

In-Situ detection of microcystin in a pre-lysed freshwater sample using an integrated centrifugal microfluidics platform

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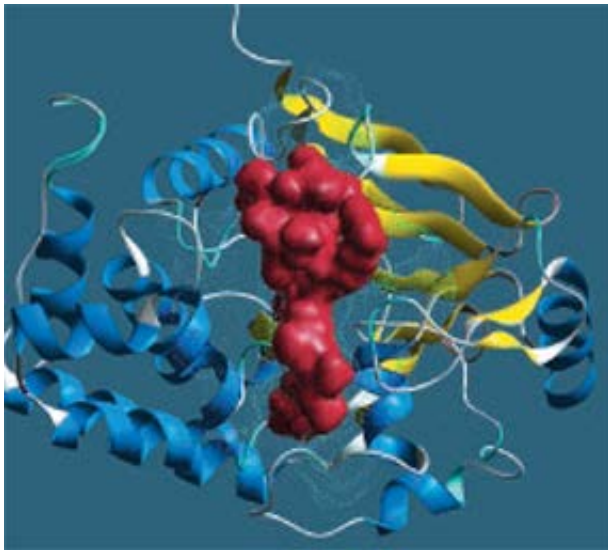
1.Introduction: General Toxicology

• What is a Toxin?

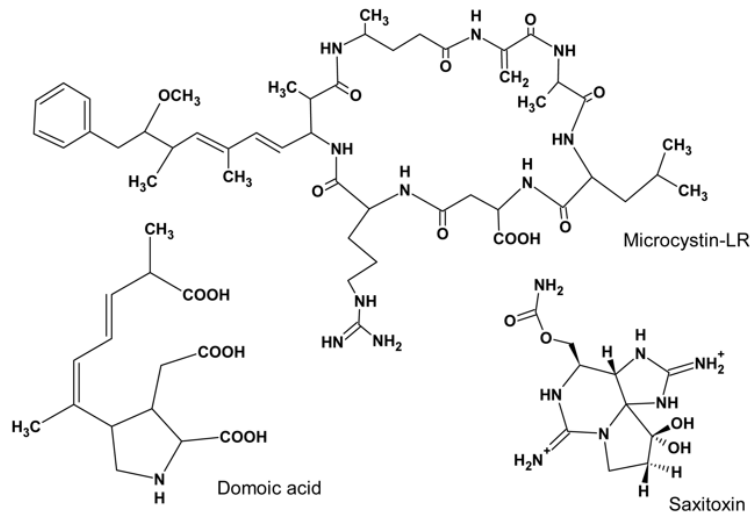
- According to Merriam-Webster:

“A poisonous substance that is a specific product of the metabolic activities of a living organism. It is usually very unstable and toxic when introduced into the tissues. It also typically capable of inducing antibody formation”.

Biologist



Chemist



Physicist

BAD*

*Should probably develop some sensors then?

Of course you should!....

1.Introduction: Microcystin

MICROCYSTIN:

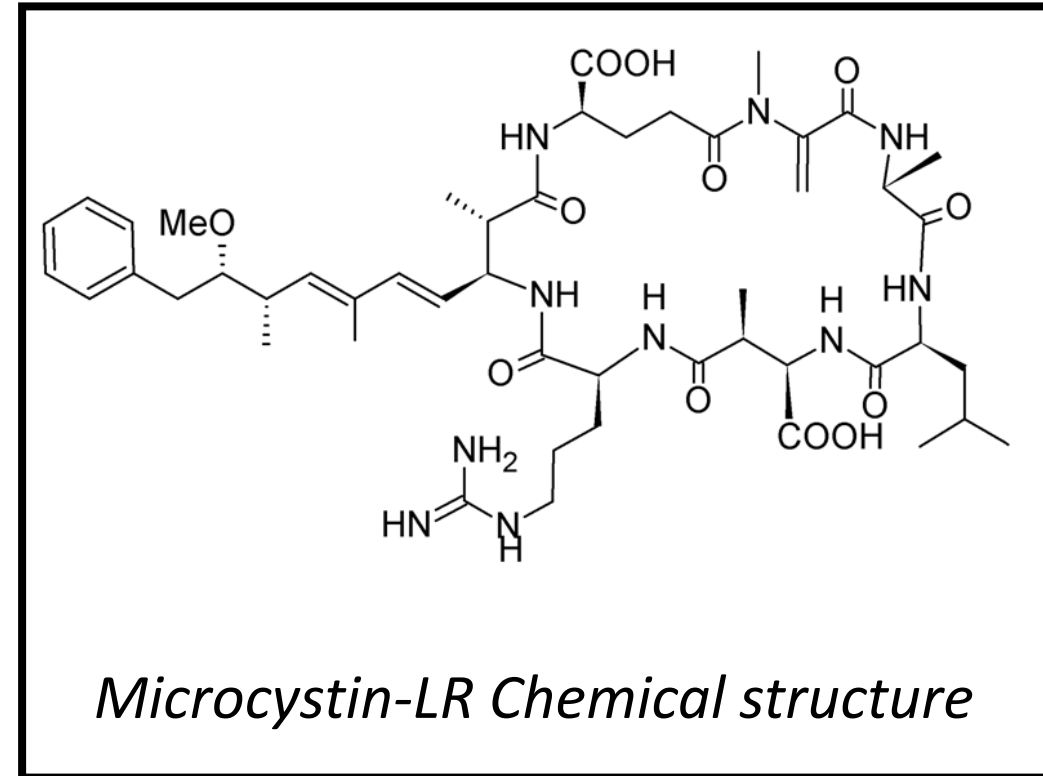
Produced from: *Microcystis Aeruginosa*,
freshwater cyanobacteria

