Hydrodynamic Flow Focusing for Microfluidic Cell Sorting Chip

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Portable pathology lab (CBC Machine)

Microscope lens

Cell sorting chip

Mobile

What is cell sorting?

Cell sorting is the ability to separate cells according to their properties.
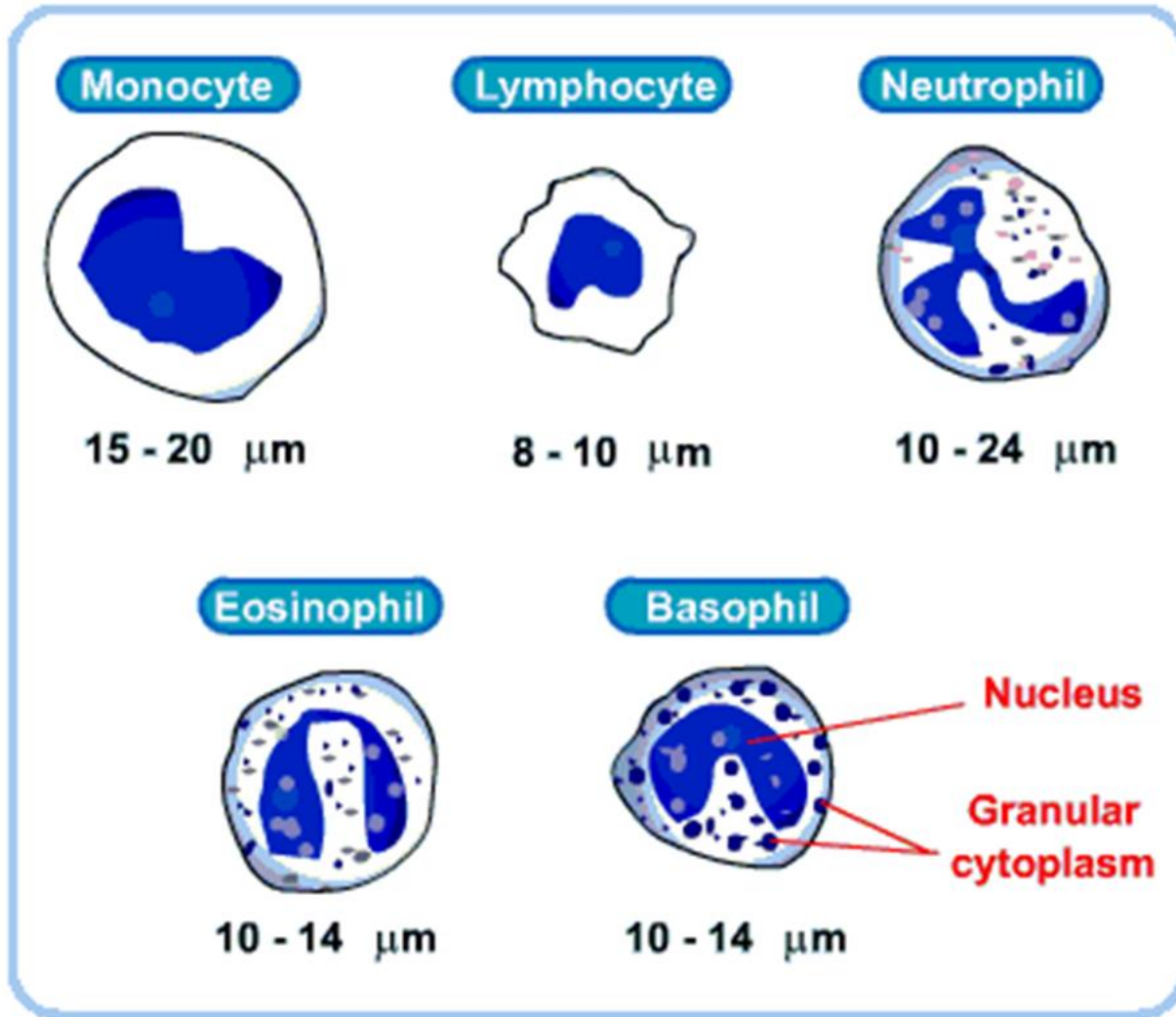
What is cell sorting?

Cell sorting is the ability to separate cells according to their properties.

What properties?

What is

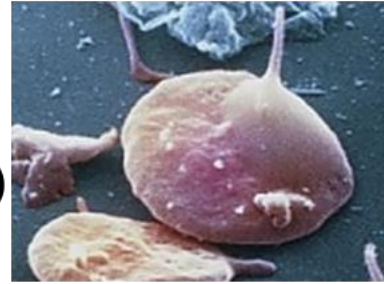Cell sorting is t

1)Size

White blood cells

Monocyte 15 - 20 μm

Lymphocyte 8 - 10 μm

Neutrophil 10 - 24 μm

Eosinophil 10 - 14 μm

Basophil 10 - 14 μm

Nucleus

Granular cytoplasm

(8-24 Micron)

Source: http://www.s-cool.co.uk/a-level/biology/transport/revise-it/blood.html
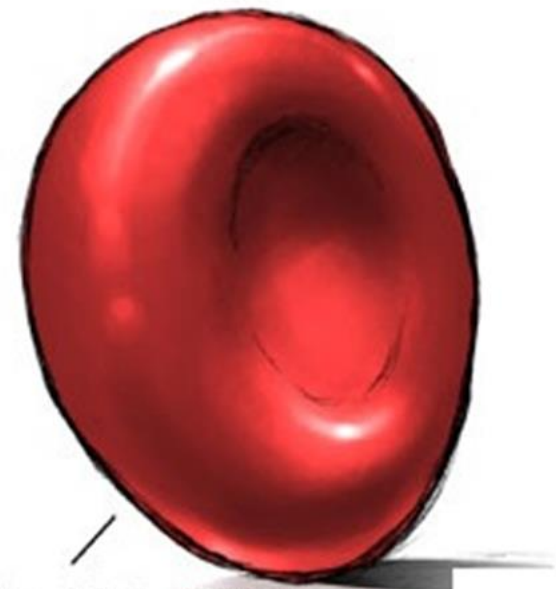
Platelets
(2-4 Micron)

Source:http://www.visualphotos.com/photo/1x600900
2/active_blood_platelets_coloured_sem_p256045.jpg
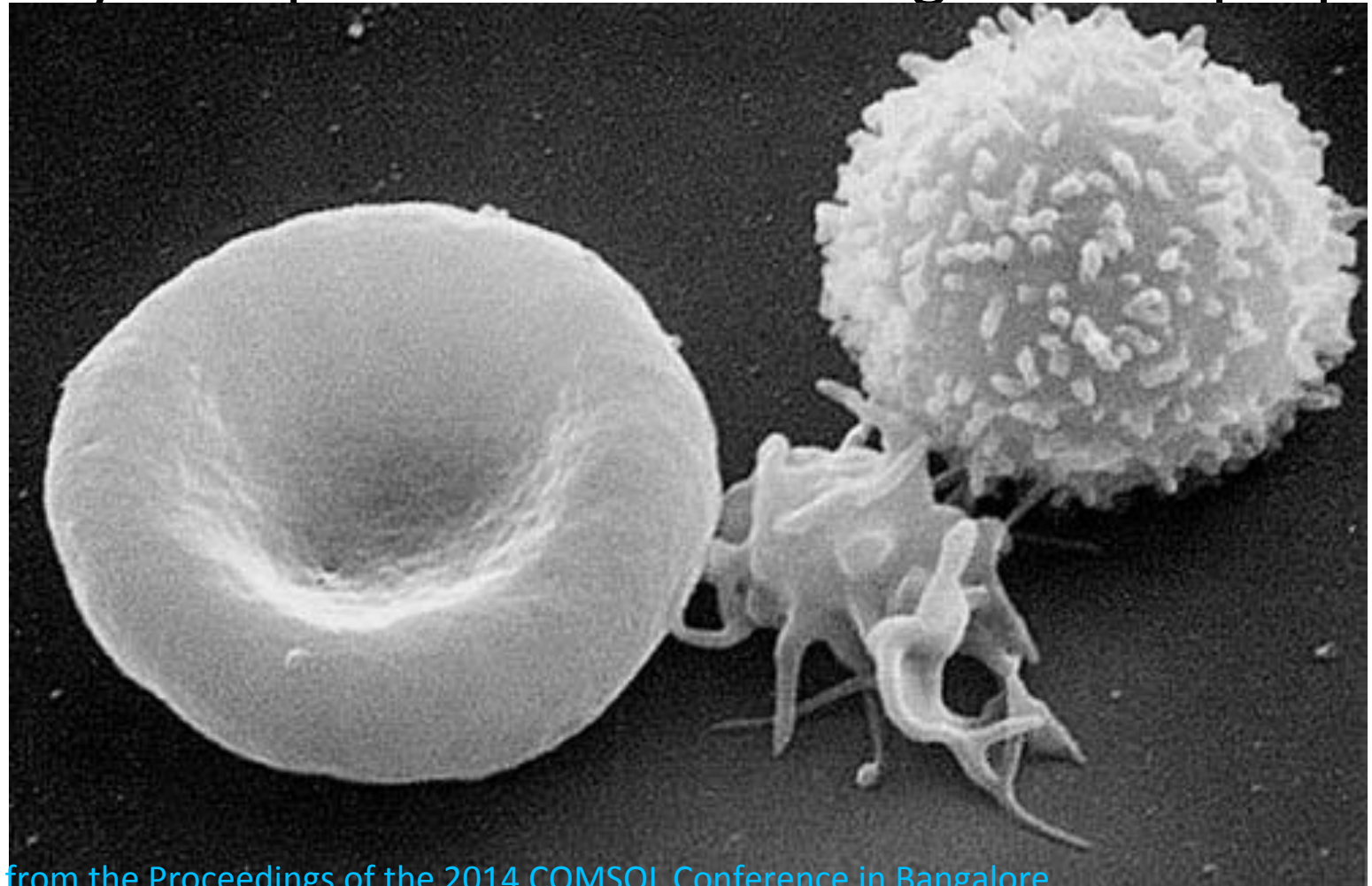
Red blood cells

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Red Blood Cells (RBCs)
(6-8 Micron)

Excerpt from the Proceedings of the 2014 COMSOL Conference in Bangalore

What is cell sorting?

