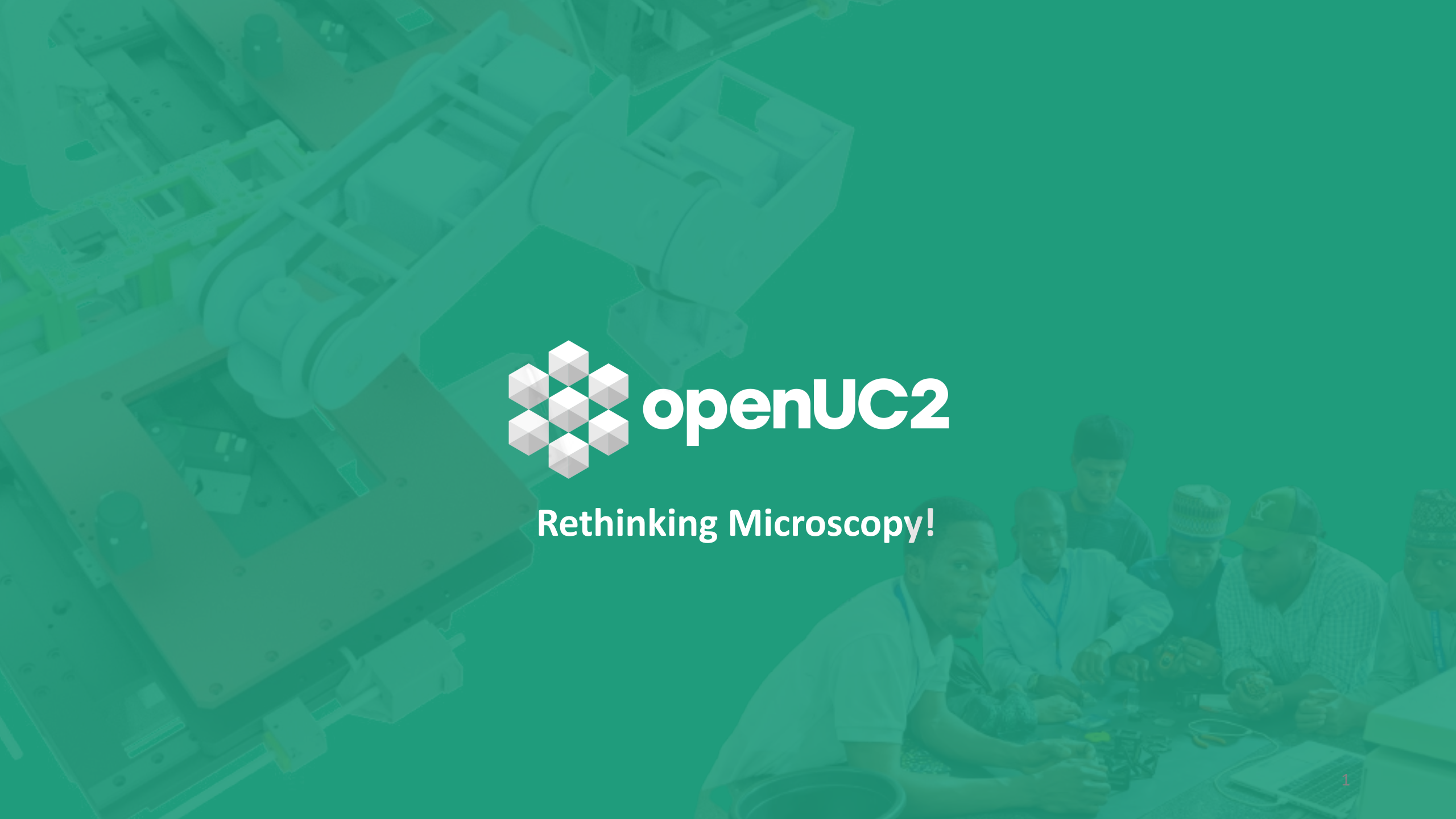
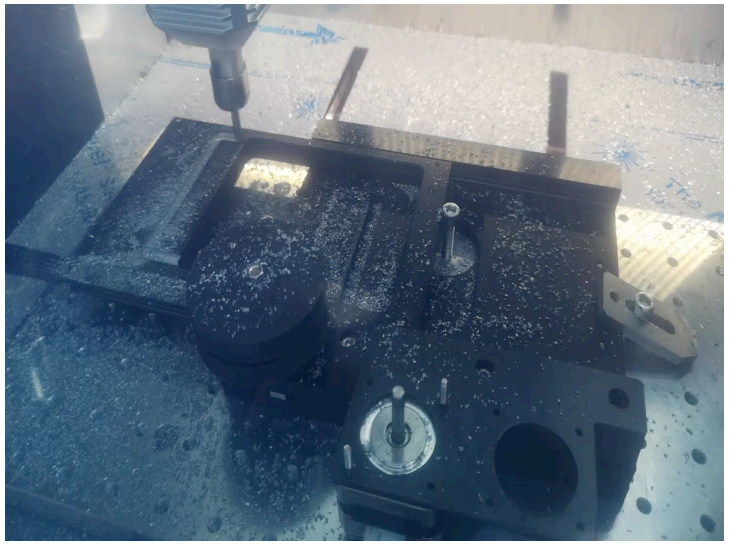