Classification: *Potent hepatotoxin*
(hepato = Liver)

Predominant Congener:
Microcystin-LR (also most toxic variant)

Regulator limit in drinking water: **1** ng mL⁻¹

It results from harmful algal blooms which can cause ecological and economical disasters



1.Introduction: Microcystis Aeruginosa Blooms



Lake Erie in October 2011: the lakes
worst cyanobacteria blooms in decades.
Caused by eutrophication



Lake Erie in July 2015:

2-ToxiSense system concept

2-ToxiSense system concept: Lab-On-A-Chip Vs. Lab-On-A-Disc platforms

- **Lab-On-A-Chip**

- Requires accurate pumping mechanisms, often at very high cost
- Chip is stationary for studies
- Easier to simulate and control fluid flow

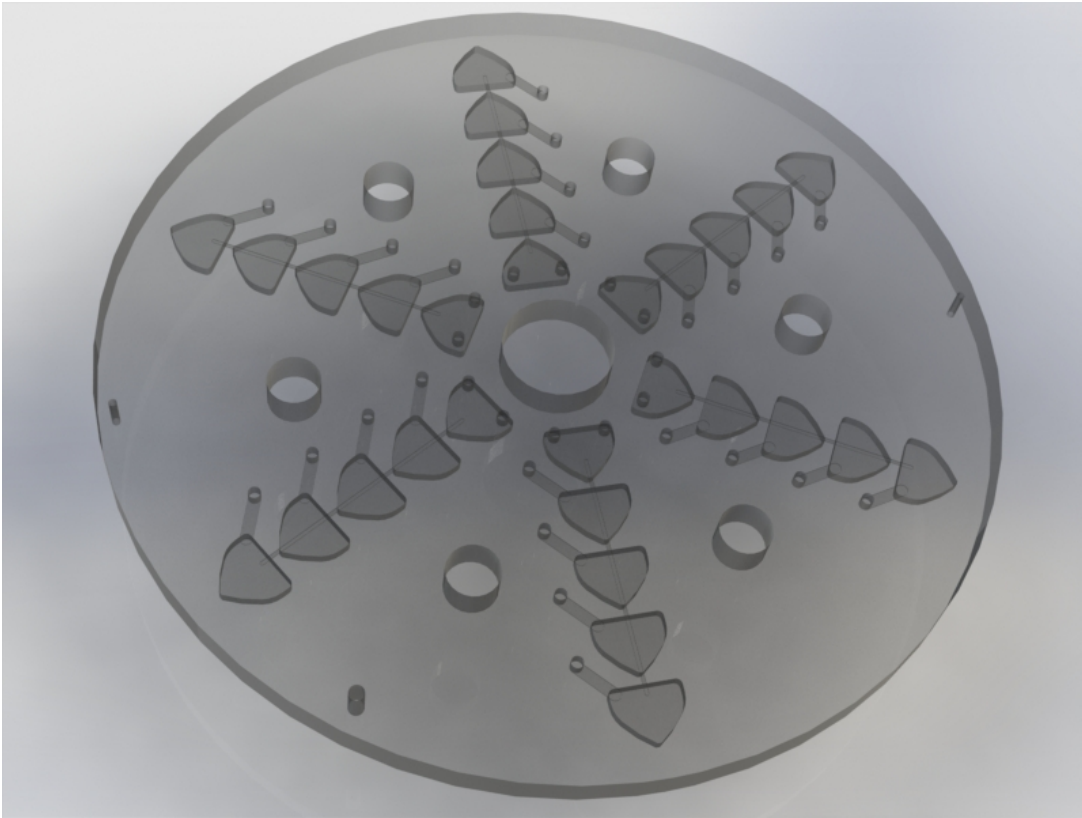
- **Lab-On-A-Disc**

- Requires a motor, often relatively inexpensive
- Disc is in motion for studies
- More difficult to simulate and control fluid flow

Cost was a decision factor in this project: Lab-On-A-Disc platform was selected

2-ToxiSense system concept: Introduction to ToxiSense system

- The ToxiSense System consists of two components.



