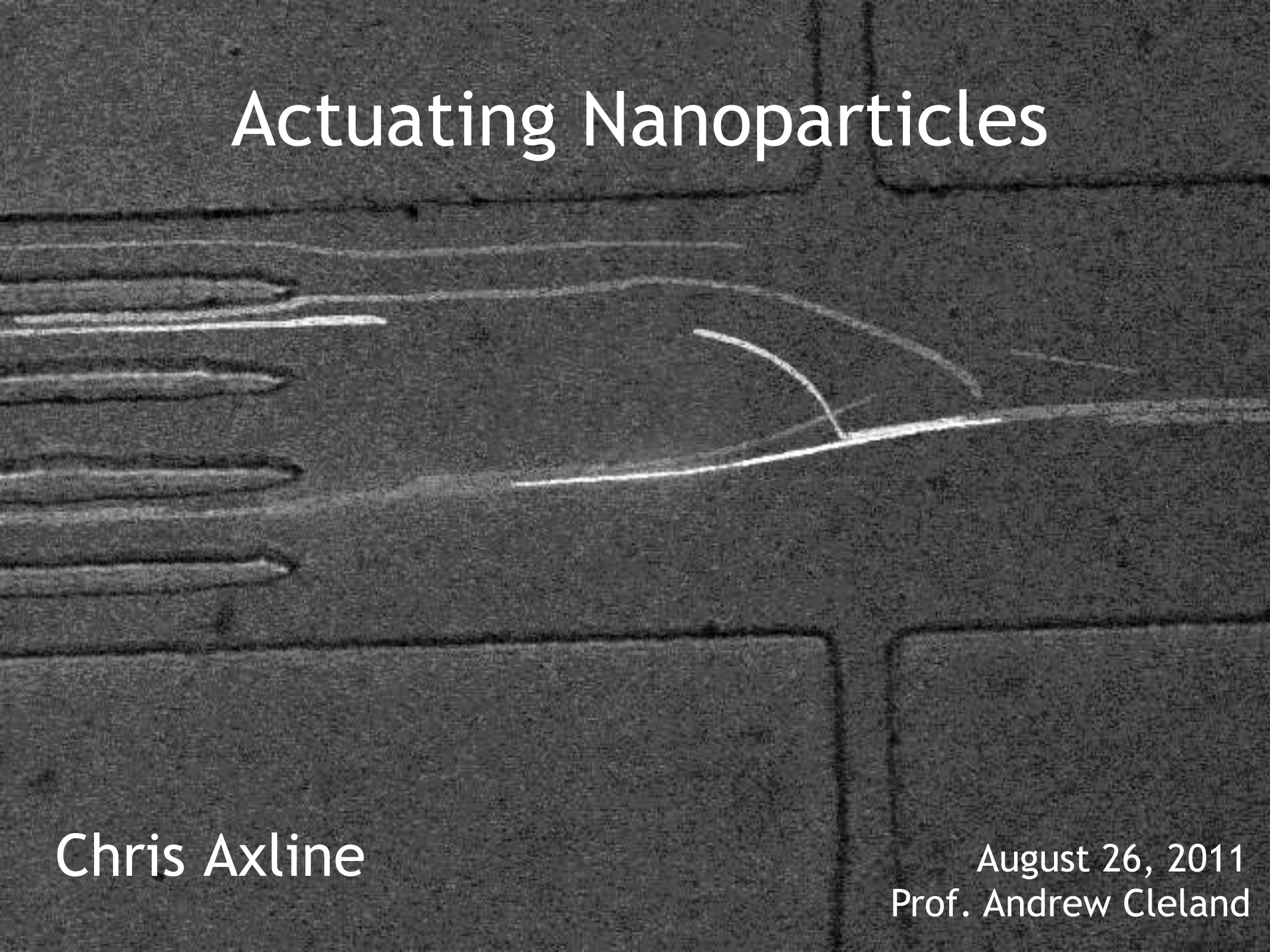
Actuating Nanoparticles



Chris Axline

August 26, 2011
Prof. Andrew Cleland

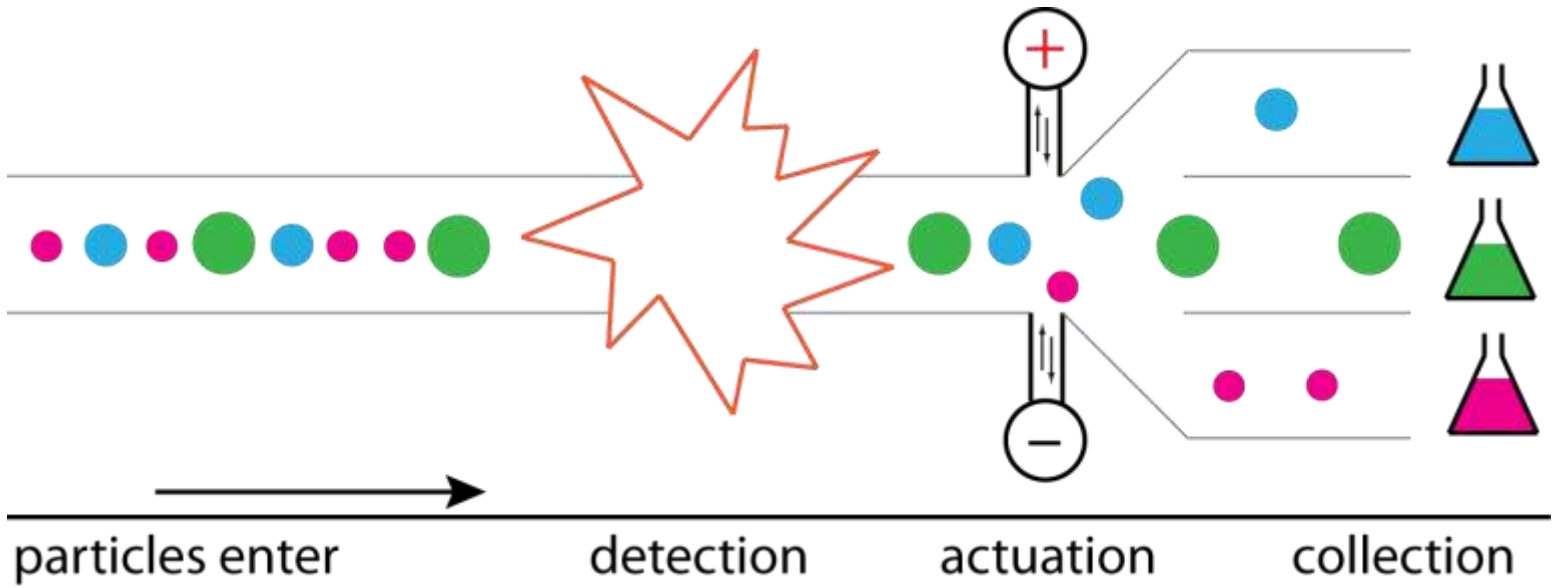
Overview

Nanoparticle sorting scheme

Nanoparticles in laminar flow in microfluidic device

Detector measures size or other characteristic

Detector triggers actuator: high-speed piezoelectric



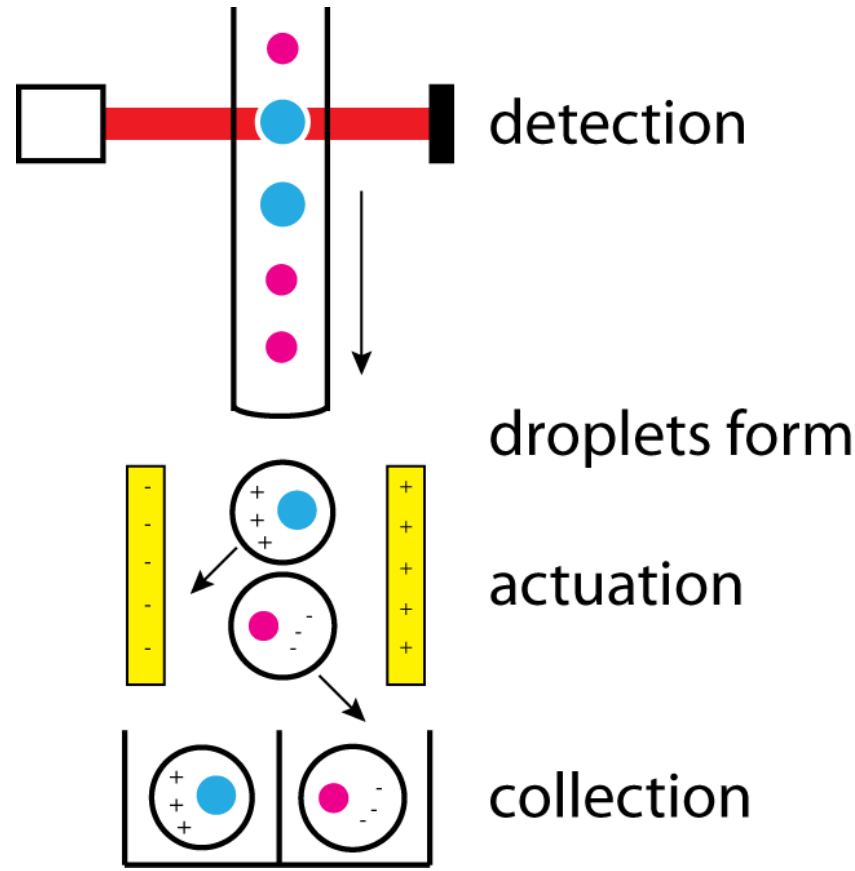
Background

A smaller FACS

Fluorescence-Activated
Cell Sorting (cells: ~10 µm)