openUC2
Rethinking Microscopy!

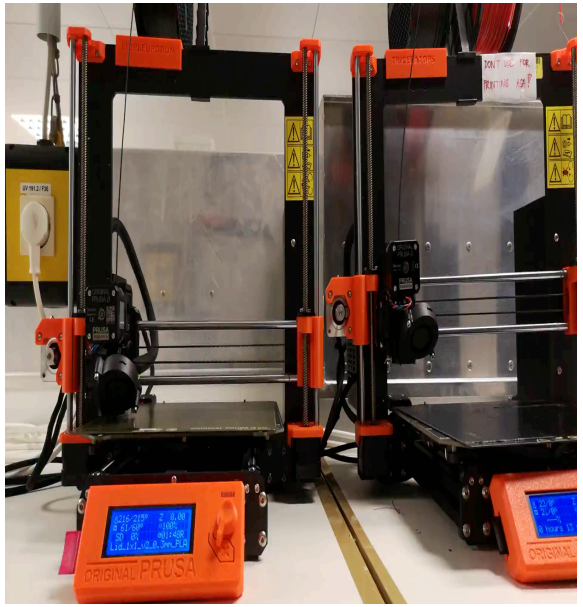
New Tools…

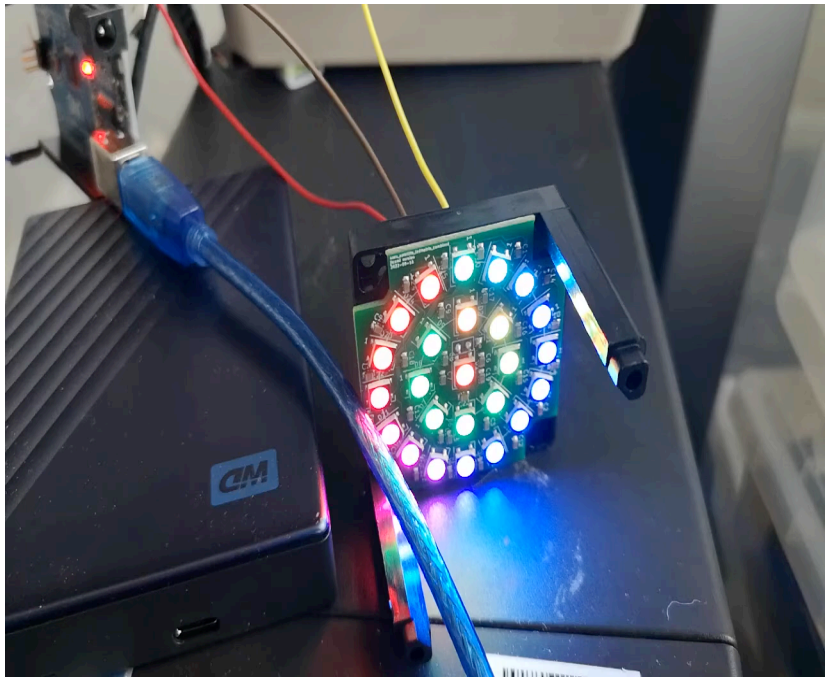
PyTorch

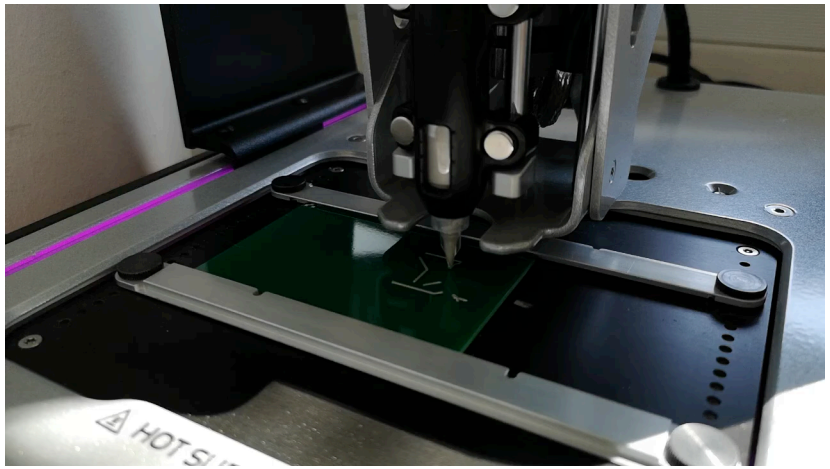
....