The ToxiSense Microfluidic Disc



The ToxiSense detection system

2-ToxiSense system concept: Microfluidic Disc

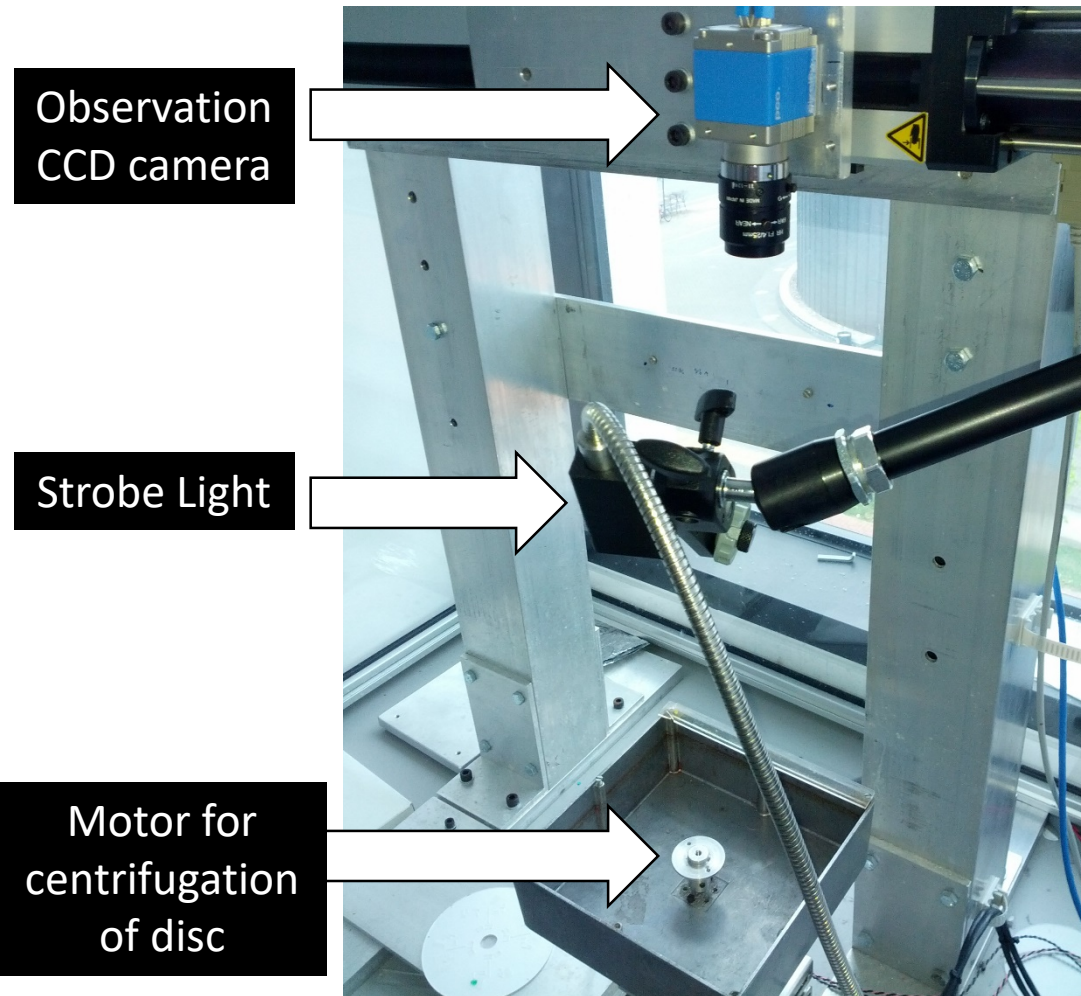
The ToxiSense Microfluidic Disc:

- On-board microfluidics (Lab-On-A-Disc platform)
- *Manufactured from poly(methyl methacrylate) (PMMA) (Radionics™) and pressure sensitive adhesive (Adhesives Research Inc.™)*
- Easily modifiable
- Microcystin-LR detection: 5-step assay.
- Low sample size
- High sensitivity
- Cheap to manufacture



