University of Glasgow

UNIVERSITY OF BATH

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

IFAKARA HEALTH INSTITUTE
research | training | services

UNIVERSITY OF CAMBRIDGE

Glasgow: J Knapper, F Whiteford
Bath: E Meng, K Bumke, K Harrington, J Stirling, J Collins, W Wadsworth, N Campbell, Y Wang, B Vodenicharski
Cambridge: S McDermott, F Ayazi, P Cicuta
IHI: C Mkindi, V Mayagaya, J Mduda
STICLab: V Sanga, P Nyakyi, G Mwakajinga

Smart microscopy for everyone with the Web of Things

Richard Bowman, WoT GC, 15/2/2024

THE ROYAL SOCIETY

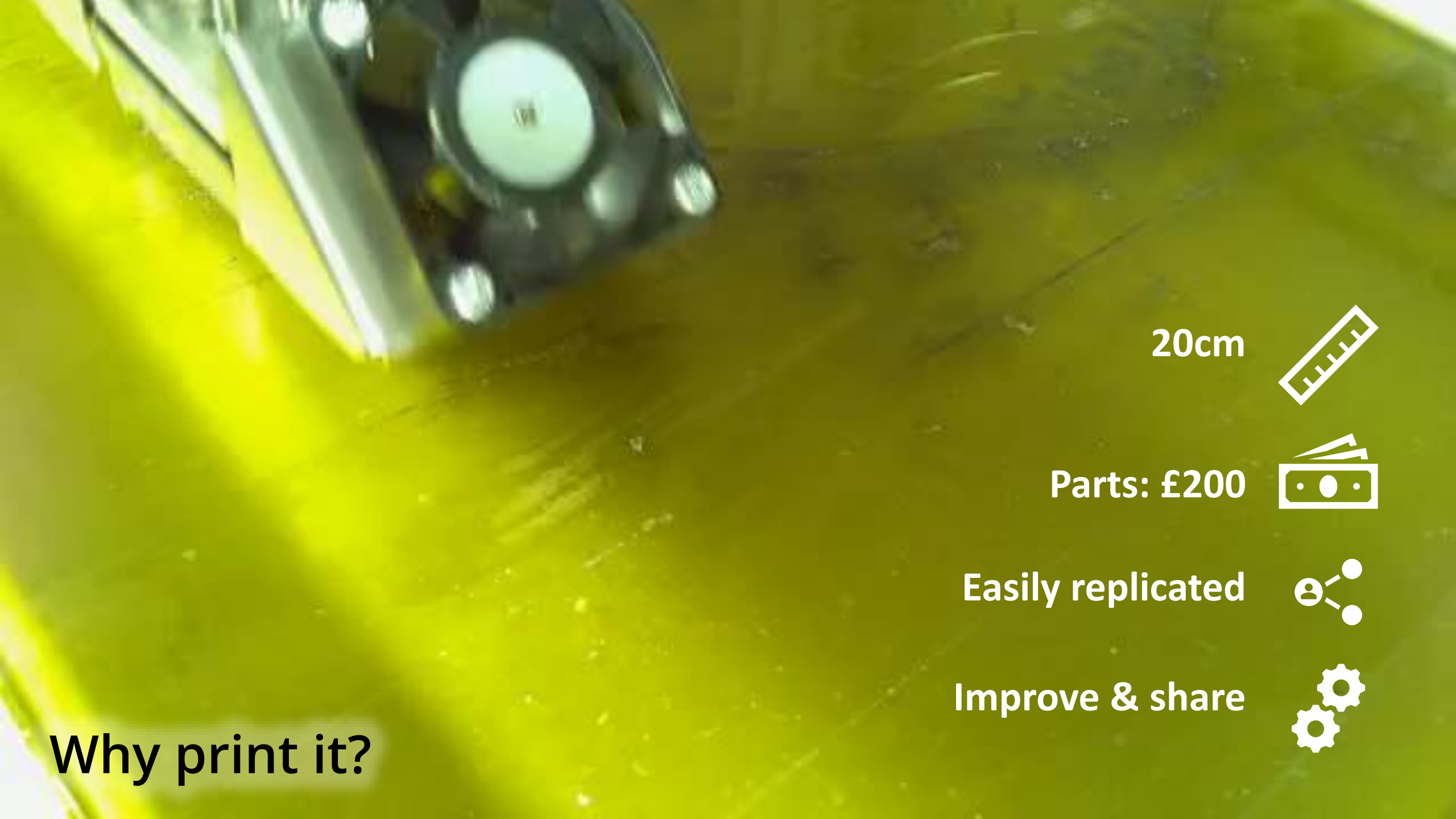
EPSRC
Engineering and Physical Sciences Research Council

NHS
National Institute for Health Research

ROYAL COMMISSION EXHIBITION OF 1851

GCRF

Credit: Joel Collins



Why print it?