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

uwa.edu.au



Background

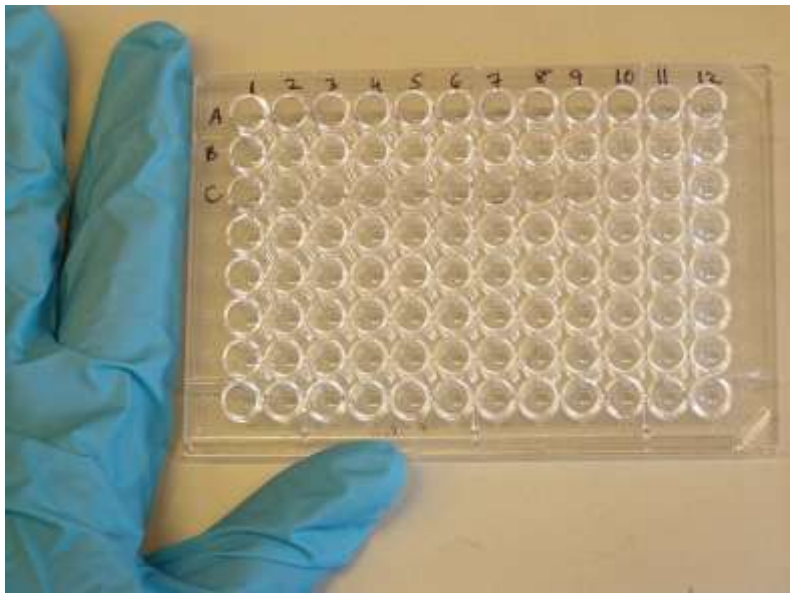
Applications

Fill role of FACS at smaller scale (~100 nm)

