



Bath: J Knapper, E Meng, K Bumke, K Harrington, J Stirling, J Collins, W Wadsworth, N Campbell, Y Wang, B Vodenicharski, R Bowman
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STICLab: V Sanga, P Nyakyi, G Mwakajinga



openflexure
microscope



Smart Microscopy for Everyone

Richard Bowman, SynBioForum, 27/07/2021



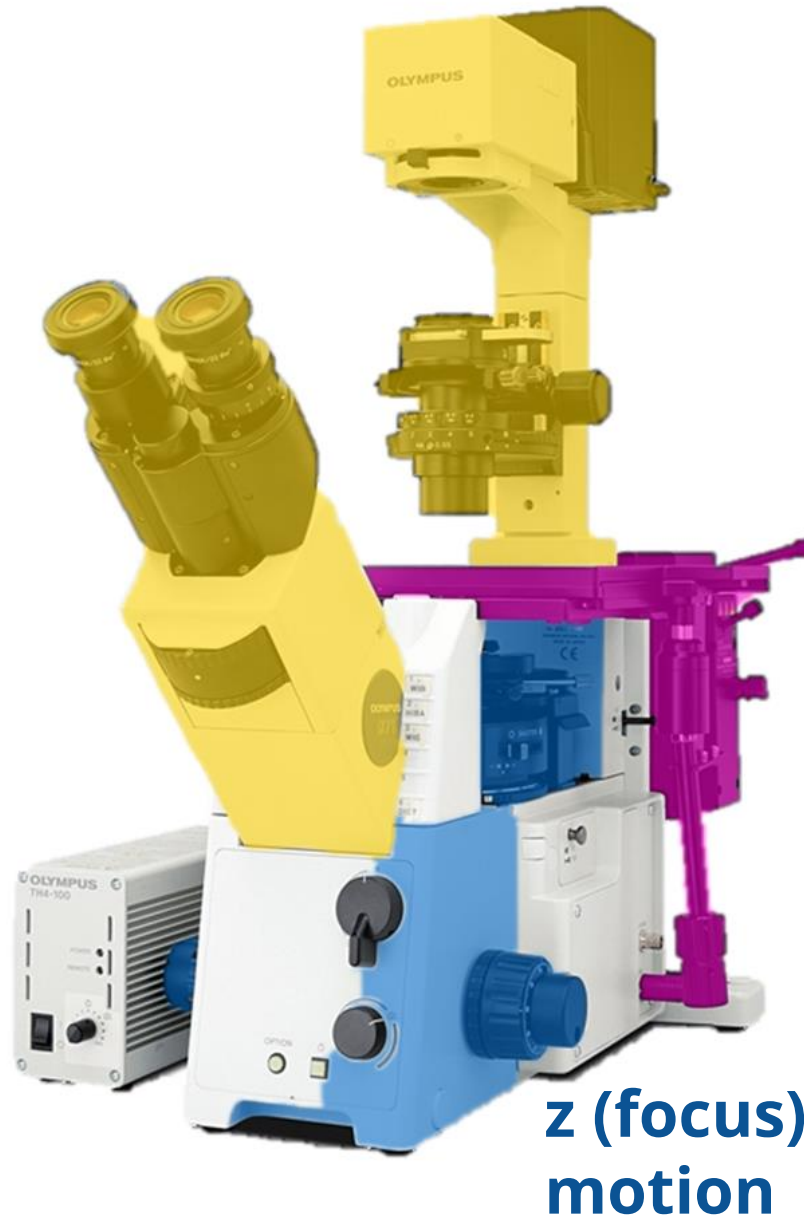
- A microscope for everyone:
 - To buy?
 - To make?
 - To repair?
 - To customise?
- How well does it work?
- How can we keep it calibrated?
- Can it be used for diagnosis?



What is a microscope?

~50c
m

Optics
(w/o
camera)



x-y
motion

z (focus)
motion

Putting the Flexures in OpenFlexure

- Sliding requires smooth, precise surfaces
- Plastic is flexible
- Flexures avoid sliding – and move very smoothly
- New plastic-friendly flexure design

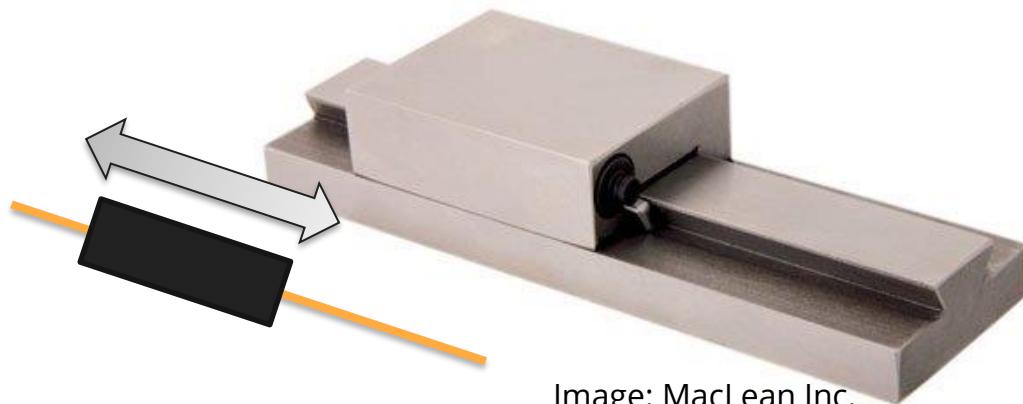
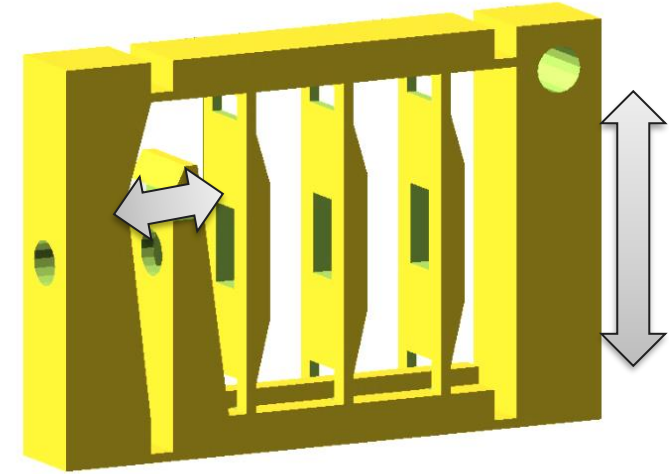
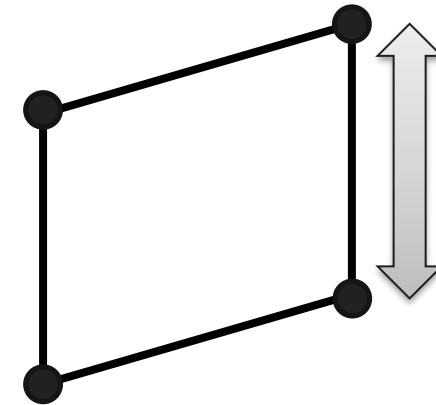


