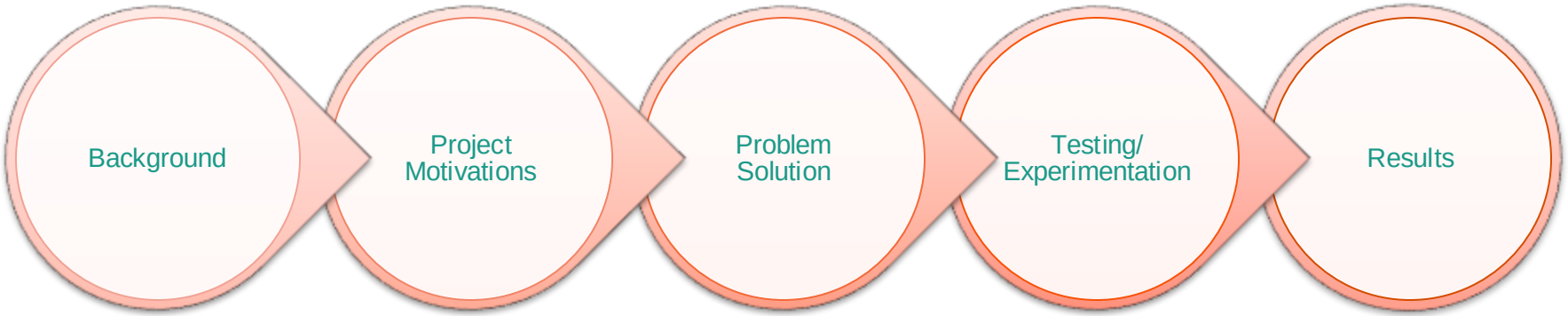
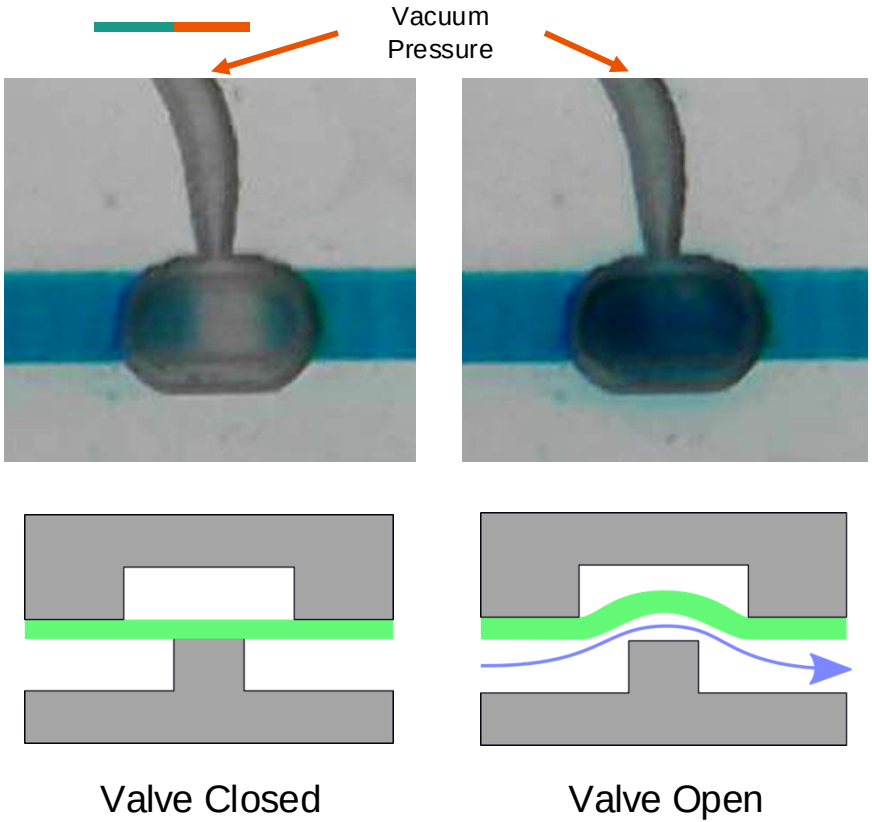
# Microfluidic Valves

