



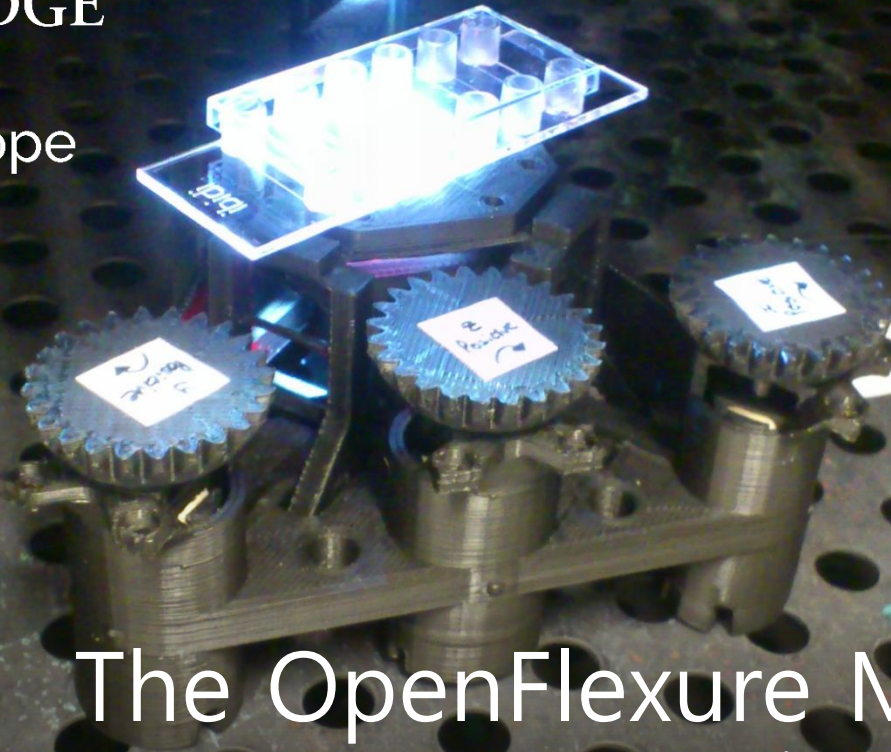
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WaterScope