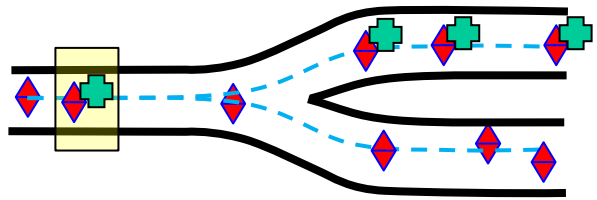
Rapid medical diagnosis, drug delivery

Secondary analysis and processing

Nanoparticle characterization



Jeffrey M. Vinocur



A. N. Cleland

Background

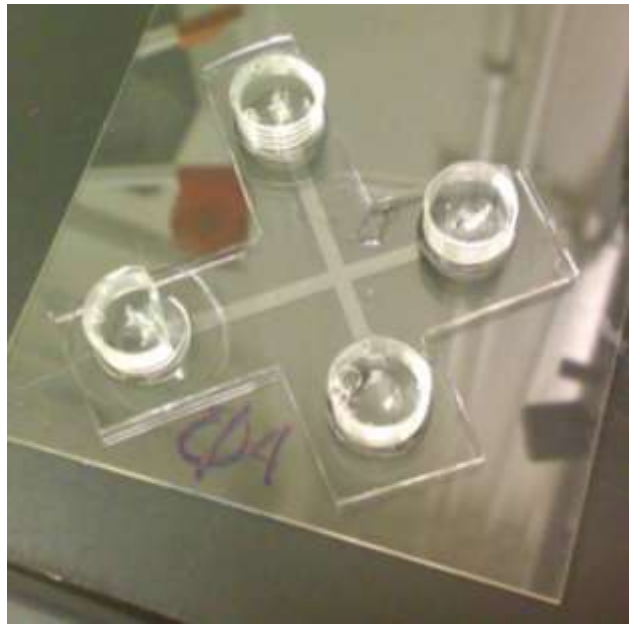
Microfluidics as a platform

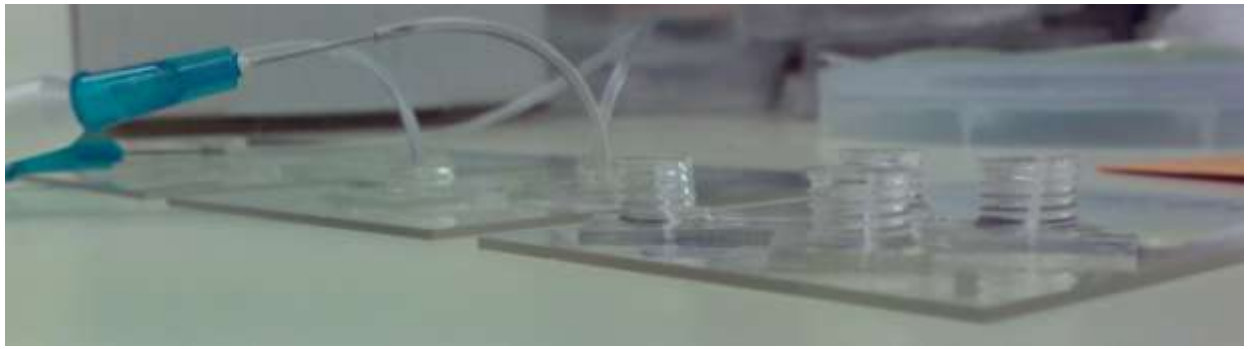
Inexpensive

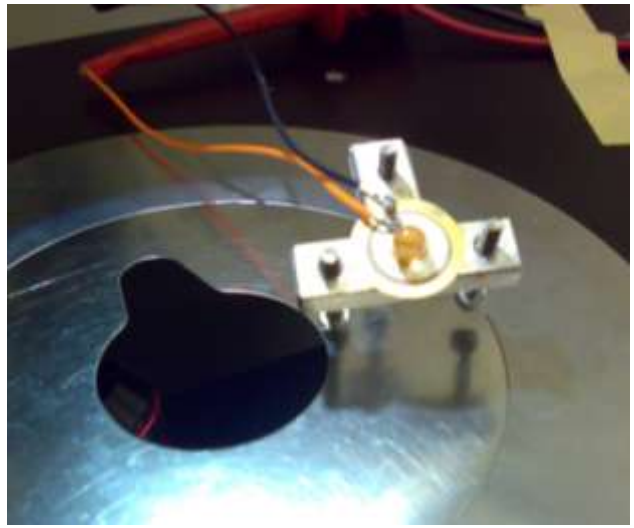
Quick prototyping

Final device can be miniature

Small volumes, high throughput



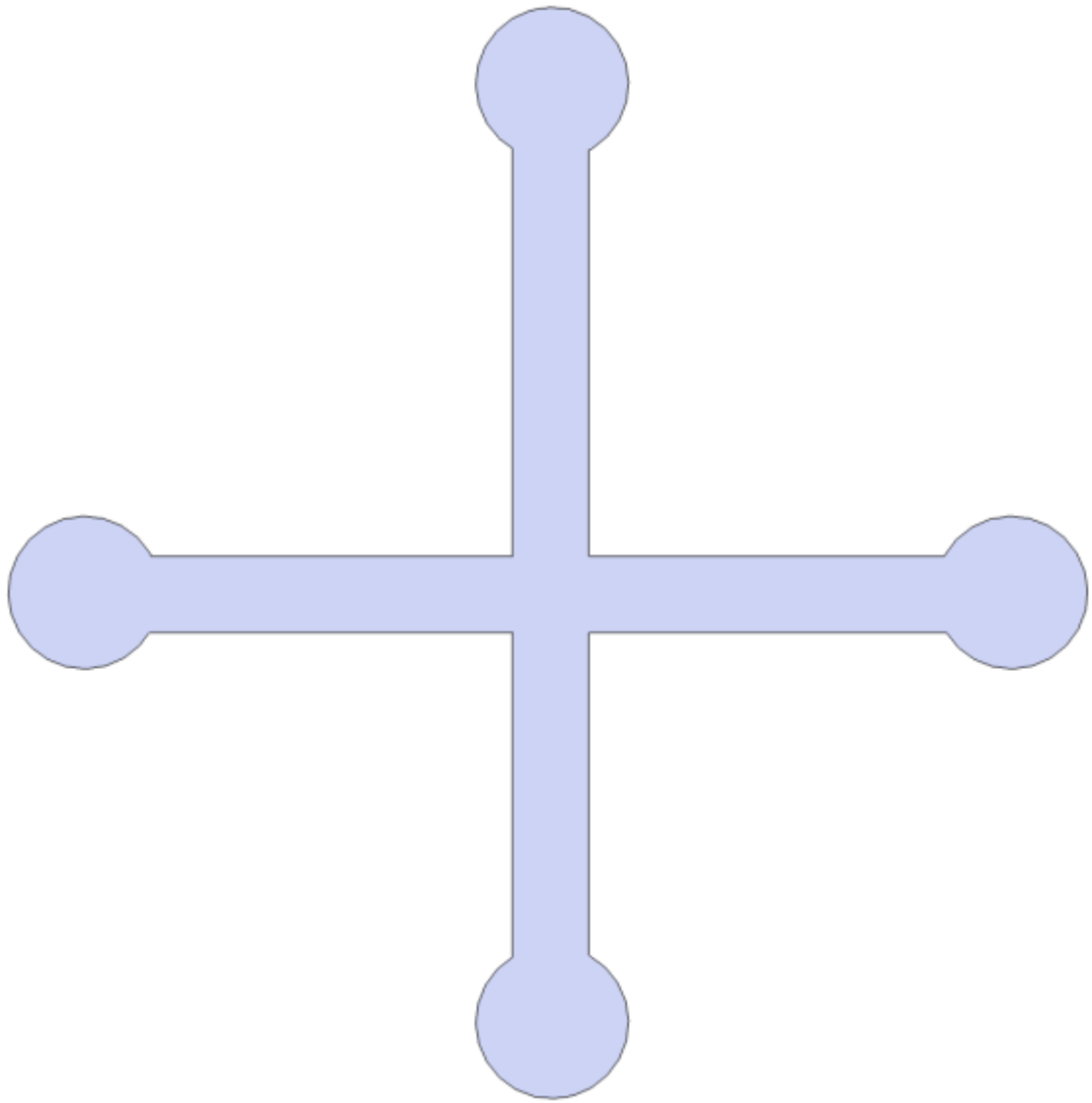




Channel design

Crossing geometry

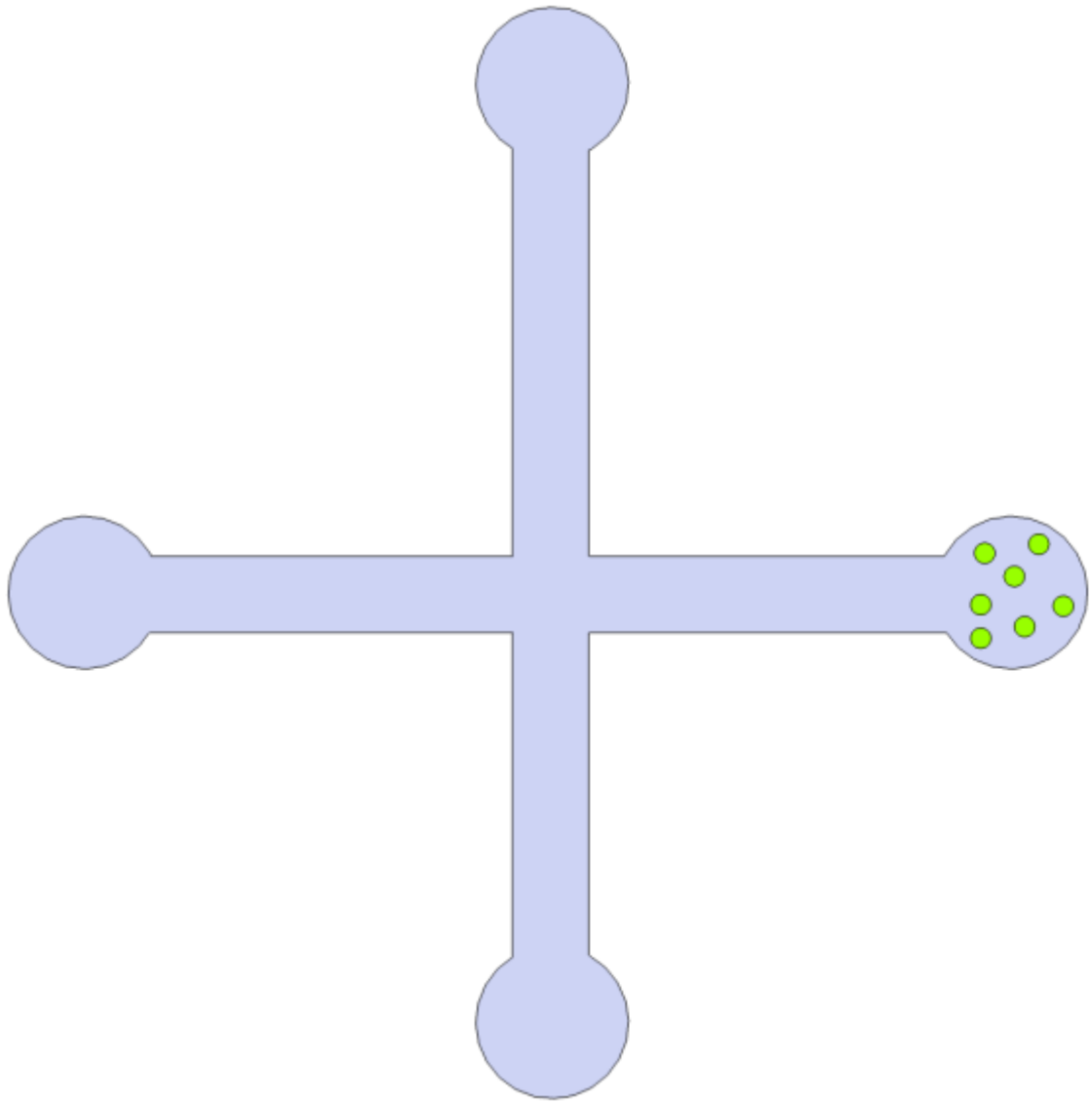