Benjamin Lam

# Agenda


Background
Project Motivations
Problem Solution
Testing/ Experimentation
Results

# Microfluidics Background



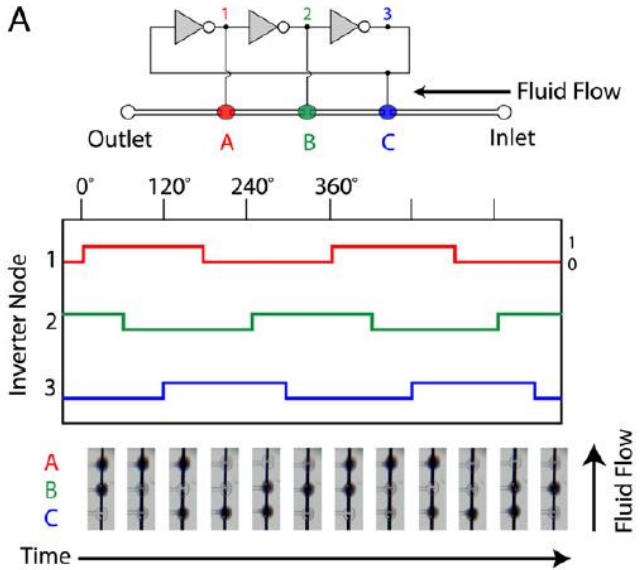



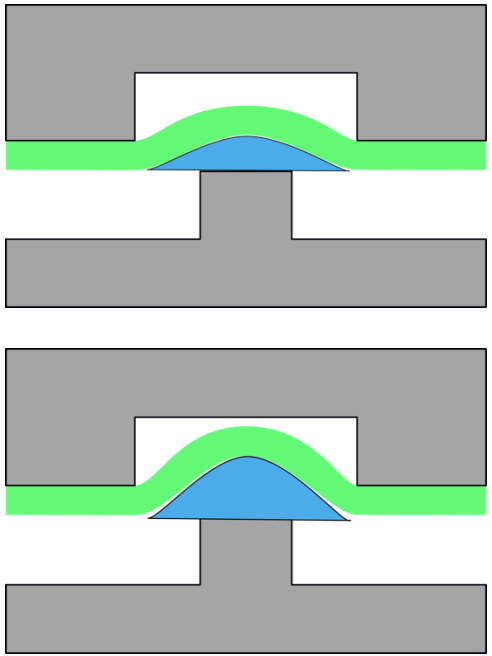

Fig 3.1 Peristaltic pumping using a ring oscillator and three pumps.
[Duncan, et al. (2013) *Pneumatic oscillator circuits for timing and control of integrated microfluidics*]