Image: MacLean Inc.



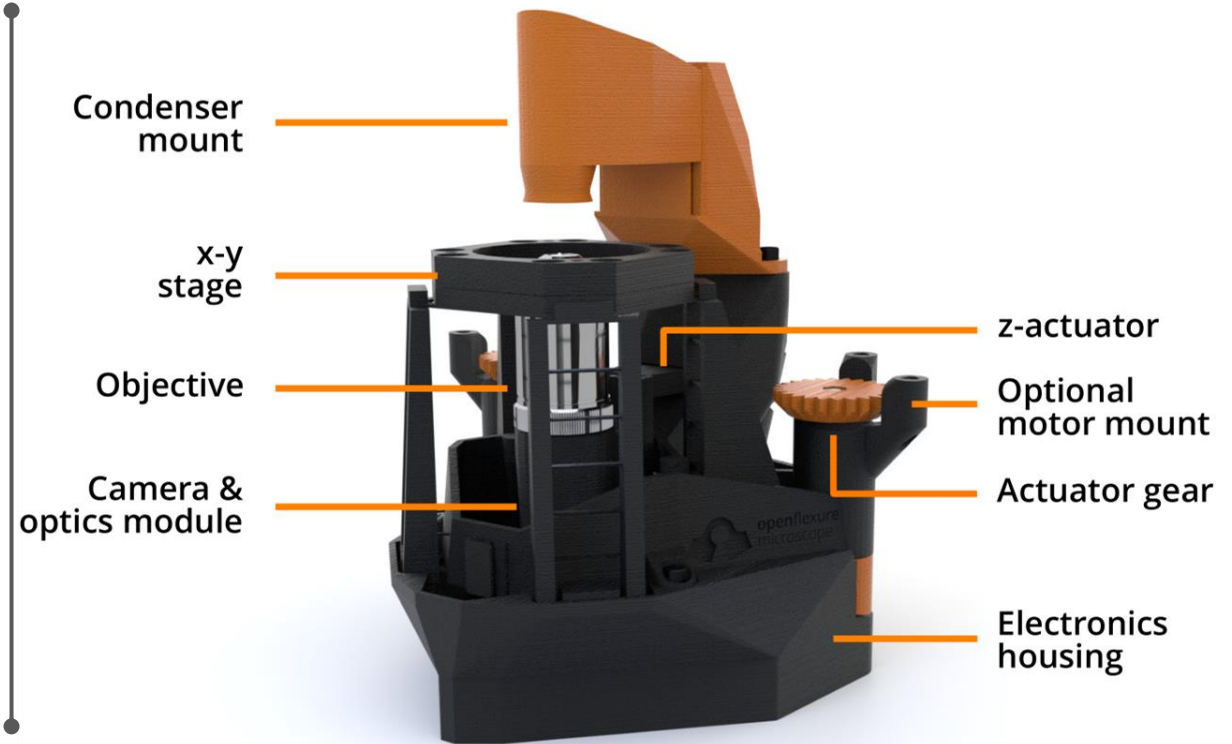
The OpenFlexure Microscope



~50c
m

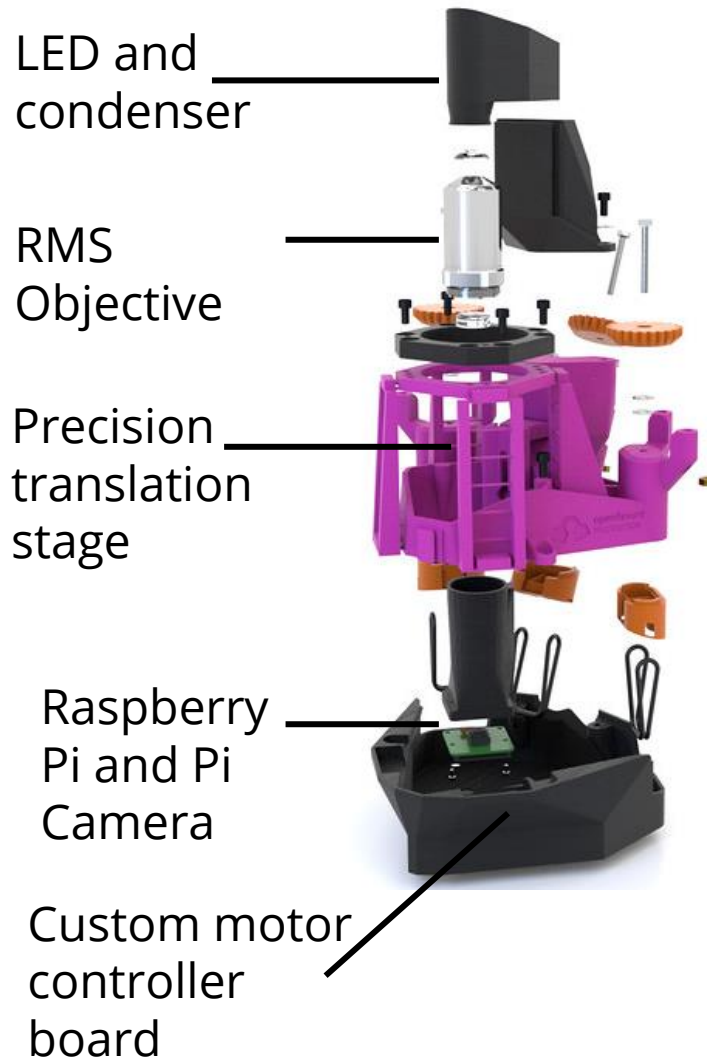


~20c
m

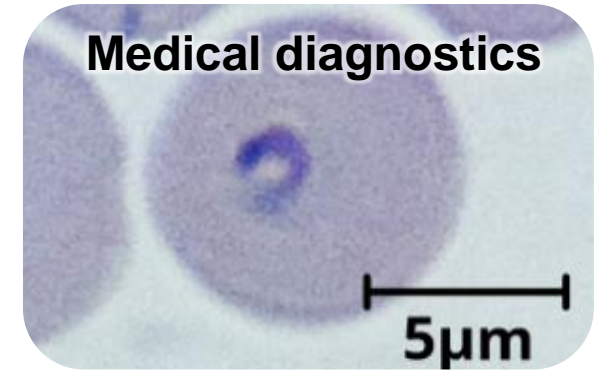


Not to scale!

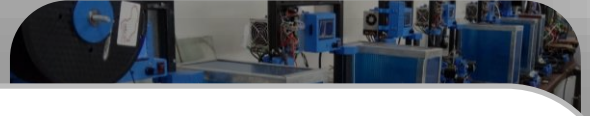
The OpenFlexure Project & Friends



- Motorised, inverted self-contained microscope
- High precision, stable 3 axis translation stage
- Integrated electronics
- Options for imaging modes & extension
- W3C WebThing
- Open toolchain



The OpenFlexure Project & Friends

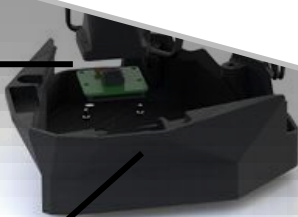


Dr Julian Stirling

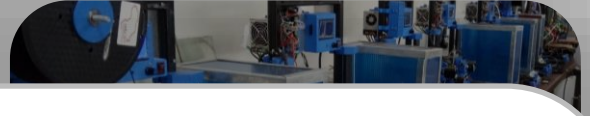
- GitBuilding <https://GitBuilding.io/>
- Markdown-based hardware documentation
- Automatic bill-of-materials generation
- Step by step instructions, embedded video/3D
- HardOps: using Software DevOps tools for hardware (preprint out)

