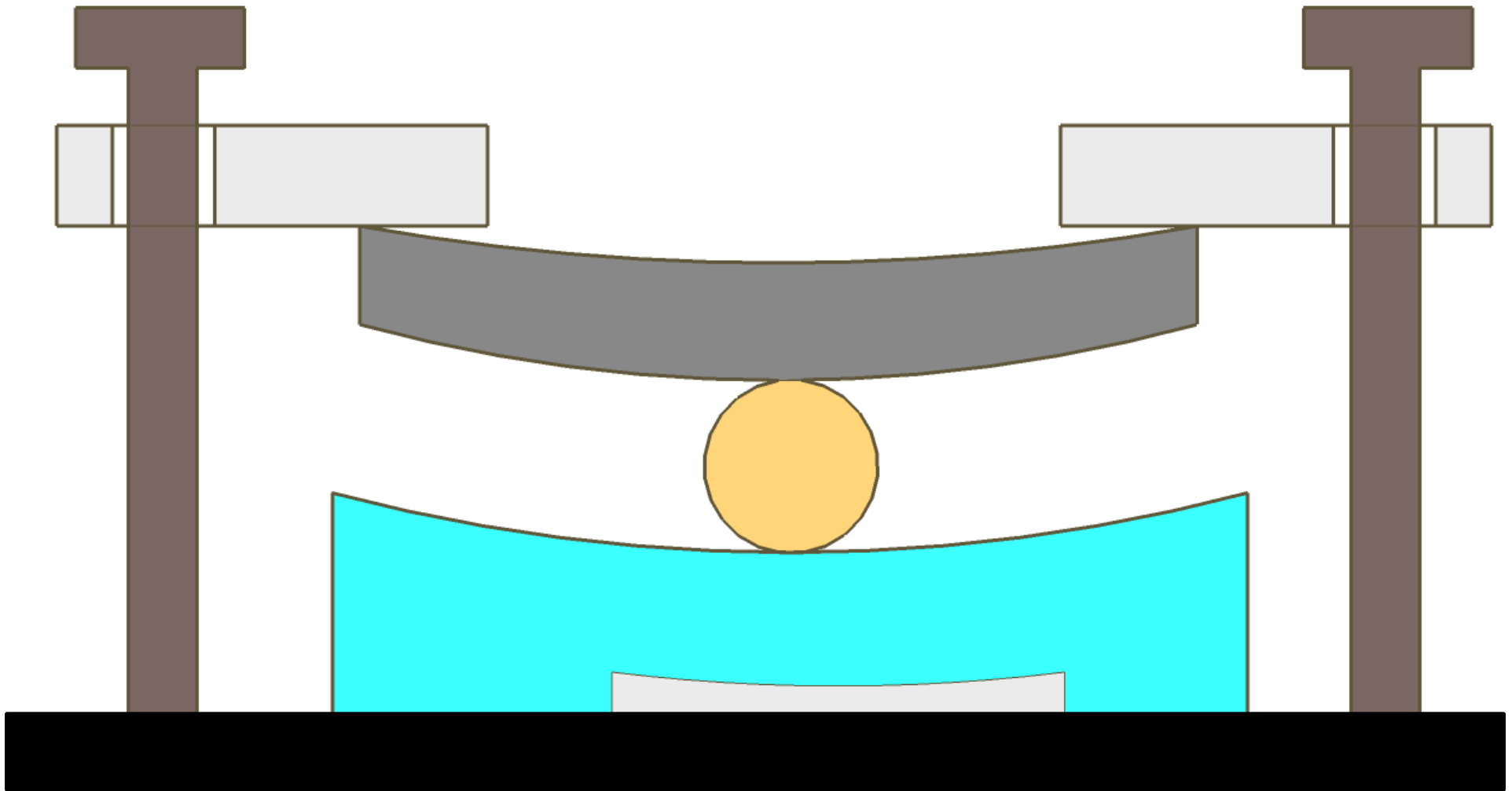
# Experiment design

*External coupling*



# Experiment design

*External coupling*