# Volume Variance

Vacuum Pressure P1

P1 < P2

Vacuum Pressure P2



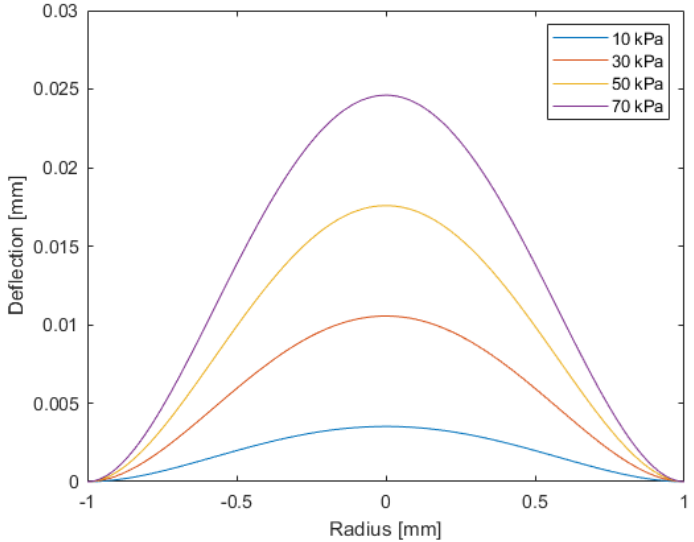
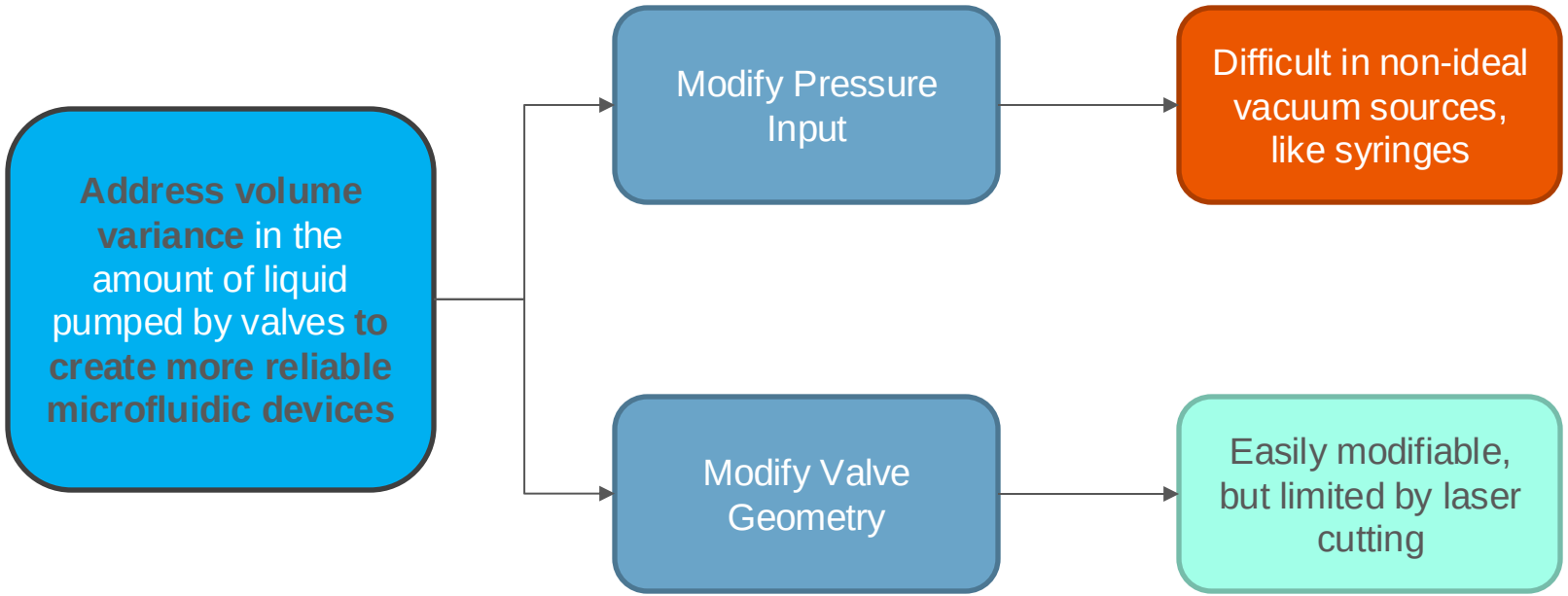



Fig 4.1 Deflections with varying vacuum pressure.

# Project Motivation



# Limited Valve Design

- Valve will have a shortened depth to constrain membrane deflection
- At high pressures, the amount of additional volume deflected is negligible
- Main idea: liquid “sucked in” reaches a saturation point as the membrane is constrained