Raspberry
Pi and Pi
Camera

Custom motor
controller
board



The OpenFlexure Project & Friends



Dr Joel Collins

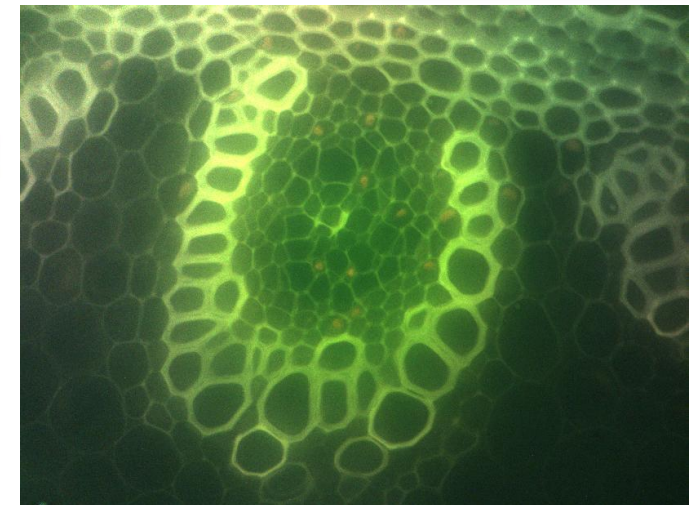
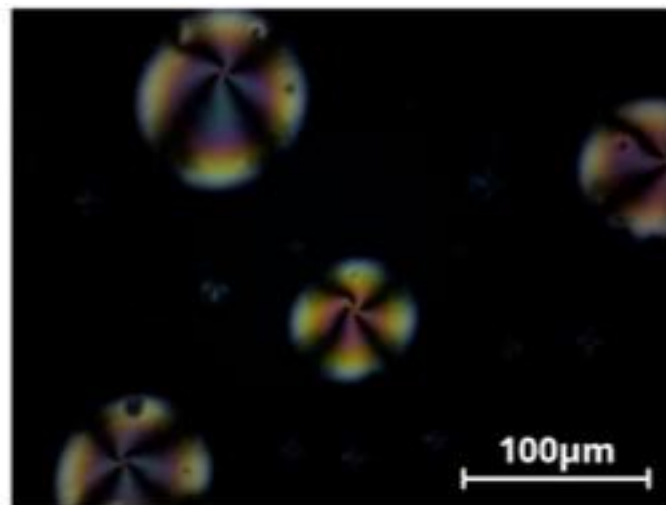
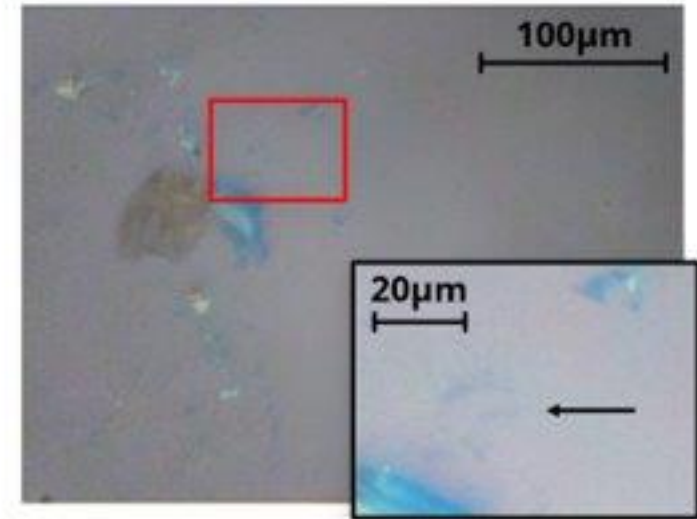
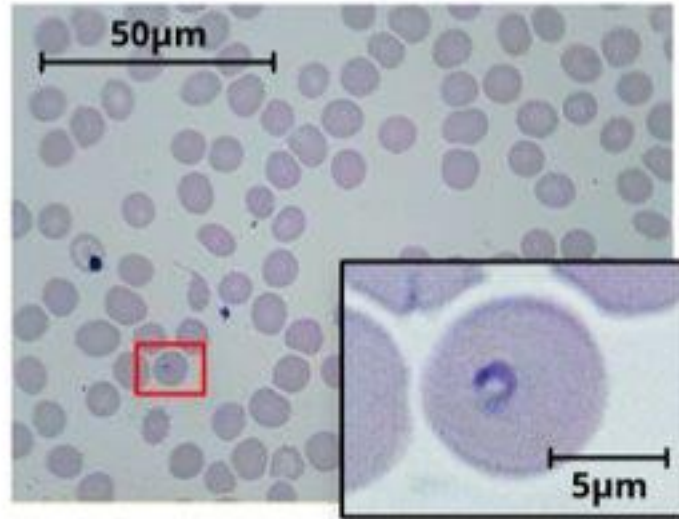
- [W3C Web of Things](https://www.w3.org/2019/04/wot-standard/) Standard: connecting together hardware devices, language/OS/hardware-agnostic
- Not specific to any class of device, or to scientific instruments
- Huge range of existing toolkits for interfacing, etc.
- <https://labthings.github.io/>