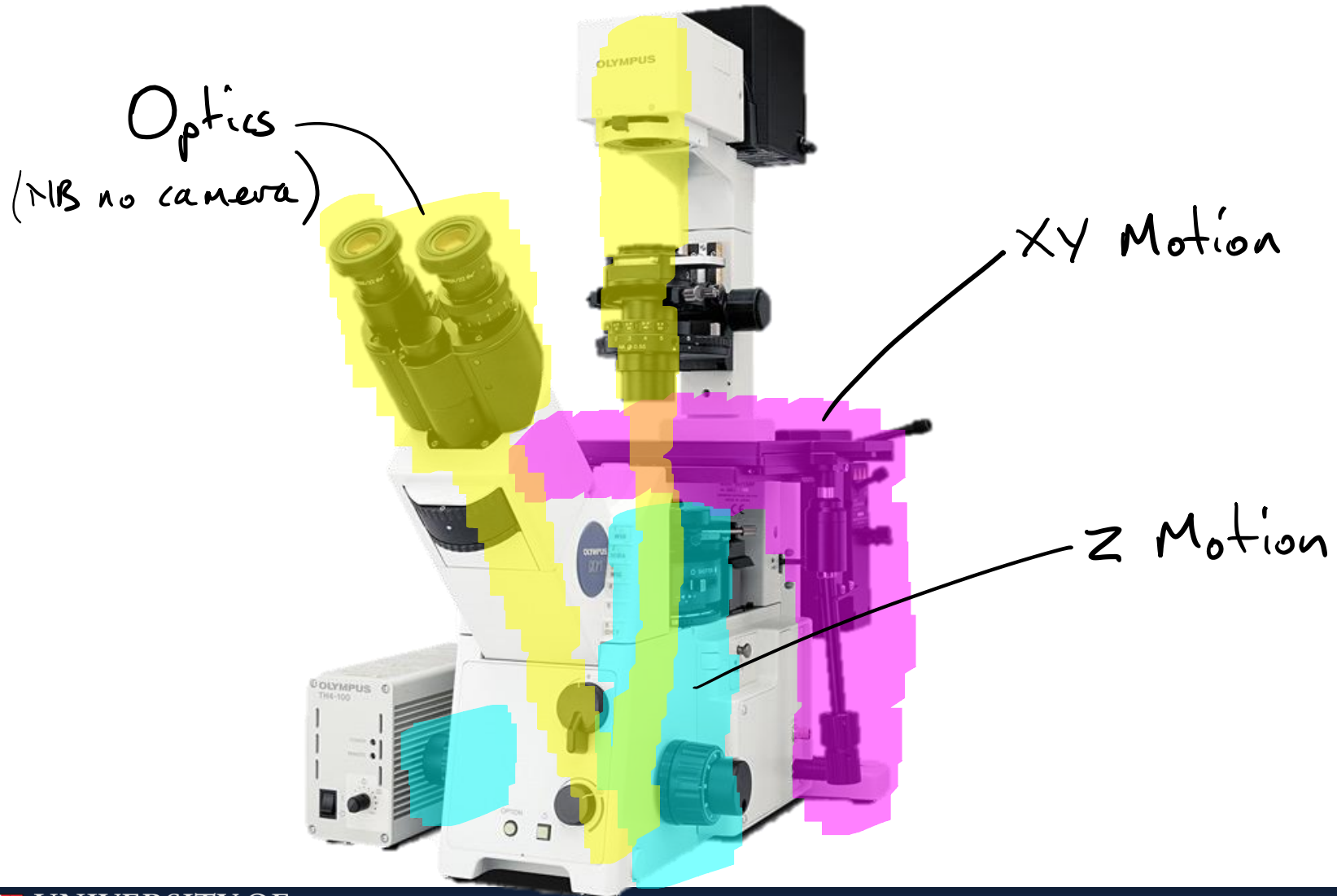
The OpenFlexure Microscope

Tianheng Zhao*

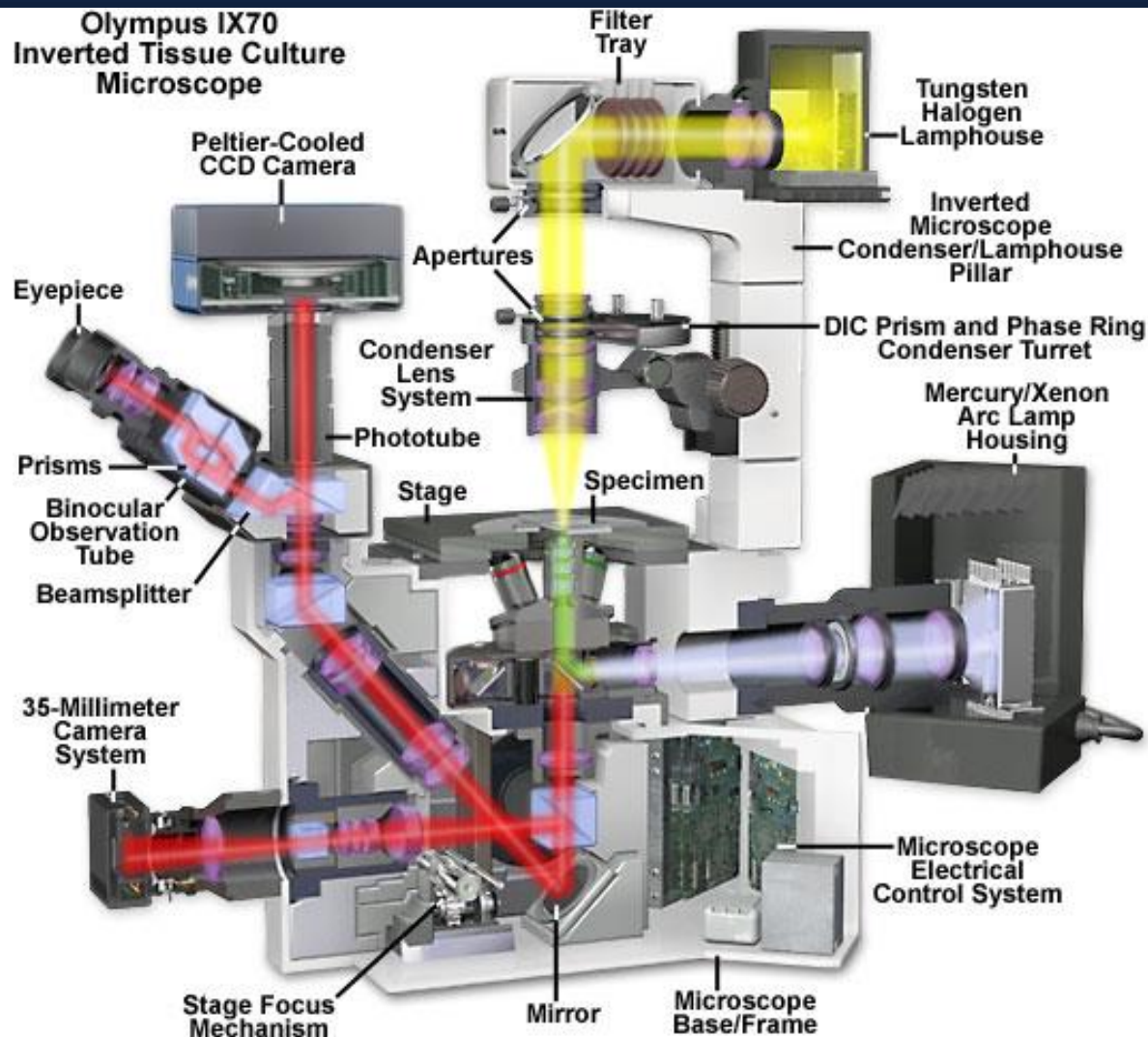
Richard Bowman**, Alex Patto**

*University of Cambridge, ** University of Bath

Parts of an optical microscope



Parts of an optical microscope



src: <https://micro.magnet.fsu.edu/primer/techniques/fluorescence/ix70fluorescence.html>



3D printed microscopes

Small:

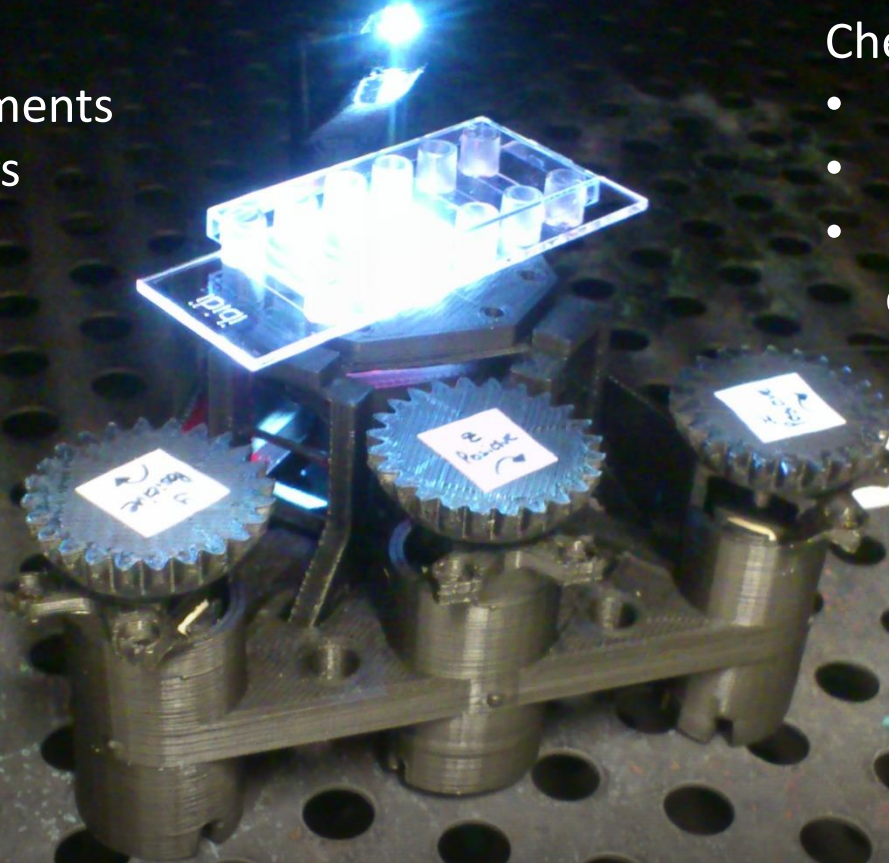
- Parallel experiments
- Fit in incubators
- Portability