Cell sorting is the ability to separate cells according to their properties.

1)Size

2)Shape

What is cell sorting?
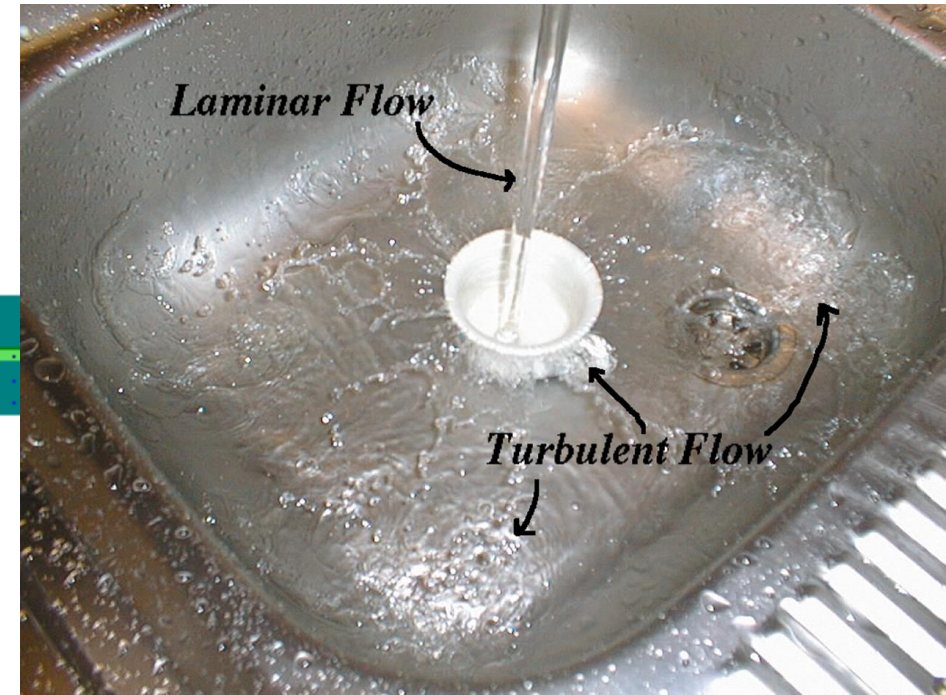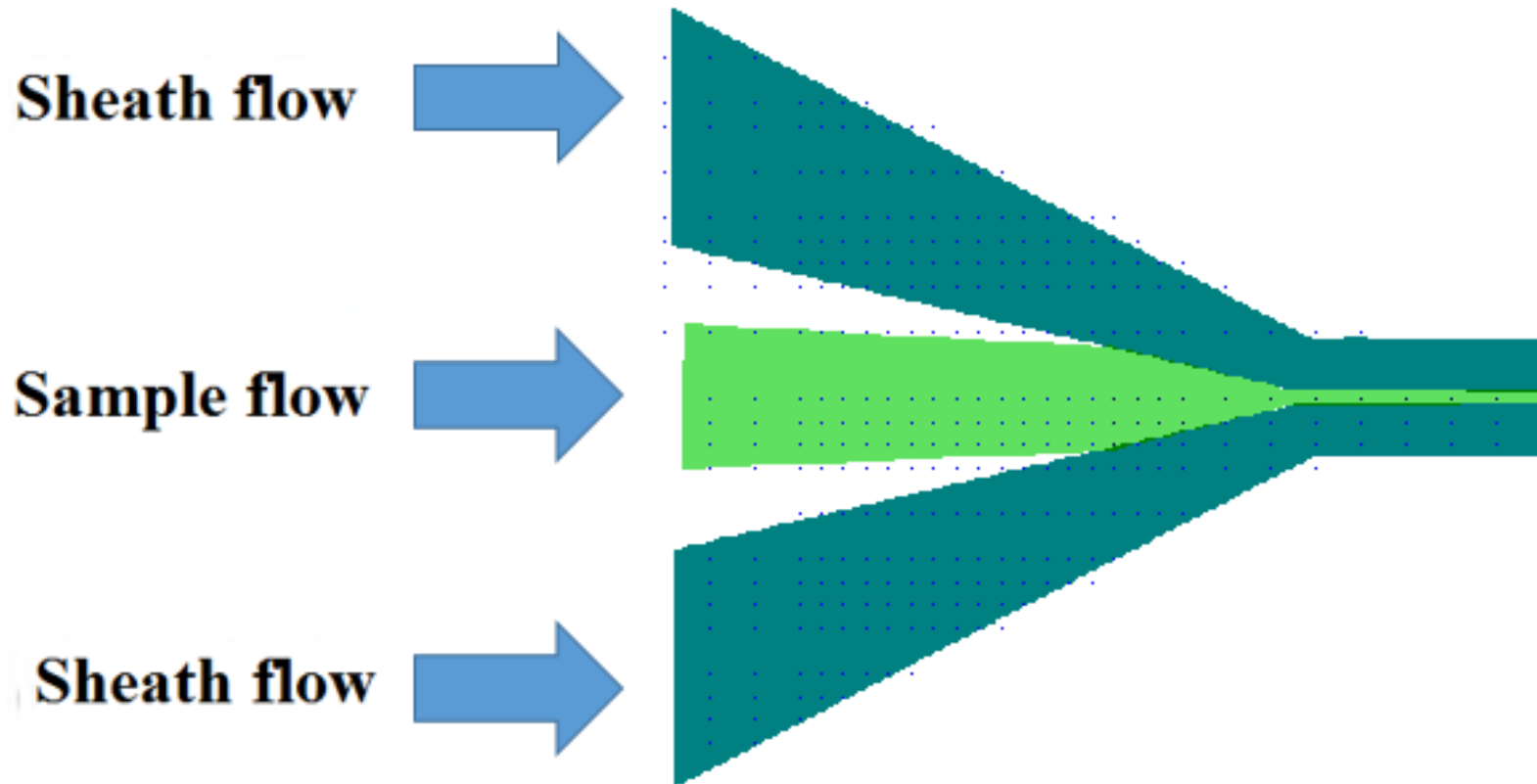
Cell sorting is the a
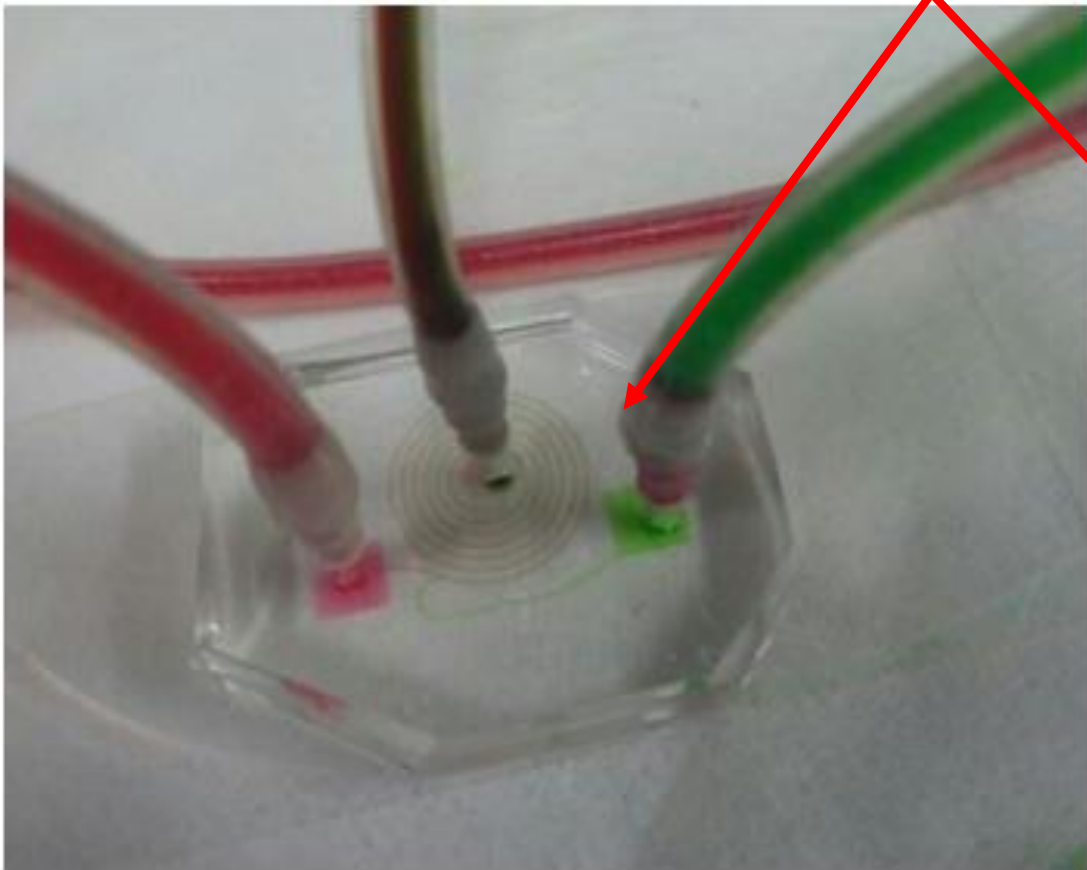
1) Size

2) Shape

3) Deformability

Hydrodynamic flow focusing

The flow from a small central inlet squeezed by two side streams (called "sheath" flows).