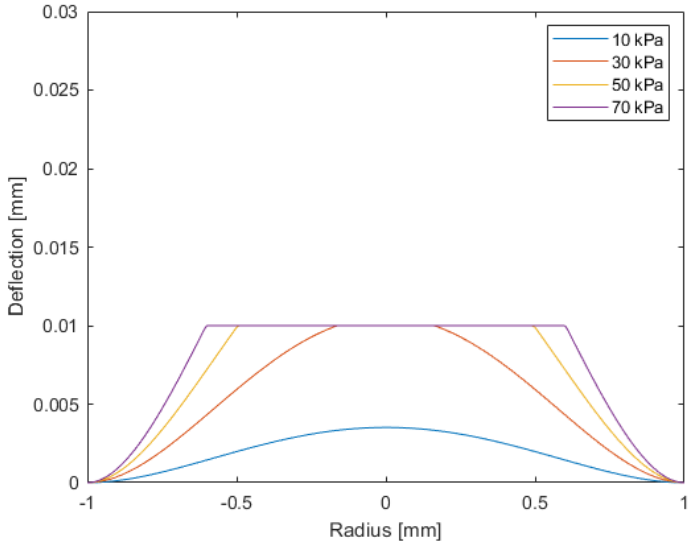



Fig 6.1 Deflections with varying vacuum pressure for a valve height-limited to 10 µm.

# Testing Challenges and Requirements

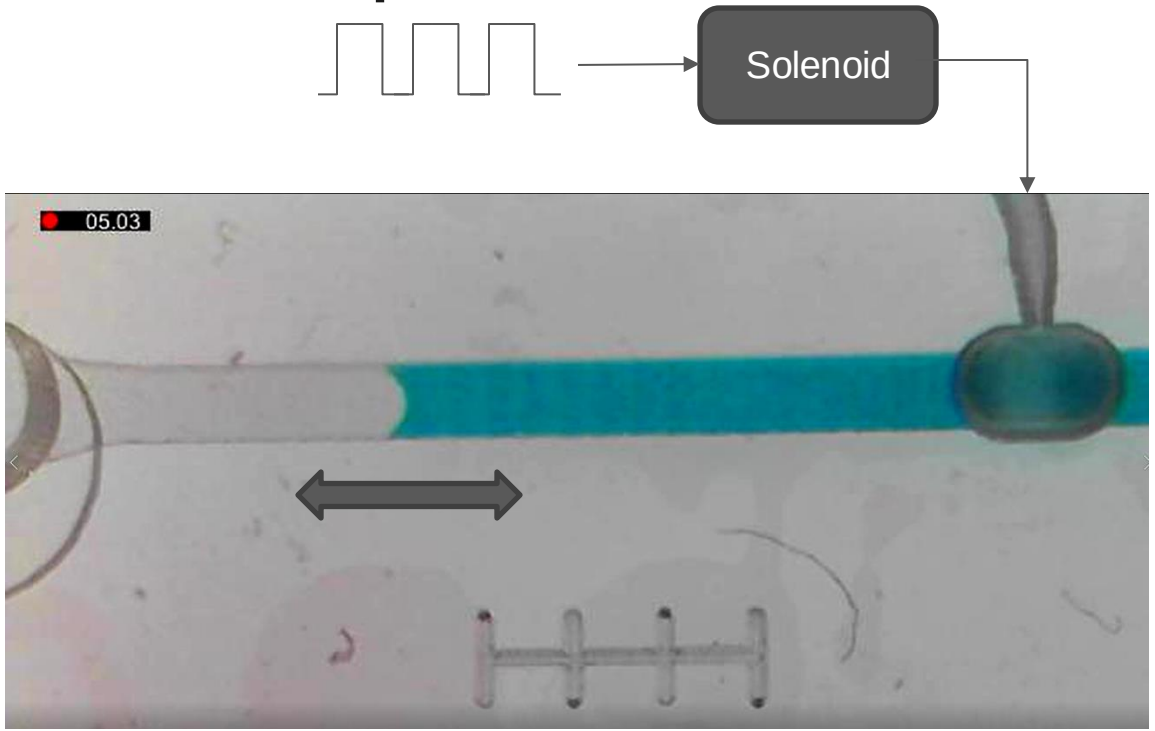
Requirements:

- Measure volume changes of <0.01 µL
- Sampling rate of ~1 s
- Measurements should be automatically processable