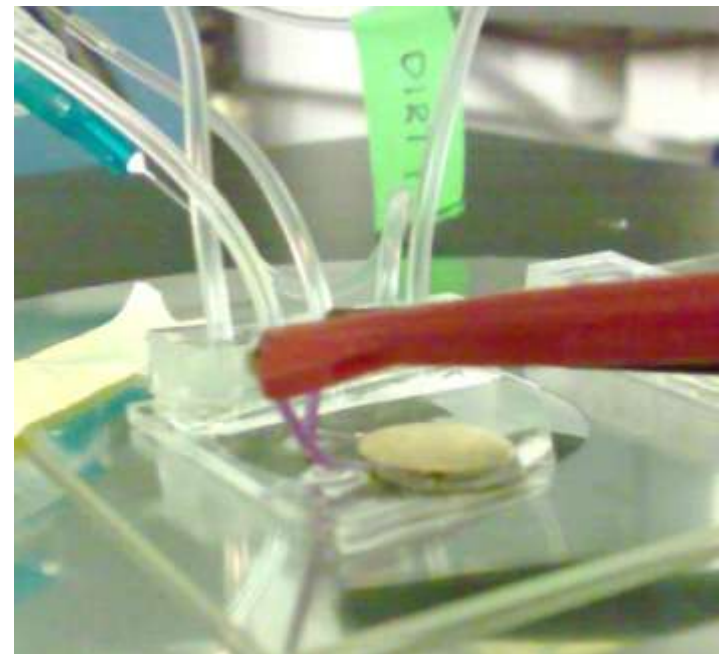
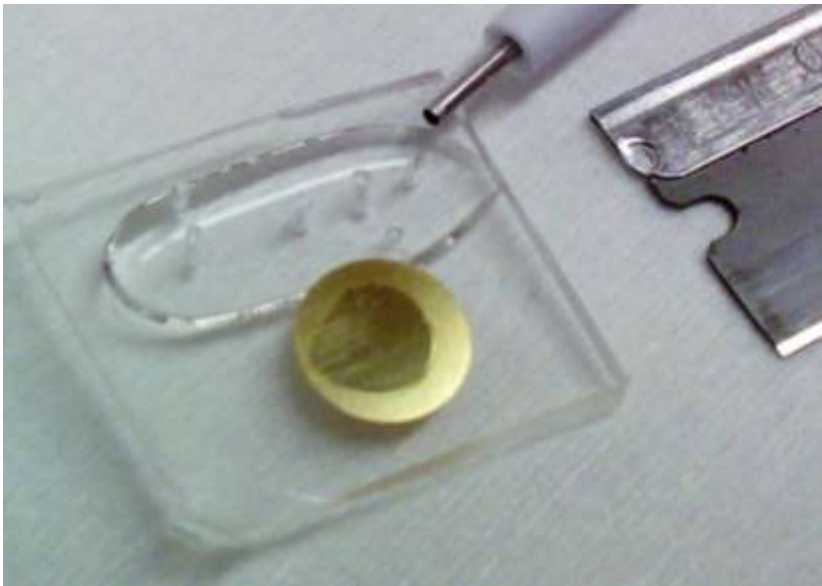
# Experiment design