Sheath flow

Sample flow

Sheath flow

Laminar Flow

Turbulent Flow

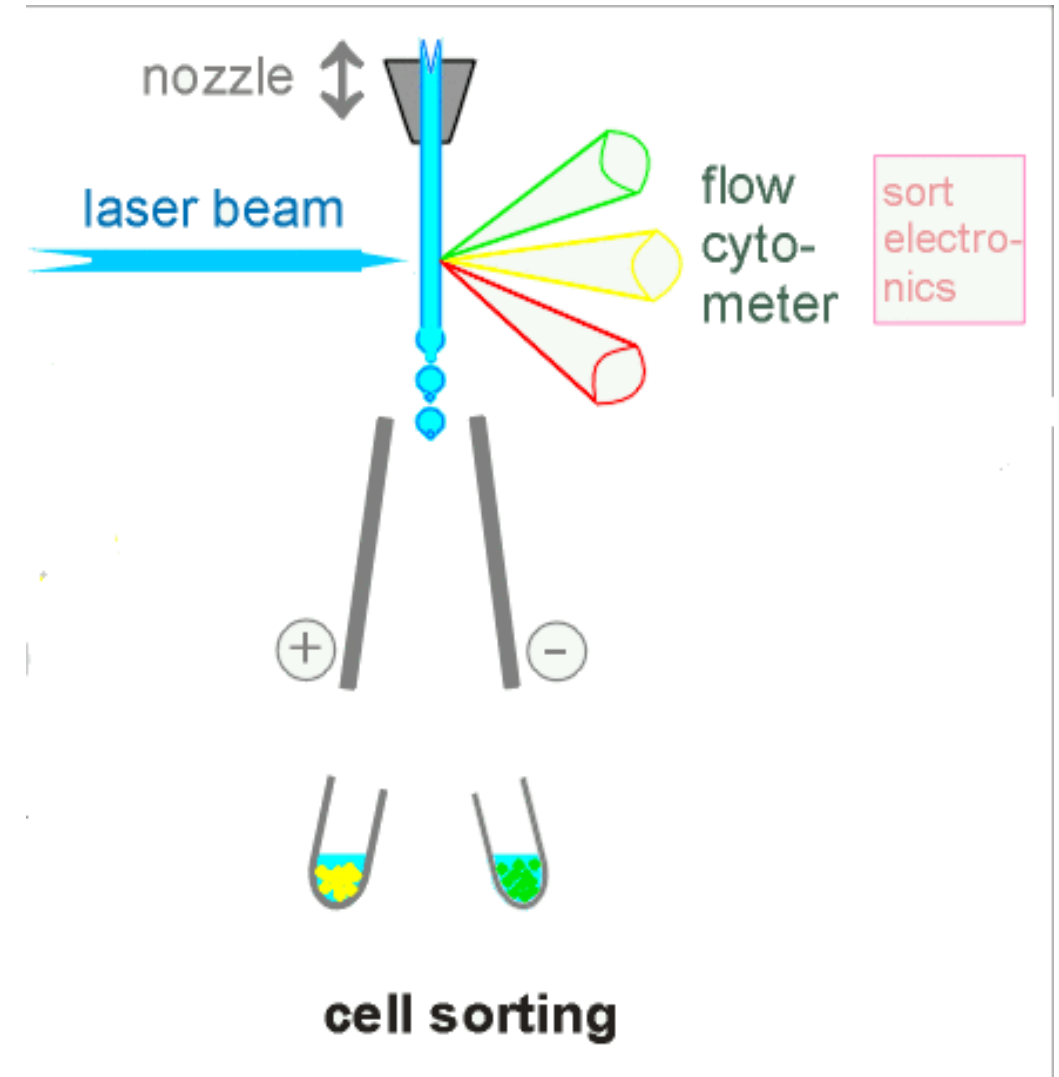# What is Microfluidics?

Microfluidic chip

Controlled fluid flow (~nL–pL) through micron-sized channels

Flow is always "laminar" in microfluidics

Hydrodynamic flow focusing : Need

Cells should arrive one by one at sorting location

A. Ease of image processing algorithm
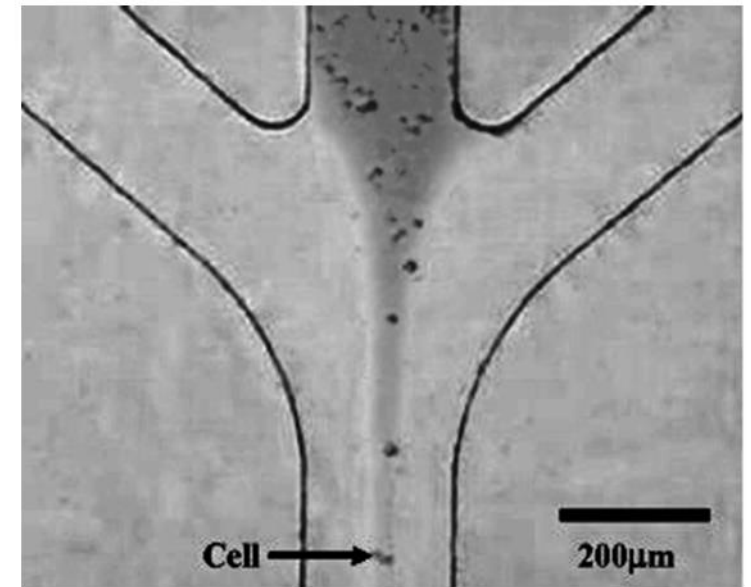
B. Ease of detection (like in FACS)

nozzle

laser beam

flow cyto-meter

sort electro-nics

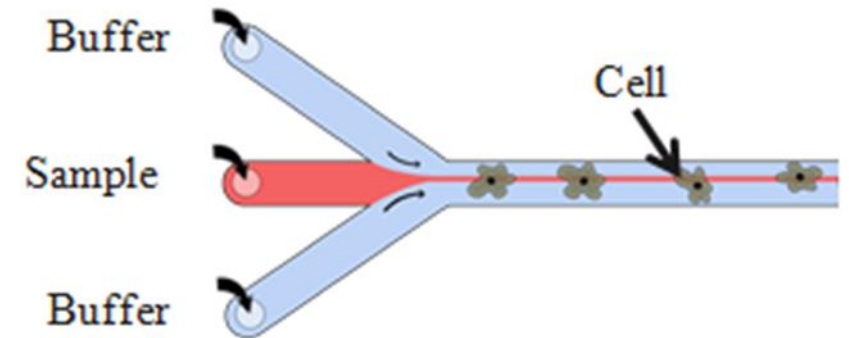cell sorting

Hydrodynamic flow focusing : Need

Cells should arrive one by one at sorting location

A. Ease of image processing algorithm

Original Image
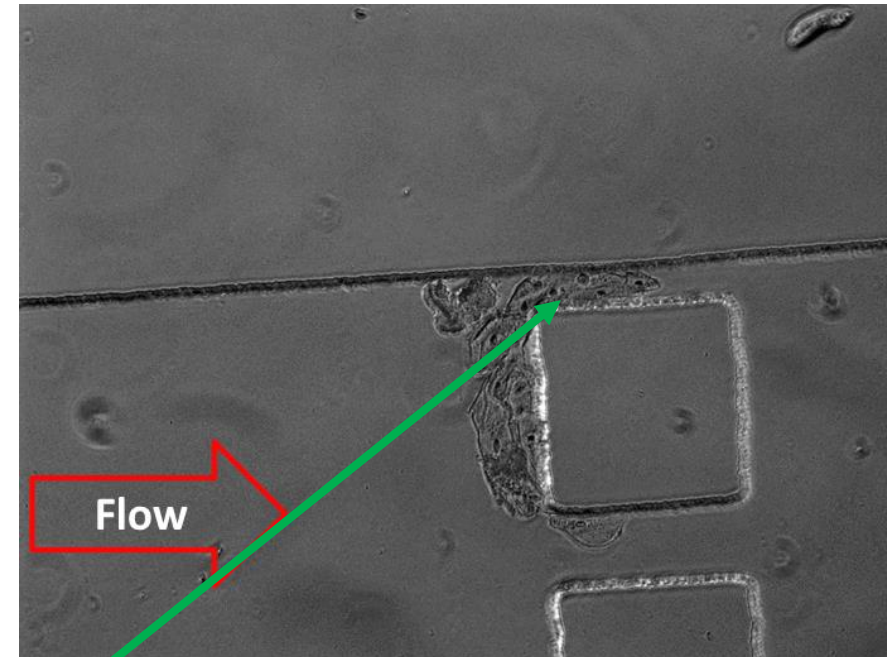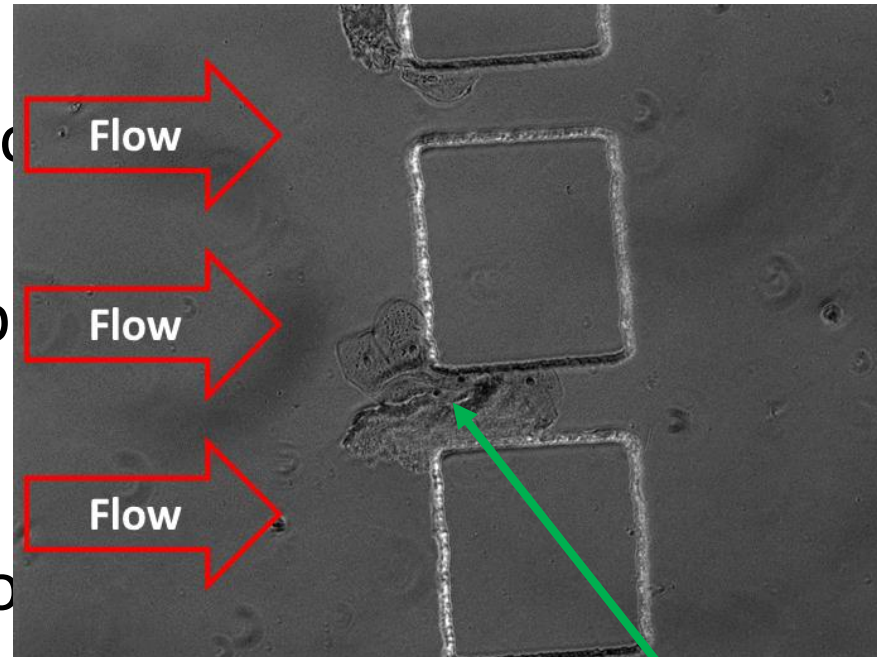
Black and white image produced by thresholding