Cheap:

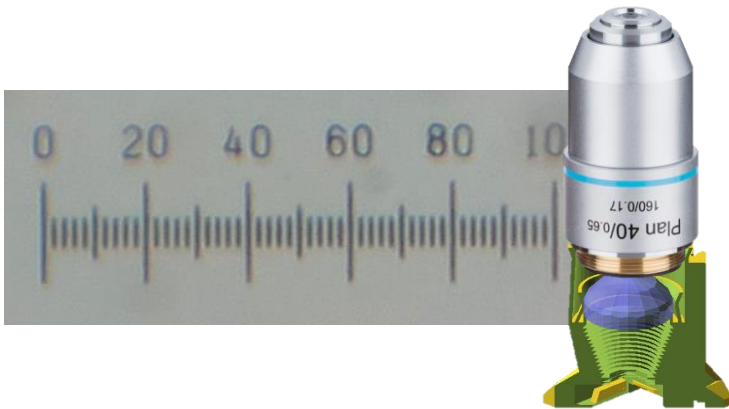
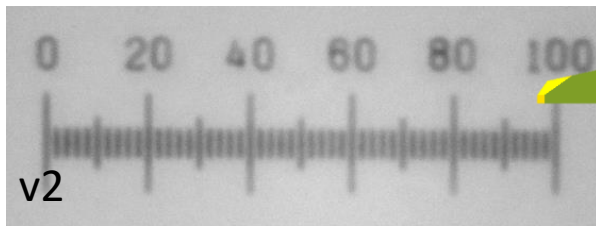
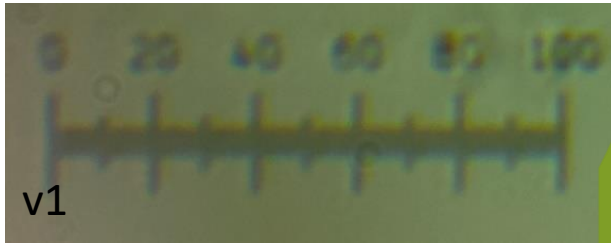
- Development
- Deployment
- Disposable after contamination

Adaptable:

- Integrated system
- Specialisation
- Improvement



Imaging performance



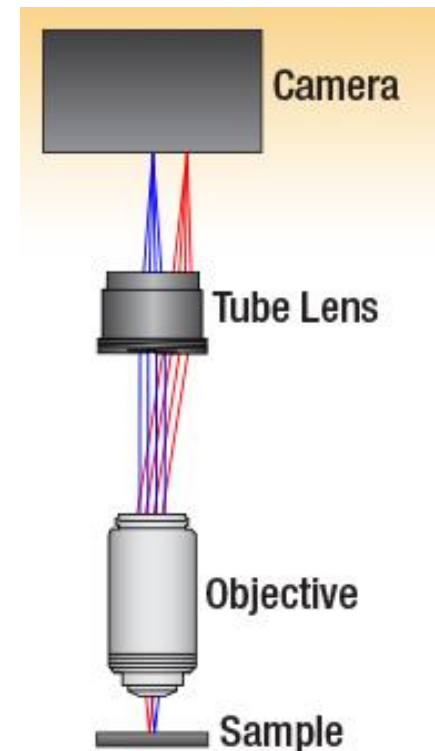
Web cam lens (flipped)

Web cam sensor

Objective lens

Tube lens

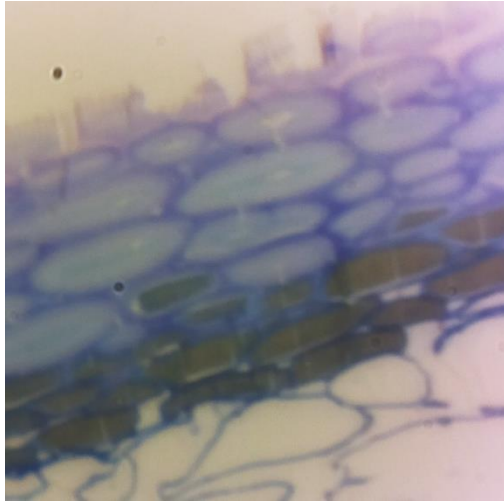
Web cam sensor



additional info: <https://www.olympus-lifescience.com/en/microscope-resource/primer/anatomy/components/>