New Tools…

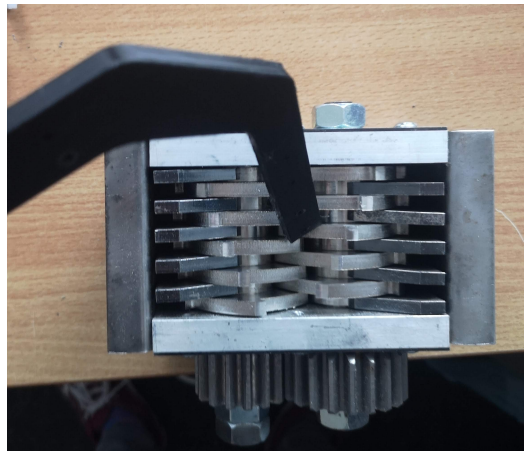




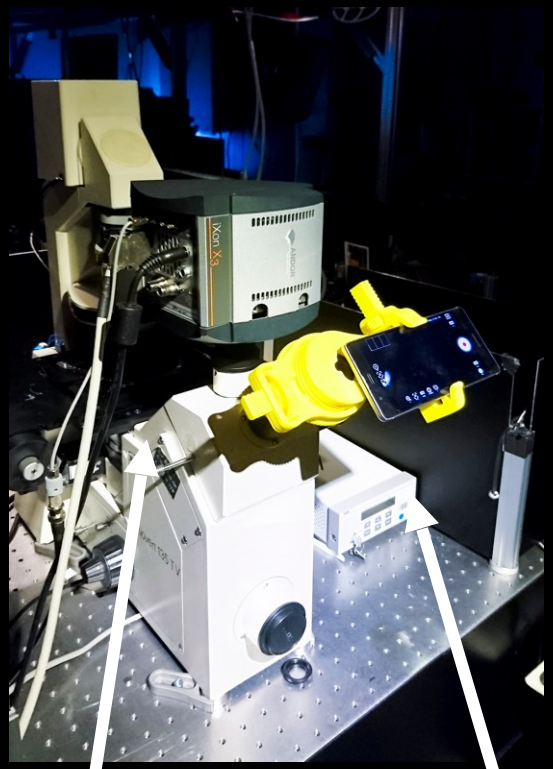


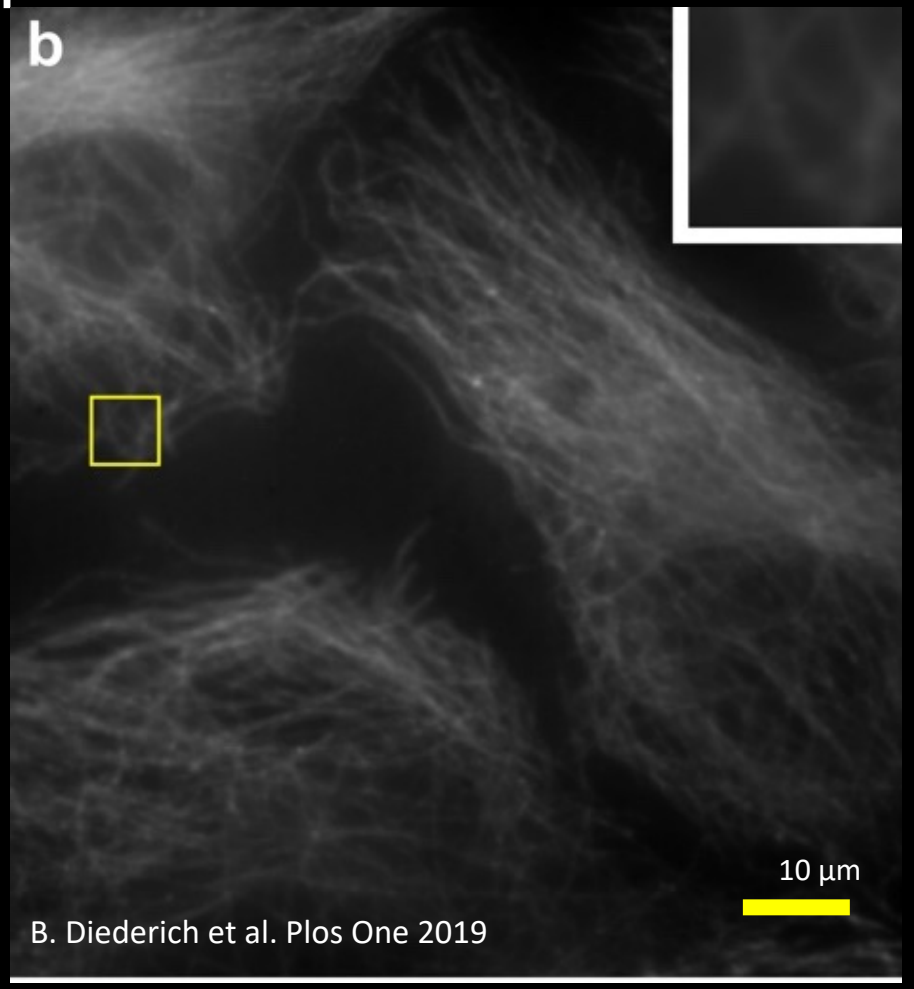


- 3D Printing
- CNC/PCB Milling
- PCB Printing
- On-Demand Manufacturing
- Injetion Molding Machine