Hydrodynamic flow focusing : Need

Cells should arrive at sorting location
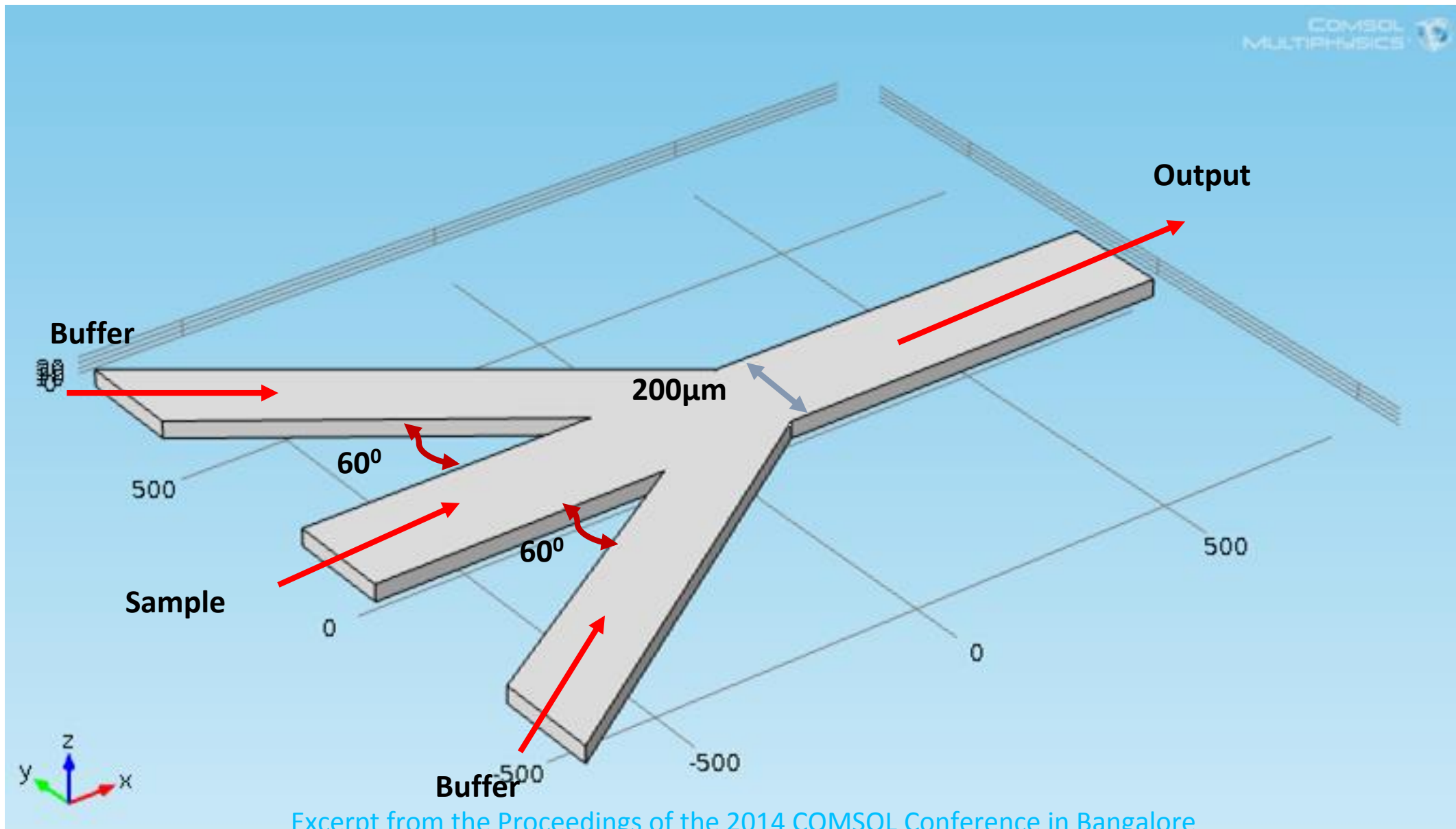
A. Ease of image processing algorithm

B. Ease of detection

C. Cells should be in center of the channel and not near walls this enables clearing of cell clogging by reverse flow
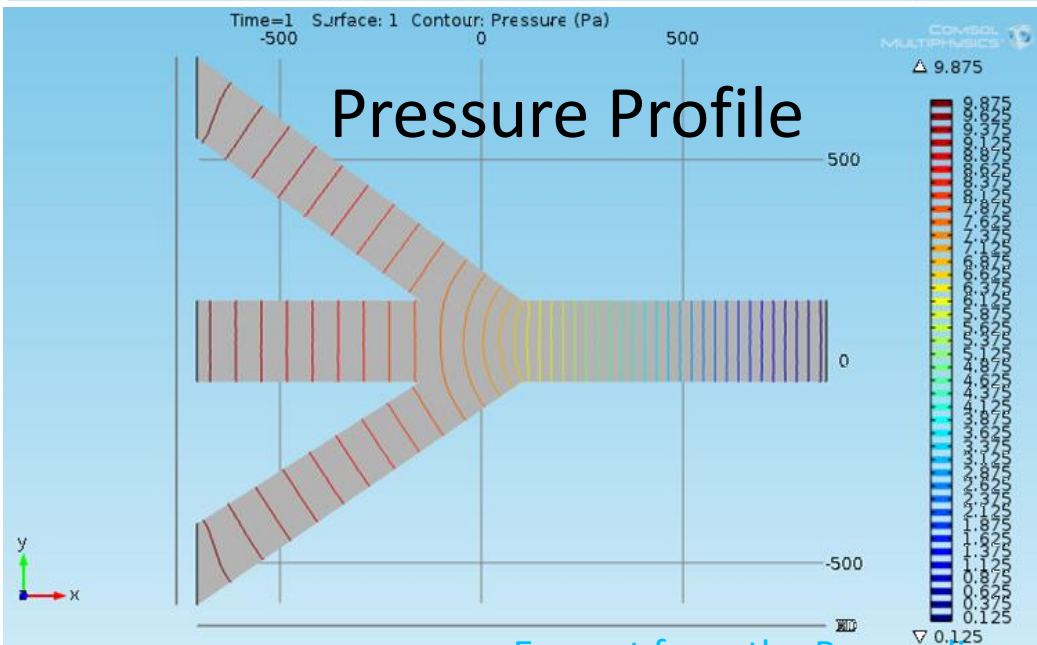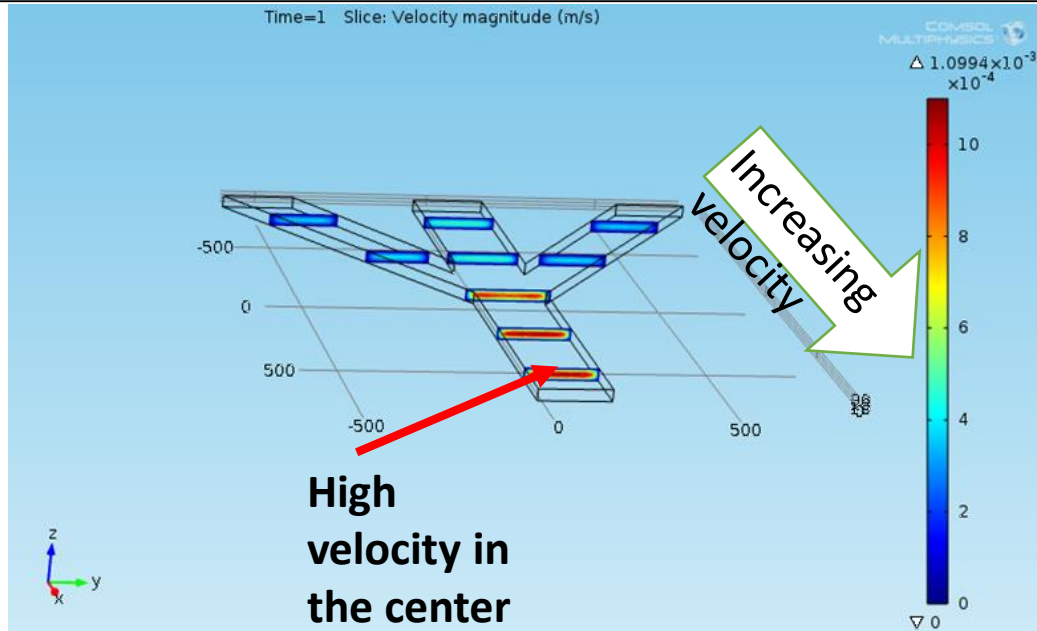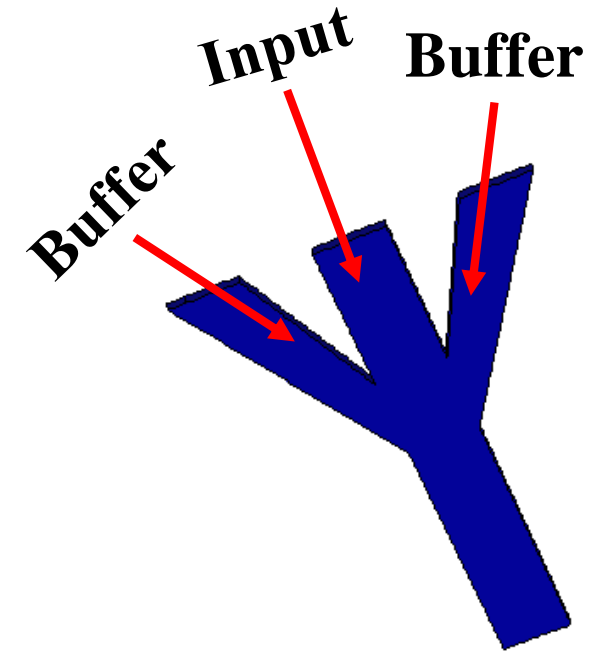