Actuation transverse to flow



Channel design

Crossing geometry

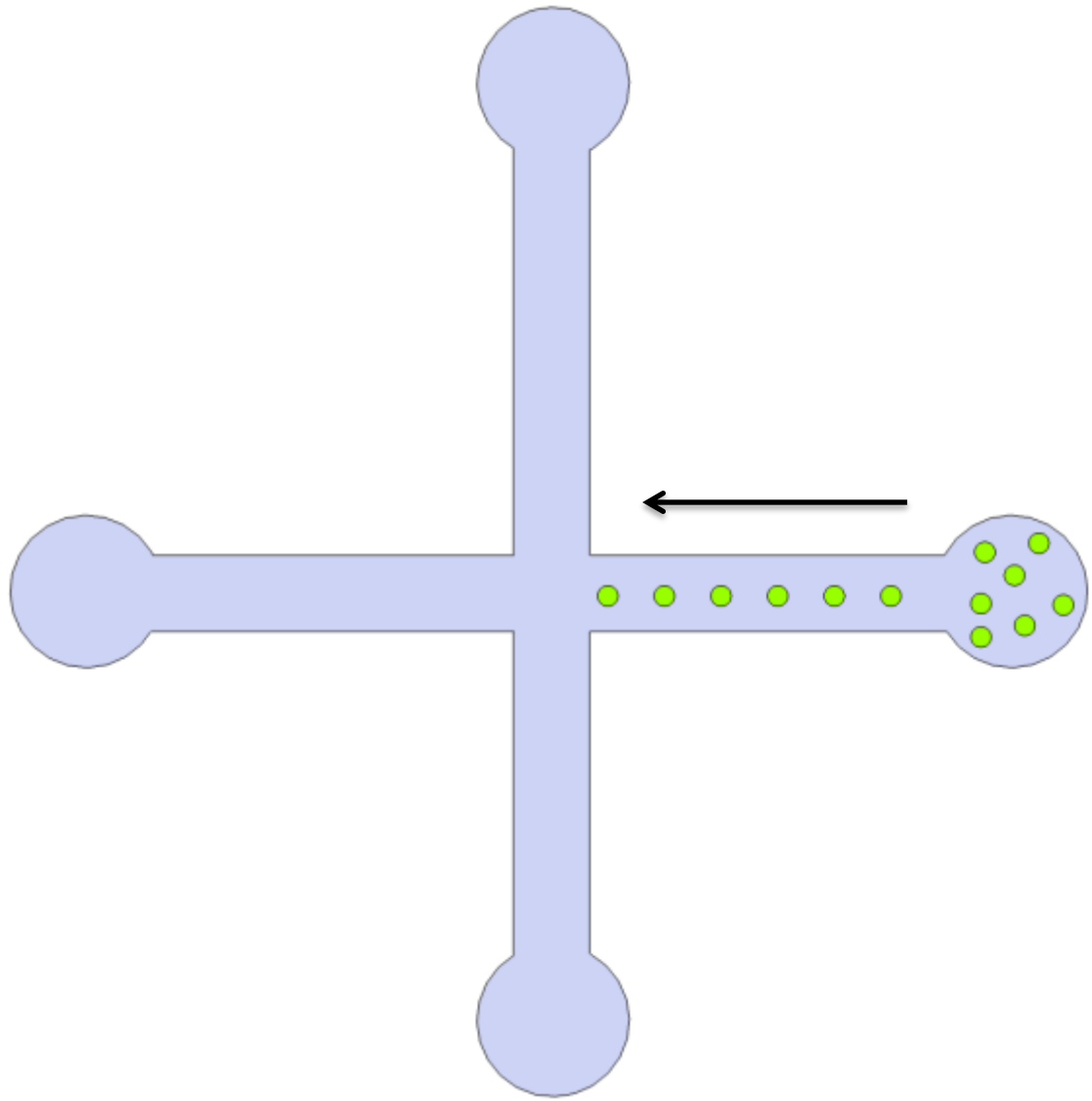
Actuation transverse to flow



Channel design

Crossing geometry

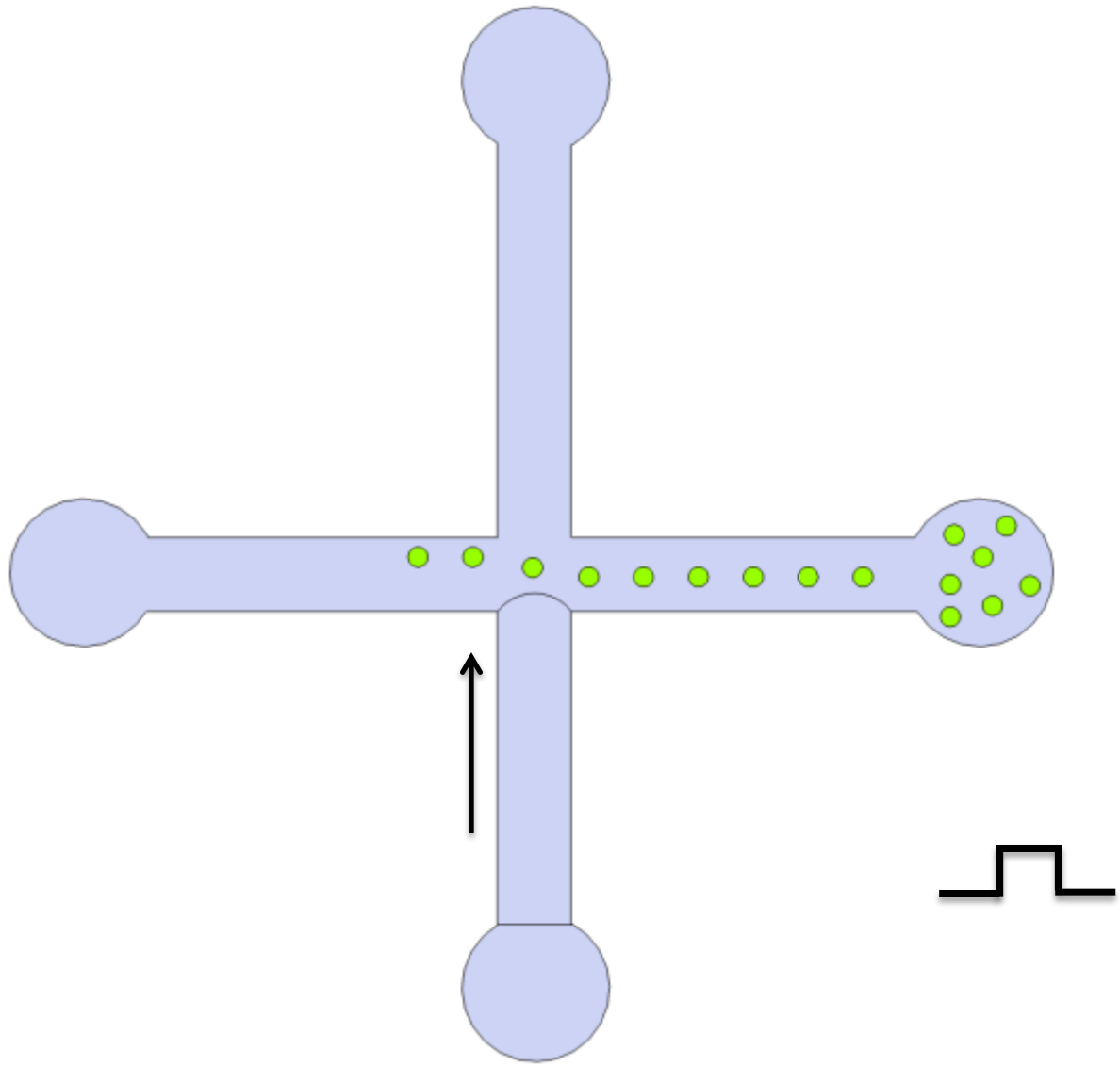
Actuation transverse to flow



Channel design

Crossing geometry

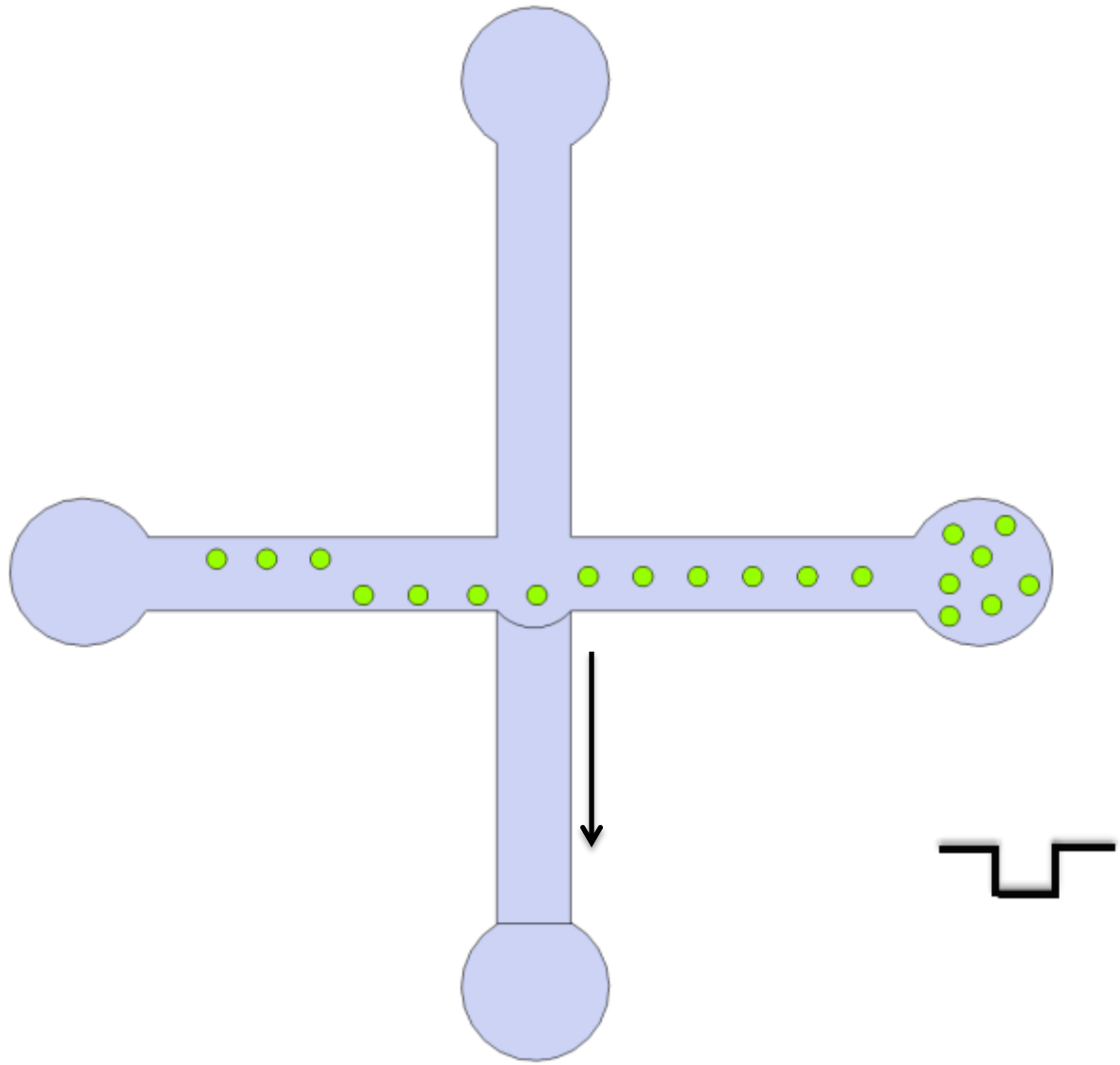
Actuation transverse to flow



Channel design

Crossing geometry

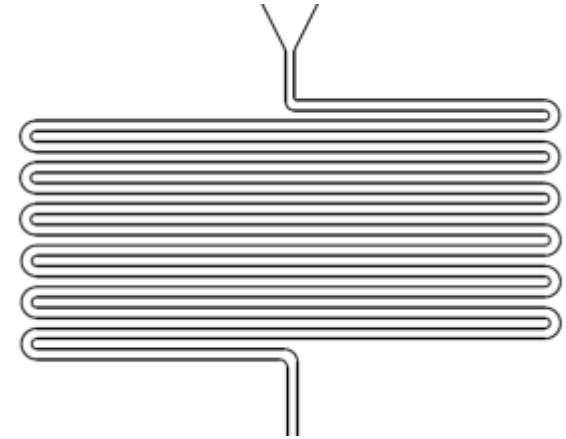
Actuation transverse to flow



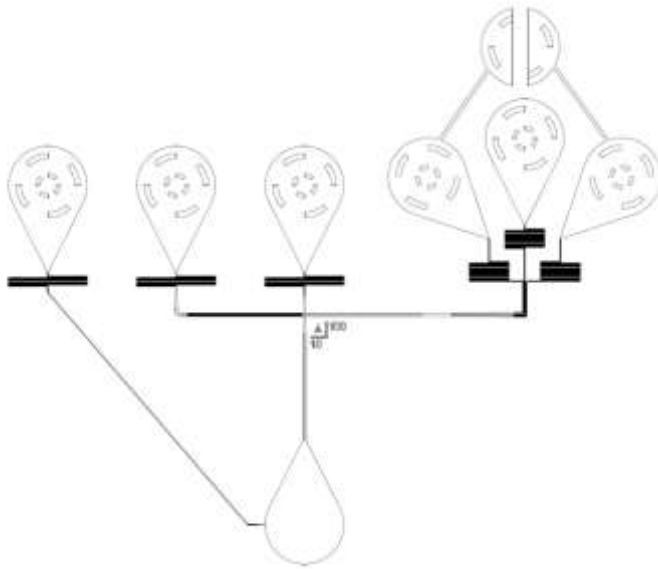
Channel design

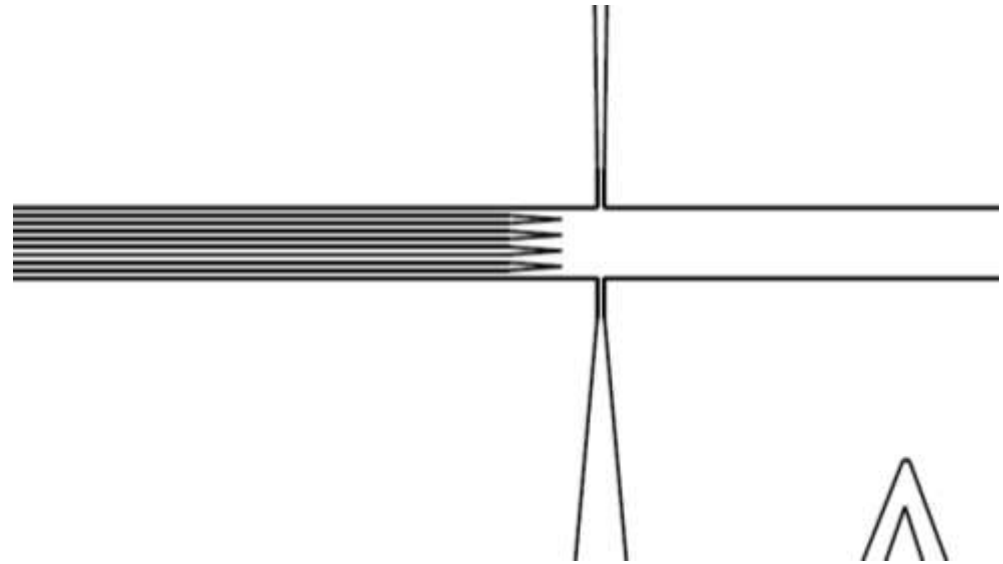