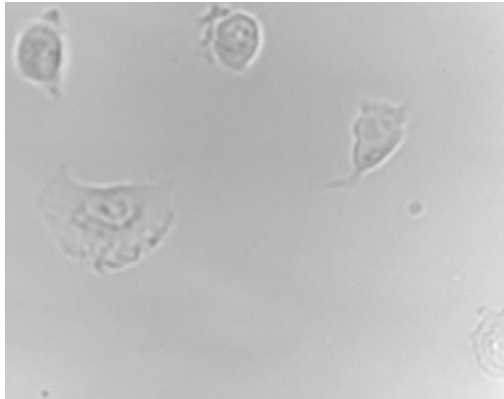
Imaging performance



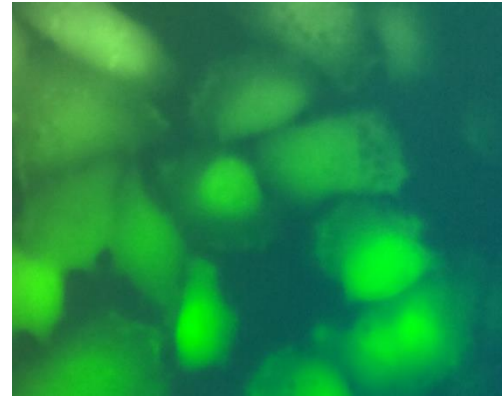
Bright field



Dark field



Time-lapse

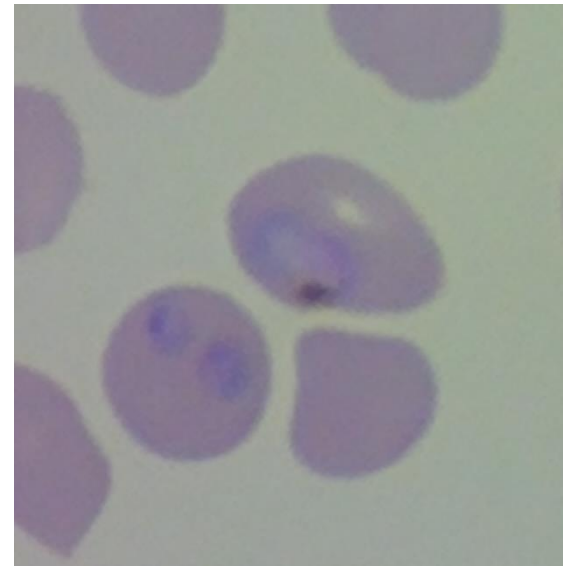
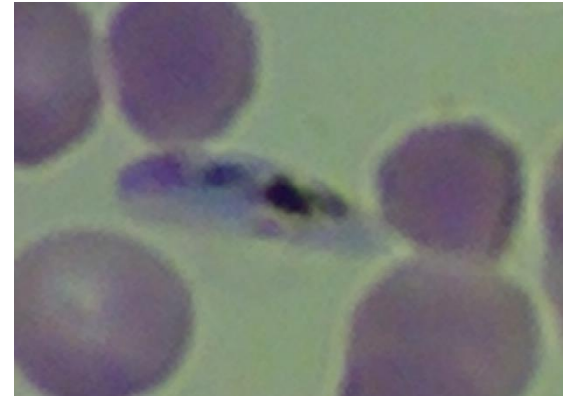
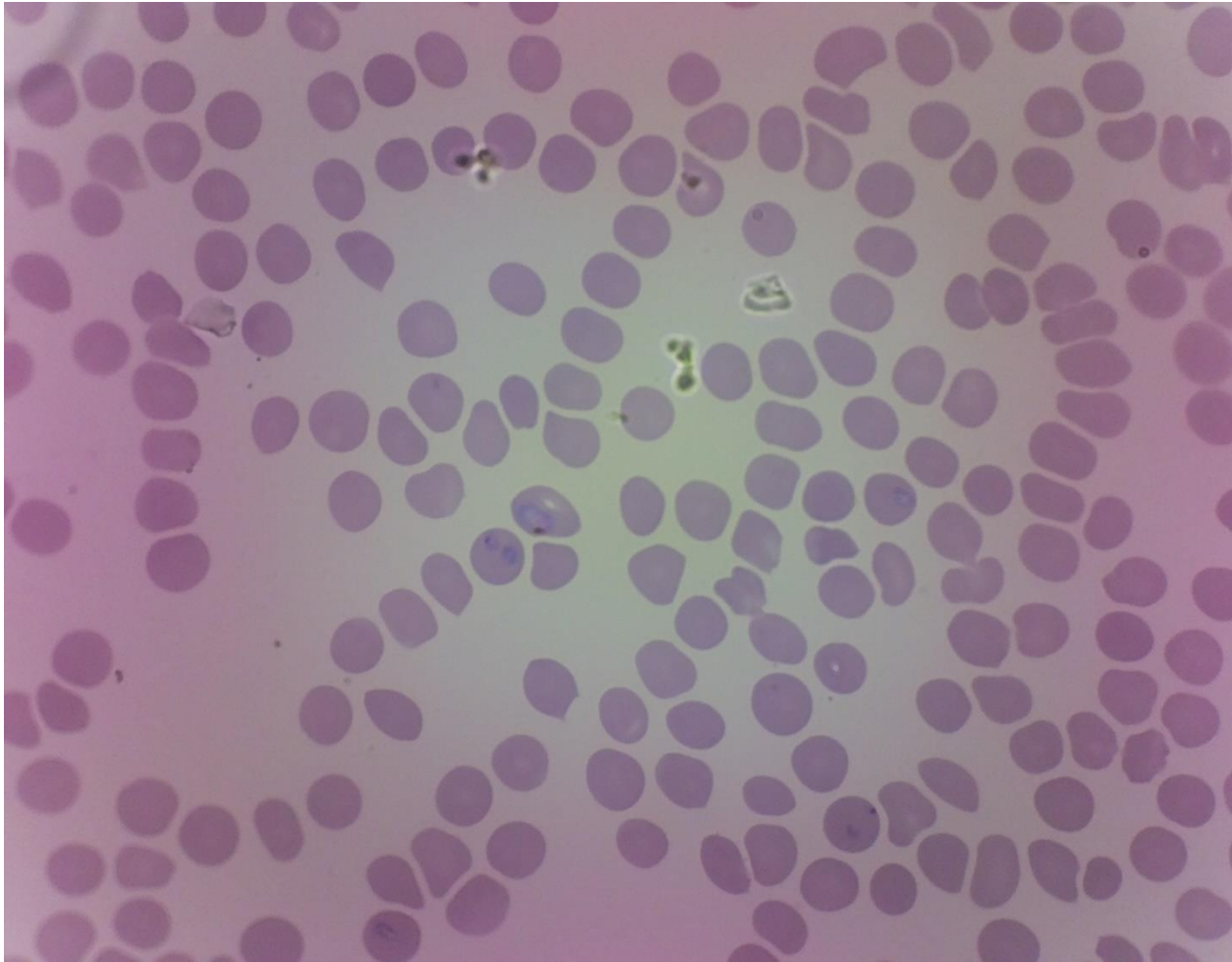


Fluorescent

- Thanks to S. Vignolini and P. Rudall for the Pollia sample
Cell images collab. D Bressan and S Reichelt, CRUK Cambridge Institute