Clogged cells

COMSOL simulation of flow focusing device

Steady state simulation	Time domain simulation

High velocity in the center

Pressure Profile

Increasing velocity

Input   Buffer

Buffer

Input color	Buffer color	Time (Sec.)
		0
		1
		2
		3
		4
		5

Flow focusing experimental setup

Syringe pumps
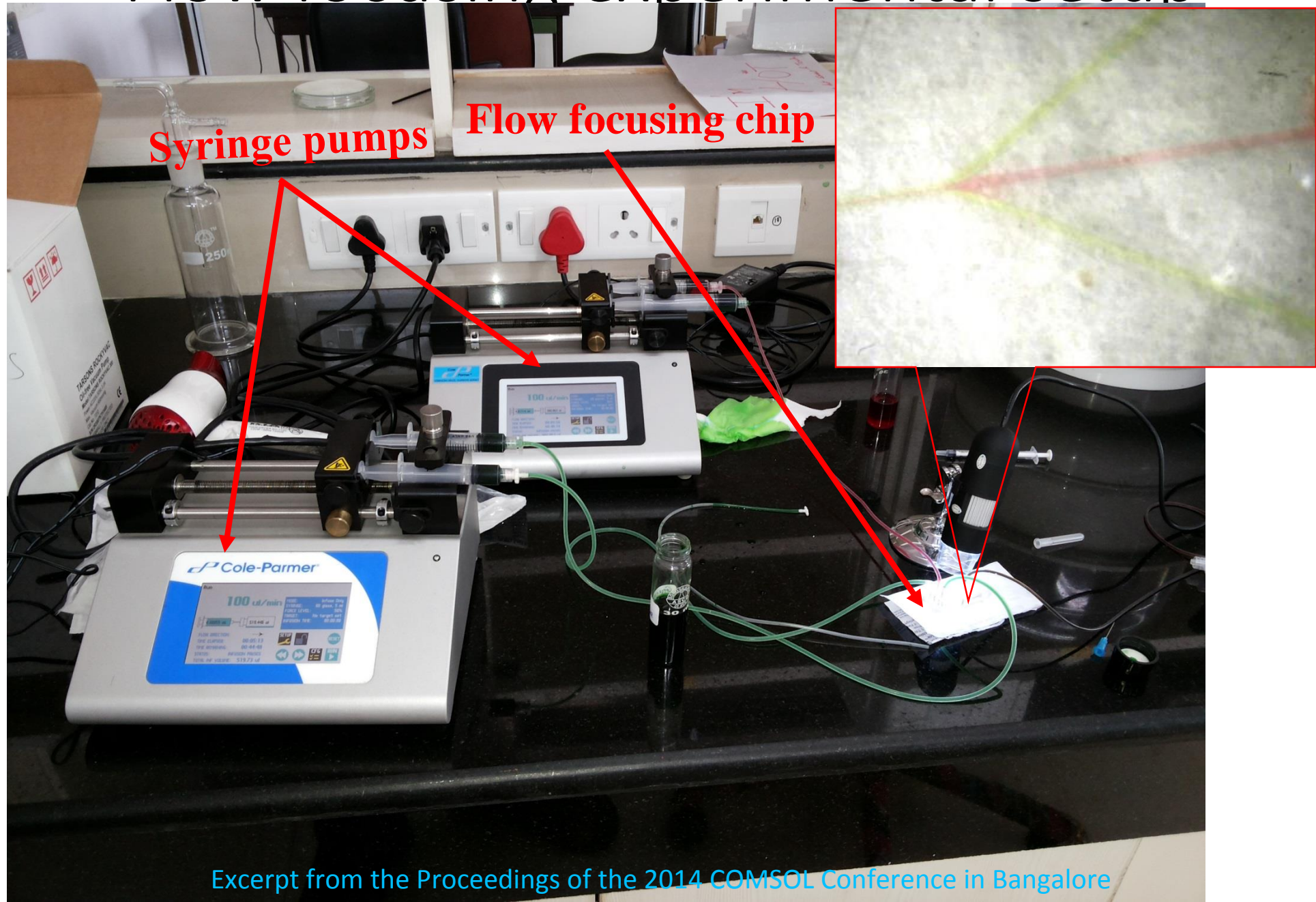
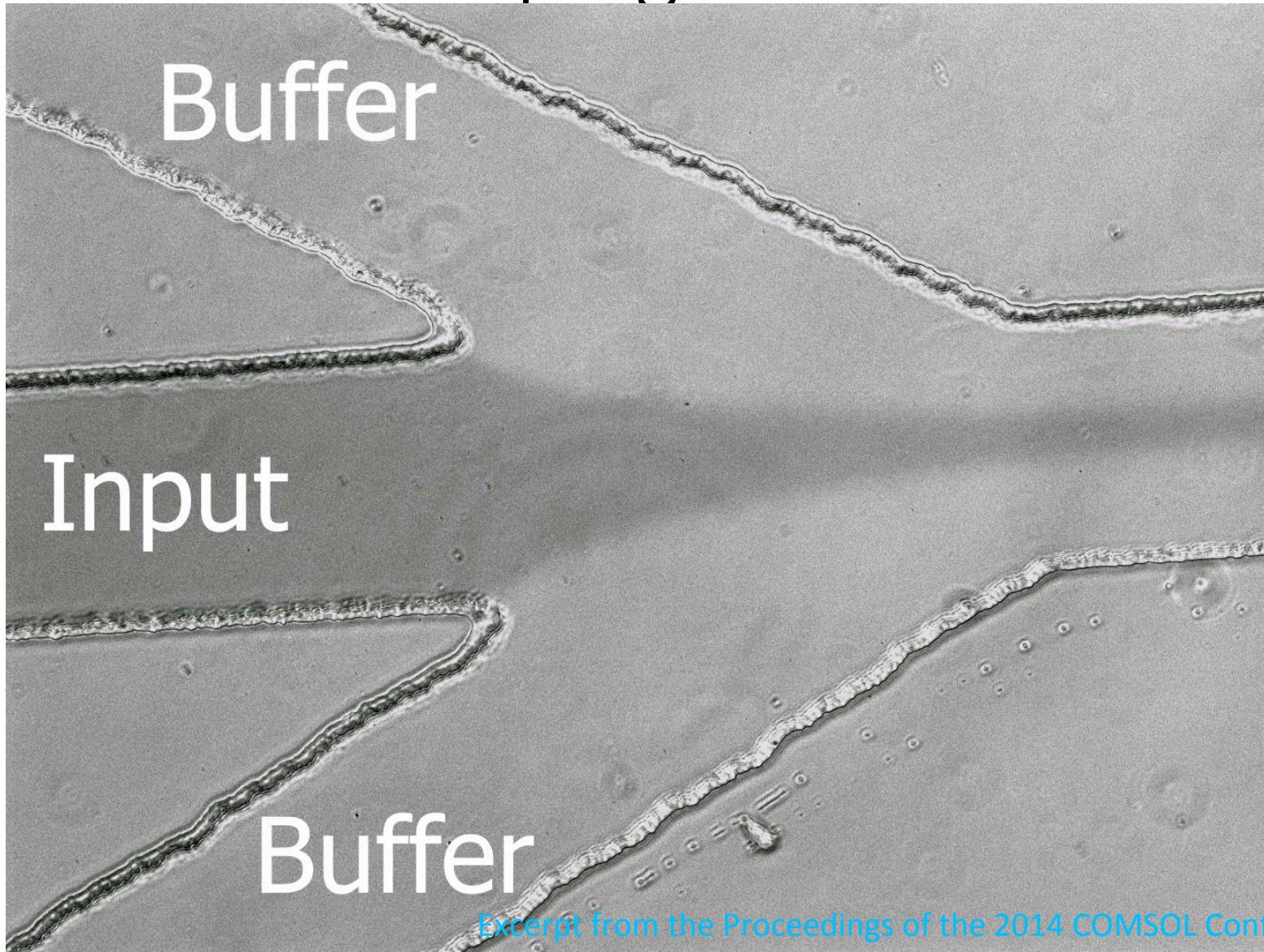**Flow focusing chip**