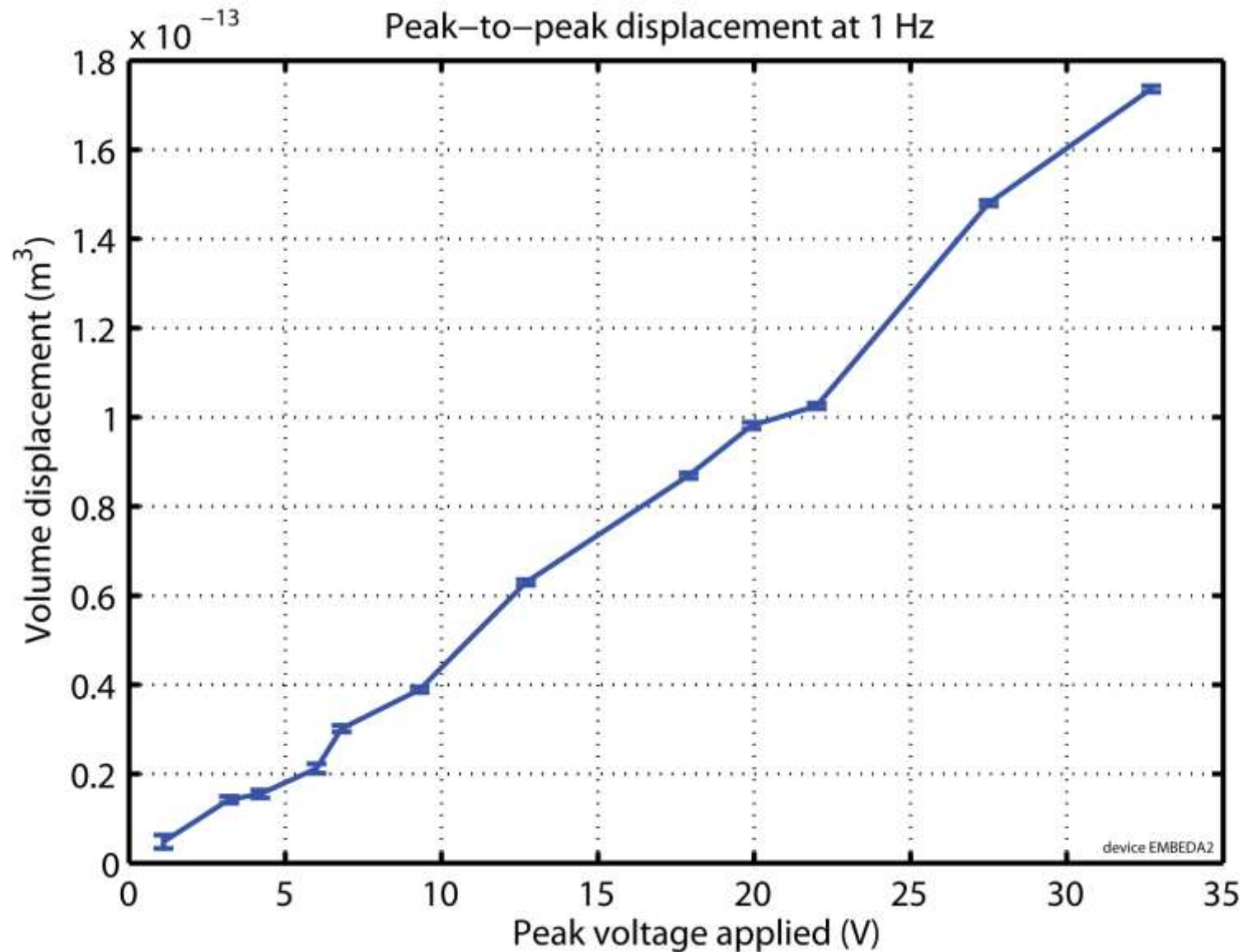
*Internal coupling*

Direct contact with fluid, no PDMS layer drawbacks

New setbacks: PZT greatly loaded, can leak

Huge displacement gain

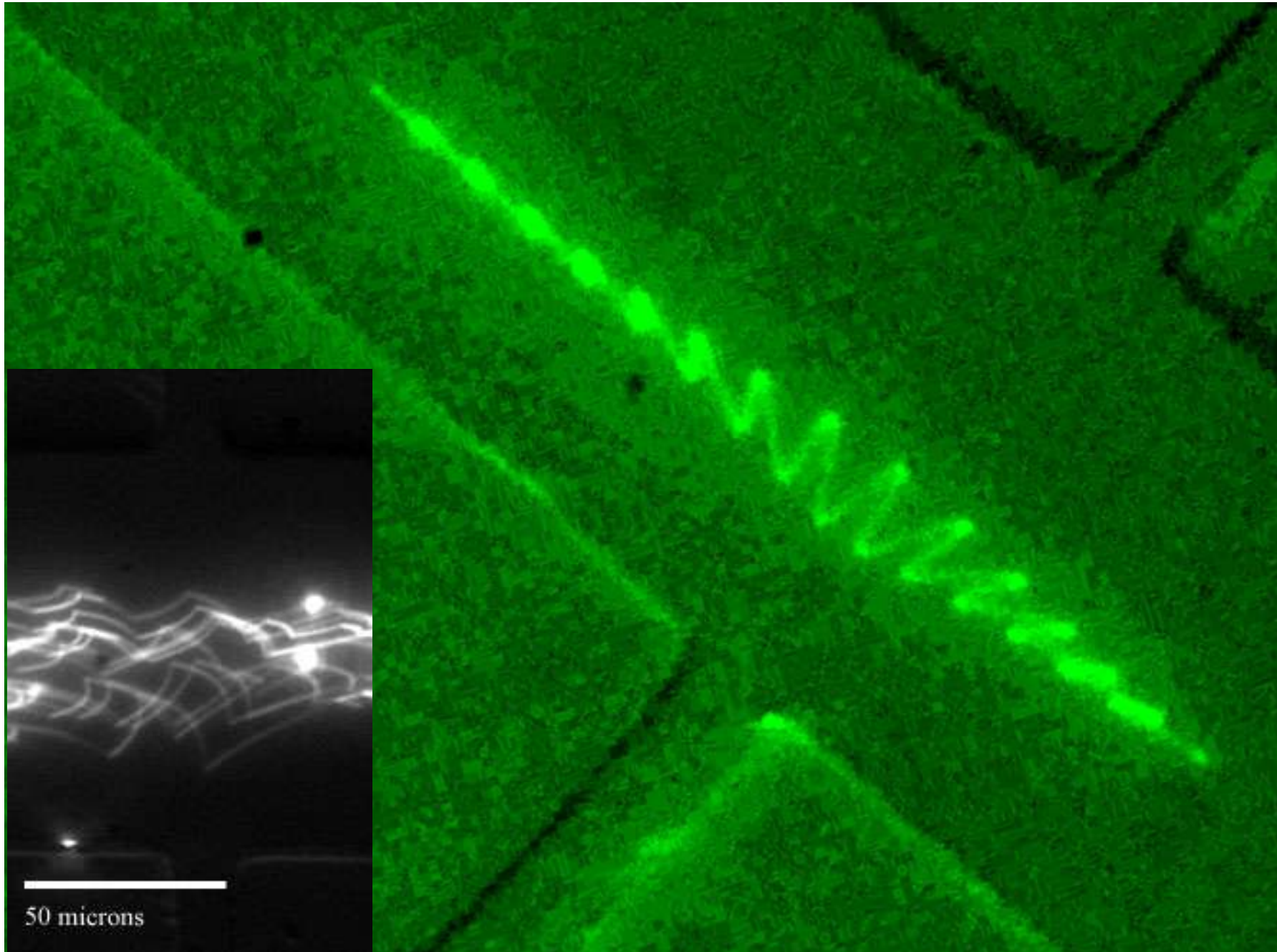




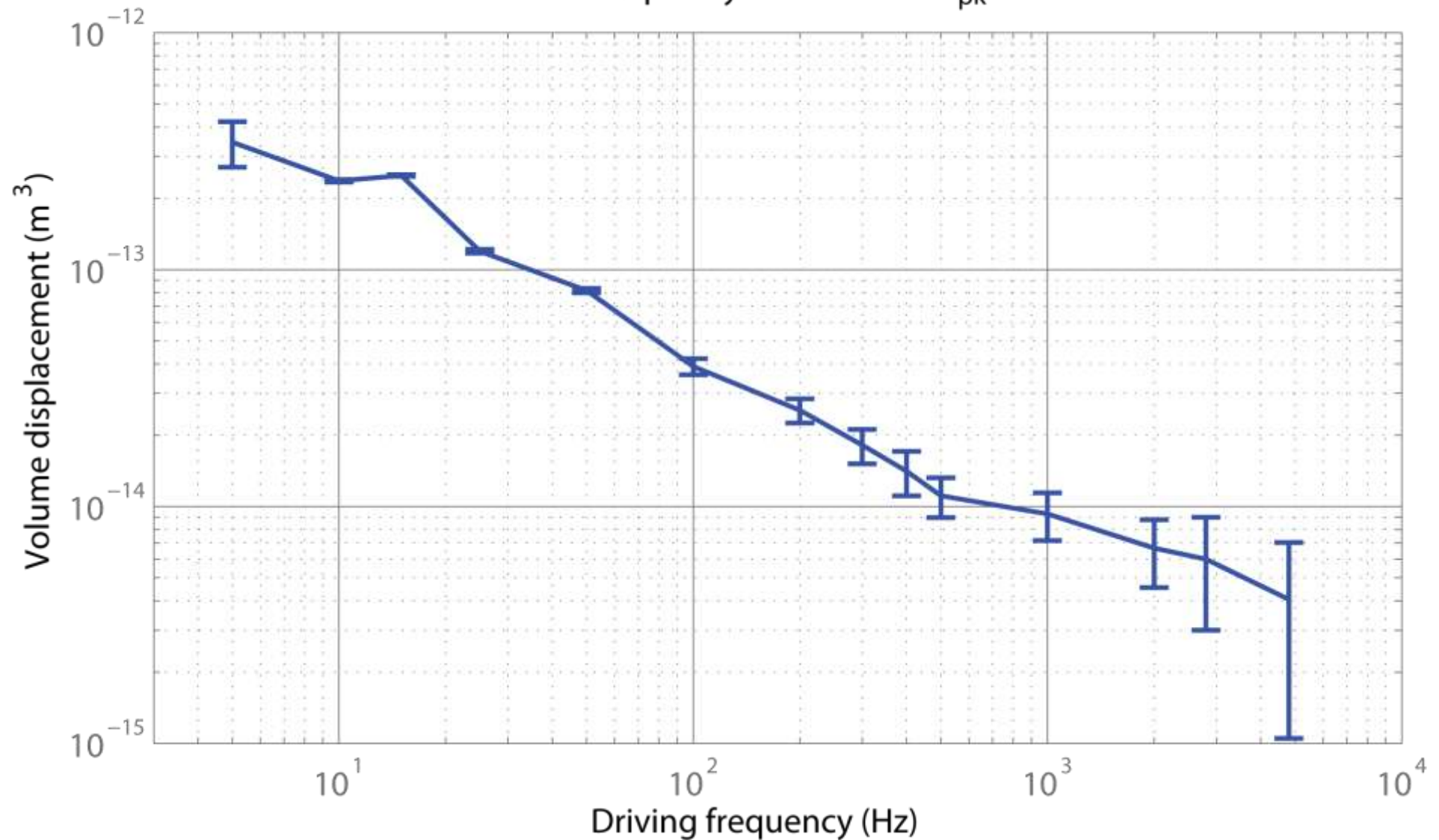


# Measurements & Data

*High frequency*



Frequency Roll-off at 45 V<sub>pk</sub>



device: EMBEDA2