Features

Geometry allows measurement,
air removal, variable impedance



Central, symmetric flow; can bias

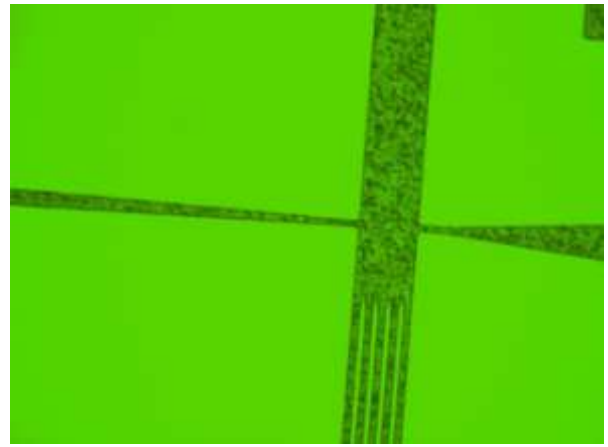


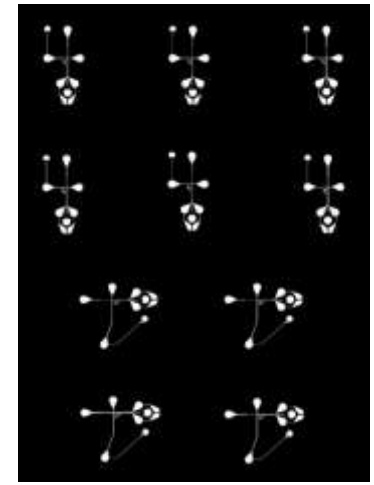


Fabrication

Method

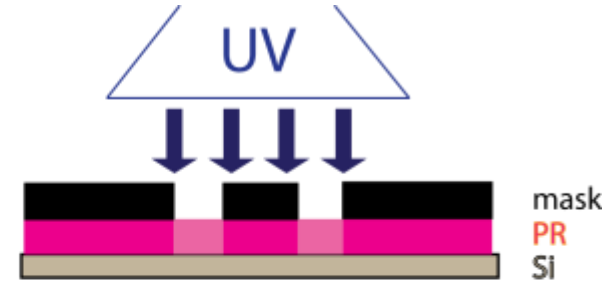
cqstech.com





Clean Si wafer.

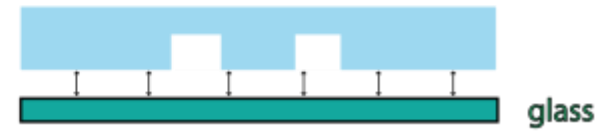
Apply photoresist.



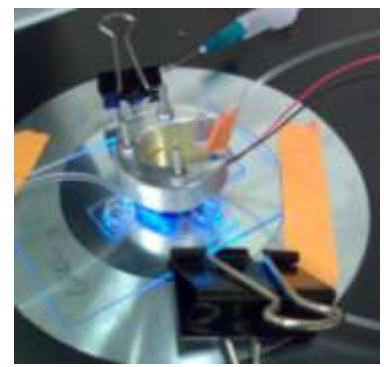
Perform lithography.

Finalize mold pattern.

Pour and cure PDMS device.

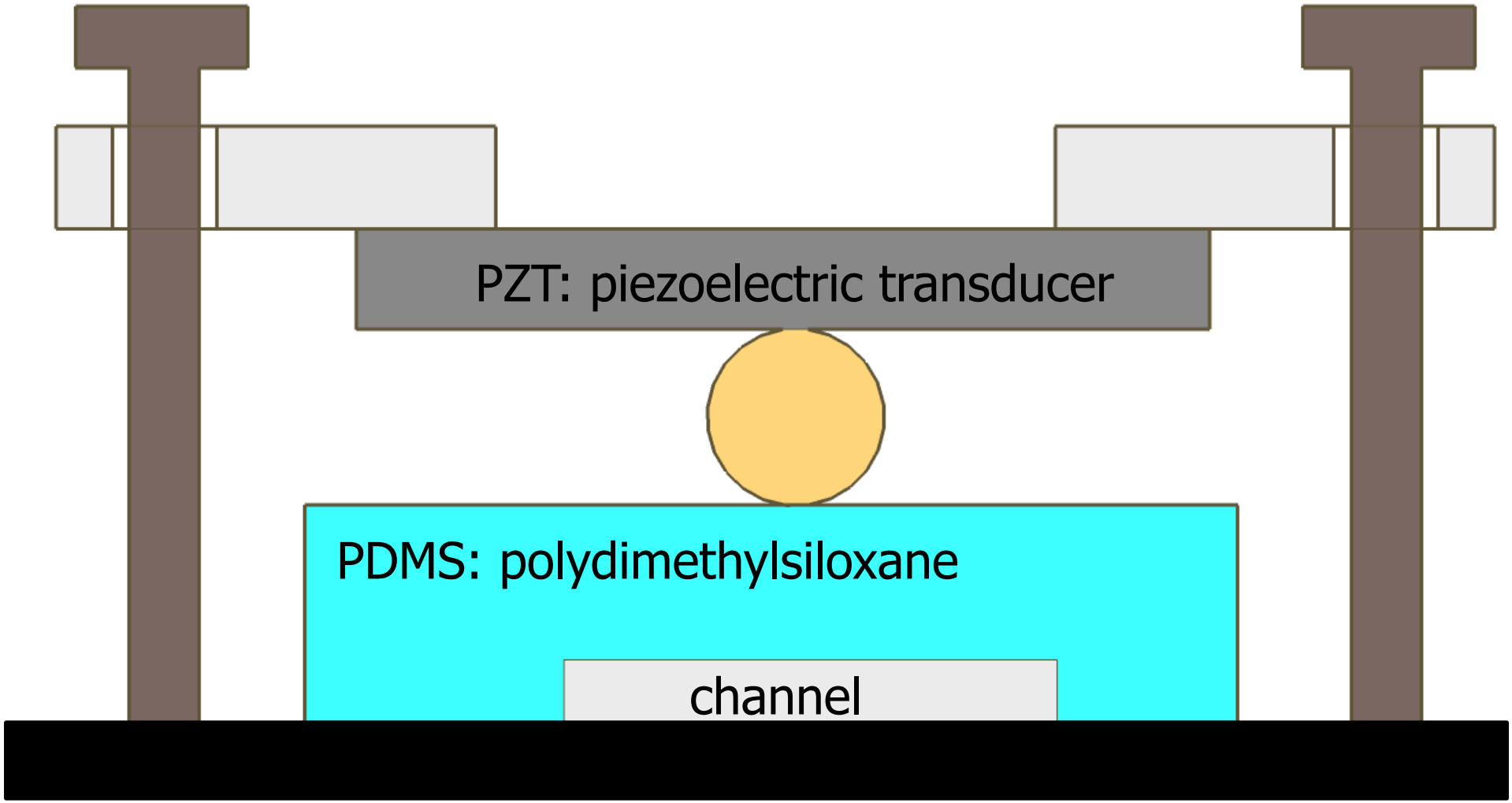


Bond glass substrate.