Flow focusing experimental setup
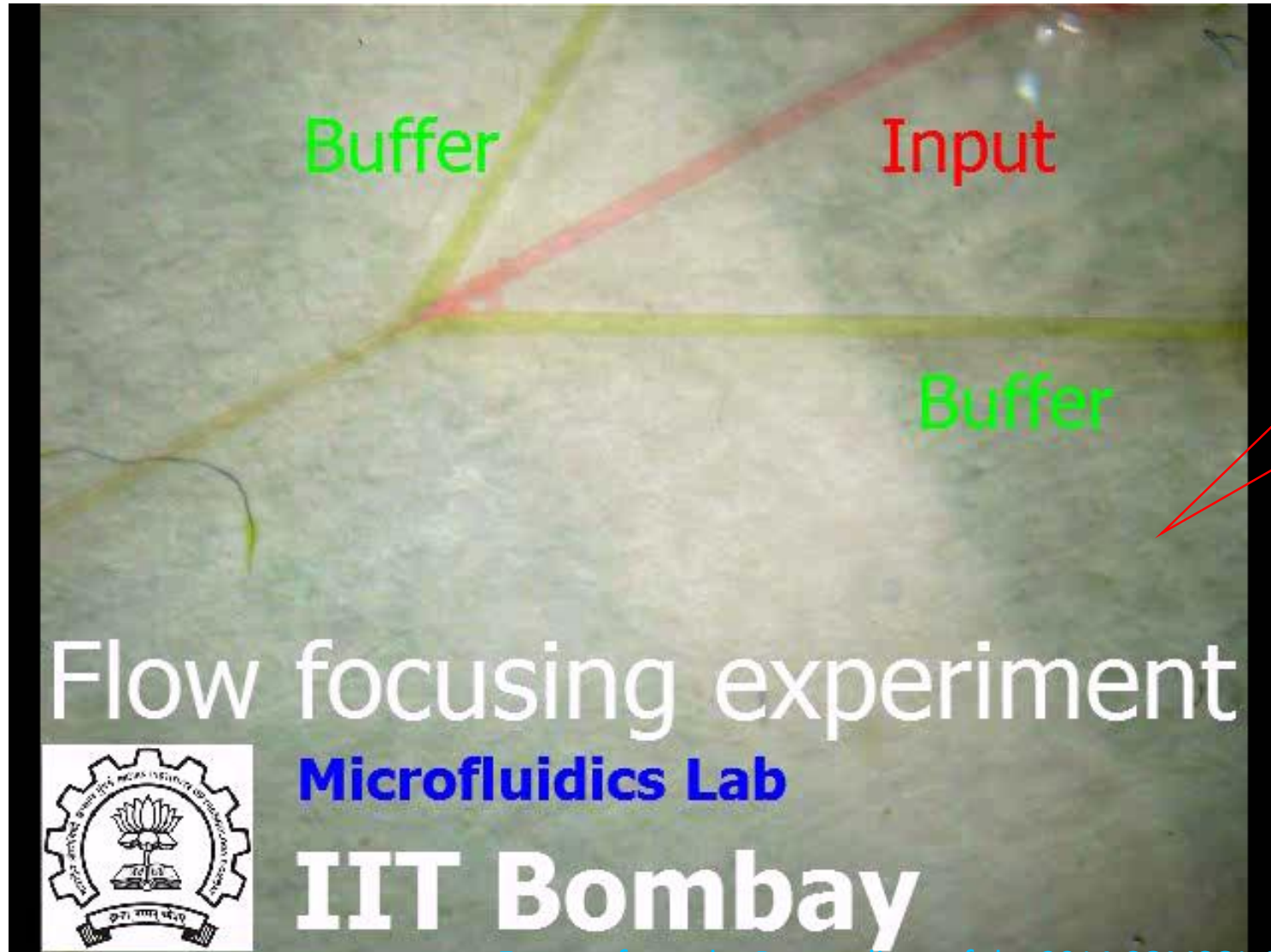
Effect of varying input flow rate keeping buffer flow rate constant

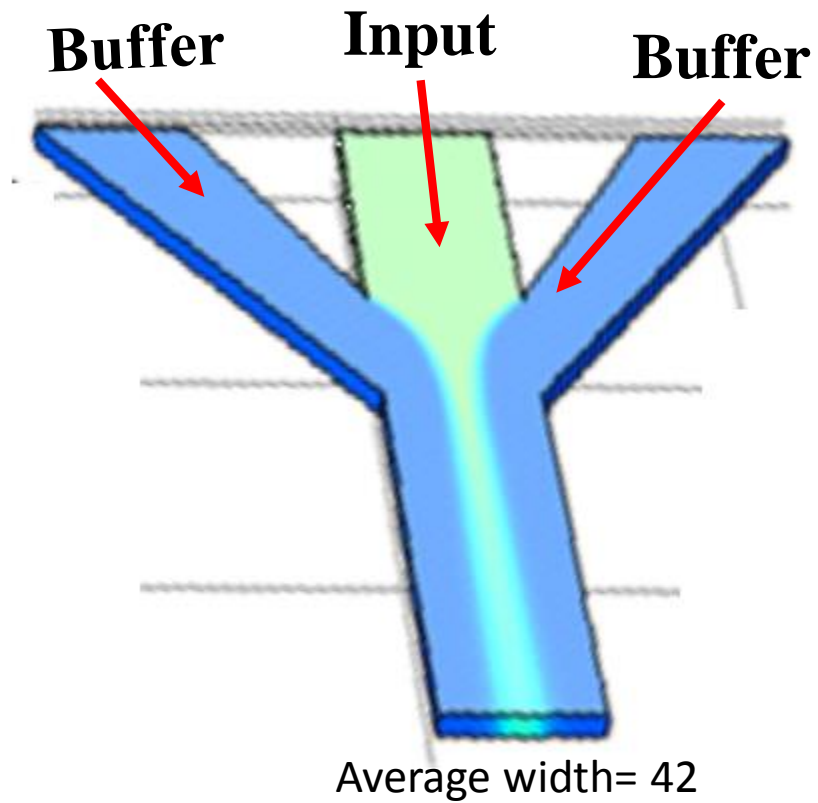| Input flow rate (Q2) = 5μl/m to 14μl/m |
| Buffer flow rate (Q1) = 10μl/m |
| Q1/Q2 = 2 to Q1/Q2 = 0.7 |