# Measurements & Data

*Auto-triggering*

The image displays the 'Microscope Triggering' software interface. On the left is a grayscale microscope image of a textured surface. Below the image, a status bar shows the timestamp '15:18:11.839', resolution '348x260', and 'Logging frame 1498.'. To the right of the image is a control panel with an 'Enable' button and a pink 'Exit' button. Below these is a 'Threshold' slider with 'Set' and 'Current' labels and numerical values '0.46' and '0.4549' respectively. At the bottom is a log window showing the following text:

```
Auto-pulsed (#75)  
Average elapsed trigger time is 11 ms.  
Auto-pulsed (#76)  
Auto-pulsed (#77)
```

device: EMBEDB2

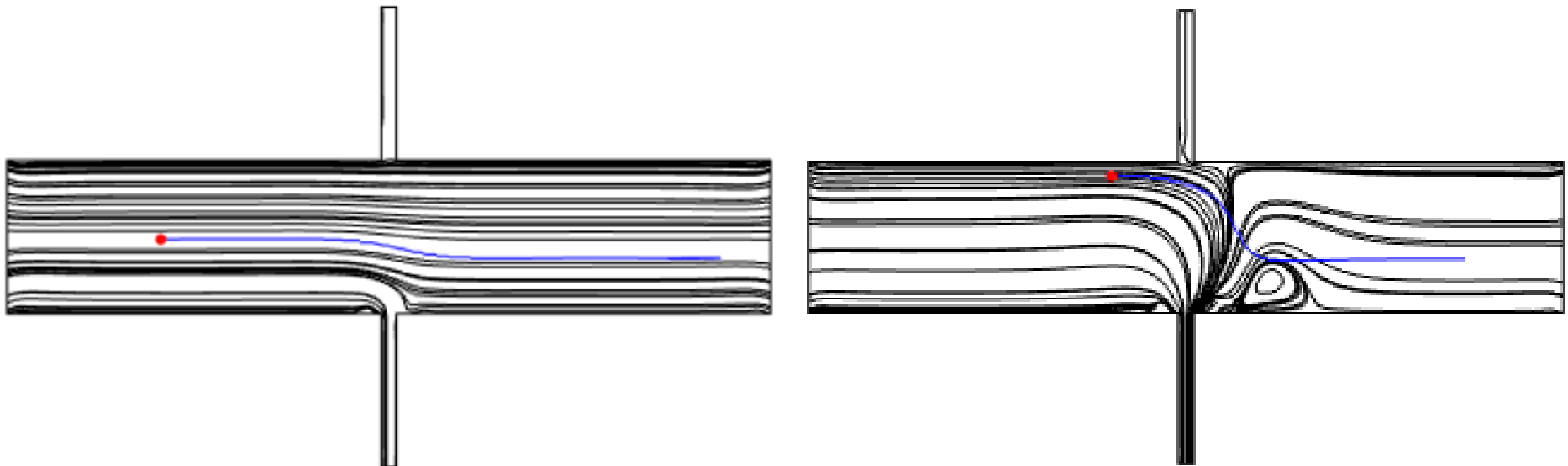
# For the future...