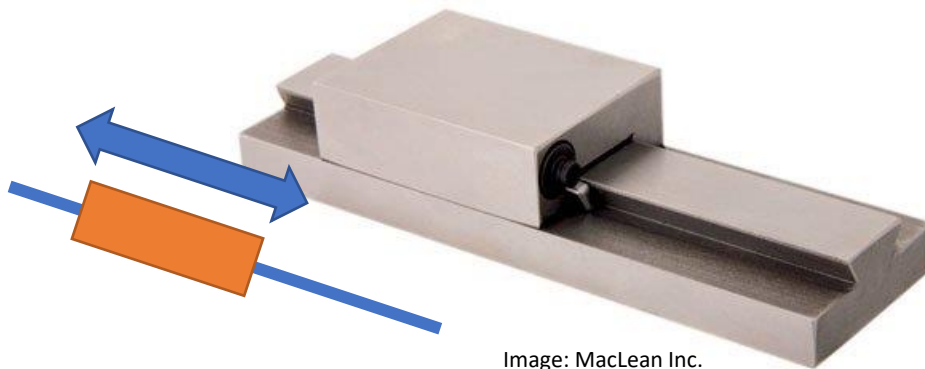


Imaging malaria with 50x oil immersion

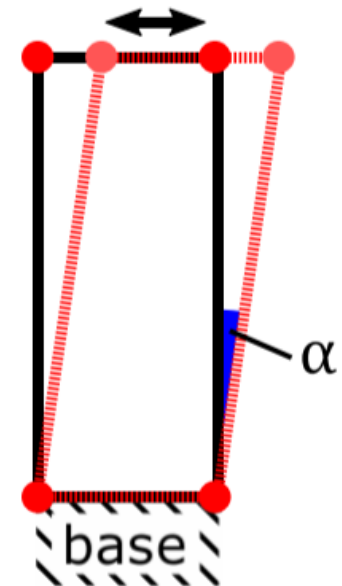
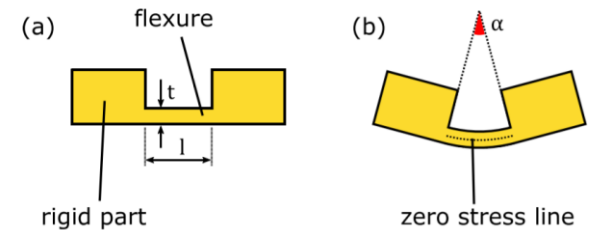


Microscope stage Design

- Sliding requires smooth, precise surfaces
- Flexures are used in highest-performance mechanisms in the lab
- New plastic-friendly flexure design using plastic's flexibility



Machined sliding stage

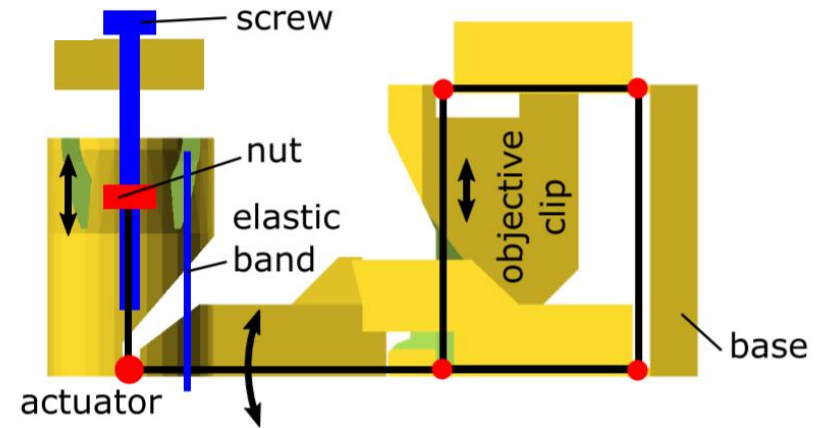
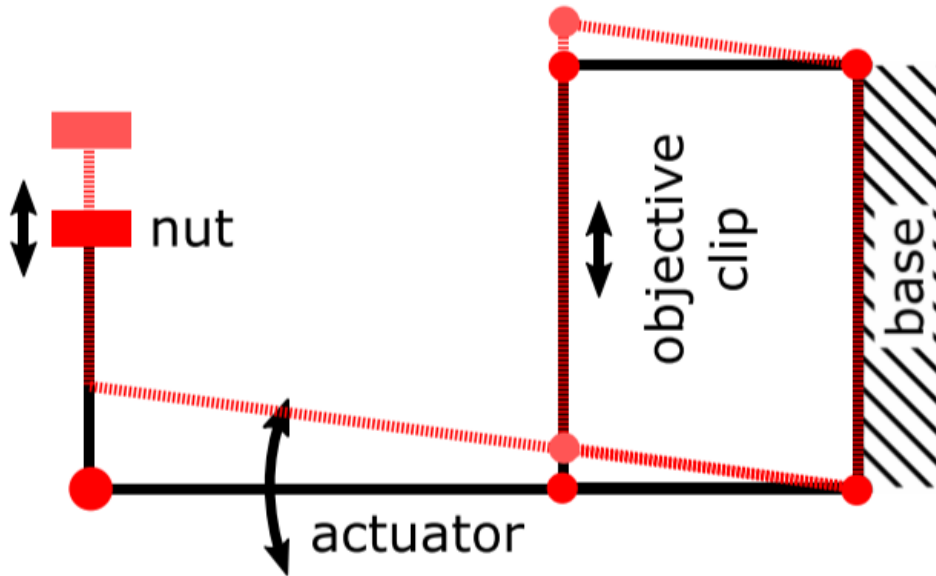