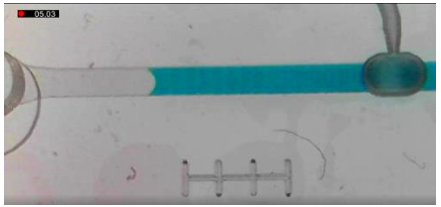
Challenges:

- Tests done in apartment with limited space, uncontrolled lighting
- Sample should not move during experiment

# Experimental Setup



# Data Flow



Storage

Microscope

Camera Script (Processing, Arduino)

.bmp images
Pressure Data

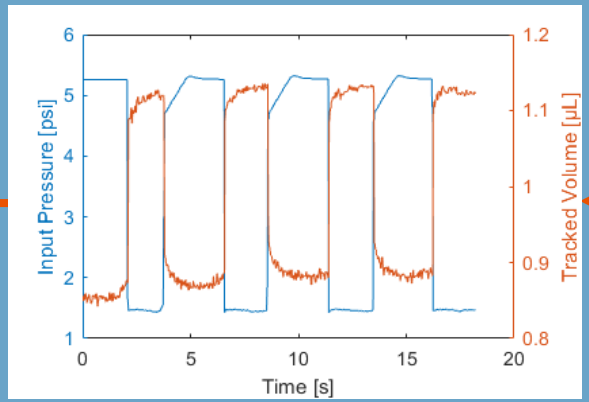
Ingest Script (MATLAB)

.avi Video
.mat Datafile

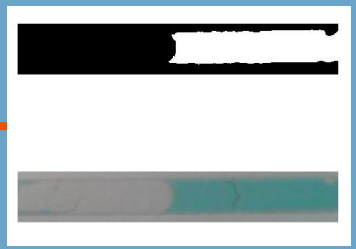
Data Processing (MATLAB)

Post Processing

Volume Conversion

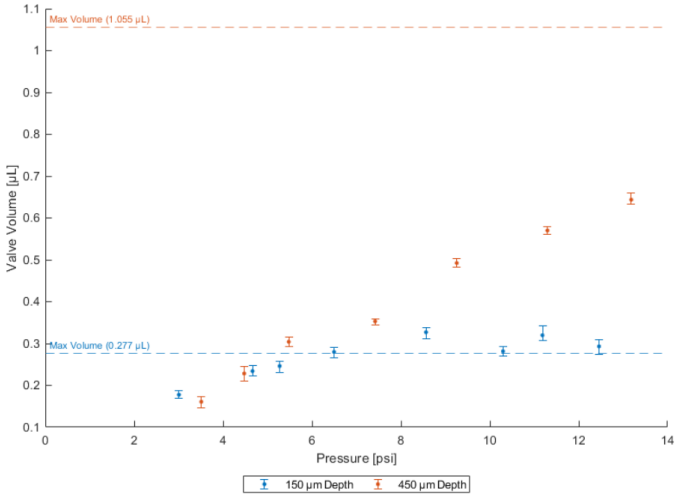



Pixel Counting
(Convert to volume units)



Color Thresholding

# Outcomes




**Supplemental Figure 3**: Valve membrane deflection measurement. The volume of water displaced by a single valve was measured for valves of depths 150 µm (blue) and 450 µm (orange). Shallow valves (blue) become limited by the depth of the displacement chamber and approach the maximum volume of the chamber at around 7 psi, while deep valves (orange) continue to displace more volume as actuation vacuum increases.

Fig 10.1 Supplemental figure for submitted droplet pump paper.