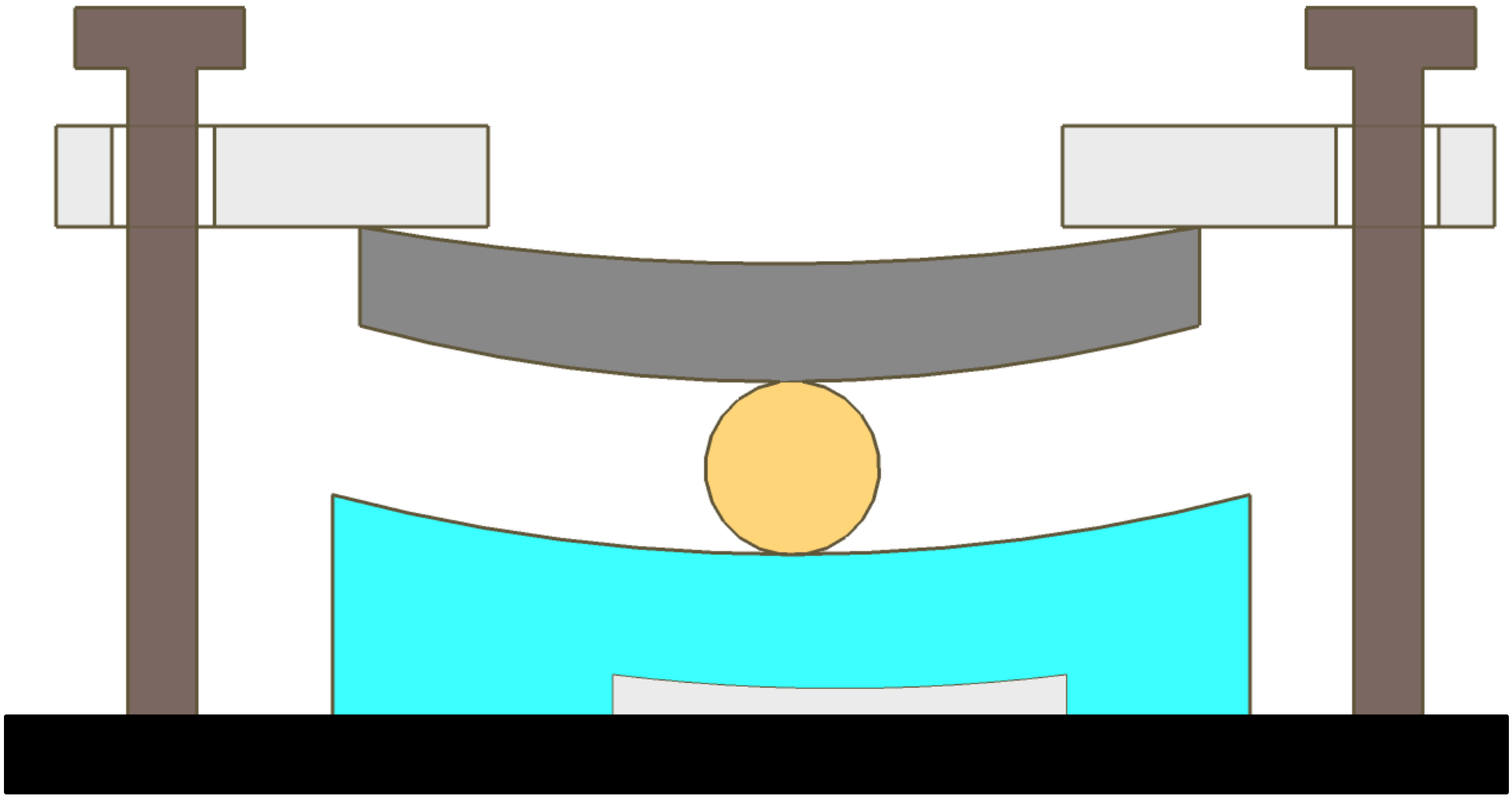
Experiment design

External coupling



Experiment design

External coupling



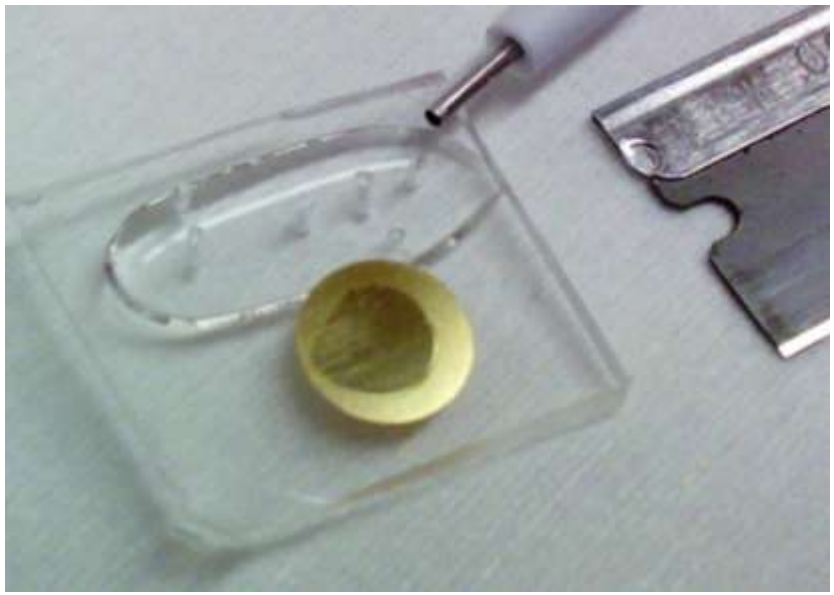
Experiment design

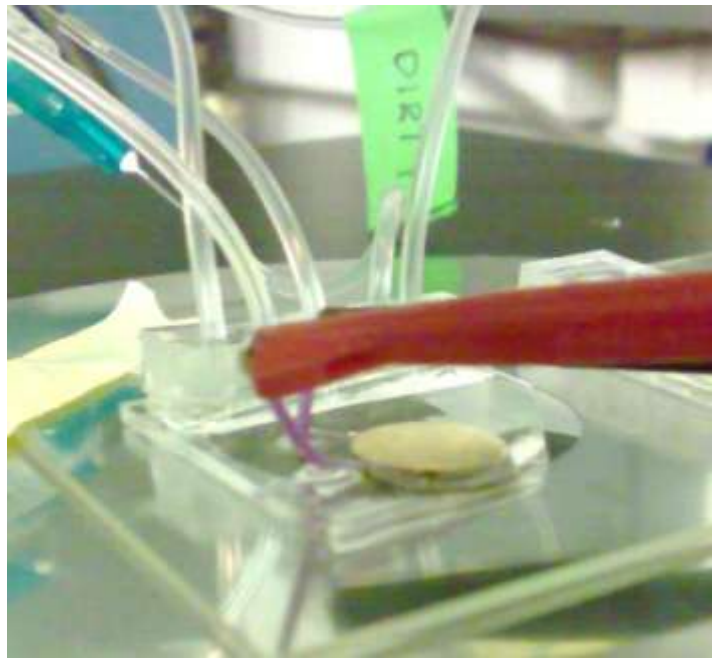
Internal coupling

Direct contact with fluid, no PDMS layer drawbacks

New setbacks: PZT greatly loaded, can leak

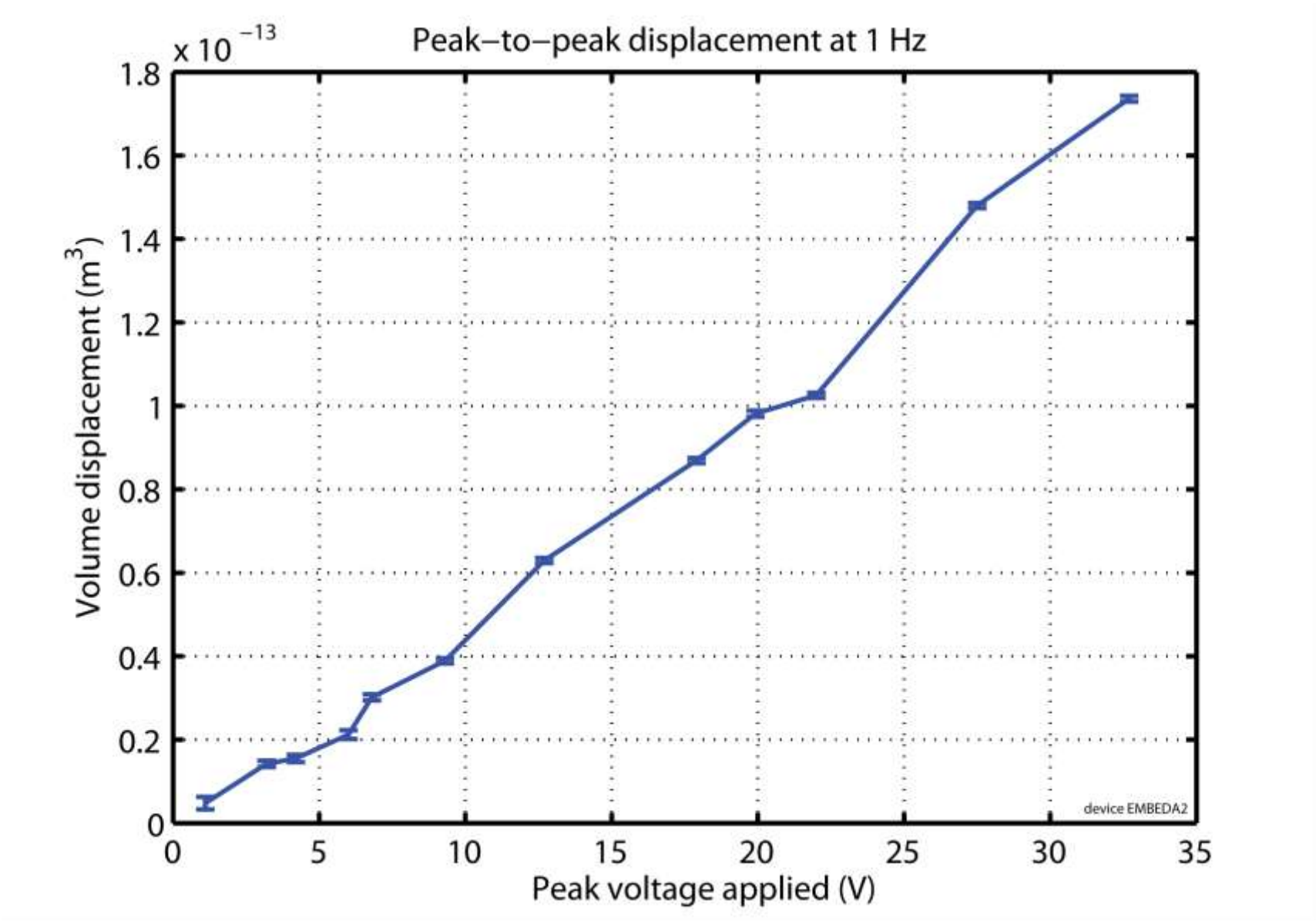
Huge displacement gain





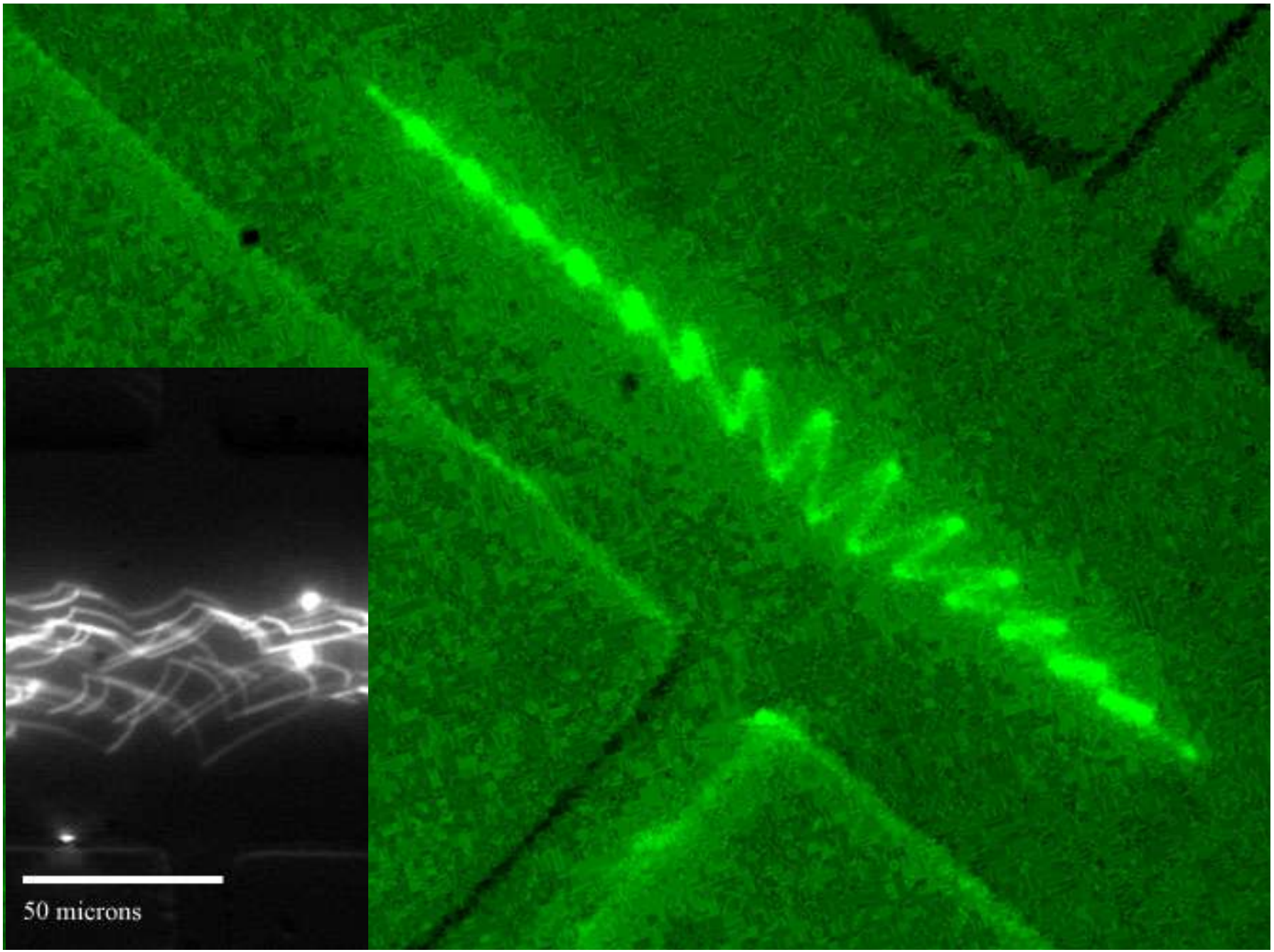
Measurements & Data

Displacement