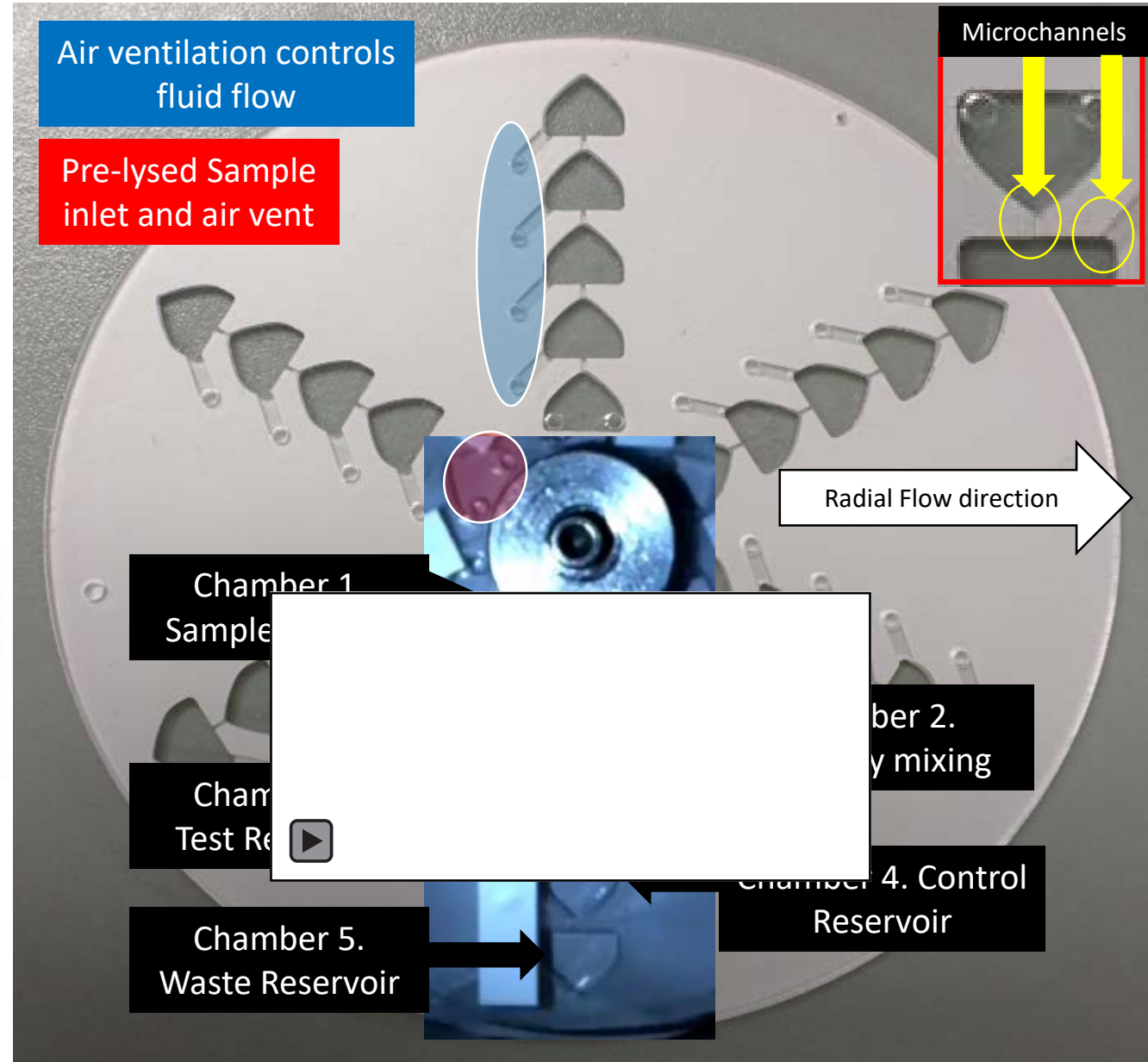
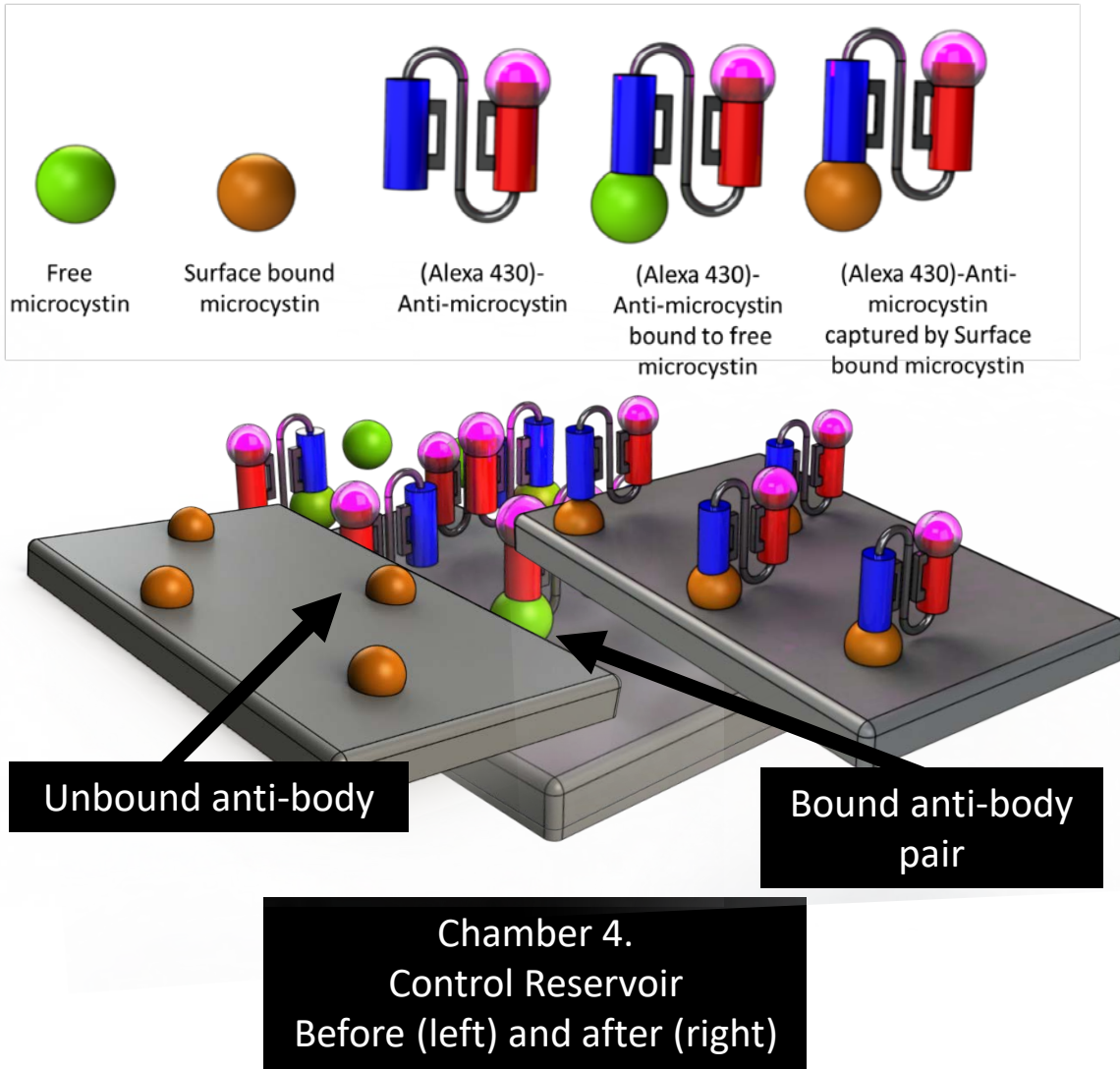
2-ToxiSense system experiments: Off-Site Fluidic studies

