



Atalanta: The autonomous analytical algal toxin platform

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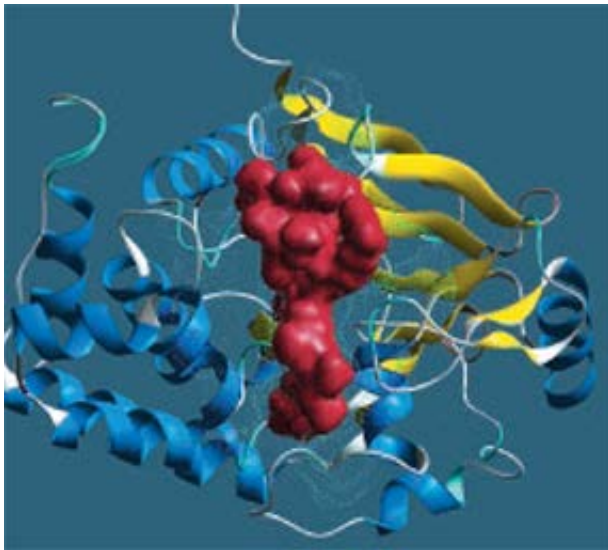
1.Introduction: general Toxicology

• What is a Toxin?

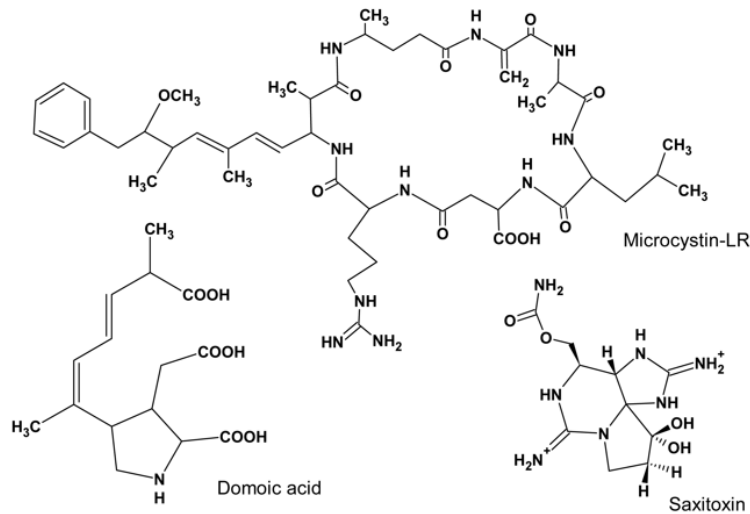
- According to Merriam-Webster:

“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:

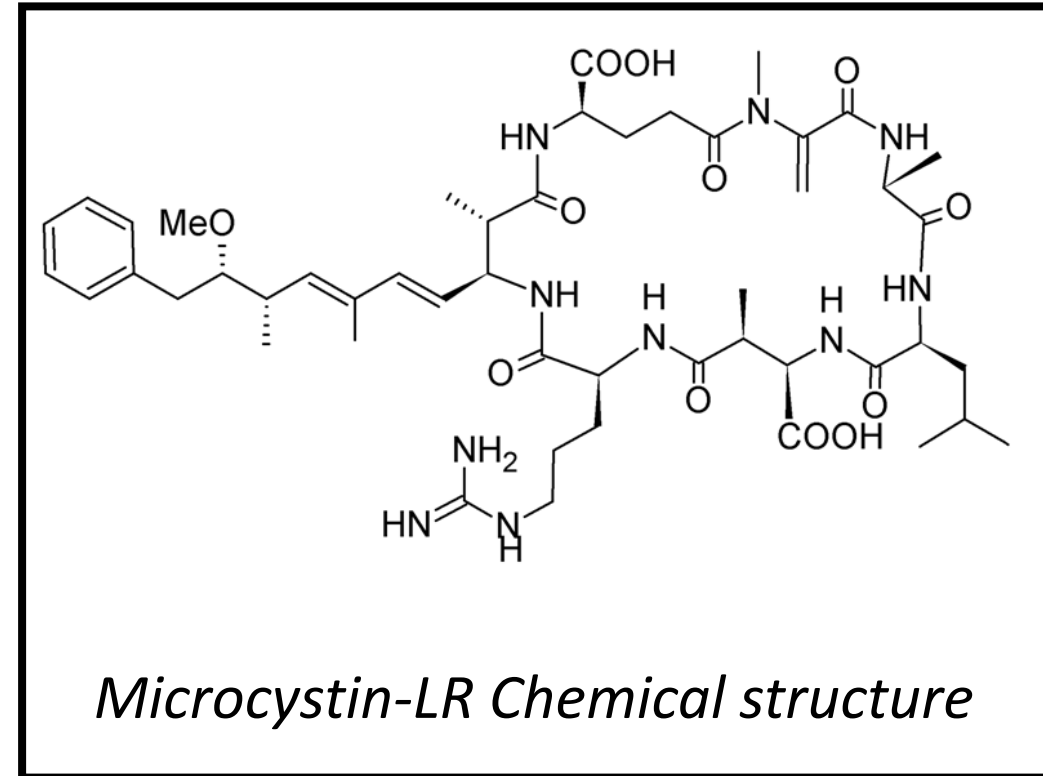
Produced from: *Microcystis Aeruginosa*,
freshwater cyanobacteria

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



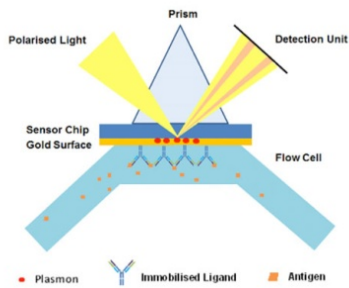
Lake Erie in July 2015:

1.Introduction: Detecting Microcystin

Methods of detection

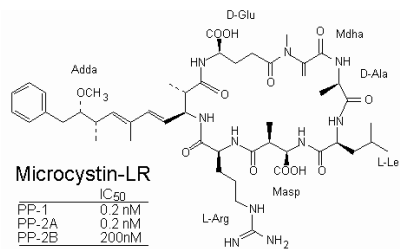
Surface plasma resonance (SPR)

LOD = 1.7ng mL⁻¹



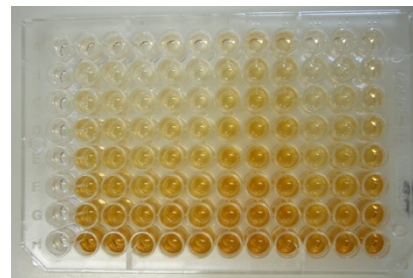
Protein phosphatase Inhibition (PPI)

LOD = 1.5ng mL⁻¹



Enzyme-linked immunosorbent assay (ELISA)

LOD = 1ng mL⁻¹



High-performance liquid chromatography (HPLC)



LOD = 1ng mL⁻¹

Atalanta: Microfluidic toxin-sensing system



LOD* = 8 ng mL⁻¹

* This is the current Limit of detection (LOD) projection according to the latest sample recordings