Raspberry
Pi and Pi
Camera

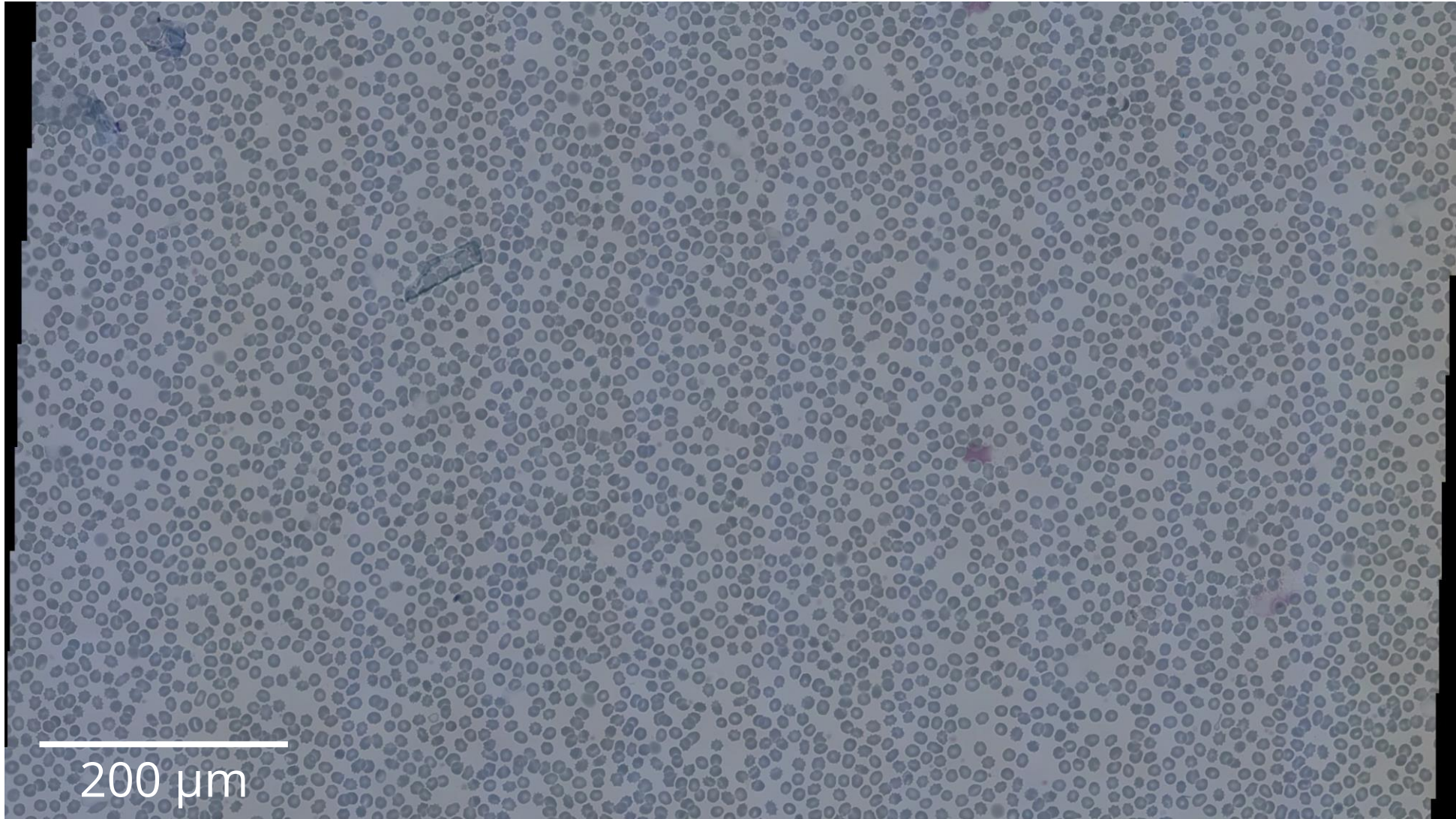
Custom motor
controller
board



OpenFlexure Microscope: Imaging



Error-correcting for long experiments

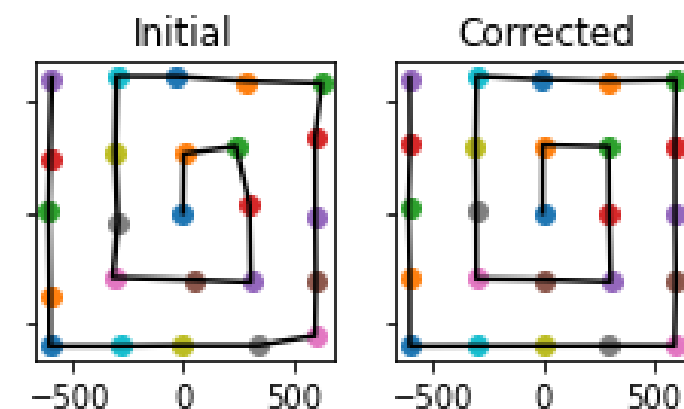


Tiled using Fiji - S. Preibisch (2009). *Bioinformatics*, **25**(11):1463-1465

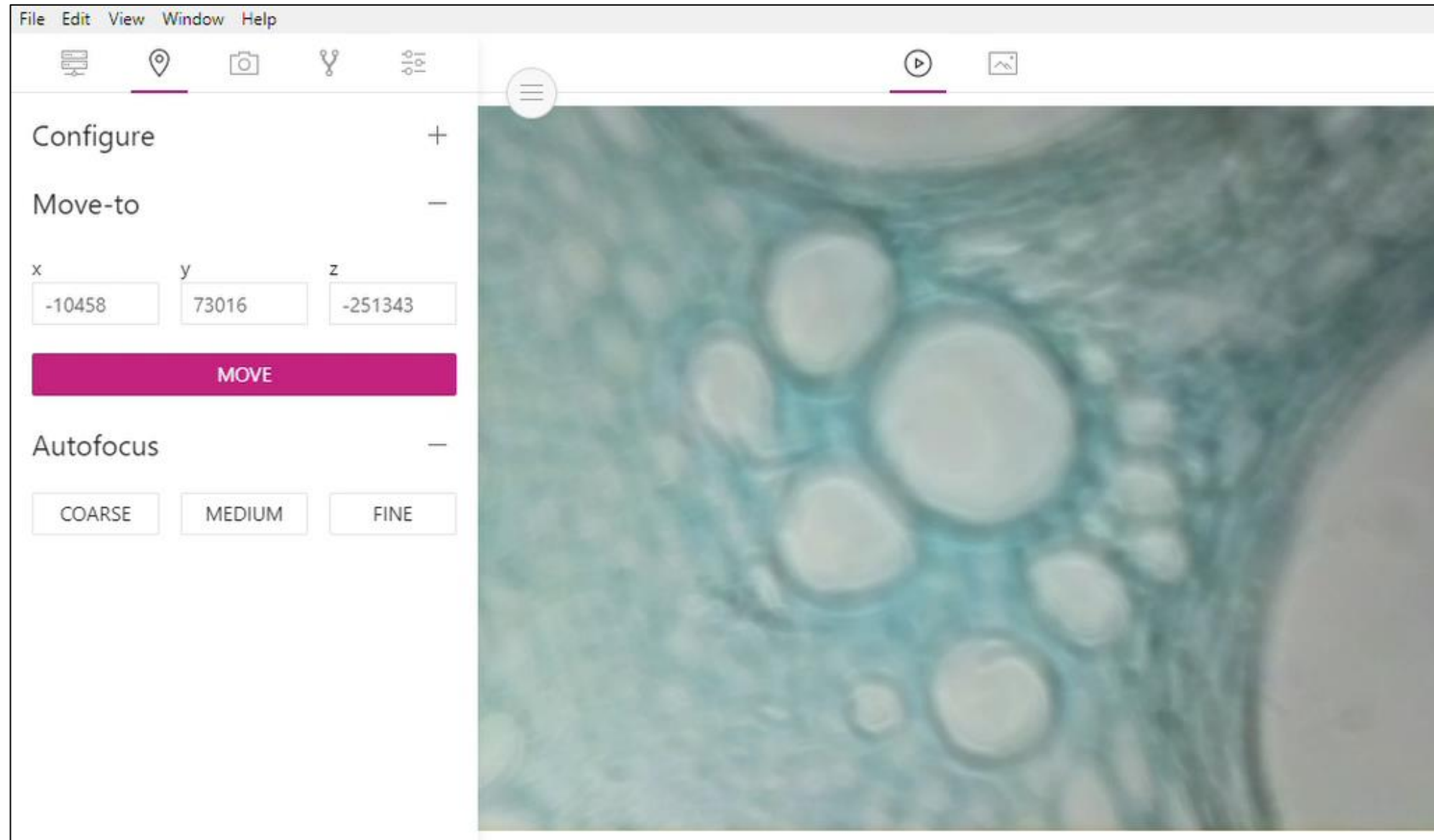
Mechanical Performance: click to move



- Auto-calibrated mapping of stage to pixel coordinates
- Closed-loop motion



Friendly, extensible user interface



The OpenFlexure Team



Julian Stirling
Ed Meng
Kaspar Bumke
Joe Knapper
Joel Collins
Kerriane Harrington
William Wadsworth
Richard Bowman