Microscopy for everyone

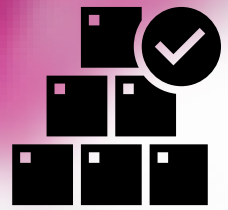
200M cases/year
500,000 deaths

Quality Assurance

Training

Local Production

A global community project



Easily to build for reproducibility, accessibility, and improvement

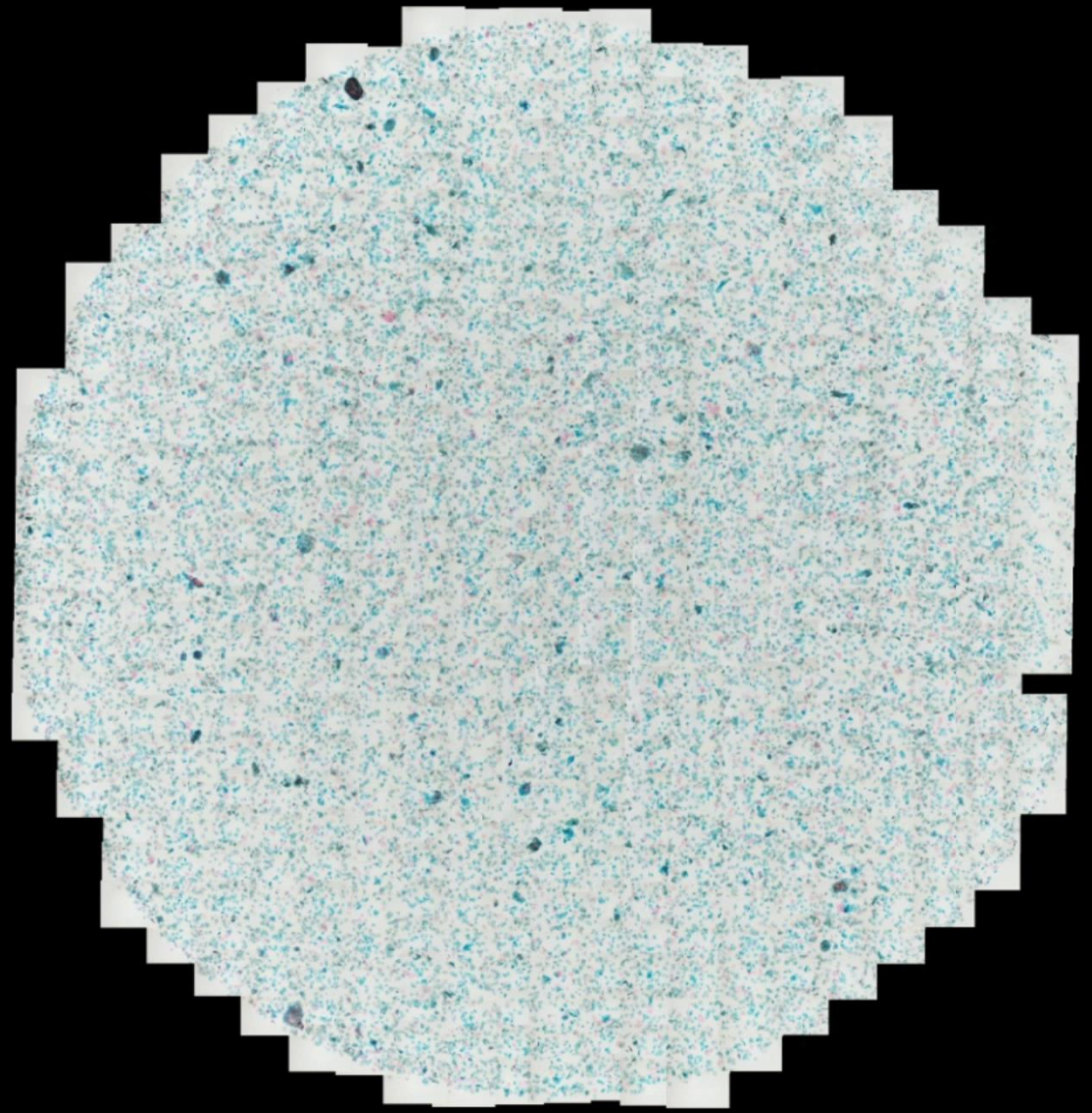
Open hardware & software development

Culture, infrastructure, and effort to **build community**

University of Glasgow

Smart scanning & tiling

openflexure microscope



SNAPSHOTS EXPLORE MORE

GigaPan

#OPENFLEXURECON2022

1. Valerian Sanga & Paul Nyakyi, Bongo Tech & Research Labs

1st EVER MAKER SPACE IN TANZANIA

- Engineering & Consultancy
- Robots & Automation
- R&D Projects
- Youth development
- IoT
- Digital Manufacturing

MED DEVICE REGULATIONS

TANZANIA

MALARIA DIAGNOSIS

THE FUTURE

- Construct office Space
- Initiate Tanzania OSH
- Host first Tanzania OSH Summit

2. Joram Mduda, Ifakara Health Institute

COLLECTING TISSUE SAMPLES & SCAN IMAGING

LOCAL REPAIRS

WE PROVED YOU CAN PRODUCE A DIAGNOSIS DEVICE THAT'S LOCALLY MANUFACTURED

ARE OPTICAL SENSORS JUST FOR EXPERTS? NO!

OPTICAL SECTIONING ROBOTIC MICROSCOPY FOR EVERYONE!

4. TATSUNOKE MATSUI, MIE UNIVERSITY

JAPAN

CONVENTIONAL OPTICAL

OBSERVED IMAGE = WELL FOCUSED IMAGE + BLURRED OUT-OF-FOCUS IMAGE

STRUCTURED ILLUMINATION

OBSERVED IMAGE = FOCAL PLANE + OUT-OF FOCAL PLANE

You can COMBINE several measurements to get back only the WELL-FOCUSED image!