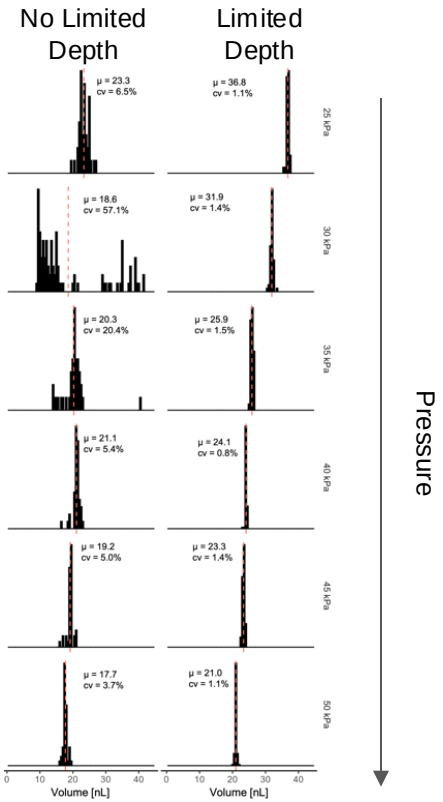



Fig 10.2 Comparison of droplet pumps with different valve geometry.

# Supplemental Slides

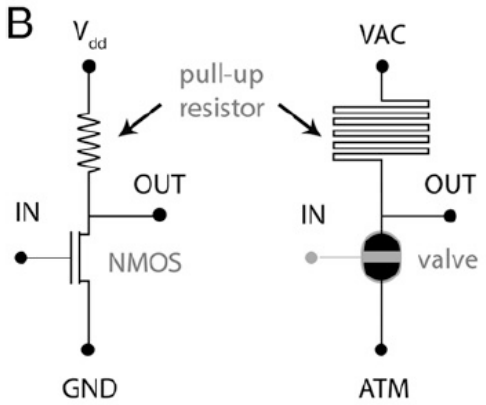



Fig S1. Microfluidic similarity to electric transistors.

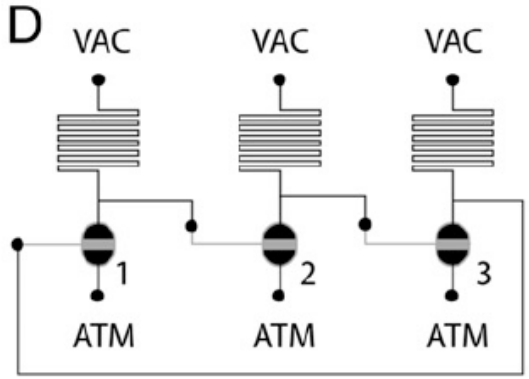



Fig S2. Ring oscillator setup for microfluidic chip.

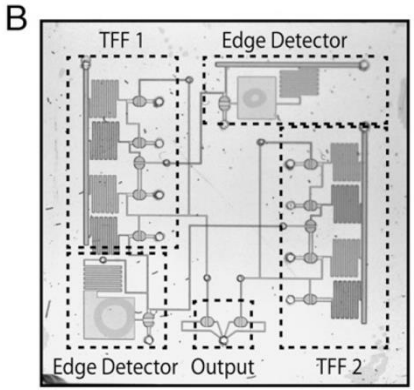



Fig S3. Frequency divider circuit

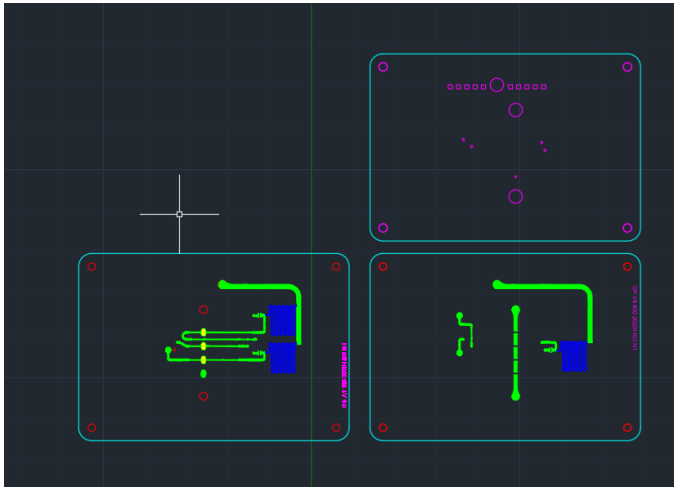


Fig S4. CAD of a microfluidic pump