Bongo TECH
& Research Labs
...defining the Future of Innovation, TODAY

Valerian Sanga
Paul Nyakyi
Grace Anyelwisye



IFAKARA HEALTH INSTITUTE
research | training | services

Catherine Mkindi
Valeriana Mayagaya
Joram Mduda



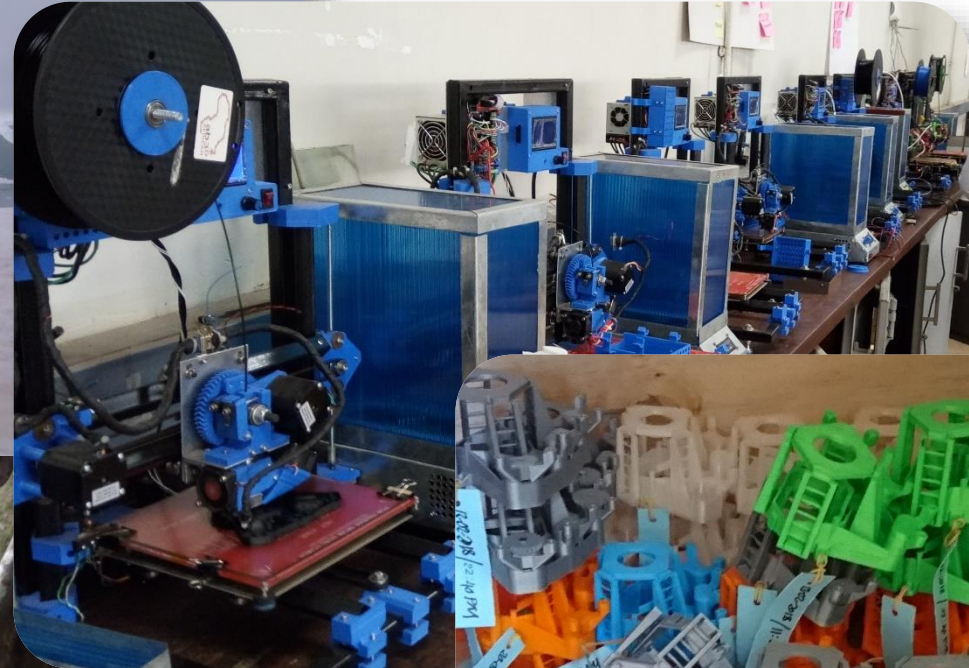
**UNIVERSITY OF
CAMBRIDGE**

Samuel McDermott
Boyko Vodenicharski
Filip Ayazi
Pietro Cicuta



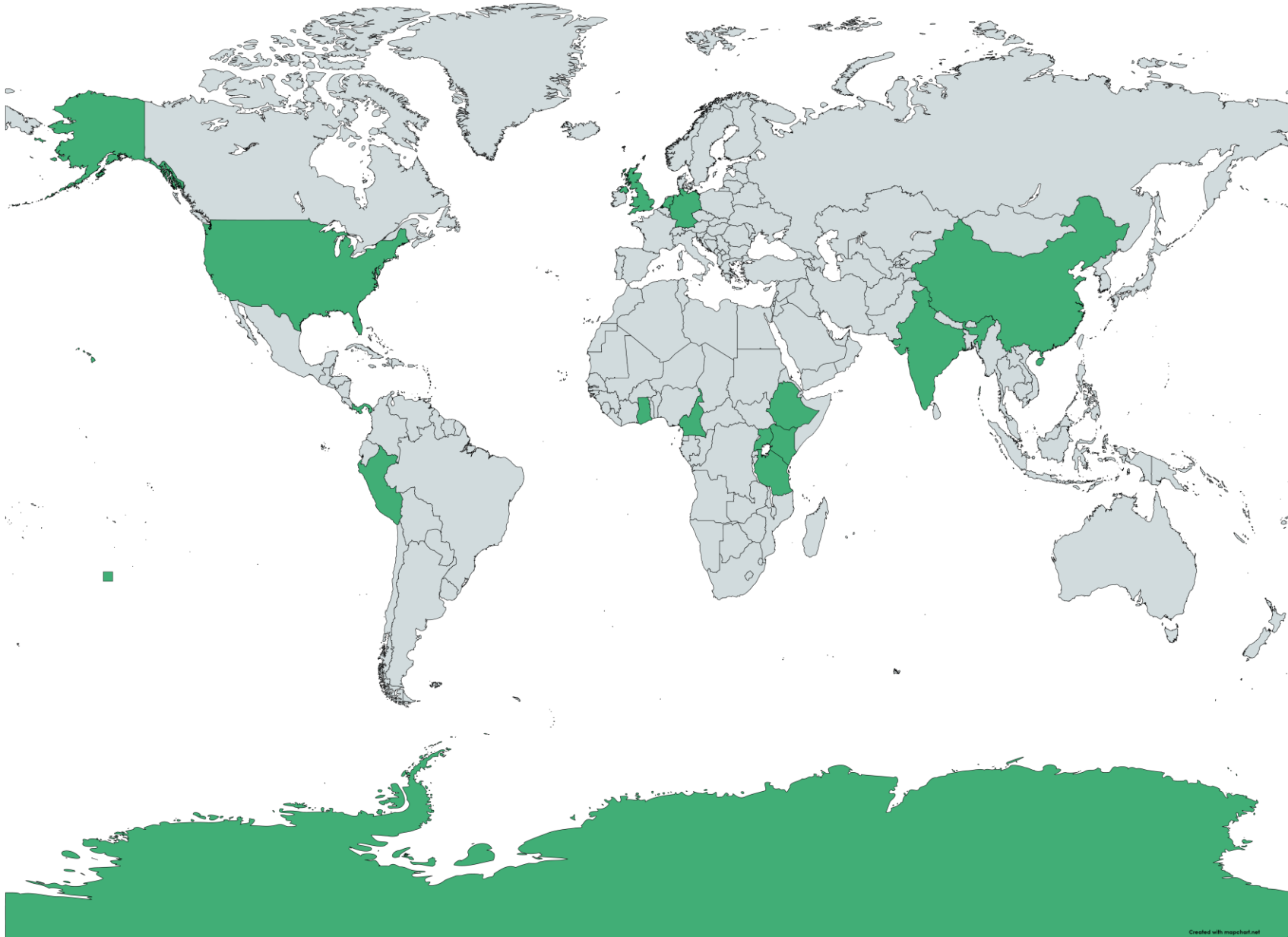
Special thanks to Joe, Julian, and Joel, whose slides I've liberally pinched for this talk!