2-Atalanta system concept

2-Atalanta 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

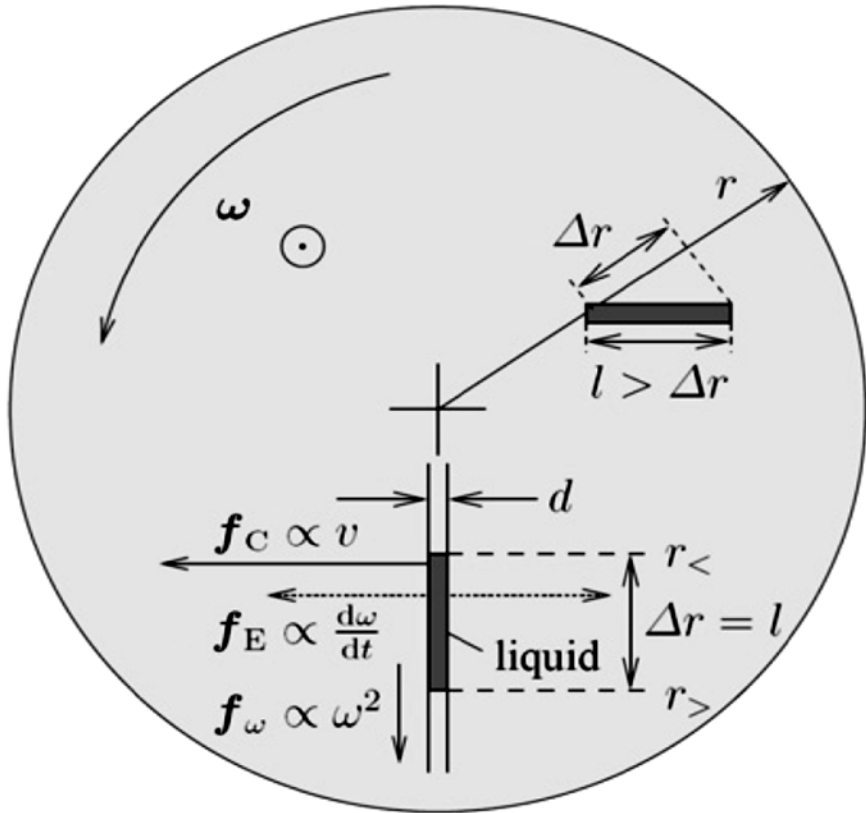
- **Lab-On-A-Disc**

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

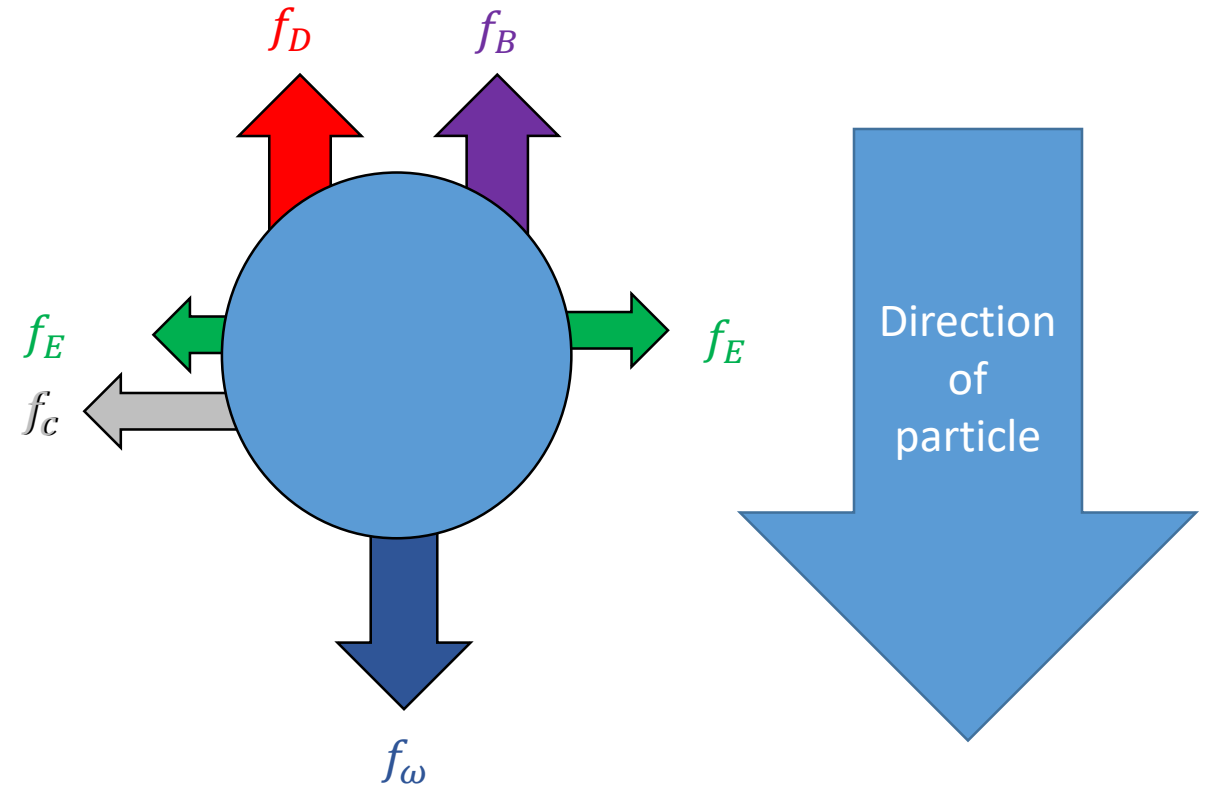
Cost was a major factor in this project: Lab-On-A-Disc platform was selected

2-Atalanta system concept: Lab-On-A-Disc platform

Disc Hydrodynamic forces for particle sedimentation



Forces on acting on a rotating disc



Particle sedimentation through a fluid on anti-clockwise rotating disc

2-Atalanta system concept: Introduction to Atalanta system

- The Atalanta System consists of two components.