11. NIAMH BURKE, UNIVERSITY COLLEGE DUBLIN

DEMOCRATISING DISCOVERY

TACKLING THE PROBLEM OF MARINE MICROPLASTICS POLLUTION WITH OPEN & ACCESSIBLE IMAGING TOOLS

JELLYLAB!

UNDERSEA MIRROR

DIRECTLY MEASURE

MODIFY

SMOOTH MOVES IN THE Z-AXIS

10. JOE KNAPPER, UNIVERSITY OF BATH

MAKING AUTO-FOCUS & SCANNING MORE RELIABLE!

BY TEACHING THE MICROSCOPE HOW TO CORRECT FOR ERRORS

9. SAMUEL MCDERMOTT, UNIVERSITY OF CAMBRIDGE

MAKING SCRIPTING EASY WITH BLOCKLY

DRAG & DROP

PERFORM SMART EXPERIMENTS

SCRIPTING A SERIES OF OPERATIONS

8. OLIVER HIGGINS, UNIVERSITY OF GLASGOW

AUTOMATED DETECTION OF HELMINTH INFECTION USING 3D PRINTED MICROSCOPY

USE OUR SMARTPHONE APP

ALGORITHM

DISEASE STATUS

NEEDLE IN A HAYSTACK

USA

3. DANIEL ROSEN, BAYLOR COLLEGE OF MEDICINE

MEDICAL EDUCATION

RESEARCH PROJECTS

HIGH RESOLUTION MICROENDOSCOPY $200 vs $500,000!

PROBLEM SOLVED

Assess integration OHM into HMRE

Investment validation of dysplasia in SQUAMOUS LESIONS of the ESOPHAGUS

Instrument validation of CERVICAL CYTOSIS SMEARS

Using images acquired with OFM to train PATHOLOGY & MED STUDENTS

WRONG PICTURE = WRONG DIAGNOSIS

WHY OPENFLEXURE?

- HIGH IMAGE RESOLUTION
- LOW INFRASTRUCTURE
- ENERGY EFFICIENT
- LOW NETWORK REQUIREMENTS
- OPEN SOURCE SOFTWARE

EDUCATIONAL WEBSITES DEVELOPED:

- GENERAL SURGERY PATHOLOGY CASES
- PROSTATE CANCER
- ENDOCRINE PATHOLOGY
- LUNG CANCER
- CERVICAL CYTOLOGY SMEARS

GERMANY

FORM FOLLOWS FUNCTION

5. DESIGNING CIRCUITS FOURIER OPTICS VS MODULAR OPTICS

BENEDICT DIEDERICH, OPEN UC2

RAPID PROTOTYPING FOR OPTICS

HIDDEN WIRES

SPLIT THE MICROSCOPE

UC2 ATTACHMENT

BIOLOGICAL PROTOCOLS → MICROSCOPIC IMAGING → IMAGE ANALSIS

SMART ALGORITHMS DECISION MAKING

6. FERNANDO CASTRO, RE-GOSH-AJUV COOPERATIVE

CONTEXT: AGROECOLOGICAL TRANSITION

FERTILITY ≠ HEALTH

- MEDICAL DEVICE CERTIFICATION
- NOT A TOY

LIVING SOIL WORKSHOPS

- MICROBIOLOGICA
- AGROPACHA

DIY SOIL MICROSCOPY

SHORT GUIDE TO SOIL MICROSCOPY

STEPHANE FADANKA, MBOALAB

"TRANSLATING THE SOFTWARE"

TRAINING

CATALYSE LOCAL SUSTAINABLE DEVELOPMENT

7.

MAKER SPACE

COMMUNITY BASED INNOVATION HUB

WORKSHOPS

EXHIBITIONS

CAMEROON

Royal Academy of Engineering

ILLUSTRATED BY Paraphrase.studio

Documentation, documentation, do...

openflexure forum

Openflexure.org Contribute Chat

Where are you? (OFM location survey)
Build Reports

OpenFlexureCon 2022
OpenFlexureCon 2022

A new alpha! v7.0.0-alpha2
Announcements

Lens shading correction for Rasp
General

Is this like the Sangaboard?
Request Help

Introduce yourself
Machine Learning

Search...

actions

GET List running and completed `autofocus` actions.

POST Perform a simple autofocus 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_up_autofo... actions.

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

GET List running and completed `move_and_measure`

Perform a simple autofocus routine.

Perform a simple autofocus routine.

The stage is moved to z positions (relative to current position) in dz, and at each position an image is captured and the sharpness function evaulated. We then move back to the position where the sharpness was highest. No interpolation is performed.