The fluidic movement can be studied to confirm fluid is obeying the assay procedure correctly



Spin stand with computer observation

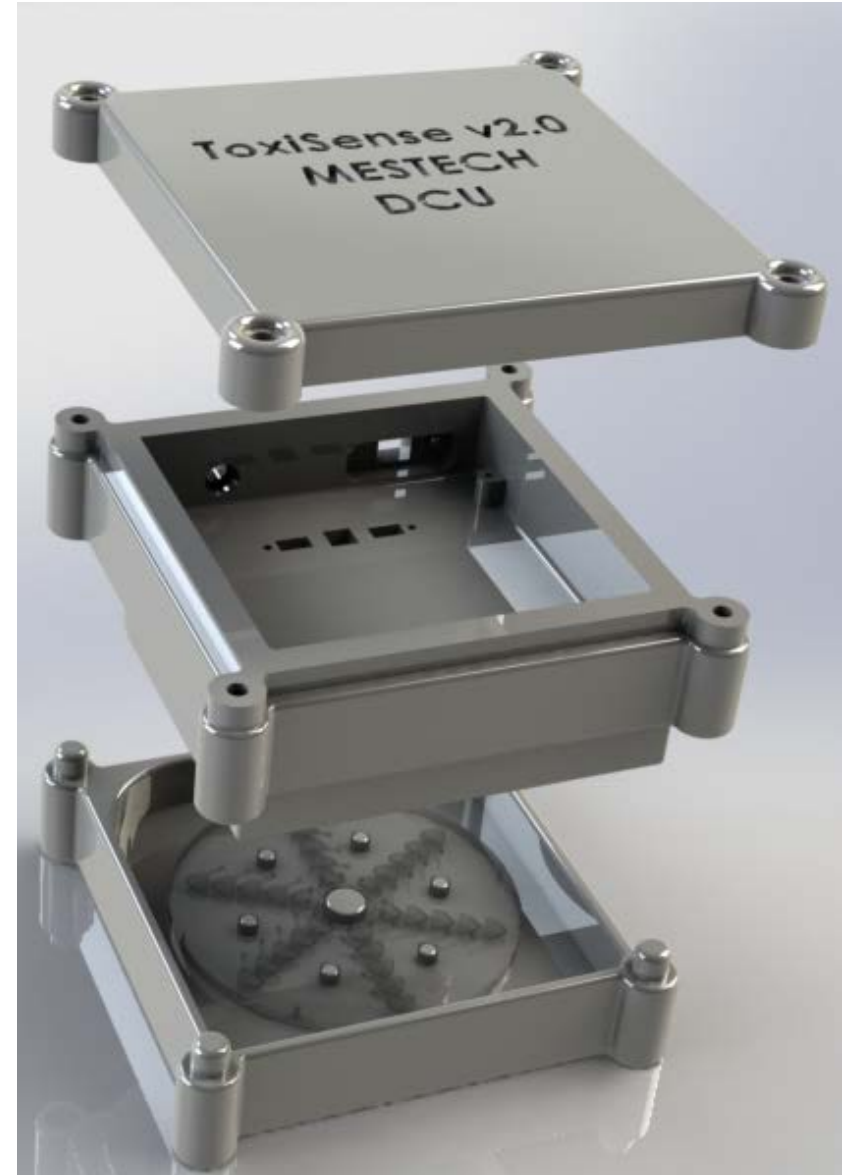
Single assay proof of concept using pneumatic pressure valving