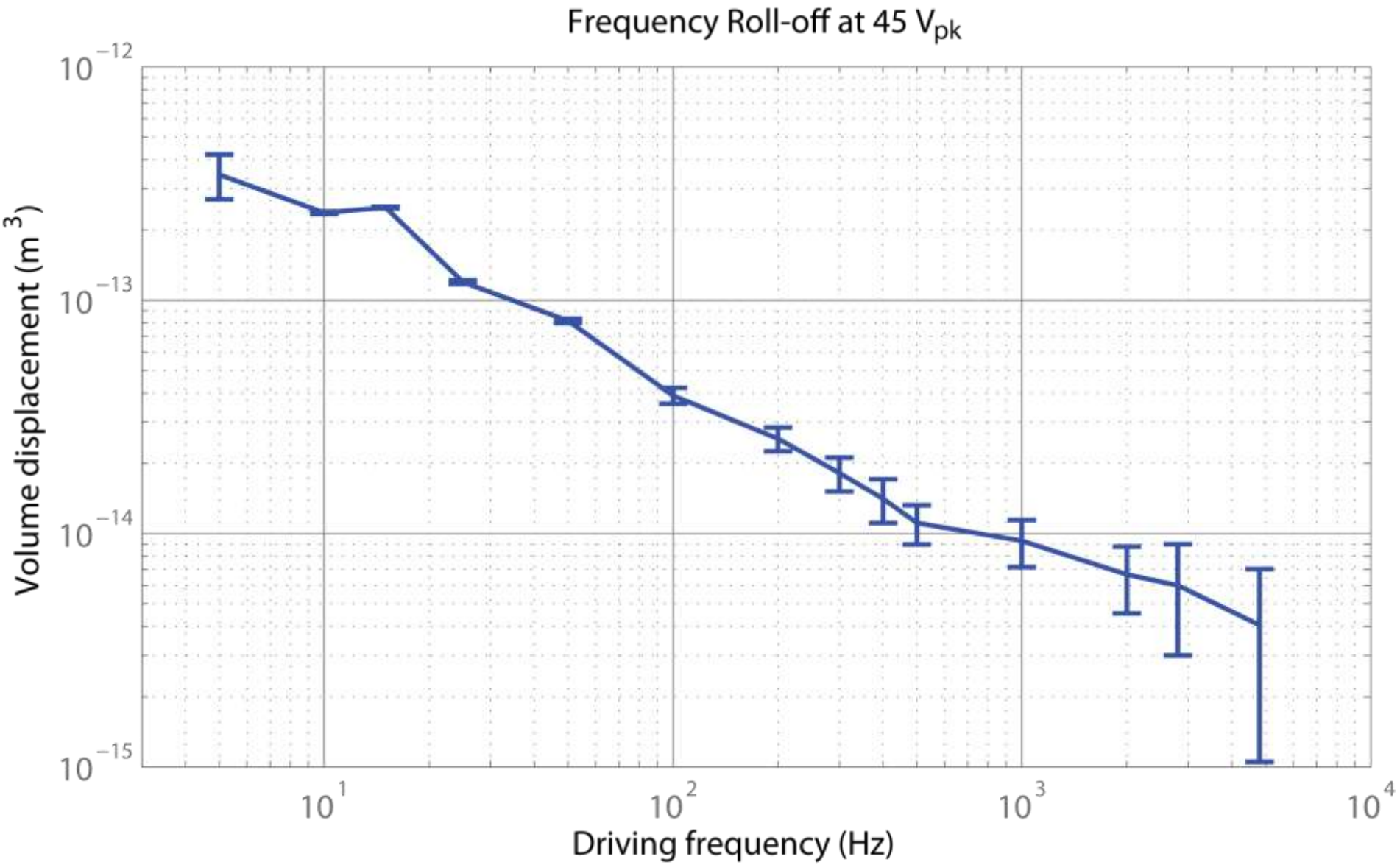
Measurements & Data

High frequency



Measurements & Data

Frequency Dependence



Measurements & Data

Single pulses

Measurements & Data

Auto-triggering

Measurements & Data

Auto-triggering

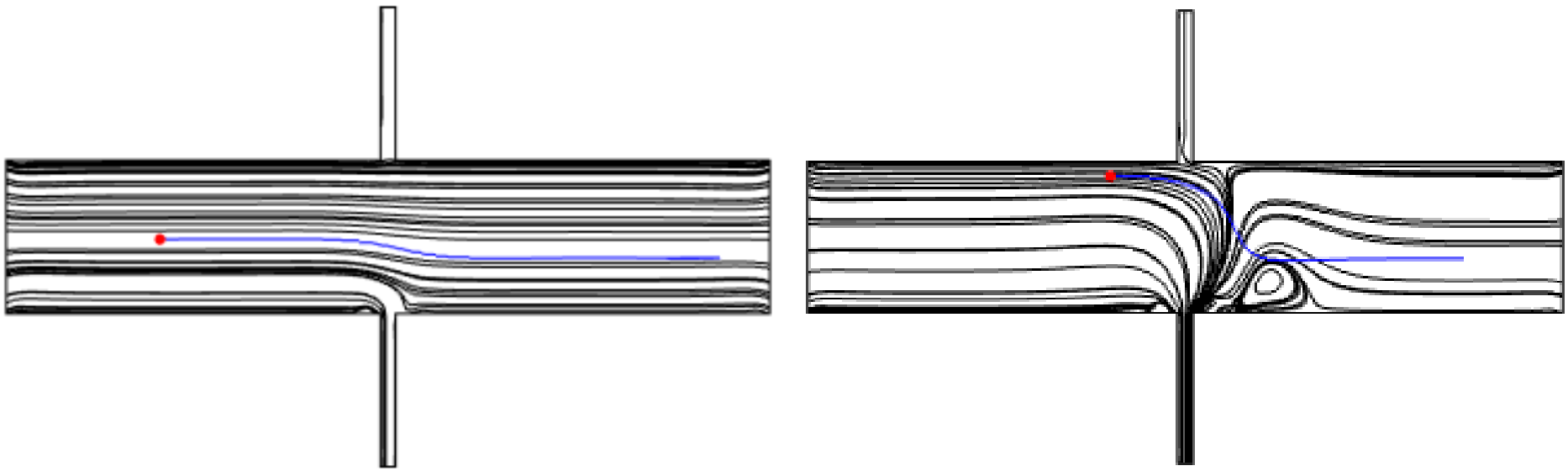
For the future…

Recover resonance in embedded devices

Use simulations with observations to understand the physics

Optimizations: smaller, quicker, more controllable

Explore scalability