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

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
    ]
}
```

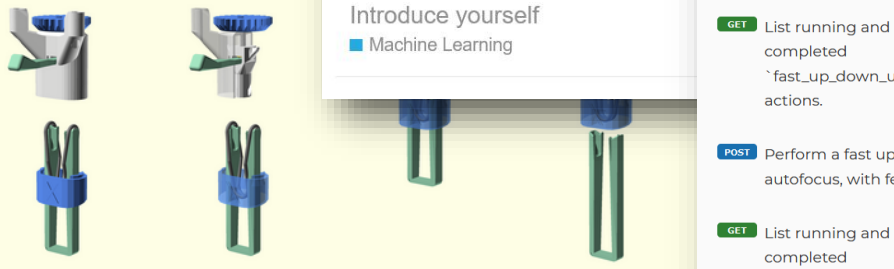
Response samples

200 201 5XX

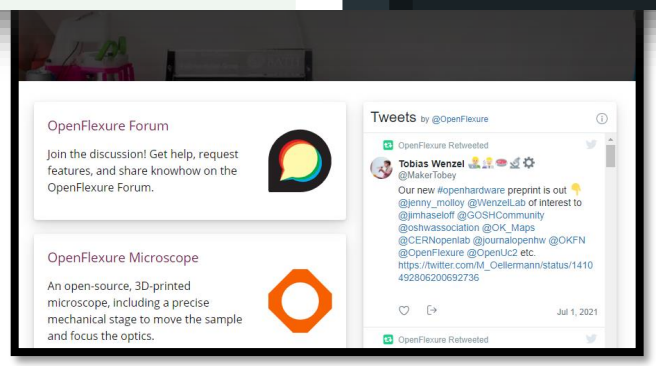
Content type

Step 5: Attaching

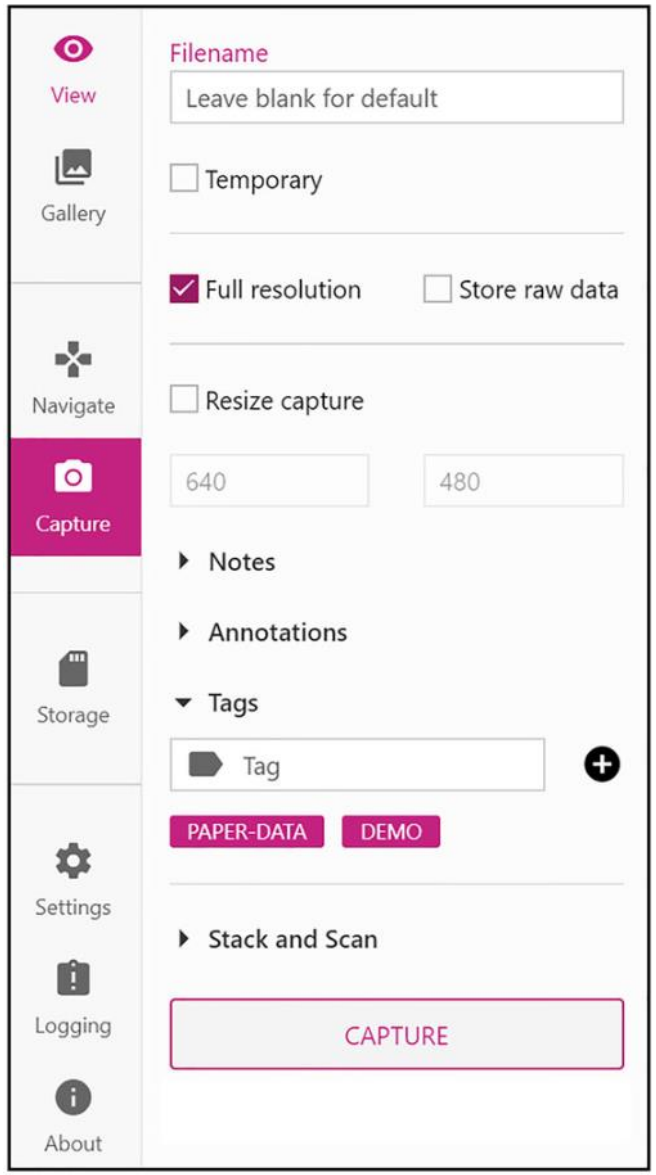
This is the trickiest part of
each actuator.



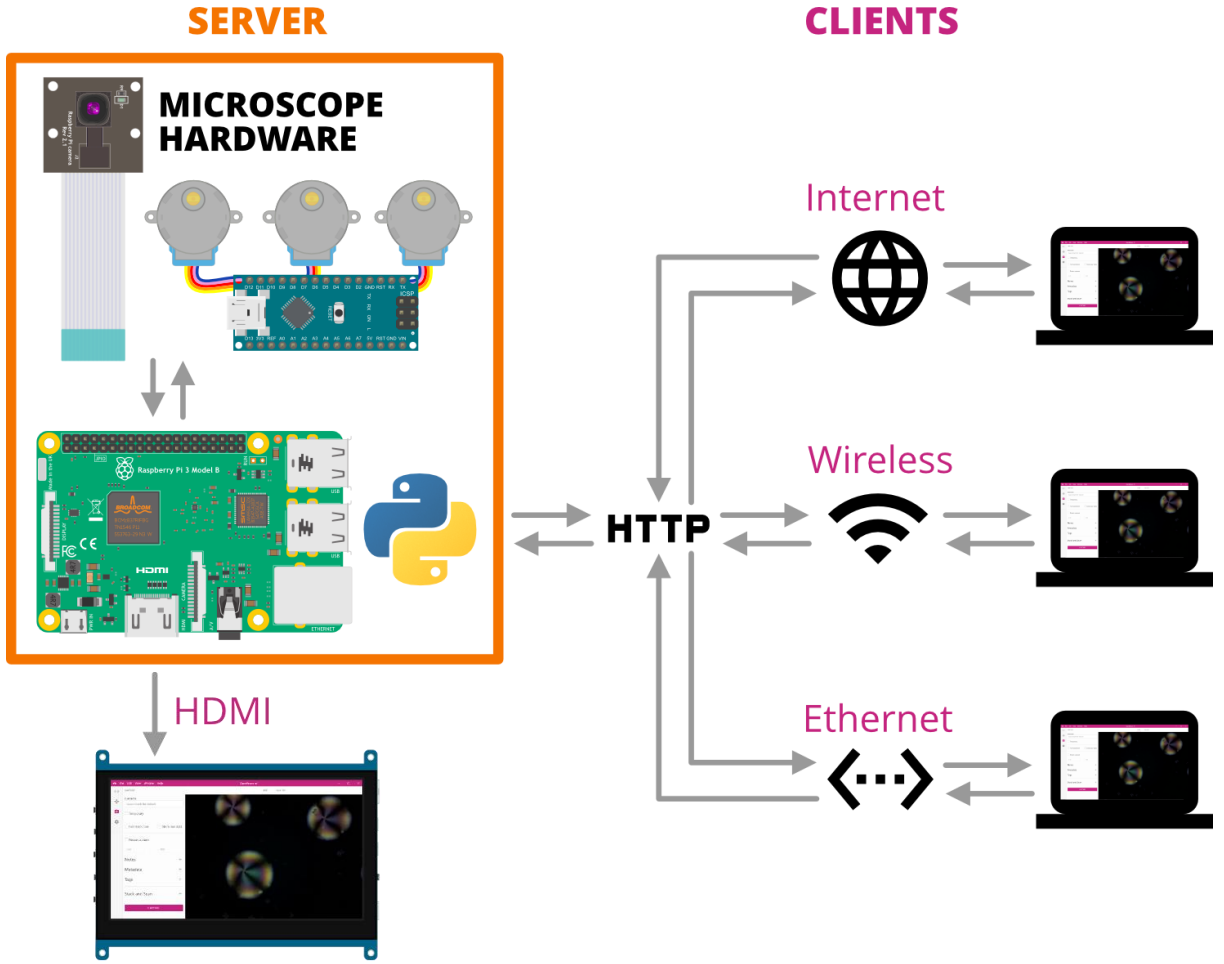
- Take the foot for the x actuator
- Loop a viton band through the foot
- Push the band tool through the foot hook the band onto the tool on each side.
- Push the band tool cover onto the bottom of the band tool
- Align the foot under the microscope so that the letter faces outwards



Friendly interface



Smarter, better-connected labs

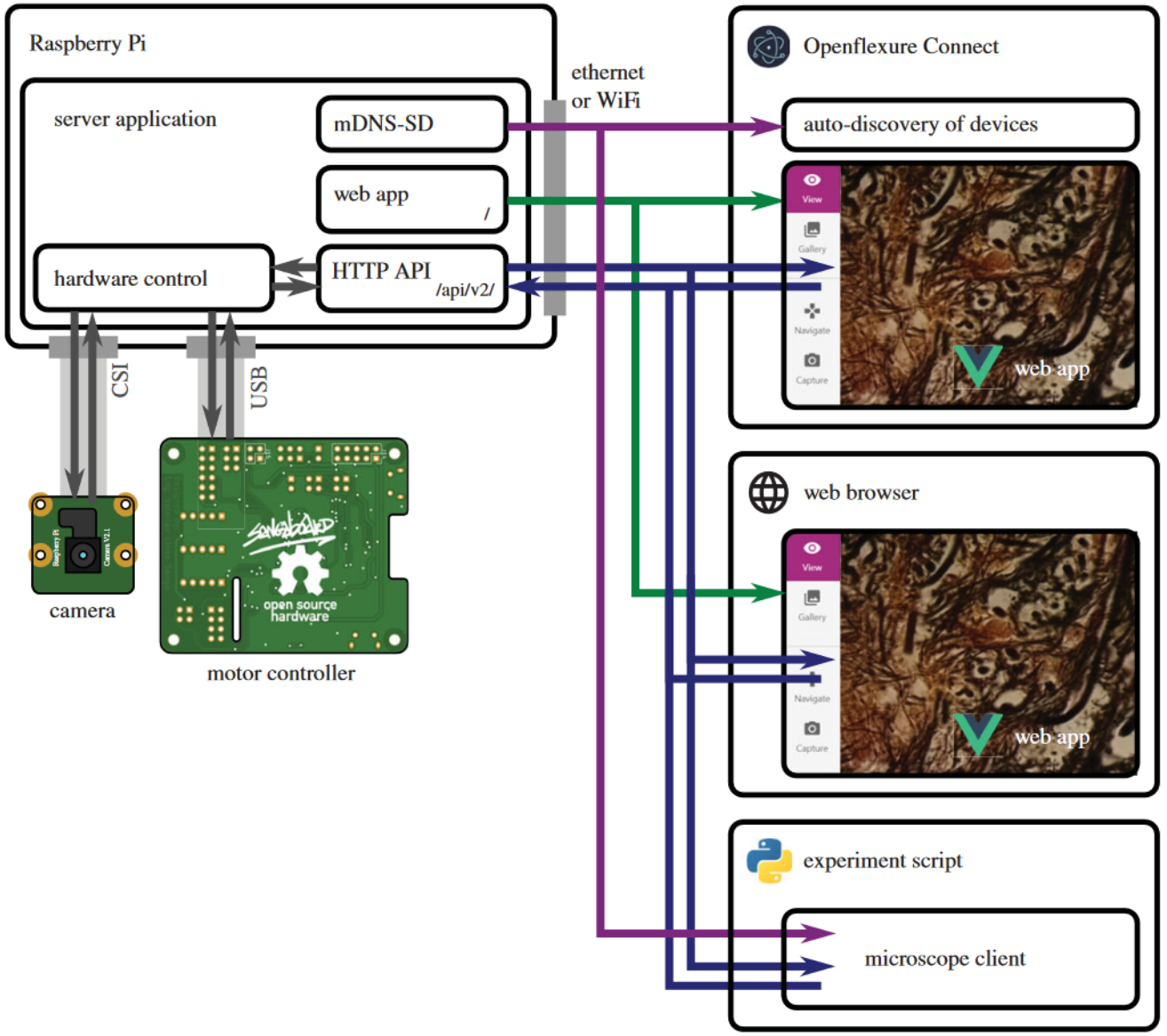