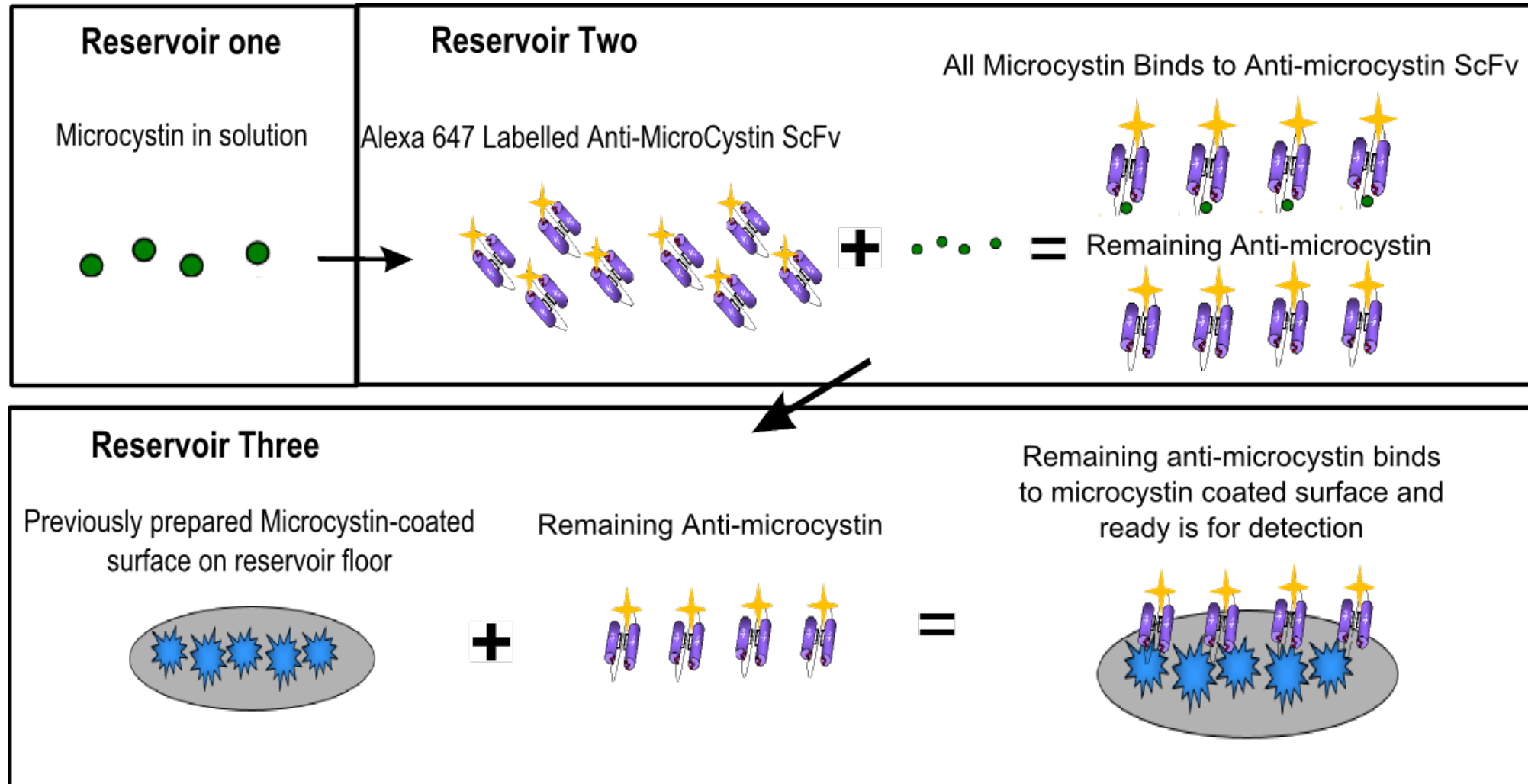


The Atalanta Microfluidic Disc



The Atalanta Sensing system

2-Atalanta system concept: detection format



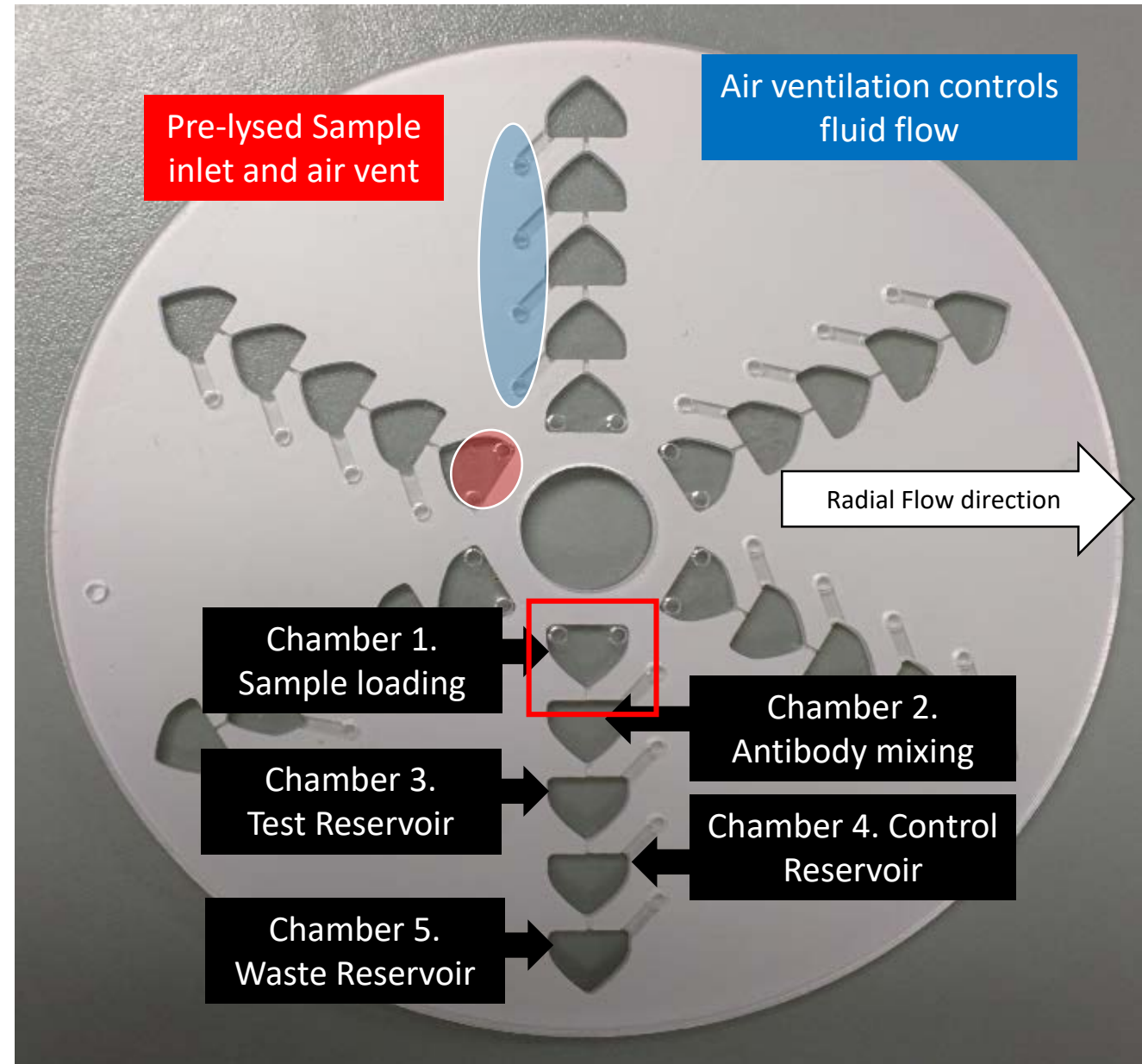
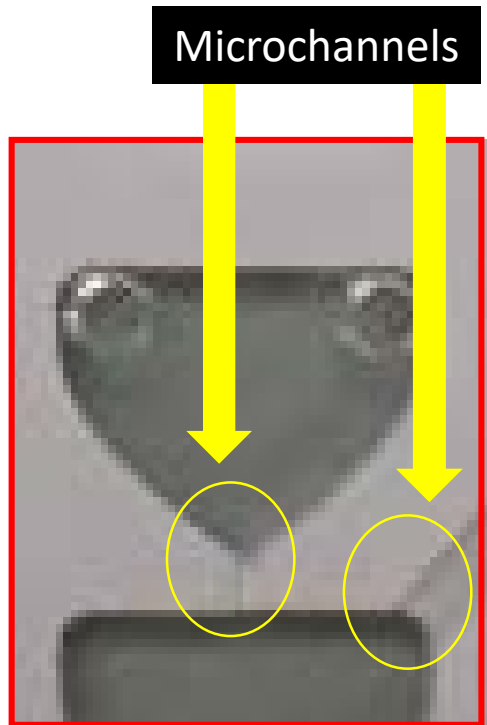
2-Atalanta system concept: Microfluidic Disc