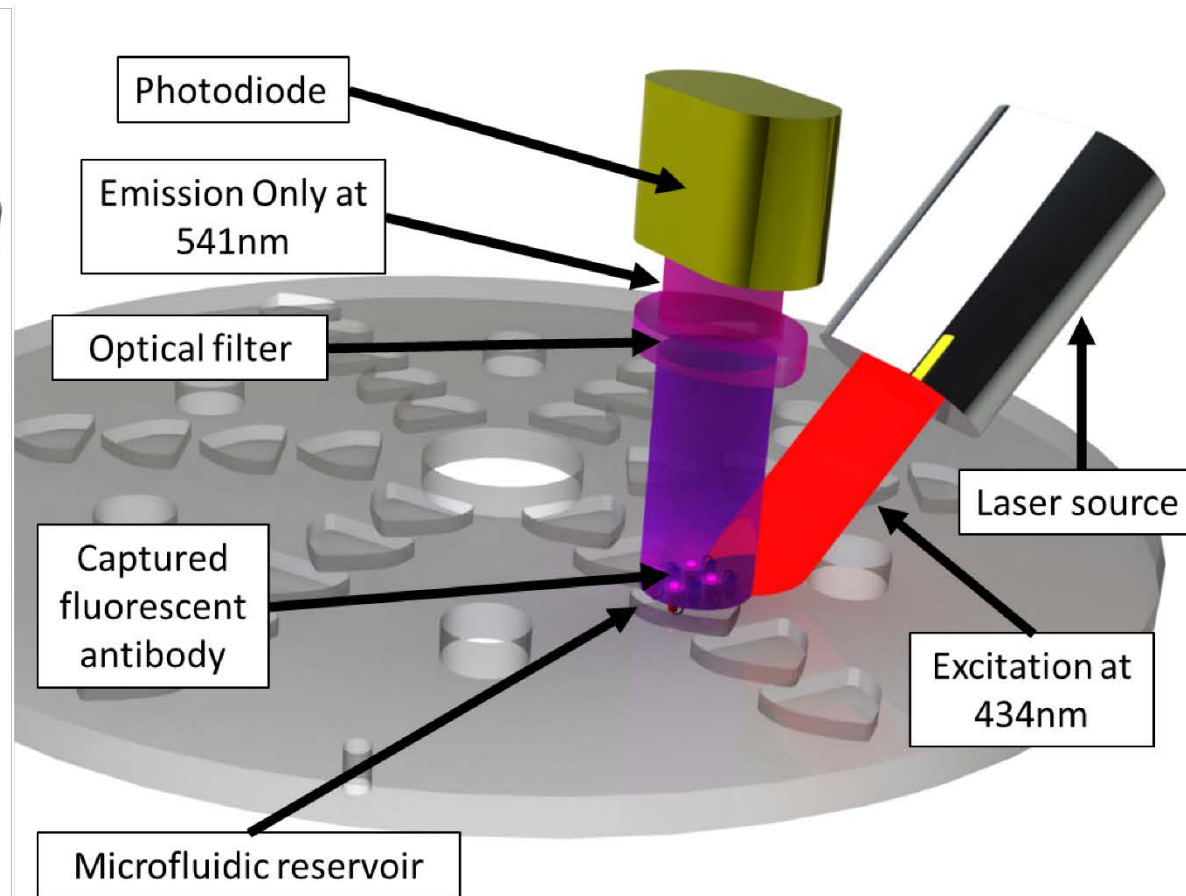
2-ToxiSense system concept: detection System

The ToxiSense detection system:

- 3D-Printed fluorescent detection system
- Casing manufactured from acrylonitrile butadiene styrene (ABS)
- Detection system developed in-house.
- Easily modifiable
- Microcystin-LR detection: Alexa fluor 430
- Powered by mains
- Communications either via USB to PC or with Wireless dongle (in-house model)