4-bar flexure

Iterations of stage designs



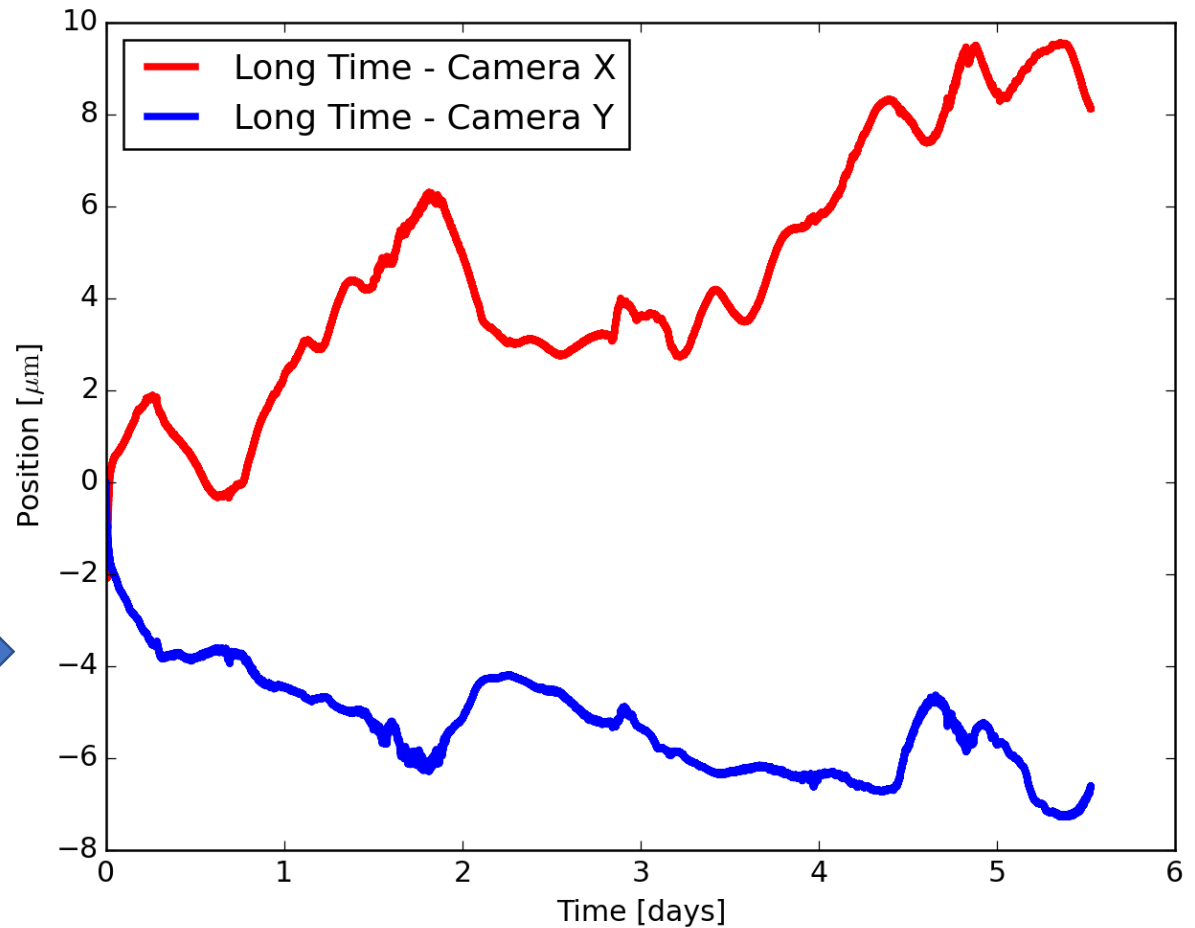
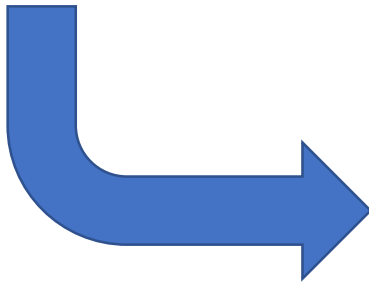
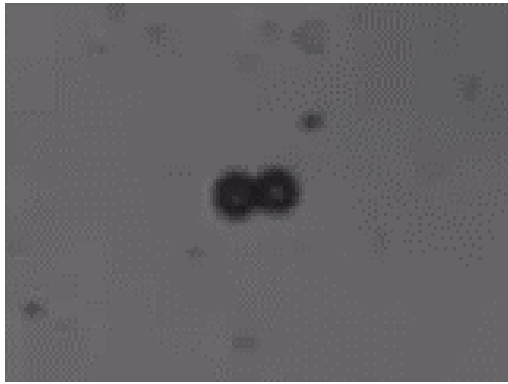
Mechanics of Z Axis



A 3D CAD model of a mechanical assembly, possibly a pump or valve component. The main body is a yellow, flange-like structure with a central circular opening and eight bolt holes around its perimeter. It is connected to a vertical shaft or pipe. Two smaller cylindrical components, also in yellow, are attached to the sides of the main body. The entire assembly is shown against a dark blue background.