The Atalanta 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.
- High sensitivity
- Low sample size
- Cheap to manufacture



2-Atalanta system concept: Microfluidic Disc



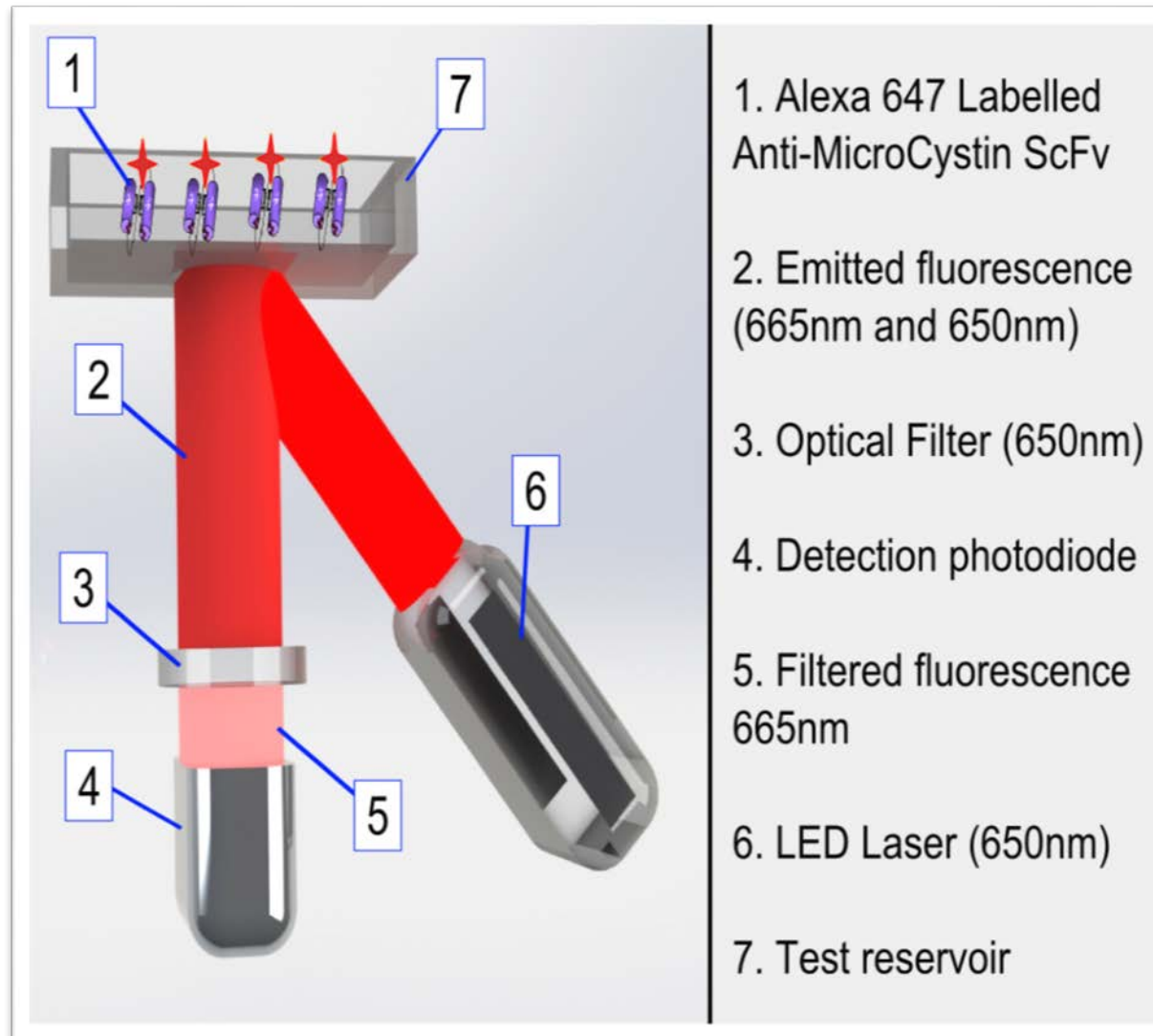
2-Atalanta system concept: Sensing System

The Atalanta Sensing system:

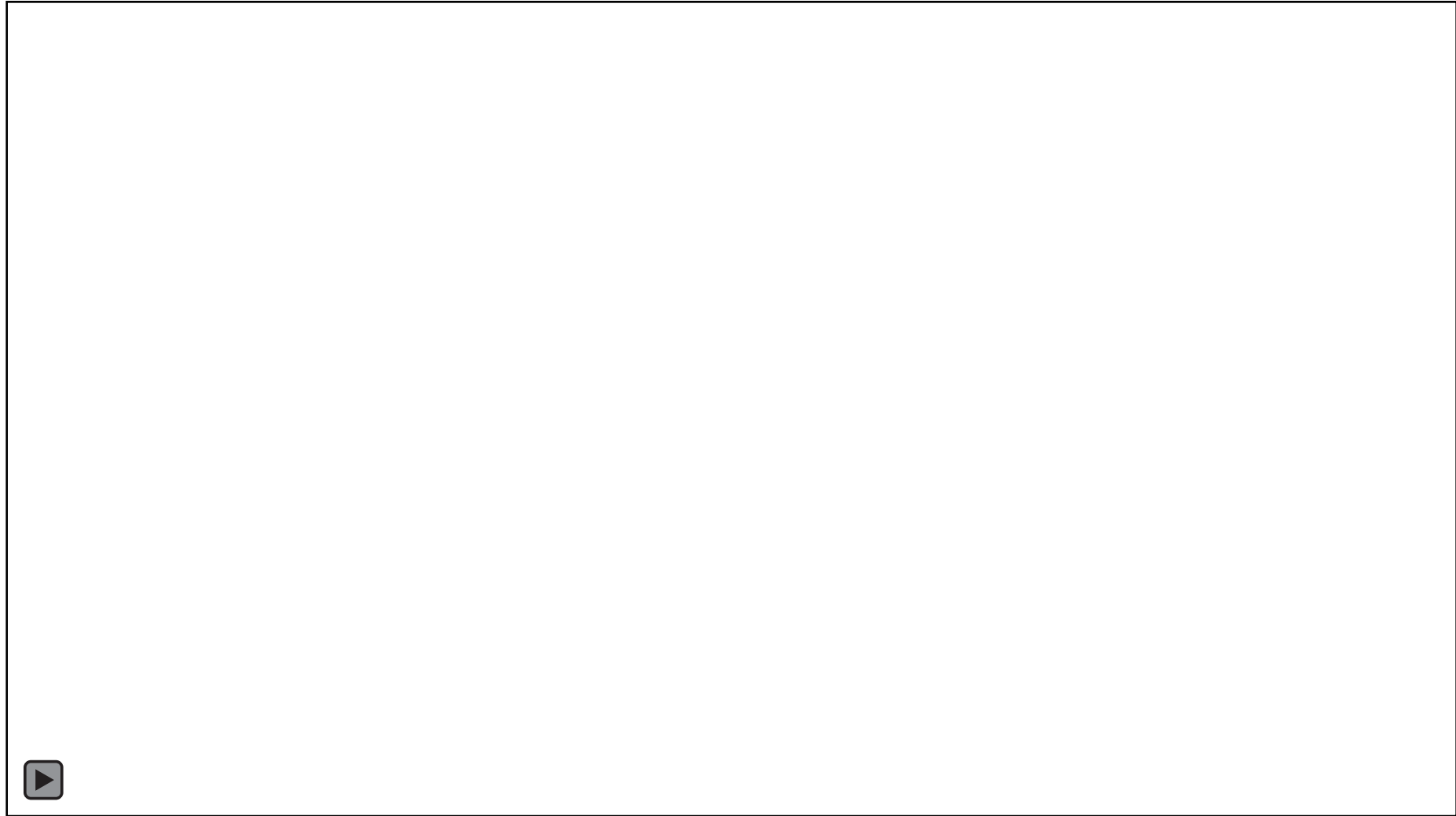
- 3D-Printed fluorescent detection system
- Casing manufactured from acrylonitrile butadiene styrene (ABS)
- Detection system developed in-house.
- Easily modifiable
- Microcystin-LR detection: Alexa fluor 647
- Powered by mains
- Communications either via USB to PC or with Wireless dongle (in-house model)