LabThings

https://github.com/labthings/

Architecture in detail

- Simple GUI
- Easily scriptable
- Script & GUI simultaneous
- Headless/unattended operation
- One computer, many microscopes

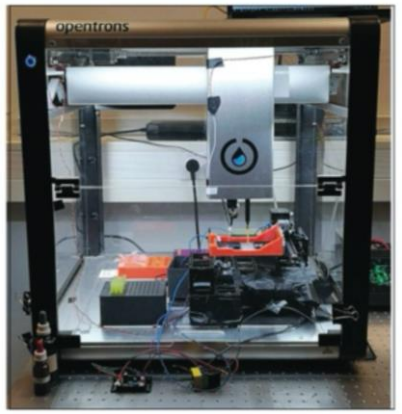


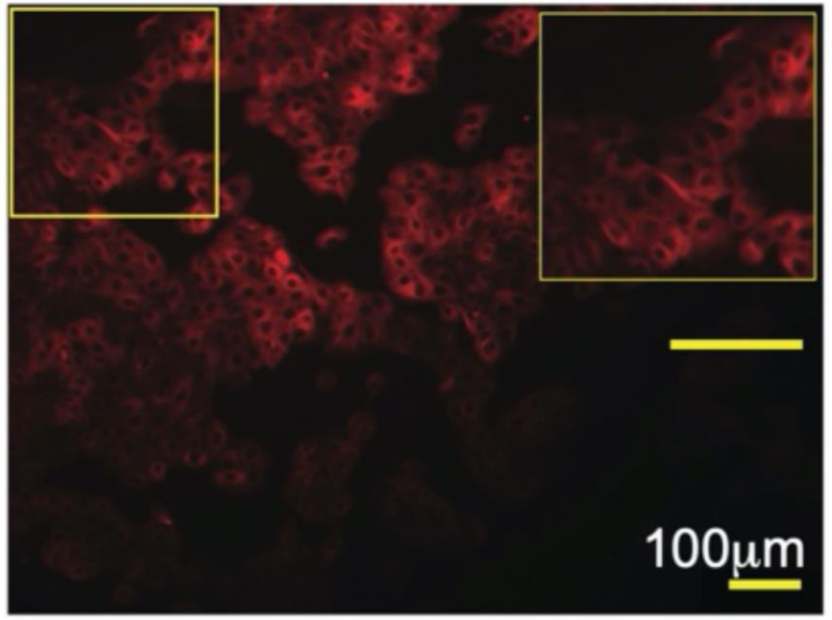
https://doi.org/10.1098/rsos.211158

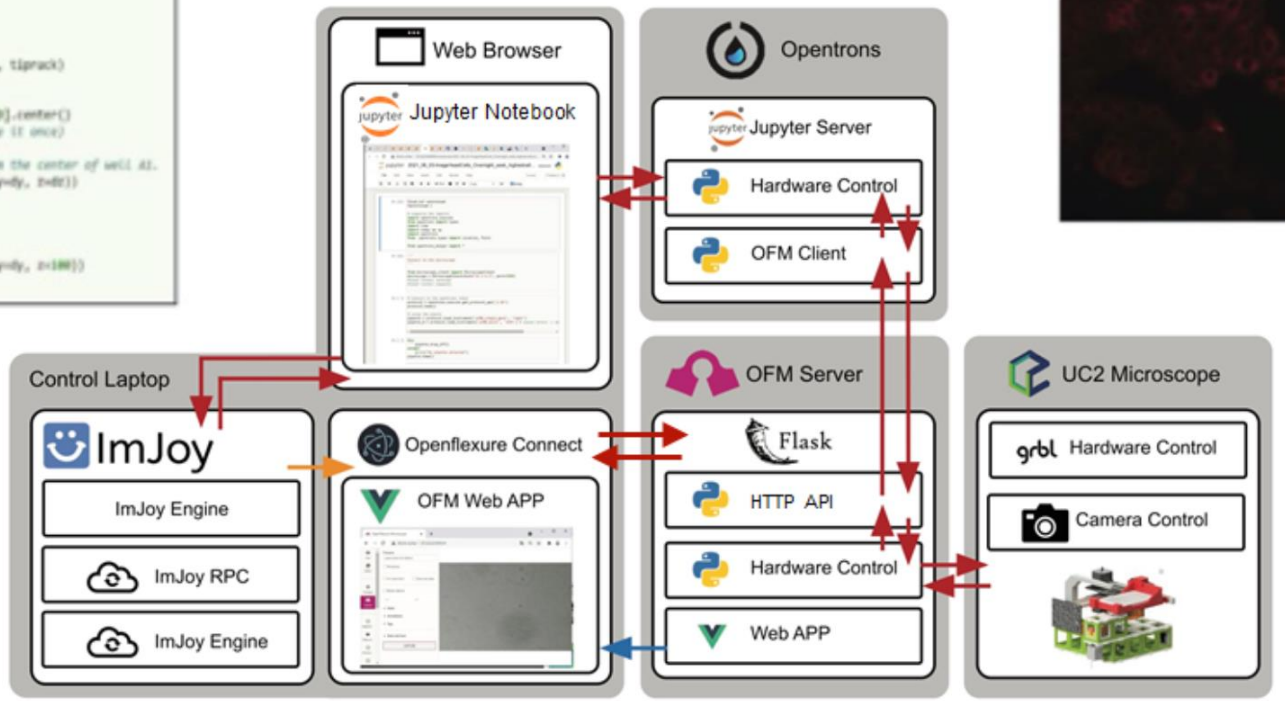
Software implementation

- Server: Python, FastAPI, LabThings (was Flask *et al.*)
  - Things are Python classes
  - Actions & properties are Python descriptors
  - The signature of a Thing and a ThingClient are ~compatible
  - FastAPI dependency injection for inter-thing dependencies
- GUI: Vue.js + Axios
  - Actions are started by a custom Vue component
  - Properties are read/written by another Vue component