Recover resonance in embedded devices

Use simulations with observations to understand the physics

Optimizations: smaller, quicker, more controllable

Explore scalability







# Thanks



Andrew Cleland

Jean-Luc Fraikin

Mike Stanton

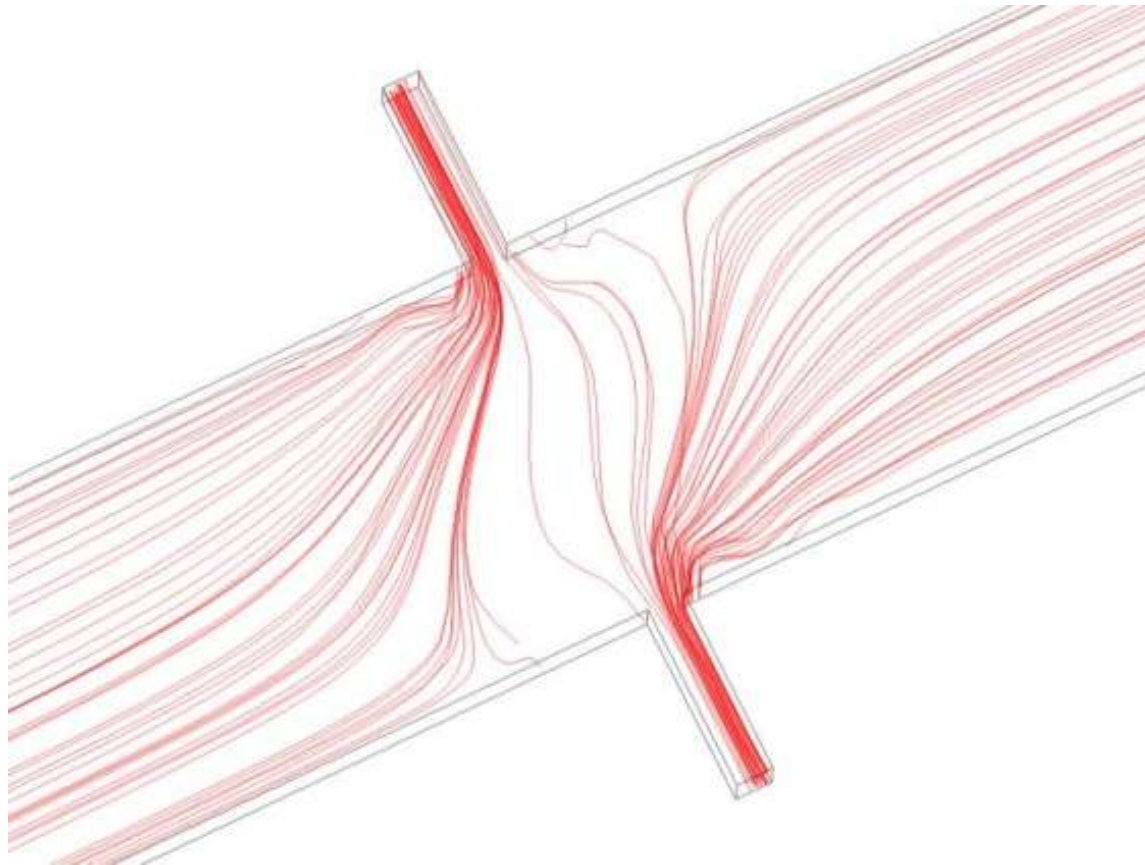
Jorge Carvalho

Sukumar Rajauria

Menon Watson Family Foundation

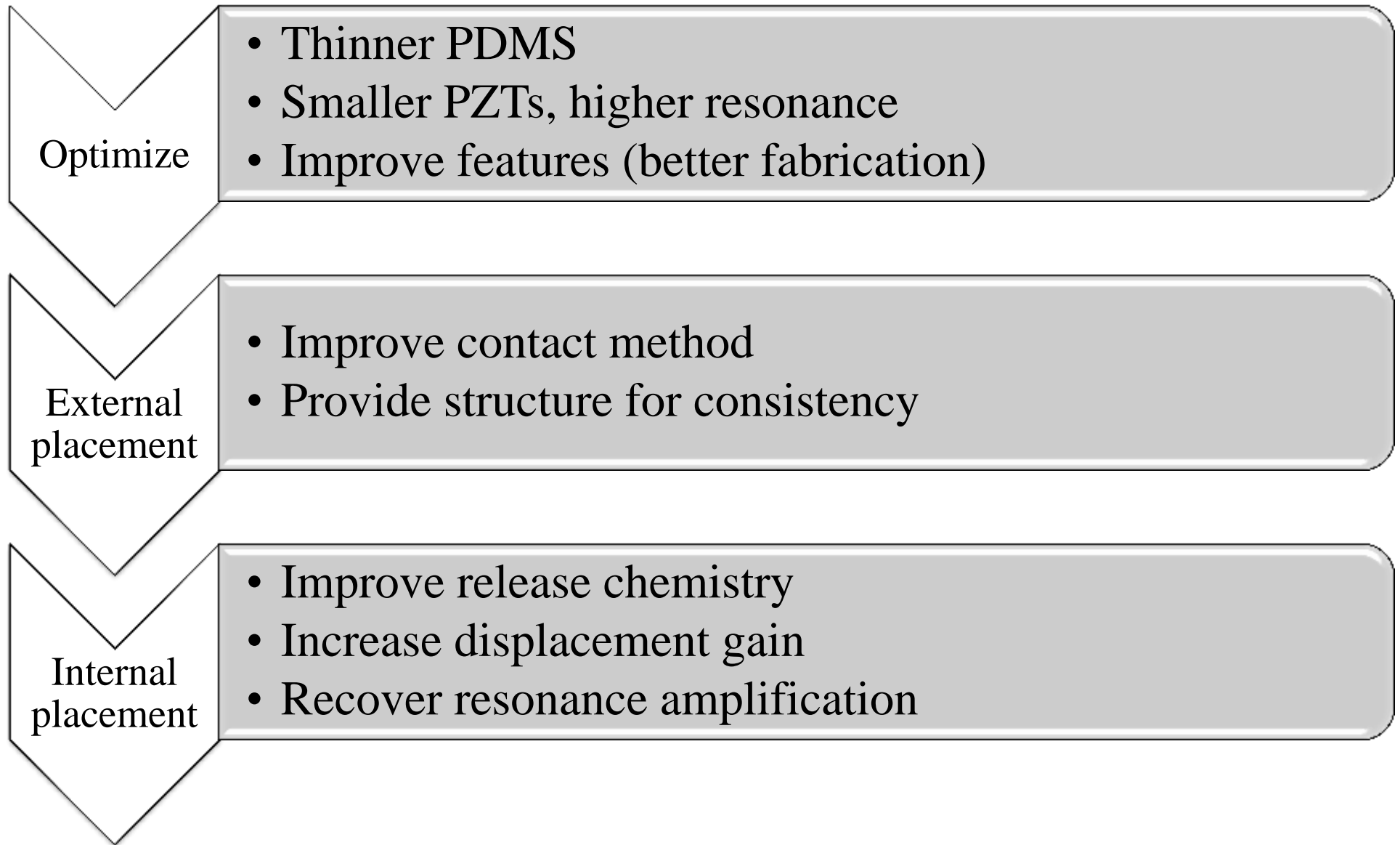
W. M. KECK FOUNDATION

# The End





# Actuator design process flow



# Channel geometry design process flow