COMSOL models of velocity streamlines and particle paths around intersection

Thanks

Andrew Cleland

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Mike Stanton

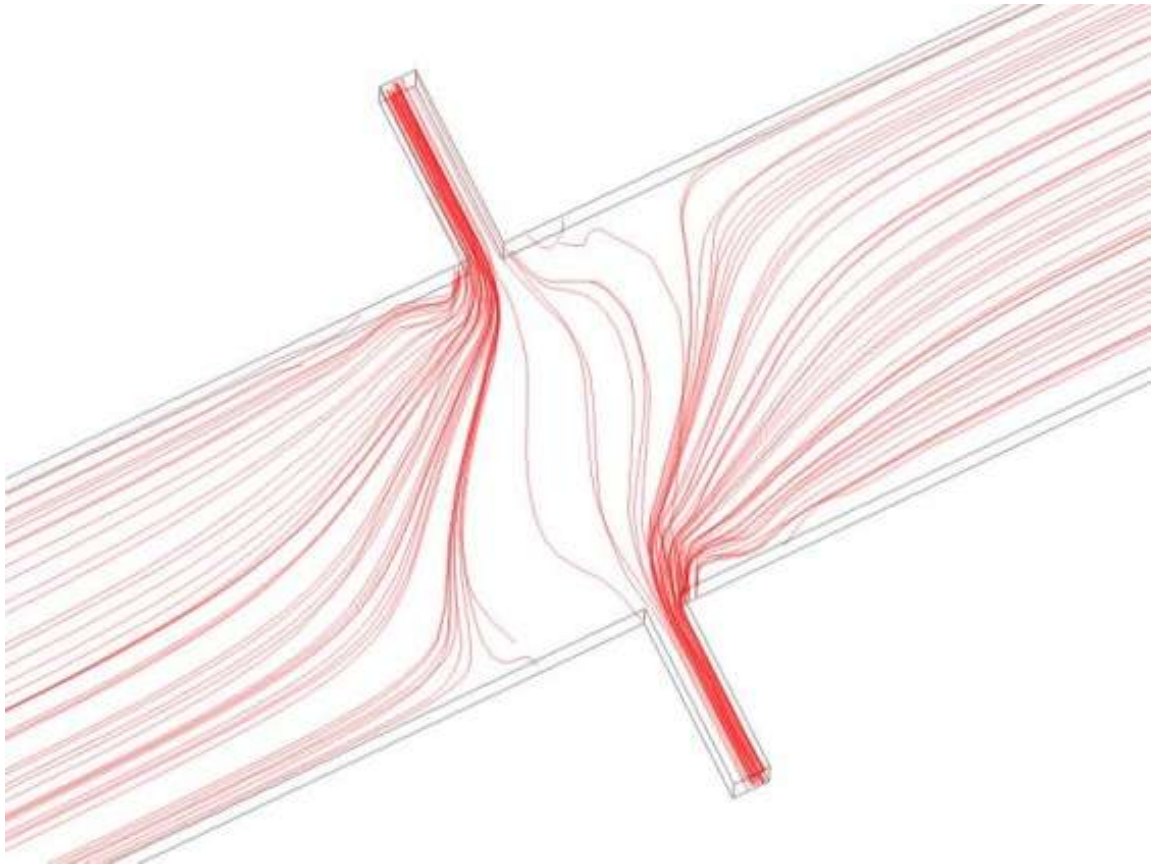
Jorge Carvalho

Sukumar Rajauria

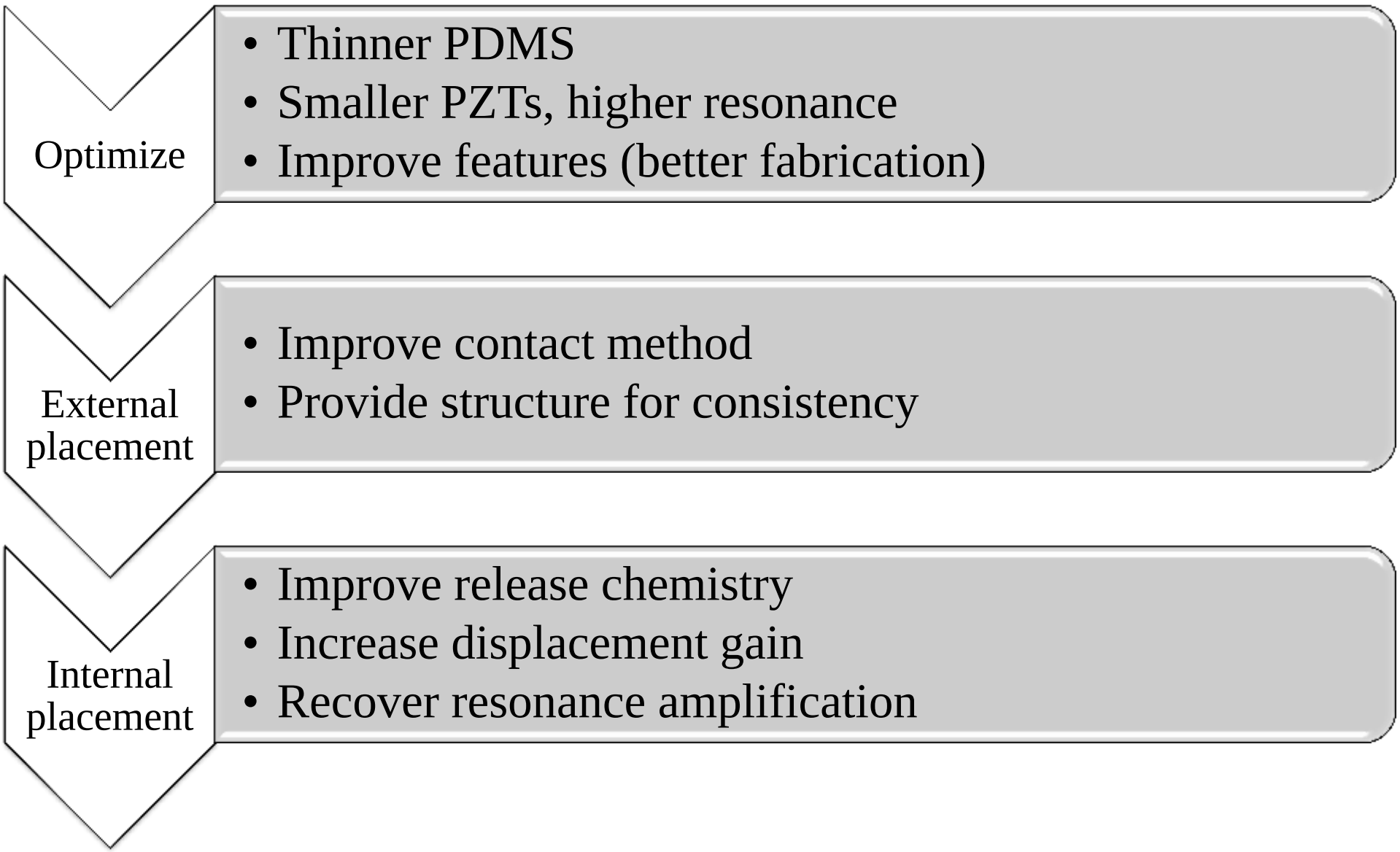
Menon Watson Family Foundation

W. M. KECK FOUNDATION

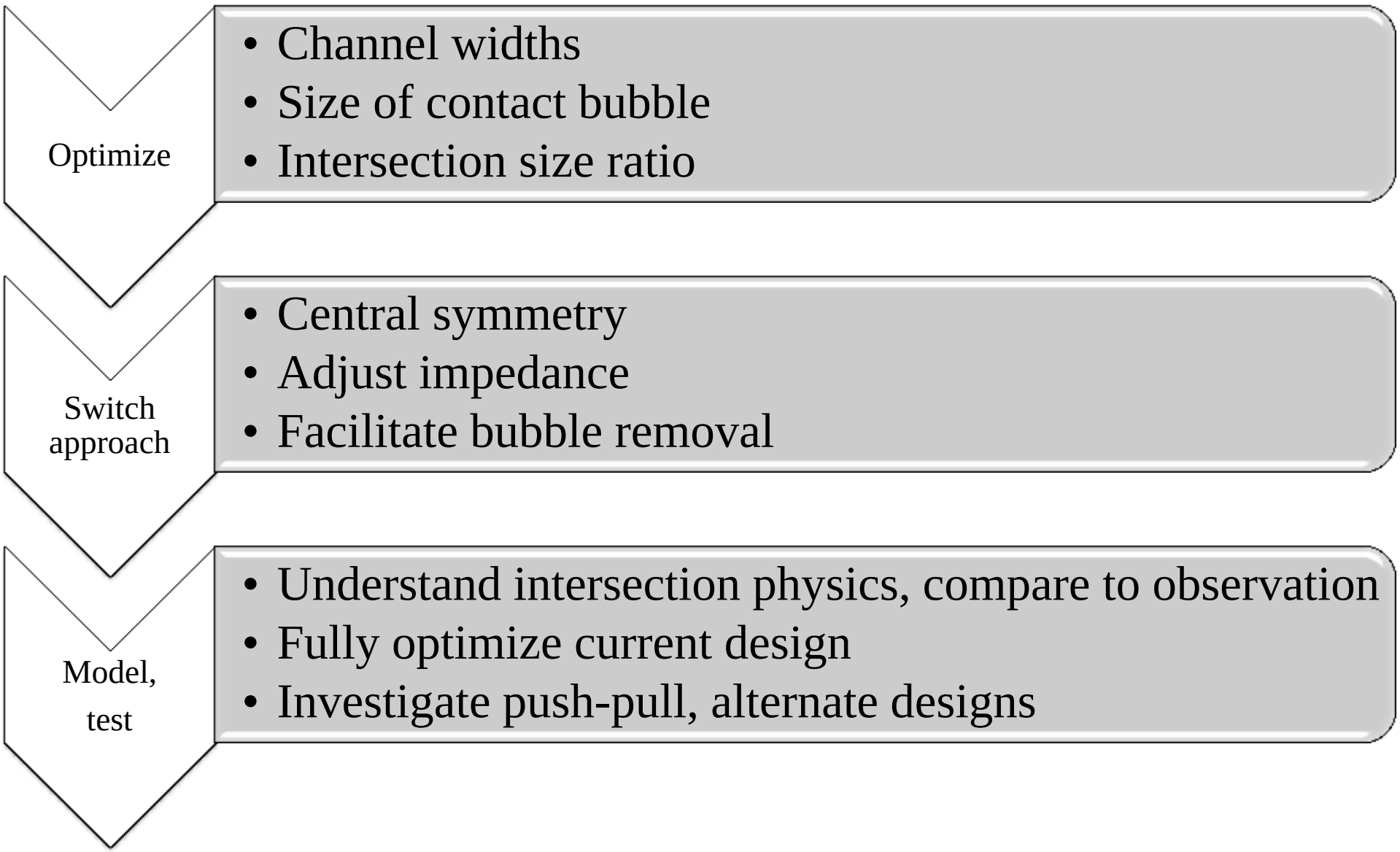
The End



Actuator design process flow



Channel geometry design process flow



Measurements & Data

Particle Tracing