  - Not (yet) using node-wot, I can't seem to use it with webpack (?)
- Thing Descriptions: multiple things (camera/stage/plugins)
  - Example from v3 pre-release: https://gist.github.com/rwb27/7e0c0b70a2e9b32cfa35a67fe1d7ae33

Connecting open projects







W Ouyang *et al.* An Open-Source Modular Framework for Automated Pipetting and Imaging Applications bioRxiv 2021

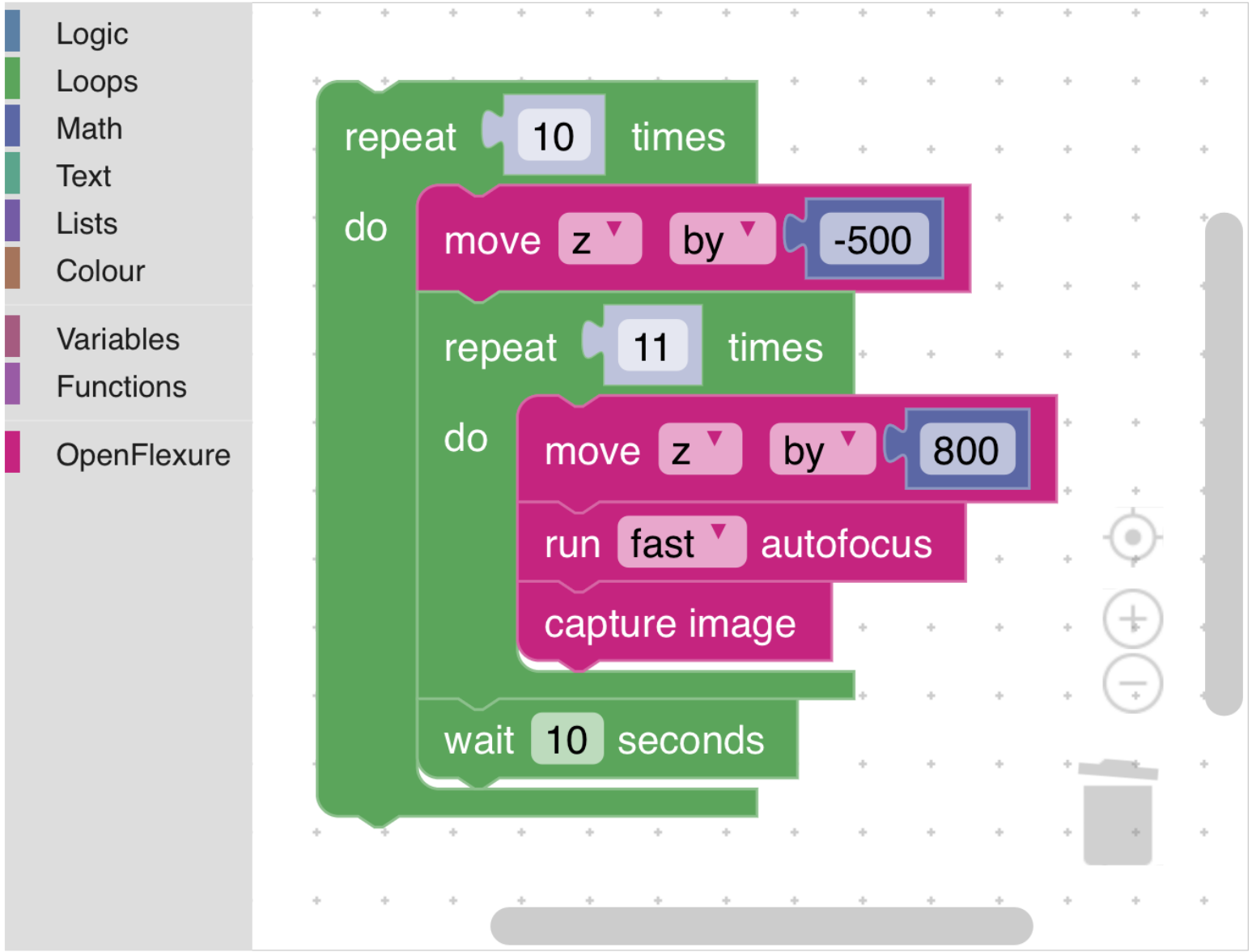
Easy automation with blockly

University of Glasgow

openflexure microscope

Live preview

To start using OpenFlexure with Blockly, connect to your microscope.



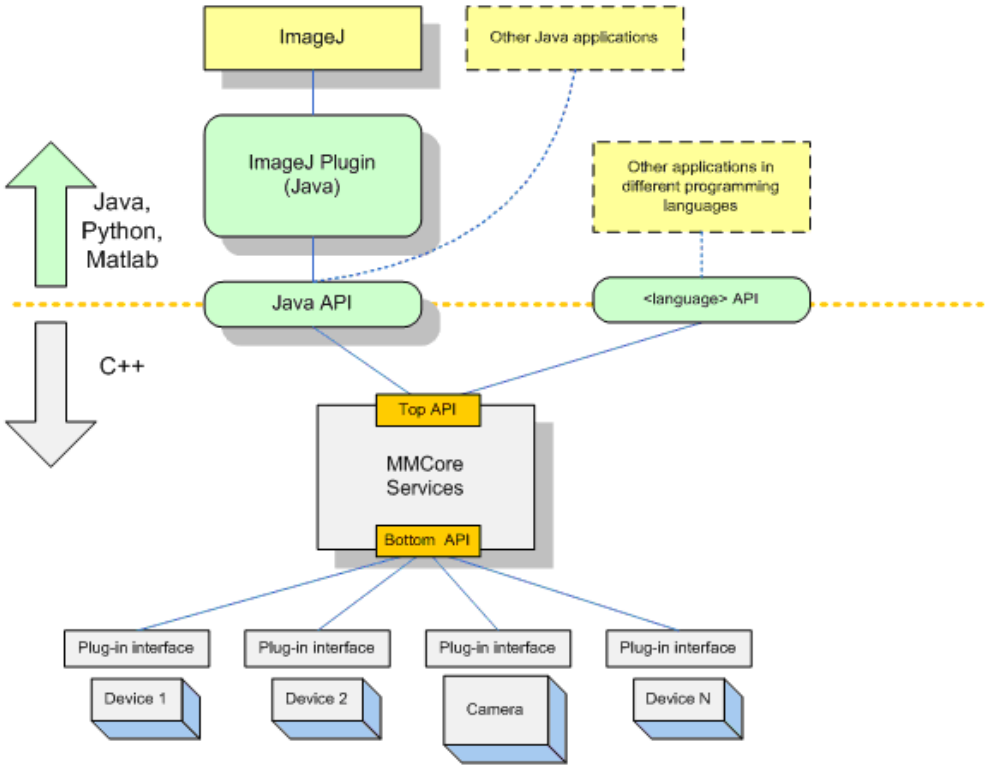
LabThings, OpenFlexure, & WoT

- Learned about WoT when searching for ReST interface advice, ~4 years ago. Credit to postdoc Joel Collins for that.