OpenFlexure Microscopes Everywhere!



Images: Joram Mduda, IHI, Tanzania, Hannah Laeverenz Schlogelhofer (Antarctica), Julian Stirling, Panama rainforest, Tech for Trade at Nairobi University Makerspace, STICLab's baseline print run

The OpenFlexure Community



Fork us on GitLab!



OpenFlexure



OpenFlexure

Group ID: 3930388

The OpenFlexure project, which aims to make high precision mechanical positioning available to anyone with a 3D printer - for use in microscopes, micromanipulators, and more. <http://openflexure.org>

Subgroups and projects Shared projects Archived projects

Search by name

Name

> microscope-extensions	Additional non-default extensions for the OpenFlexure Microscope software	0 7 2
> server-utilities	Small tools and utilities for managing the build server	0 2 1
Design Review	Minutes of meetings to discuss the OpenFlexure Microscope design.	★ 0 4 months ago
gallery-wiki	A wiki for anyone to upload images taken with (or pictures of) their OpenFlexure Micros...	★ 1 9 months ago
Microscope Failure Mode Analysis	Failure mode analysis for the OpenFlexure Microscope	★ 0 4 months ago
microscope-handbook	User guide and maintenance information for the OpenFlexure Microscope, and it's varia...	★ 0 1 year ago
microscope-stls.openflexure.org	STL file selector for the OpenFlexure Microscope https://microscope-stls.openflexure.org	★ 3 3 weeks ago
OpenFlexure Delta Stage	A delta-bot stage based on the OpenFlexure Design	★ 2 3 weeks ago
OpenFlexure Enhancement Proposals	OpenFlexure Enhancement Proposals (OFEs) are a way for important changes to be dis...	★ 0 2 months ago
OpenFlexure Microscope MATLAB Client toolbox	A MATLAB client toolbox for the OpenFlexure Microscope.	★ 0 8 months ago

- Everything's online, everything's open source!
- We put lots of time and effort into the docs (not that they're ever perfect)
- Really exciting stuff happens when projects join together (e.g. UC2, ImJoy)

Fun demo: ImageJ.JS

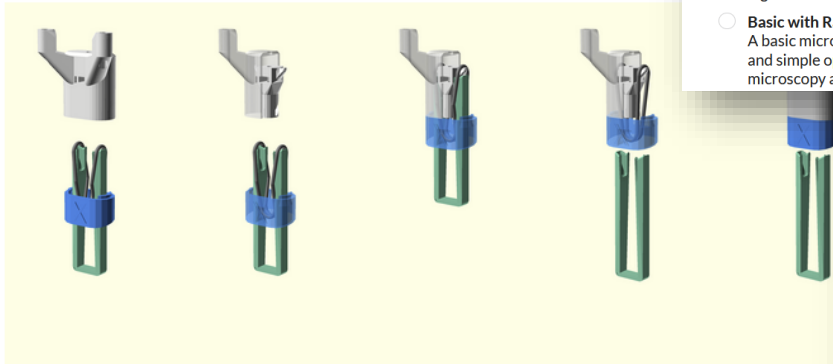
Edit View Window Help



- Everything's in Electron or your web browser
- Dynamically loads ImageJ over the web, no installation needed!
- Potential to connect up lots of online tools

Step 4: Attaching the viton bands a

This is the trickiest part of the microscope build. In each actuator.



- Take the **foot** for the x actuator
- Loop a **viton band** through the foot
- Push the **band tool** through the foot hook the band onto t
- Push the **band tool cover** onto the bottom of the band too
- Align the foot under the microscope so that the letter face
- Check that the nut tool is still blocking the actuator column.

openflexure.org

Projects Downloads About Community Latest

OpenFlexure Microscope STLs


This is a configurator for the OpenFlexure Microscope a low-cost 3D-printed microscope with a high quality mechanical stage.

Select the microscope configuration you would like below to download the right STL files to 3D-print.

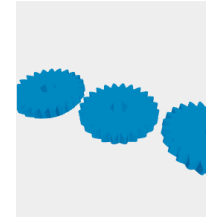
Assembly Instructions →

☐ Preview All

Customisable:



feet.stl



gears.stl

Presets

Select a common configuration of the microscope that will set multiple options at once.

- ☒ **High Resolution with Raspberry Pi**
A microscope using the Raspberry Pi camera and high resolution optics, as used for medical work.
- ☐ **Basic with Raspberry Pi**
A basic microscope using the Raspberry Pi camera and simple optics. Best suited for low resolution microscopy and educational workshops.

routine.

GET List running and completed ``fast autofocus`` actions.

POST Perform a fast down-up-down-up autofocus

GET List running and completed ``fast_up_down_autofo...` actions.