2-Atalanta system concept: Sensing System



2-Atalanta system concept: assembly

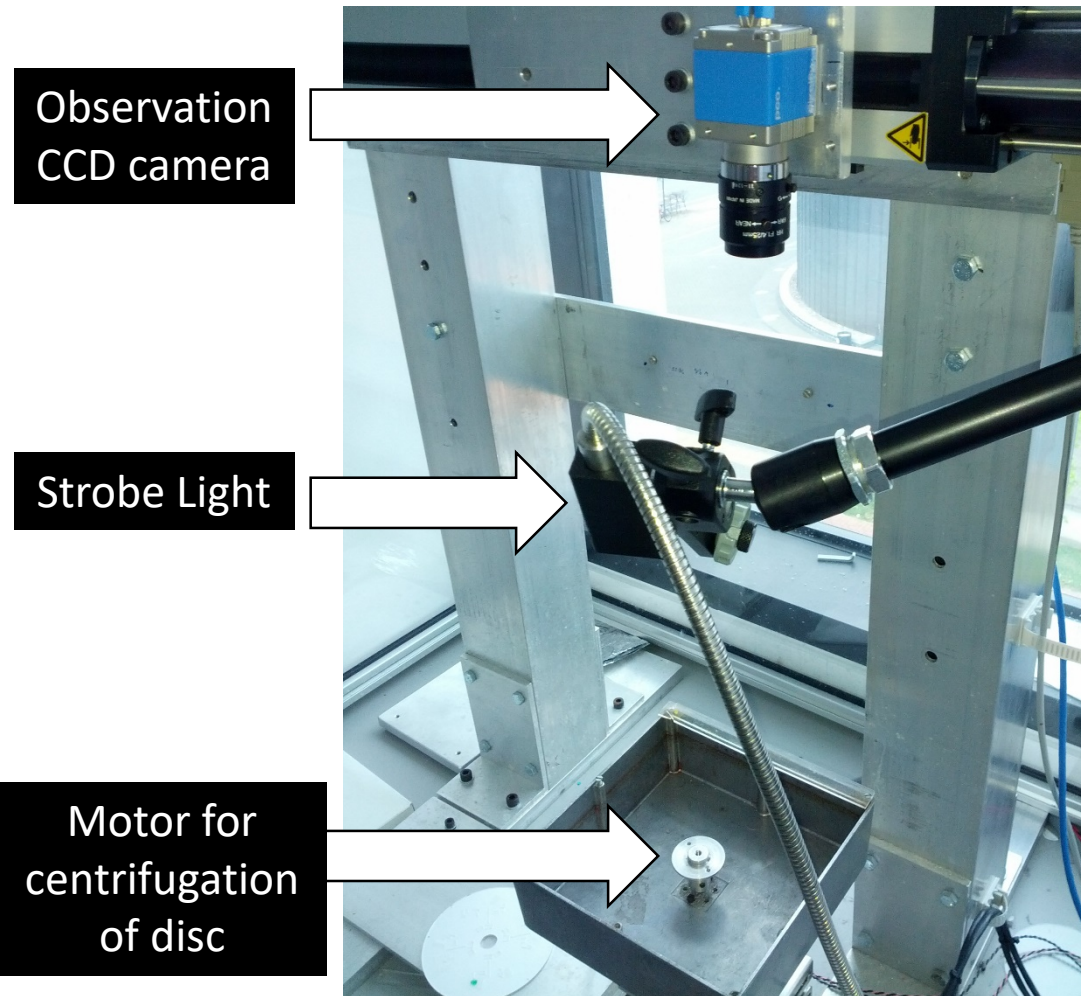


Video of Atalanta System

3-Atalanta system experiments

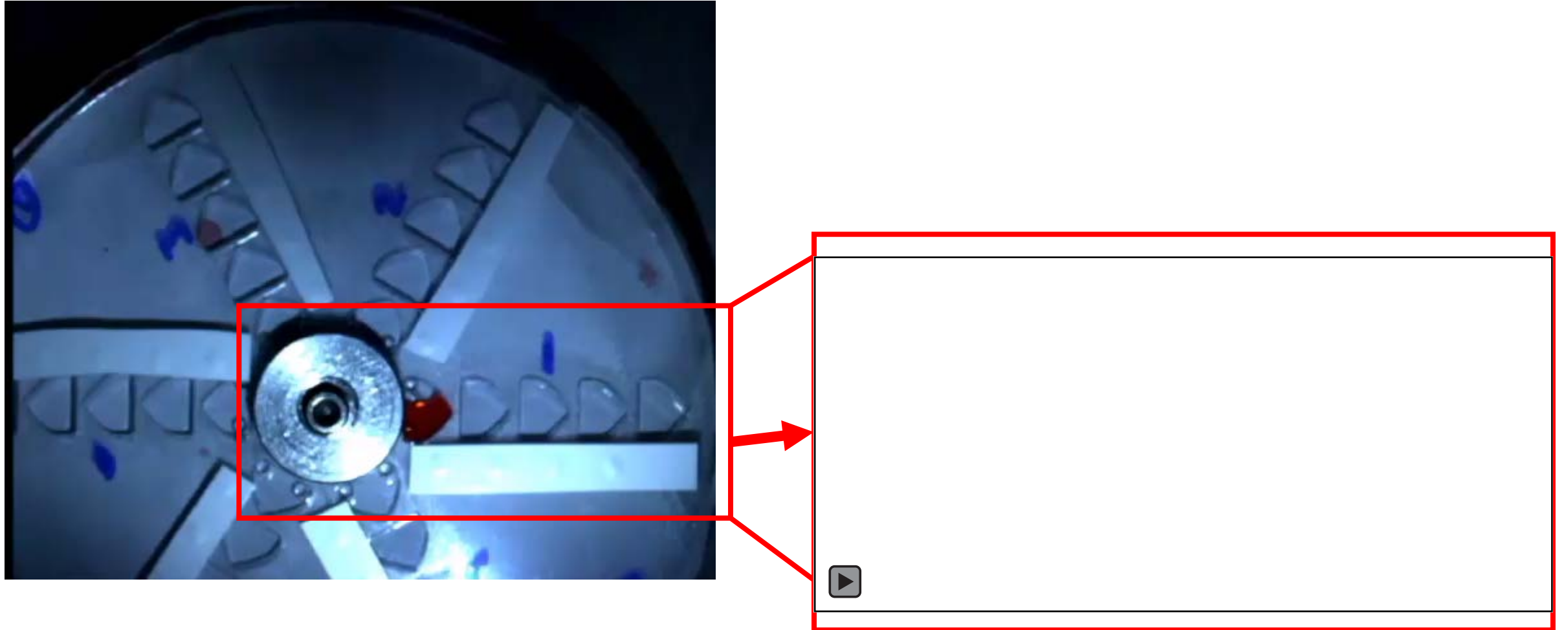
3-Atalanta system experiments: Off-Site Fluidic studies