- What has it solved?
  - Clear way to control hardware with HTTP
  - Nice documentation for hardware API
  - Cross-language, cross-platform hardware control
  - (future) linking up frameworks/ontologies with semantic types
- Pain points
  - Standard ways of dealing with long/interactive actions
    - Synchronisation – e.g. an Event that's associated with an Action
  - Detail on protocol bindings (e.g. websockets)
  - Where is Swagger for my Thing Description?
  - Thing Description is not *quite* JSON Schema

General control frameworks

- Top-down taxonomy of instrument types, as classes
  - Advantage: abstraction
  - Disadvantage: not flexible
- Language-specific
- Complicated to install/set up environment
- Only one process at a time

μManager



napari

Microscope-Cockpit

ImSwitch: Generalizing microscope control in Python

Xavier Casas Moreno[1], Staffan Al-Kadhimi[1], Jonatan Alvelid[1], Andreas Bodén[1], and Ilaria Testa[1]

1 SciLifeLab, KTH Royal Institute of Technology

How to not be a framework?

- Standardised, cross-platform, language-independent way to run *and document* actions, get/set properties, watch for events [WoT – TD & protocol binding]
- Opt-in taxonomies, allowing frameworks to align gradually over time [WoT semantic types]
- Neat ways to determine compatibility of devices [TD?]
- Needs to be useful *immediately* without huge up-front time investment
- Gradually becomes more useful as it's more fully implemented

University of Glasgow

http://openflexure.org/

openflexure microscope