Effect of equal flow rates

Average width= 42

Average width= 42.46
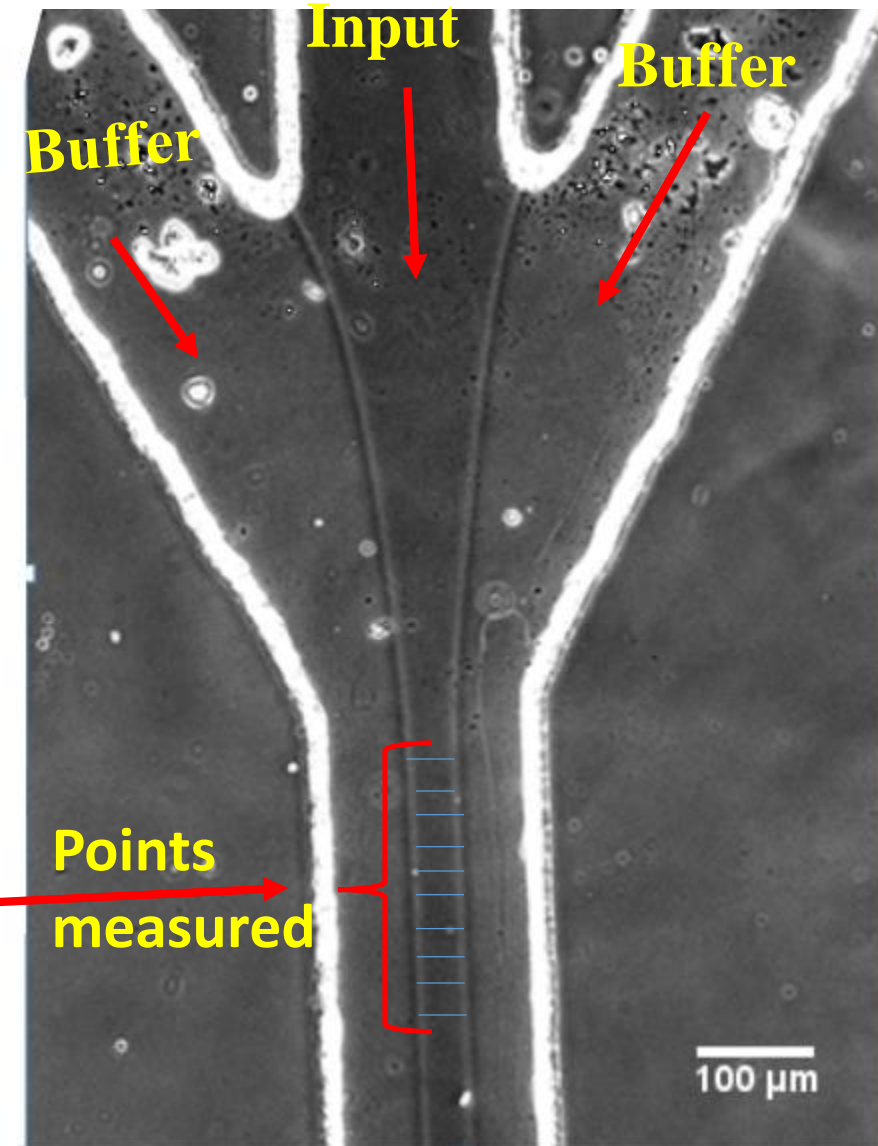
Effect of increasing central flow rate
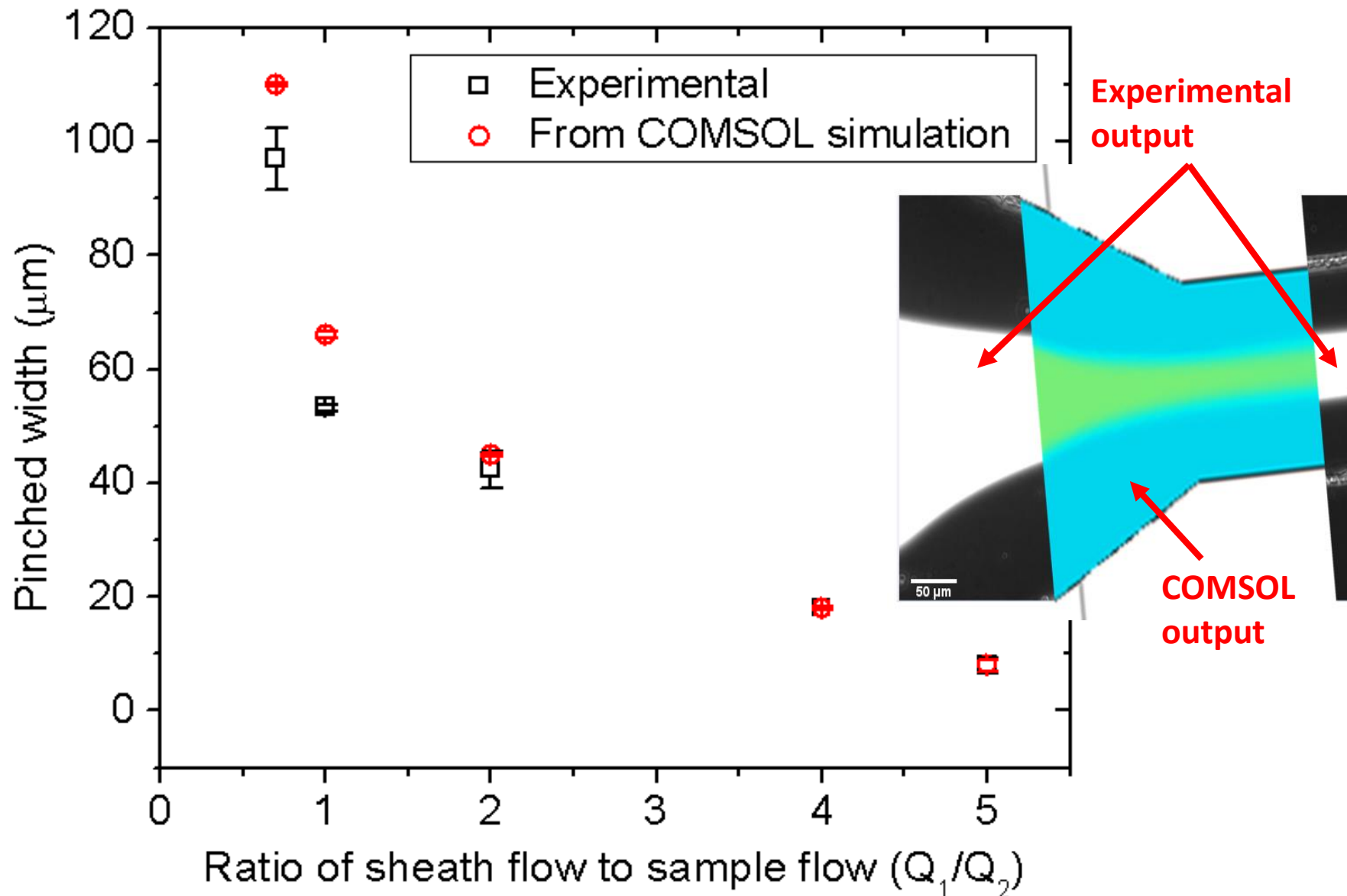