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



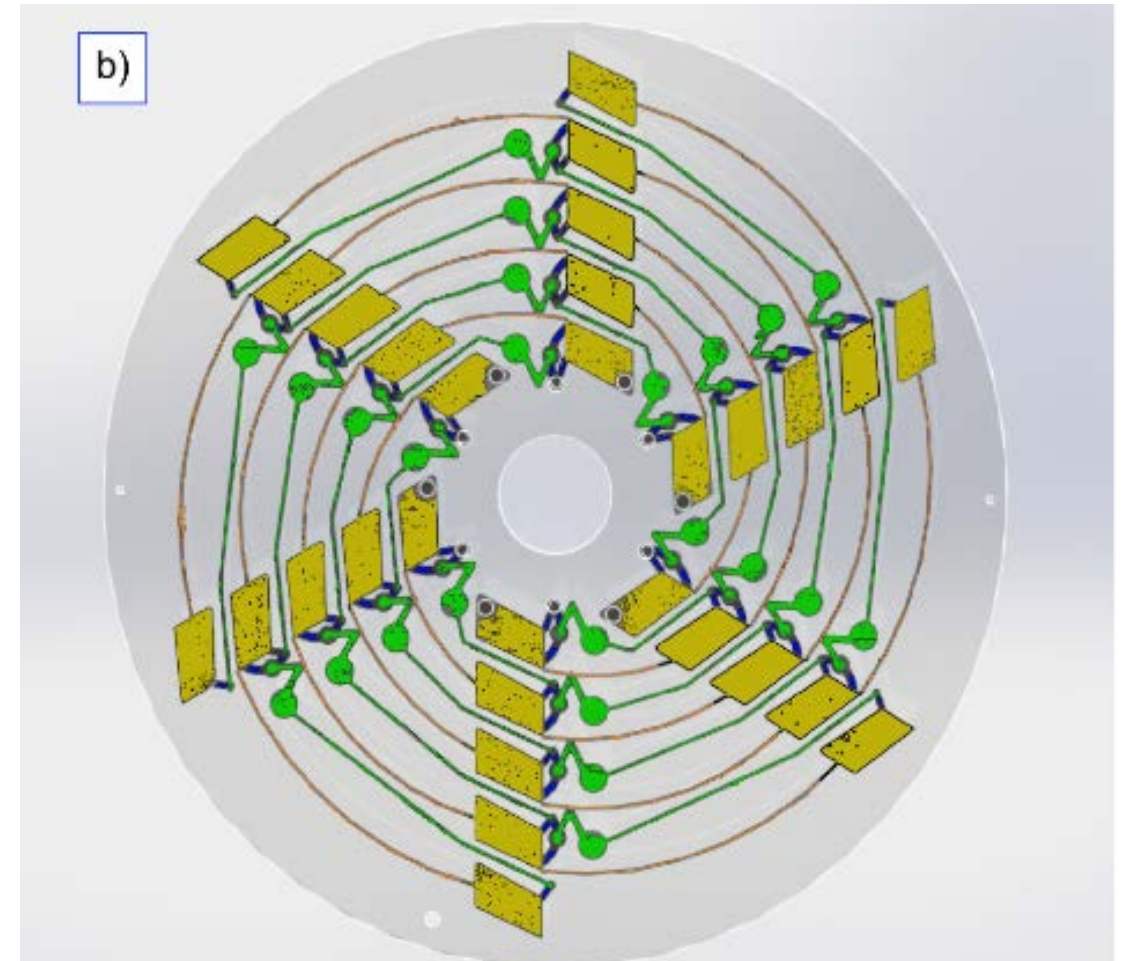
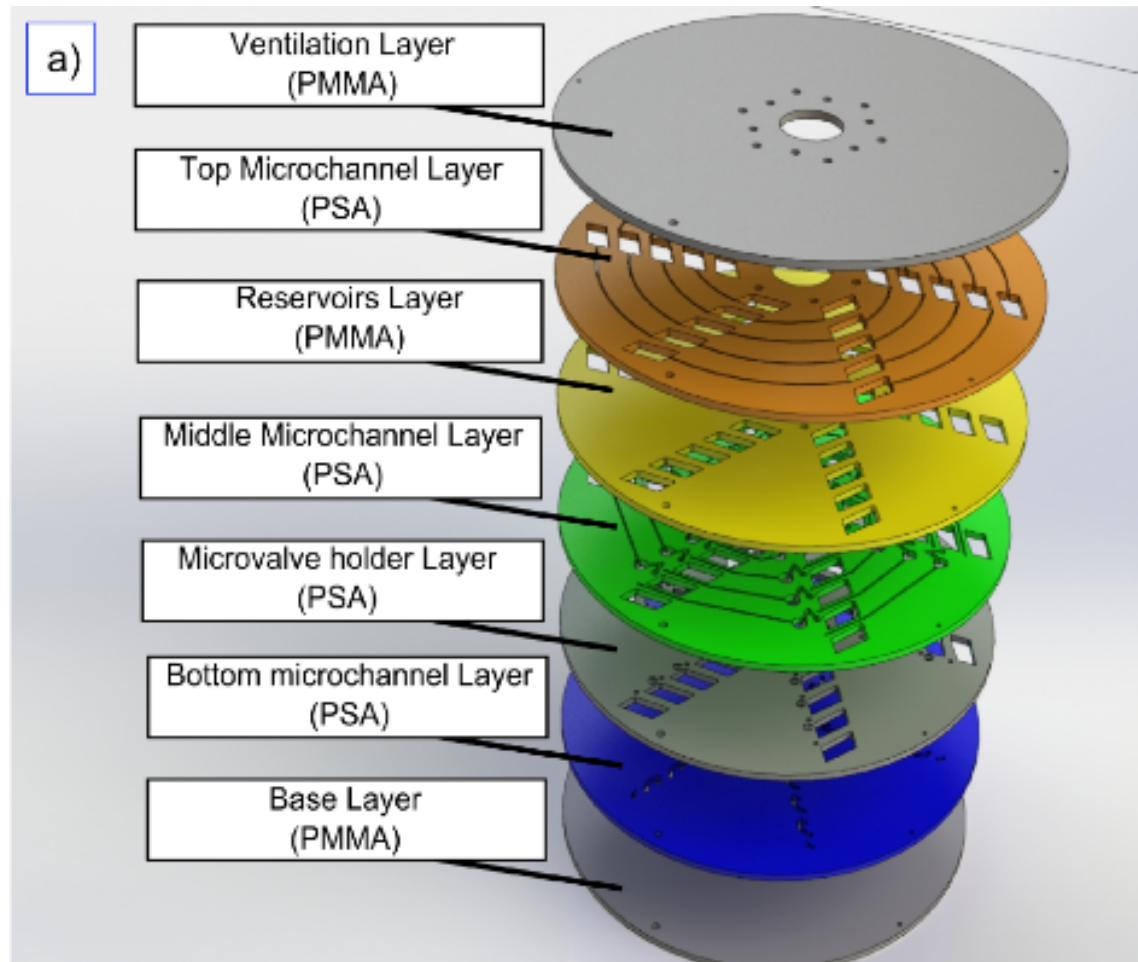
Spin stand with computer observation