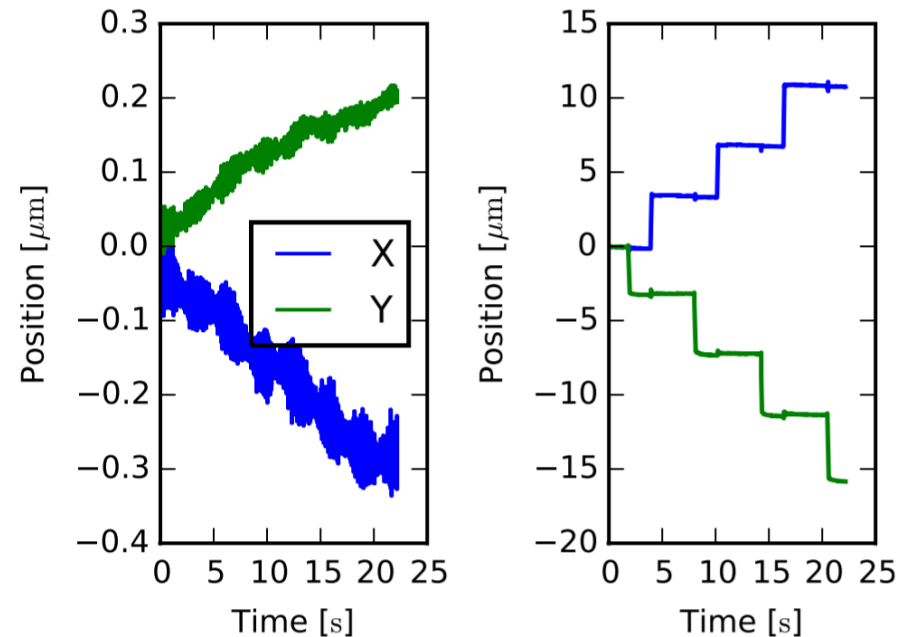


Mechanical Performance: Drift



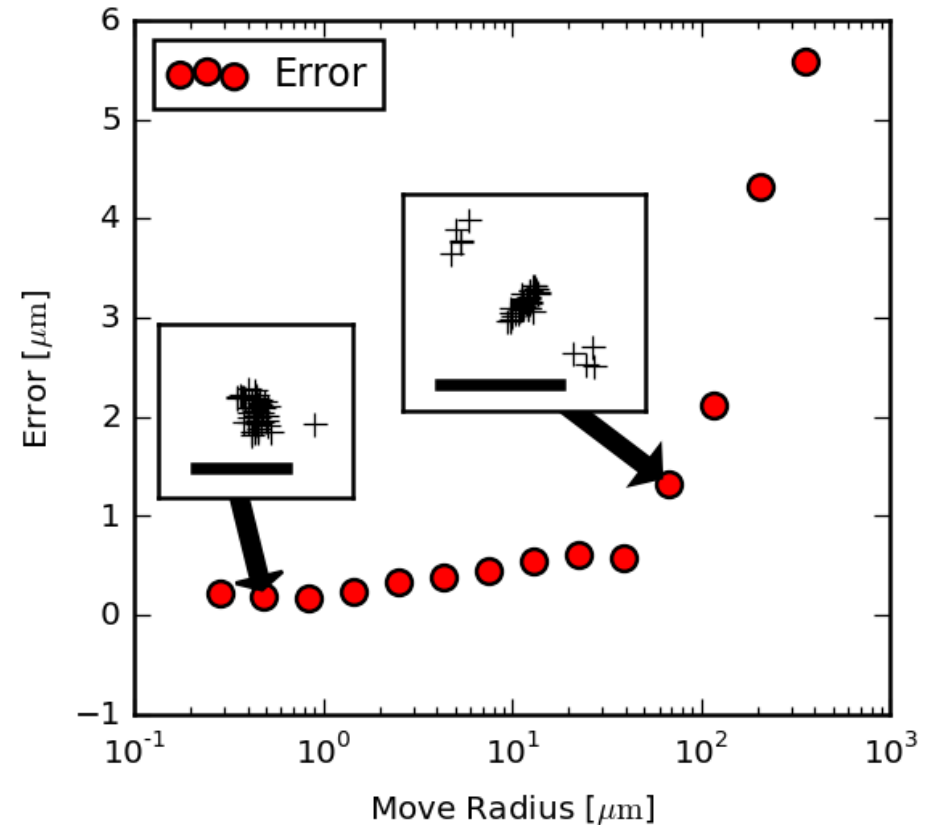
Mechanical Performance: Steps & Repeatability

(a)



(a) Motorised stage: step size and variation at small and big steps

(b)