POST Perform a fast up-down-up autofocus, with feedback

GET List running and completed ``move_and_measure``

dz is assumed to be in ascending order (starting at -ve values)

This **POST** request starts an Action, i.e. the hardware will do something that may continue after the HTTP request has been responded to. The response will always be an Action object, that details the current status of the action and provides an interface to poll for completion.

If the action completes within a specified timeout, we will return an HTTP status code of **200** and the return value will include any output from the action. If it does not complete, we will return a **201** response code, and the action's endpoint may be polled to follow its progress.

REQUEST BODY SCHEMA: application/json

→ dz Array of integers
An ascending list of relative z positions

Responses

> **200** Action completed immediately

h position an image is
tion where the sharpness

POST /api/v2/extensions/org.openflexure...

Request samples

Payload

Content type
application/json

Copy Expand all Collapse all

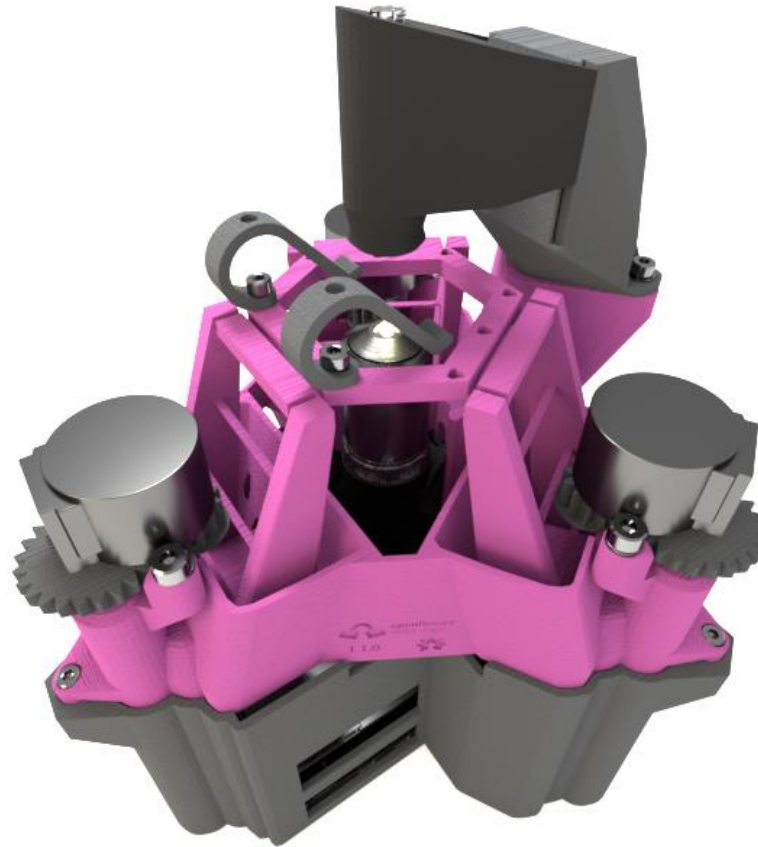
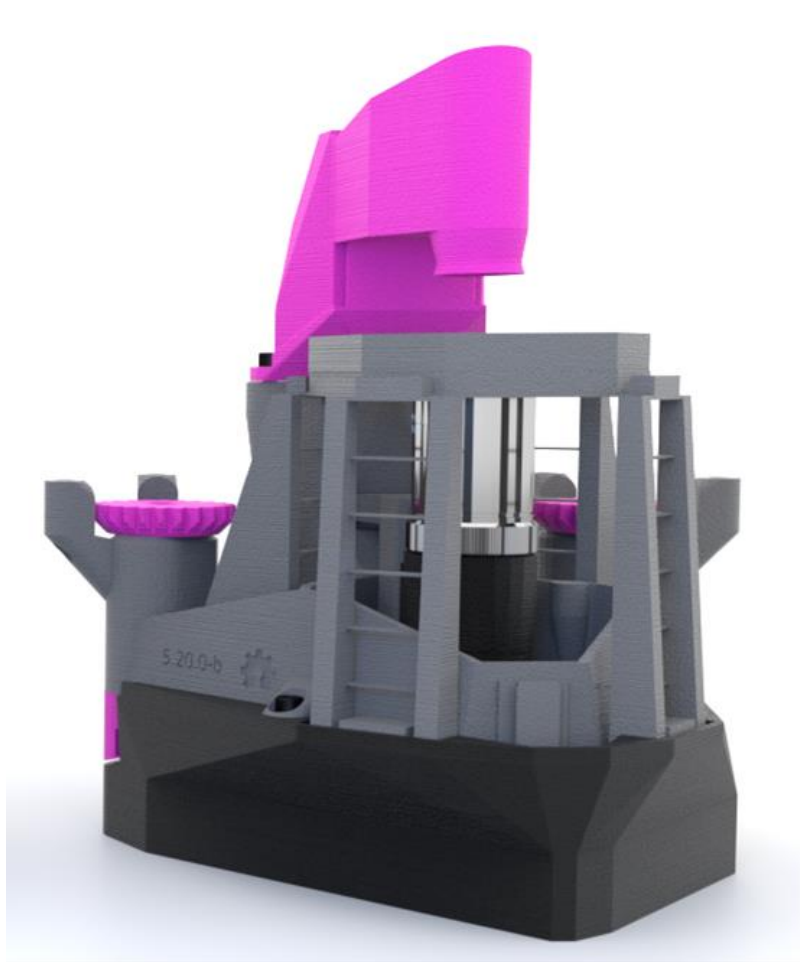
```
{  - "dz": [    -300,    -200,    -100,    0,    100,    200,    300  ]}
```

Response samples

200 **201** **5XX**

Content type

Ongoing and Future Work



OpenFlexure and Microscopy for Everyone