3-Atalanta system experiments: Off-Site Fluidic studies

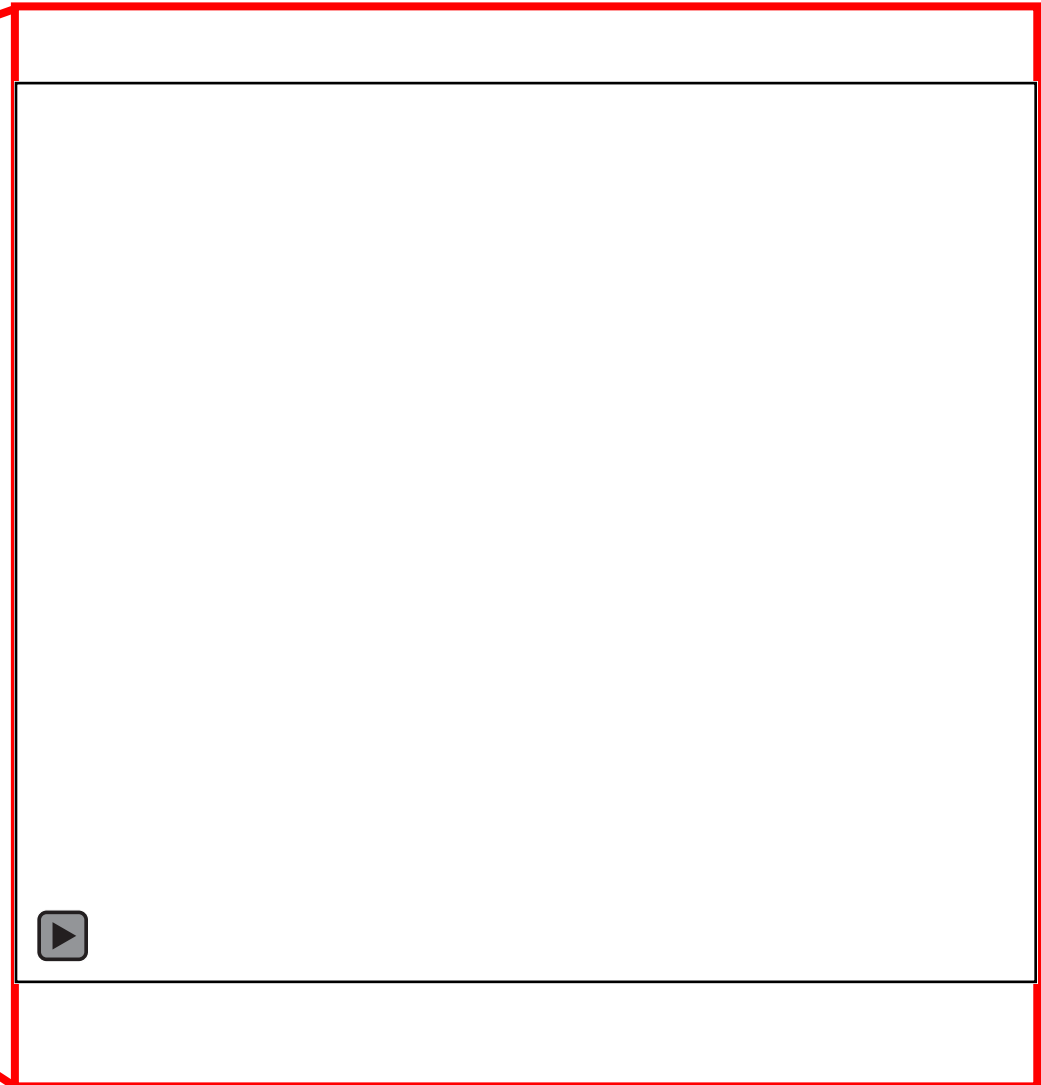
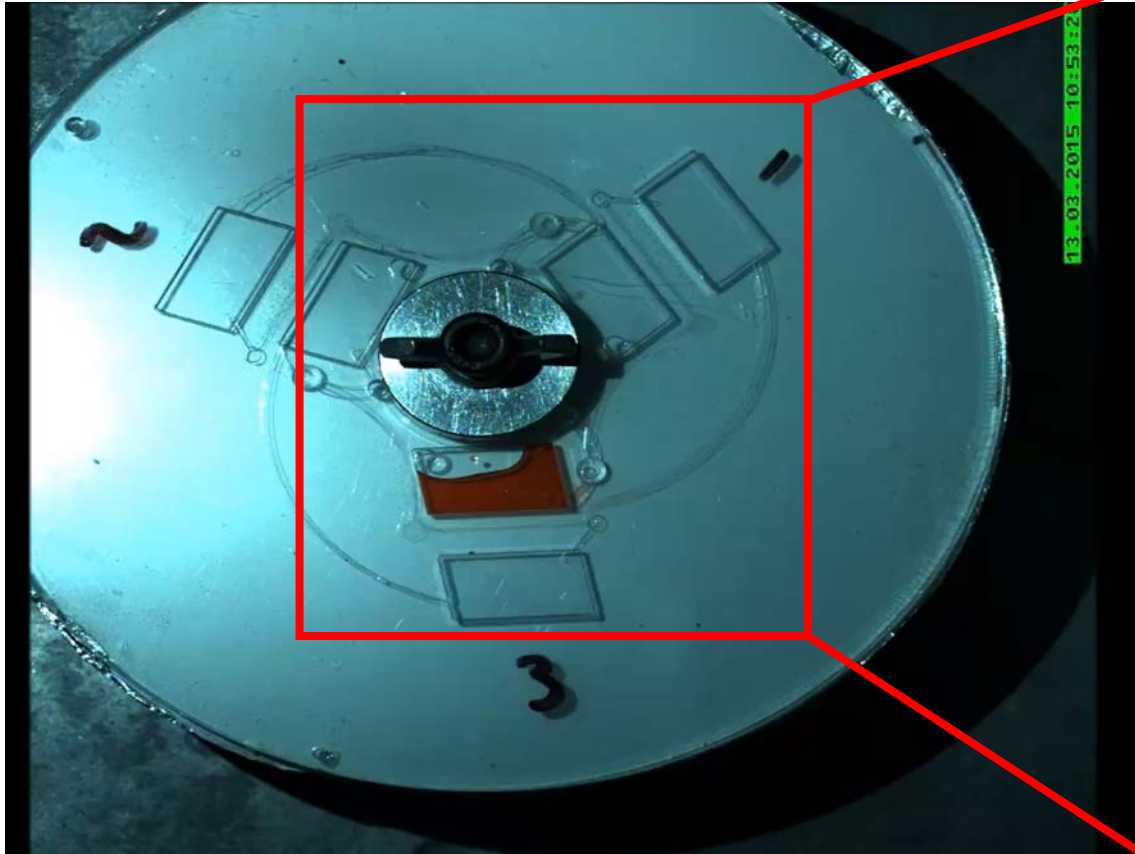