(b) Positioning errors moving to random places and back



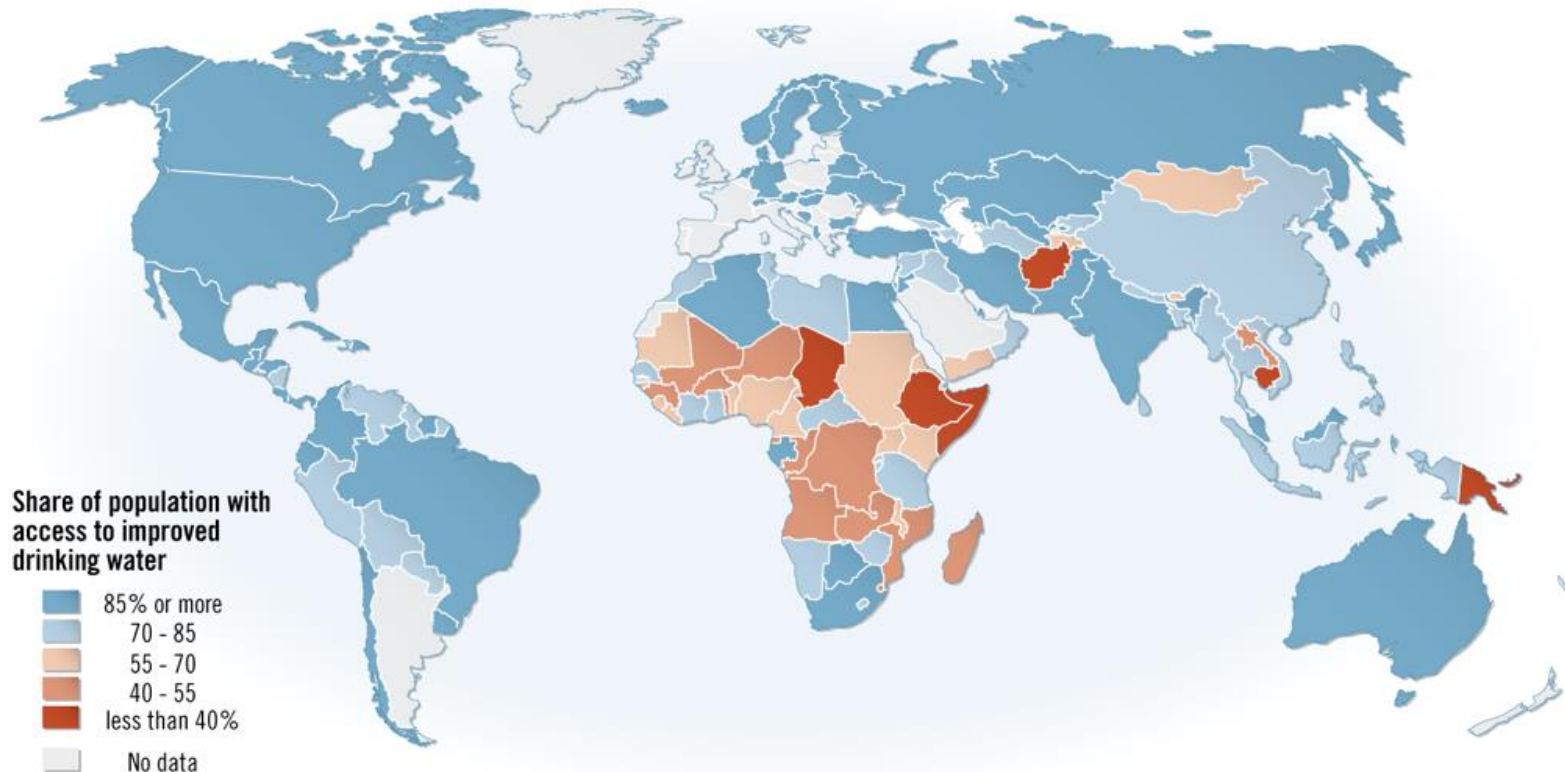
WaterScope

Empowering the bottom billion to
find clean water

Real world applications of
the OpenFlexure Microscope

The Water Crisis

- 1 in 10 people have no access to clean drinking water
- Over 80% live in rural communities
- No knowledge about water contamination
- Dependence on external aid to test and purify water



Existing bacteria testing methods



Aquagenx
Safe water for anyone, anywhere, anytime



Water Canary

>24 hrs incubation

Insufficient precision



- Short incubation time
- Precise measurement
- Simple to use
- Cost effective



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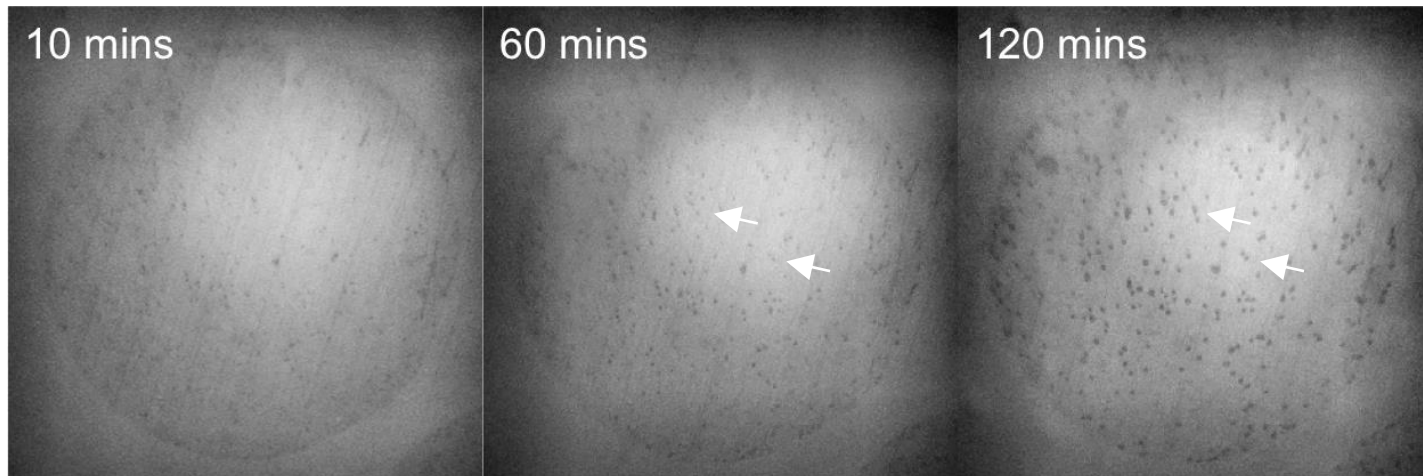
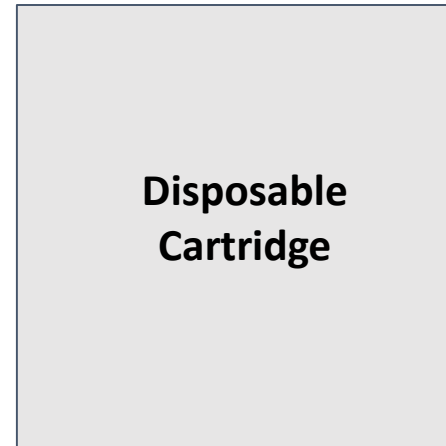
 **WaterScope**

Our solutions

- Fast and inexpensive portable water testing
- Disposable cartridge enabling anybody to use it
- Visual readout for community education
- Results in <2 hour
- Database for mapping, feedback and intervention



Our solutions



The team



**Tianheng
Zhao**

Engineering
& Software



**Dr. Richard
Bowman**

Instrumentation
design
& optics



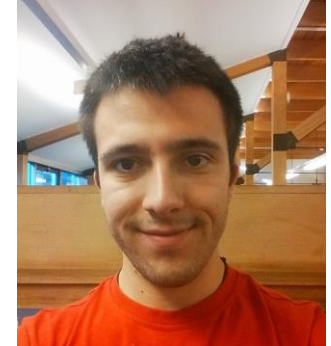
**Alexander
Patto**

PhD Genetics
Microbiology



**Dr. Nalin
Patel**

Management
& Start-up
Experience



**Sammy
Mahdi**

Sensor
Technologies
and
electronics

Achievements to date

Established in **July 2015**

Can detect bacteria under **2 hours**, refined prototype

Raised over **£90,000 of non-dilutive funding**

Automated microscope developed that can identify malaria

Malaria trials ongoing in Tanzania with **JHPIEGO**

Printing microscopes out of **plastic bottles** in tanzania with **STIClab**

Have tested the microscope around the world, including India, Columbia, Tanzania, U.S. and Gambia.

Core technology developed in WaterScope used to support **1 million EPSRC GCRF research grant**



Long-Term Vision

Our definition of success is to achieve **worldwide social impact**, reaching 10 million people in the next 4 years, as a self-sustaining business.