2-ToxiSense system concept: detection method



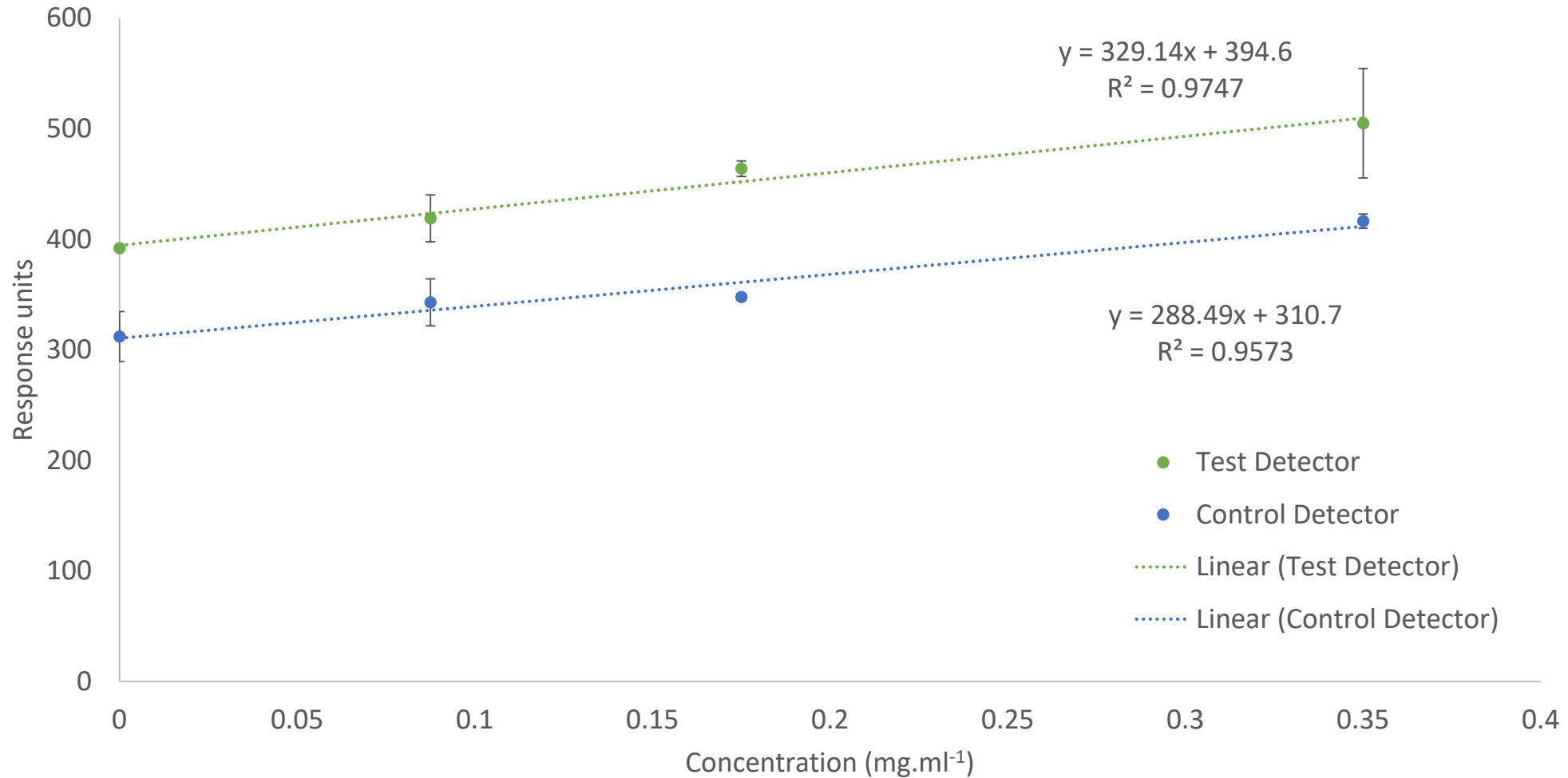
2-ToxiSense system concept: Video demonstration



3-ToxiSense system studies

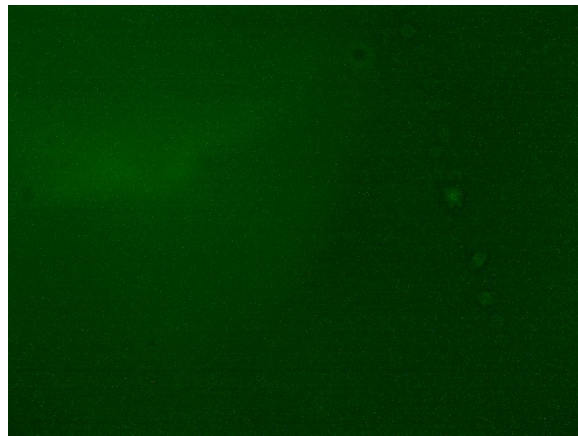
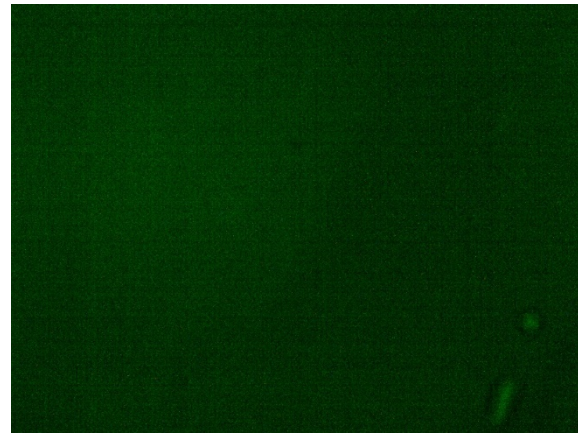
3-ToxiSense system studies: Initial microcystin detection results