Bulge

Points measured

100 μm
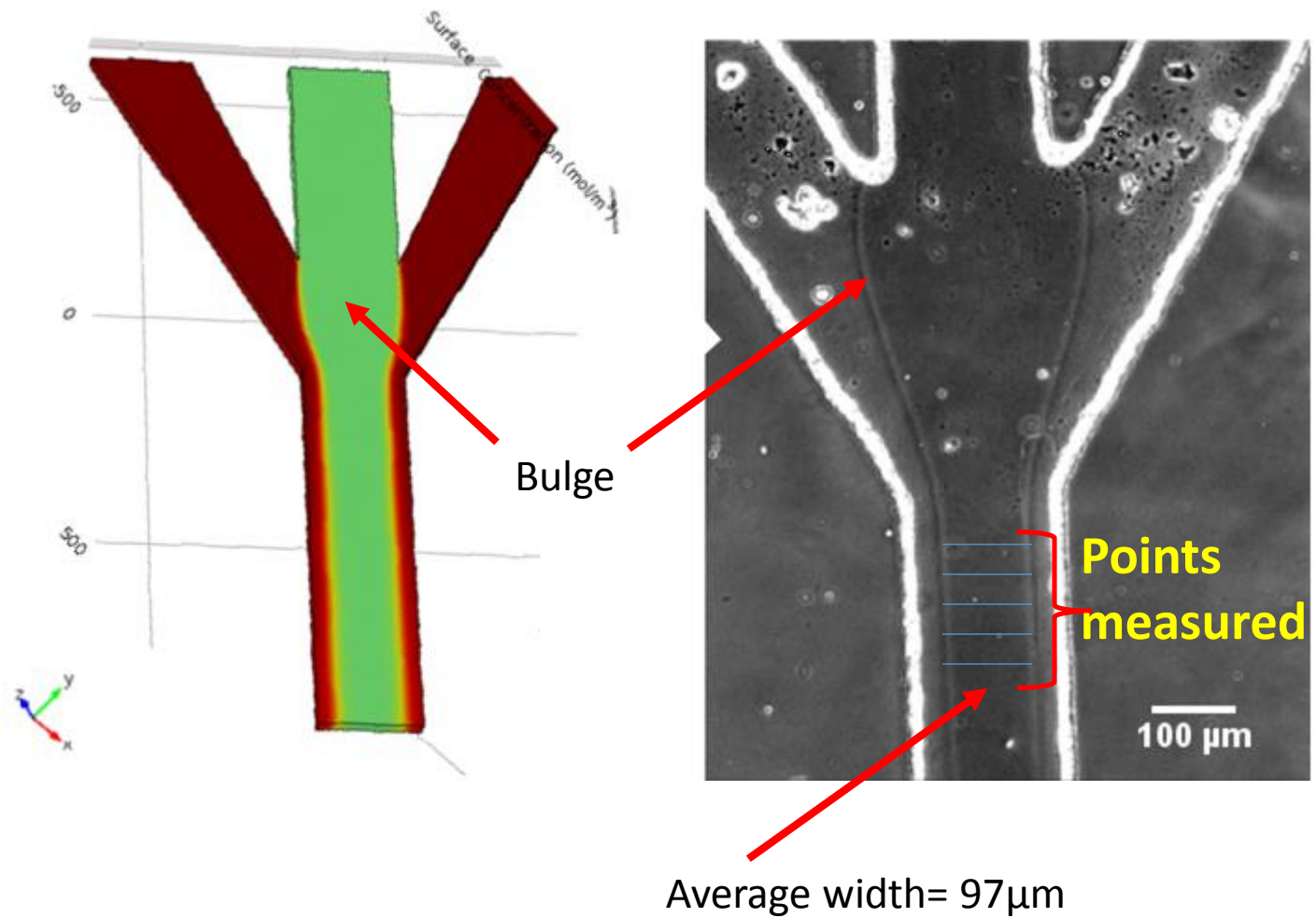
Average width= 97μm

Minimum pinched flow width with our device
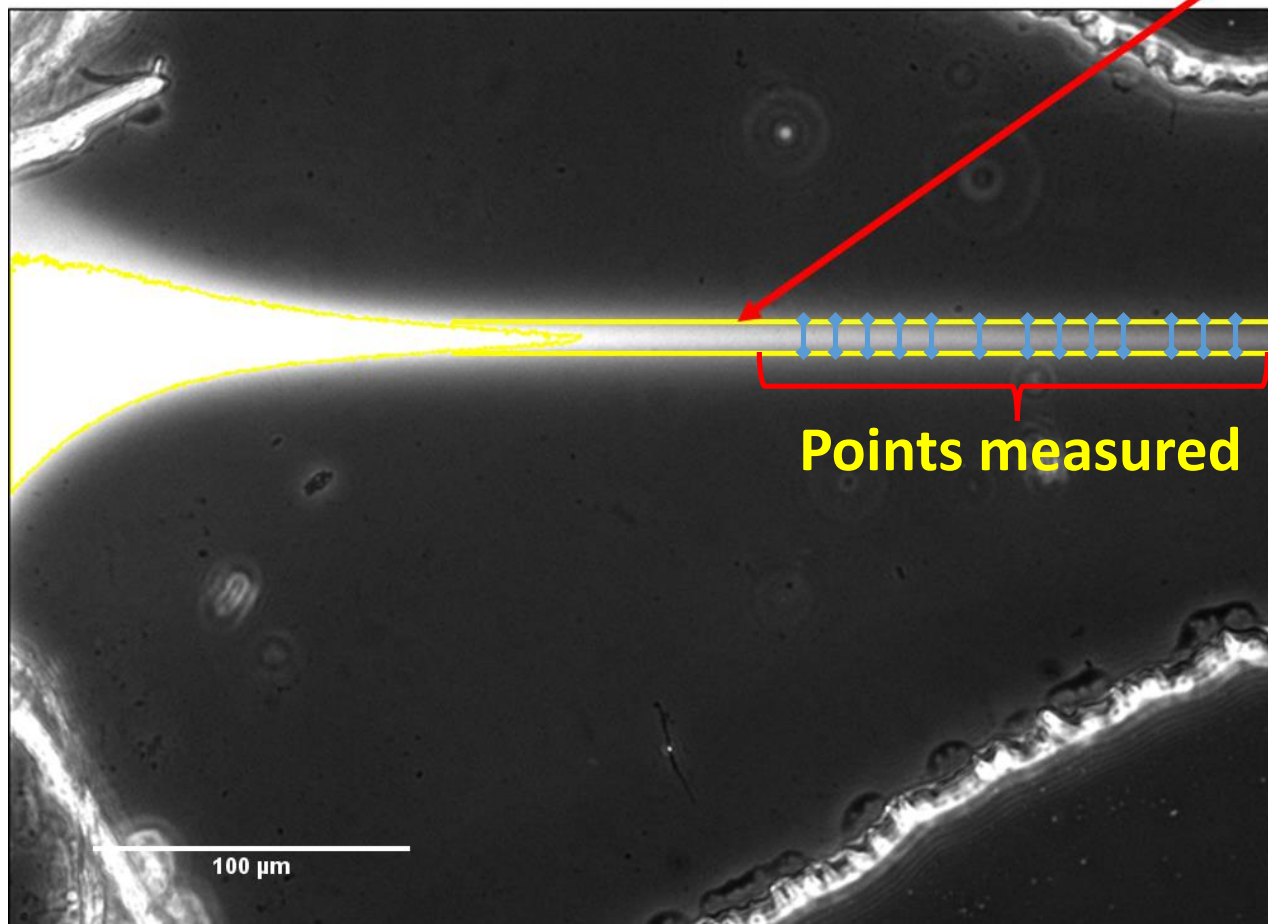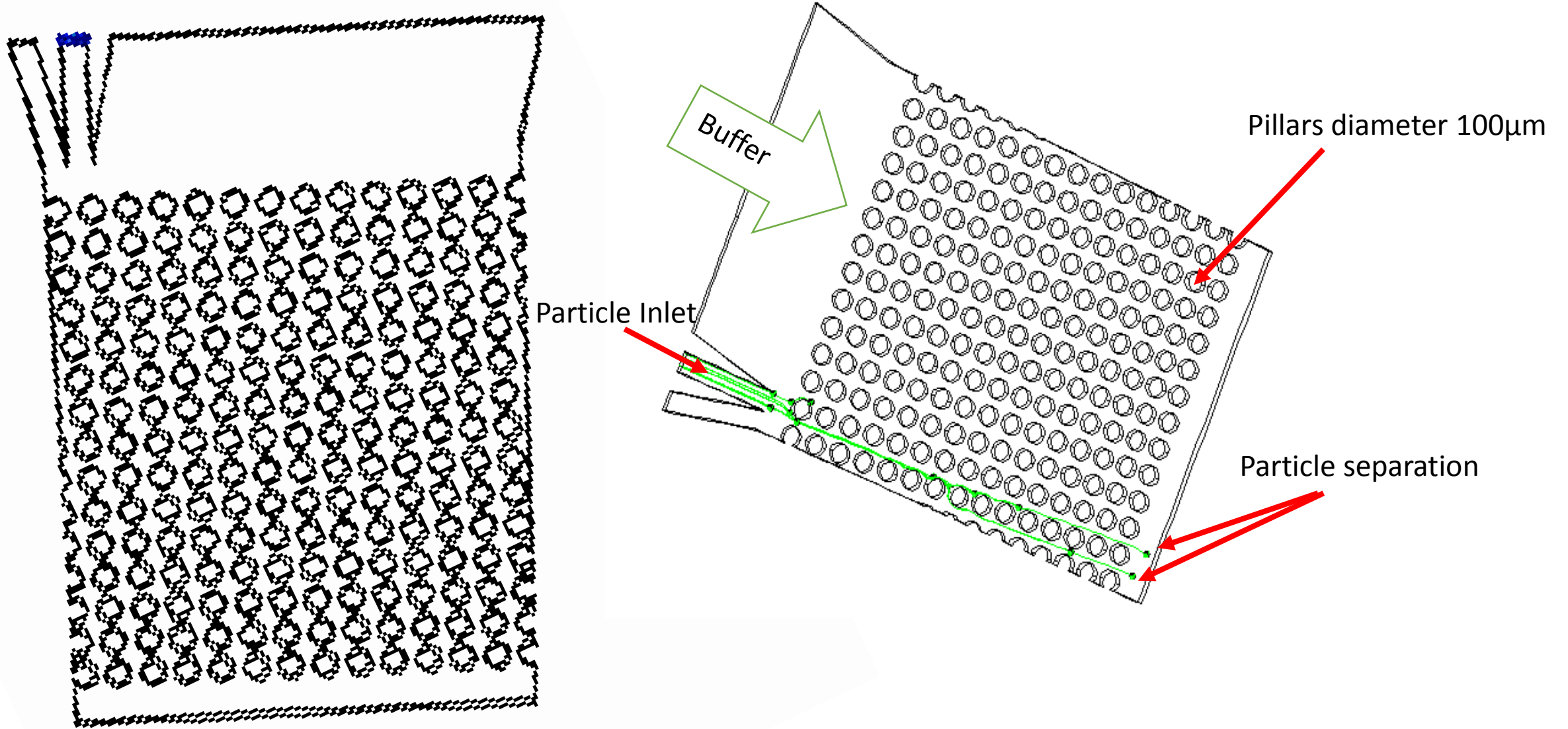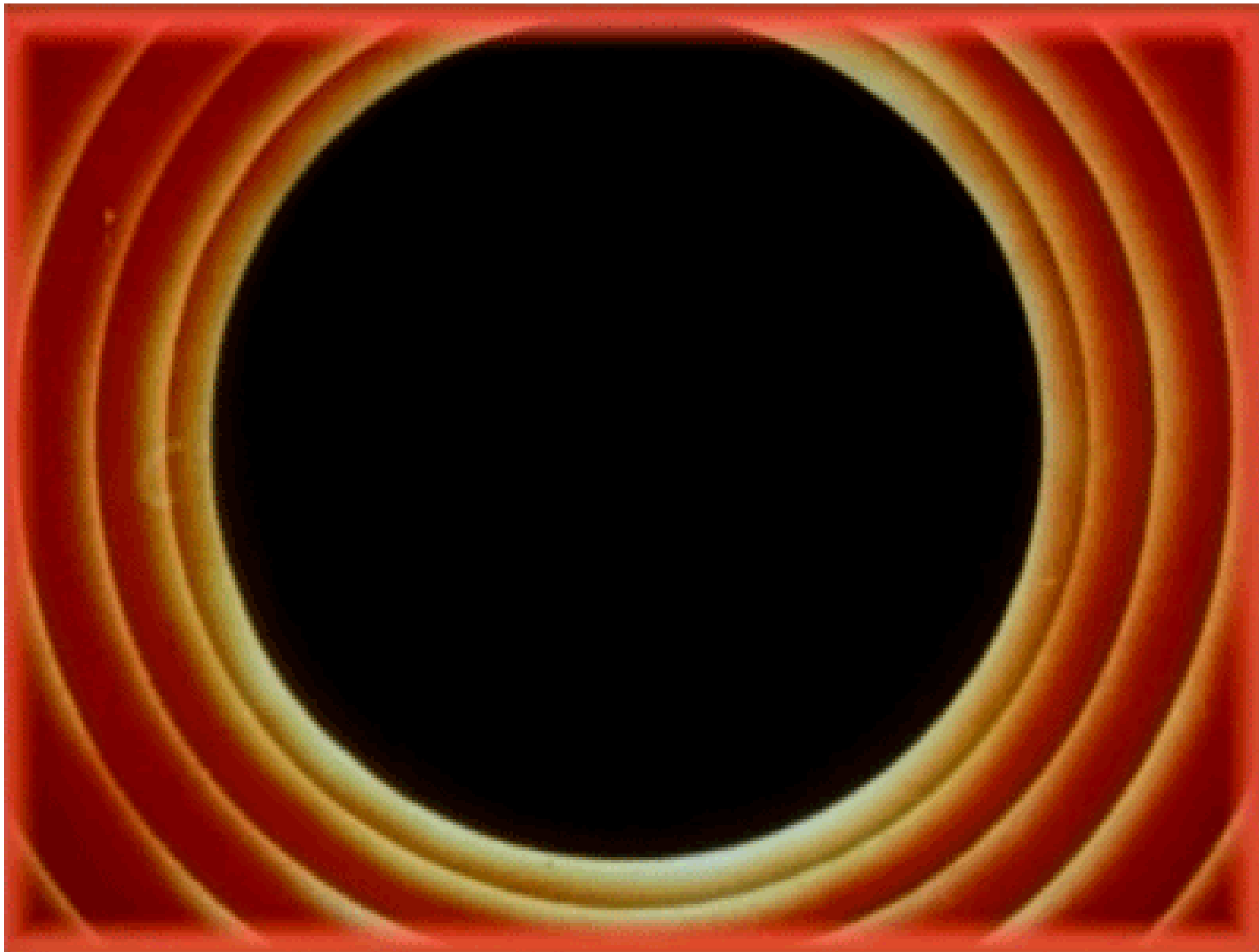
Simulation Vs. practical

Conclusions

There exist upper and lower limit to focusing width achievable by controlling flow rates.

The confined width is not a function of flow rates but the ratio of flow rates.

Future scope

Buffer

Pillars diameter 100μm

Particle Inlet

Particle separation

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