The Atalanta Microfluidic disc in action. The disc is loaded into the previous shown Spin stand with computer observation

3-Atalanta system experiments: Automation of microfluidic actuation

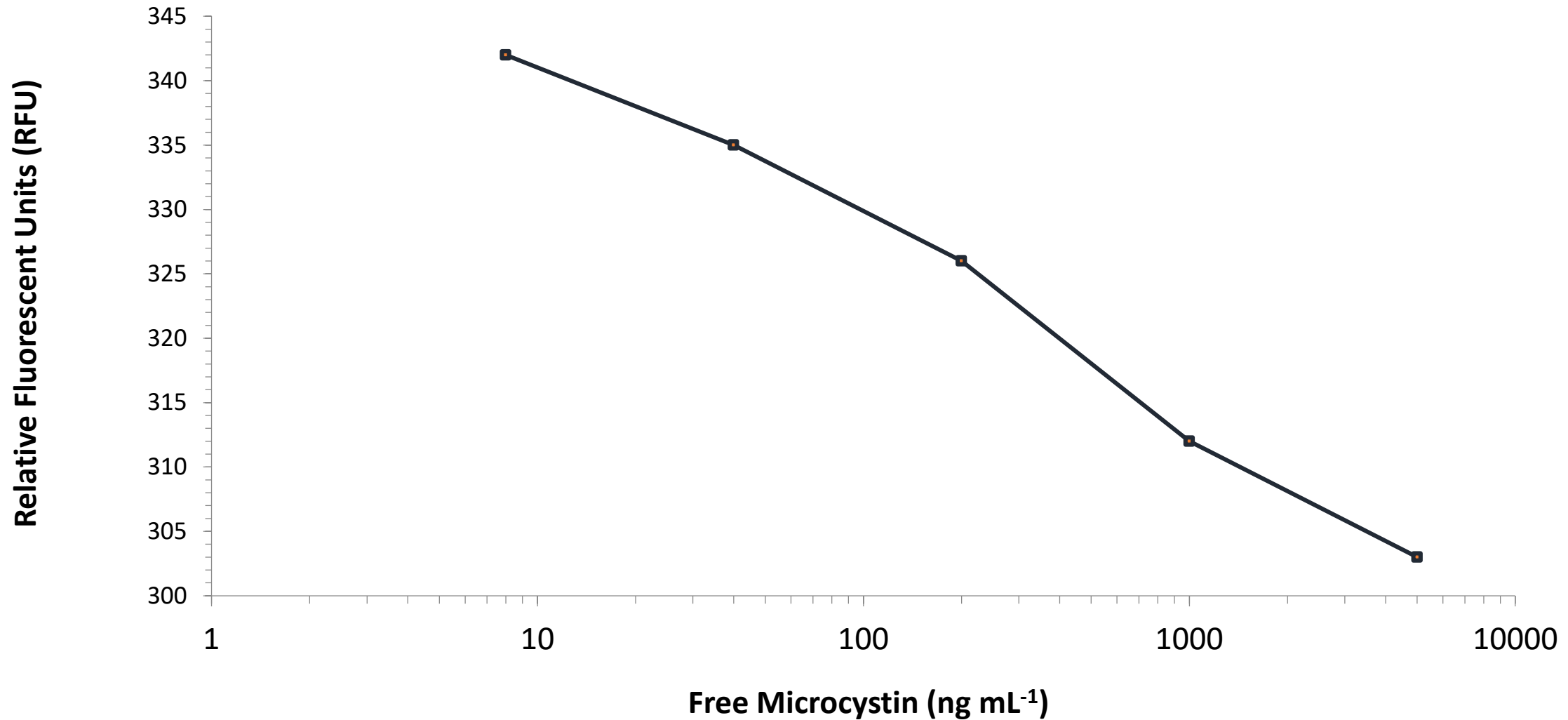


3-Atalanta system experiments: Automation of microfluidic actuation



Video of automation by dissolvable film (DF) valve opening by pulsing motor speed

3-Atalanta system experiments: Initial* microcystin detection results



*Requires significant more testing and optimisation, but demonstrates detection function.

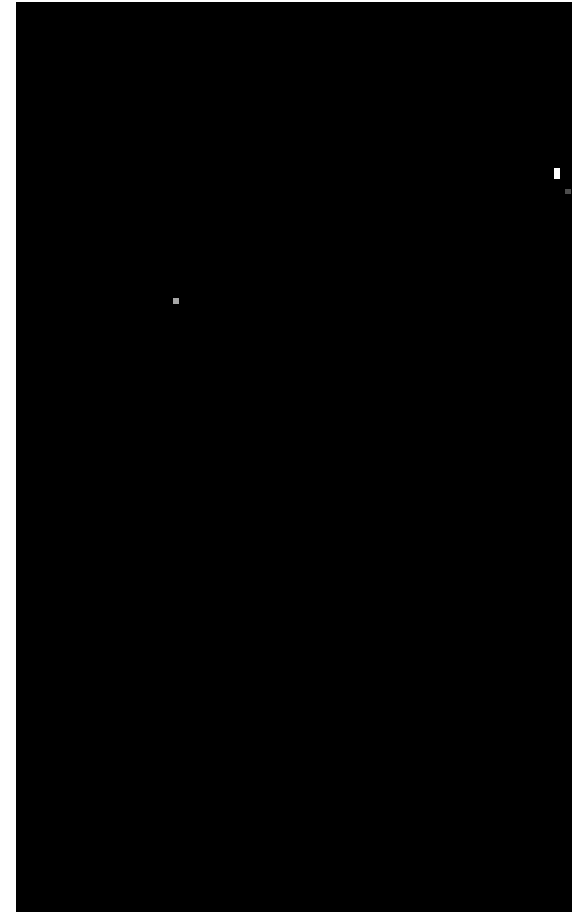
3-Atalanta system experiments: Fluorescent Microscopy images of test reservoirs



8 ng mL⁻¹



40 ng mL⁻¹



5000 ng mL⁻¹

Microcystin Concentration

4-conclusions: Summary of the Atalanta system

- The Atalanta 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



Acknowledgements

Dr. Jenny Fitzgerald

Brendan Heery

Dr. Caroline Murphy

Dr. Charles Nwankire

Prof. Jens Ducreé

Prof. Richard O' Kennedy

Prof. Fiona Regan

MESTECH