Fluorescent response units vs concentration of fluorescent abs in sedimentation

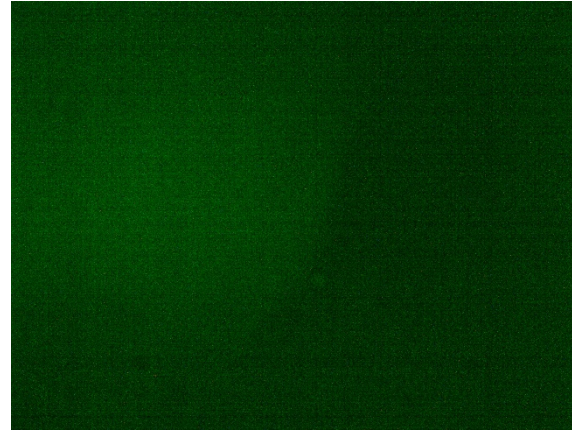
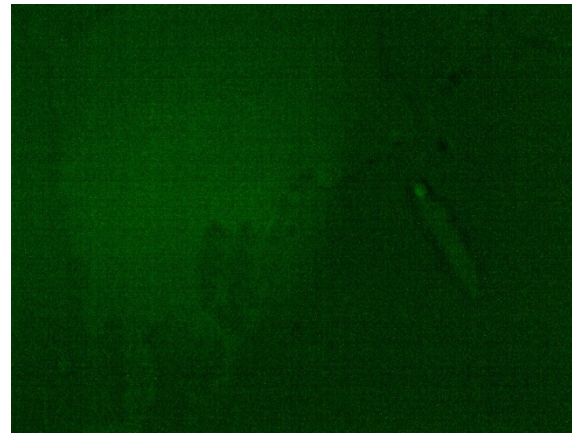


Next stage is to test full inverse assay

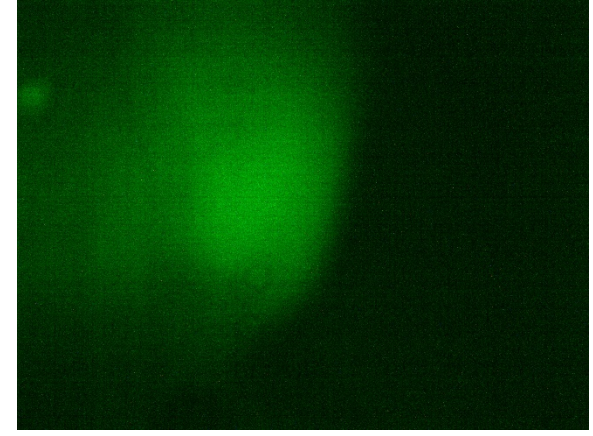
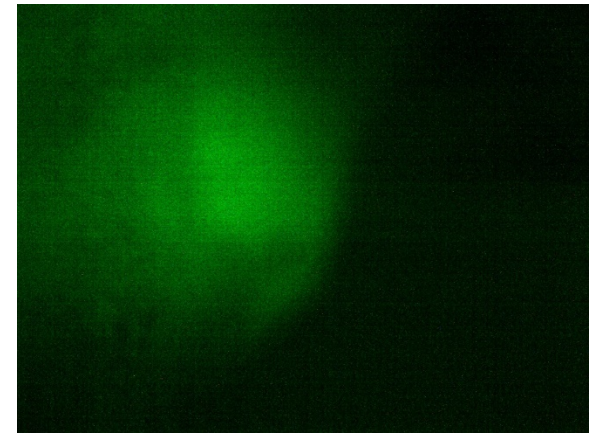
3-ToxiSense system studies: Fluorescent Microscopy images of test reservoirs



0 $\mu\text{g.mL}^{-1}$



2 $\mu\text{g.mL}^{-1}$



10 $\mu\text{g.mL}^{-1}$

Microcystin Concentration bound to reservoir surface

4-Conclusions

4-Conclusions: Summary of the ToxiSense system

- The ToxiSense detection system is:
 - A highly sensitive and portable toxin detection system.
 - A flexible and easily modifiable system.
 - An easy-to-use and cost effective solution to *in-situ* toxin detection
 - The first step in developing a fully autonomous and *in-situ* toxin detection system

Further information can be found on the poster: P1.134 – “Enhancing the capabilities of a biosensor for microcystin-LR”



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MESTECH