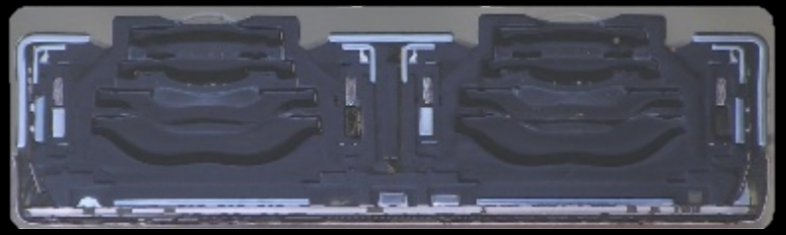
cellSTORM
Cellphone-Based SMLM





Measured resolution:
~300 nm

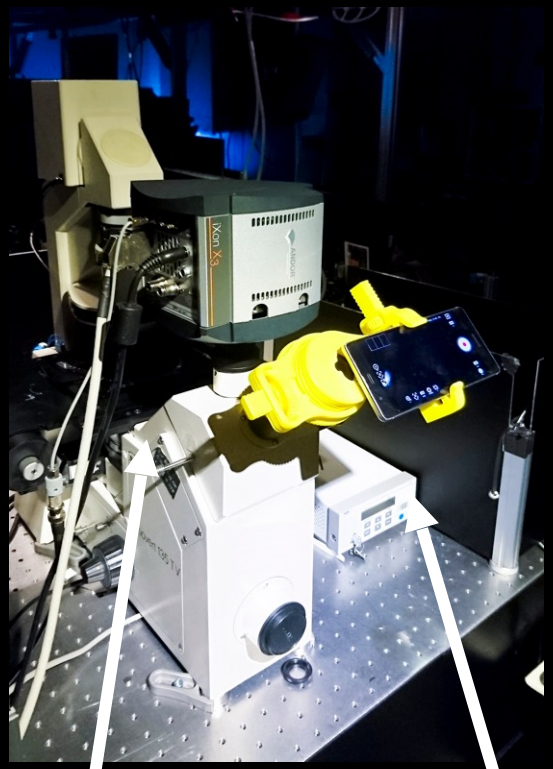
©Andor



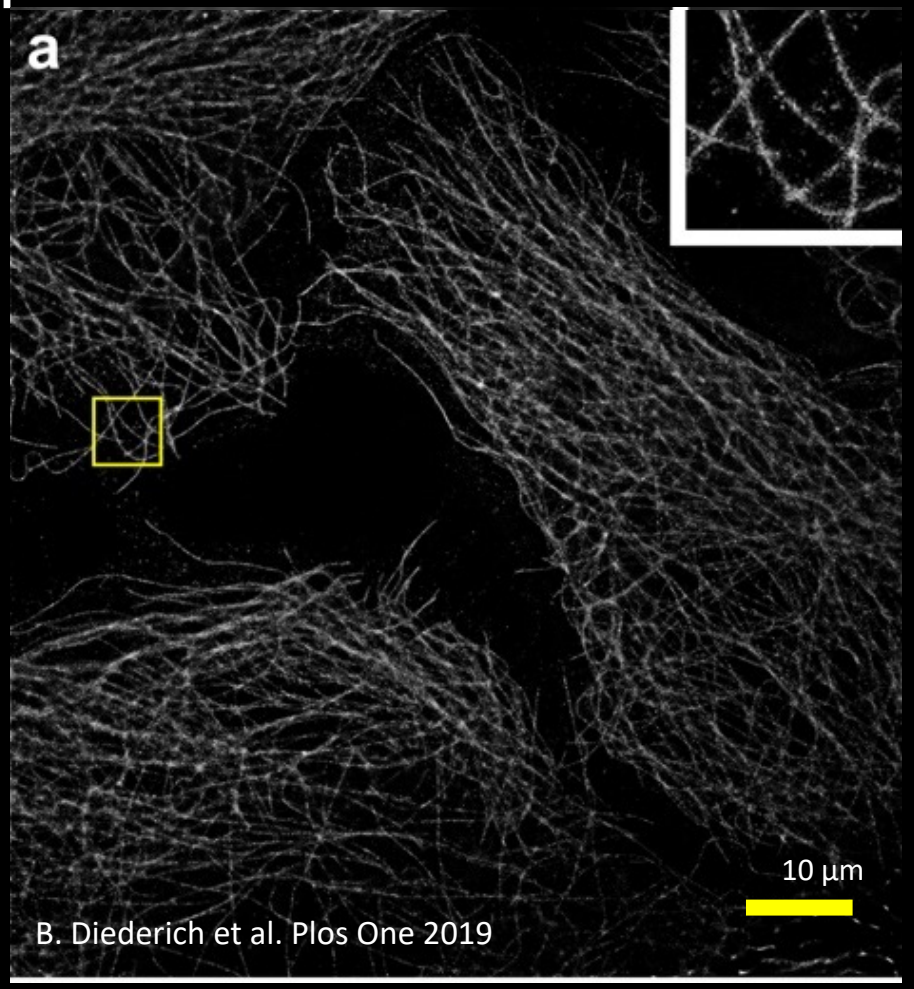
© System plus consulting

[BD2]

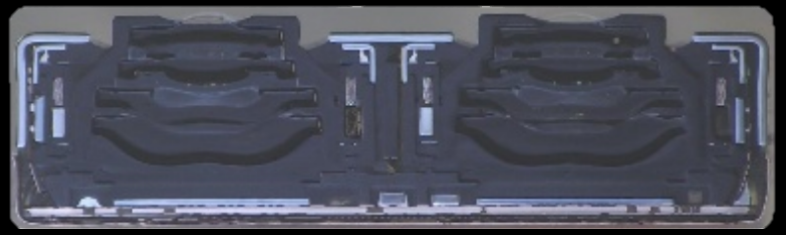
cellSTORM
Cellphone-Based SMLM



©Andor



Measured resolution:
~80 nm

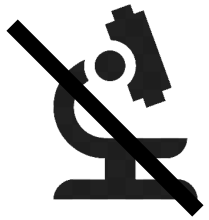


© System plus consulting

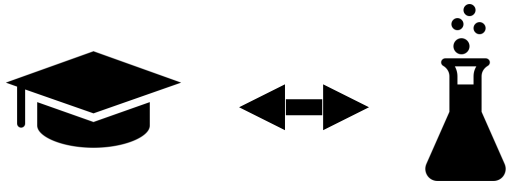
[BD2]

Problem Statement

Affordability, Availability, Accessibility

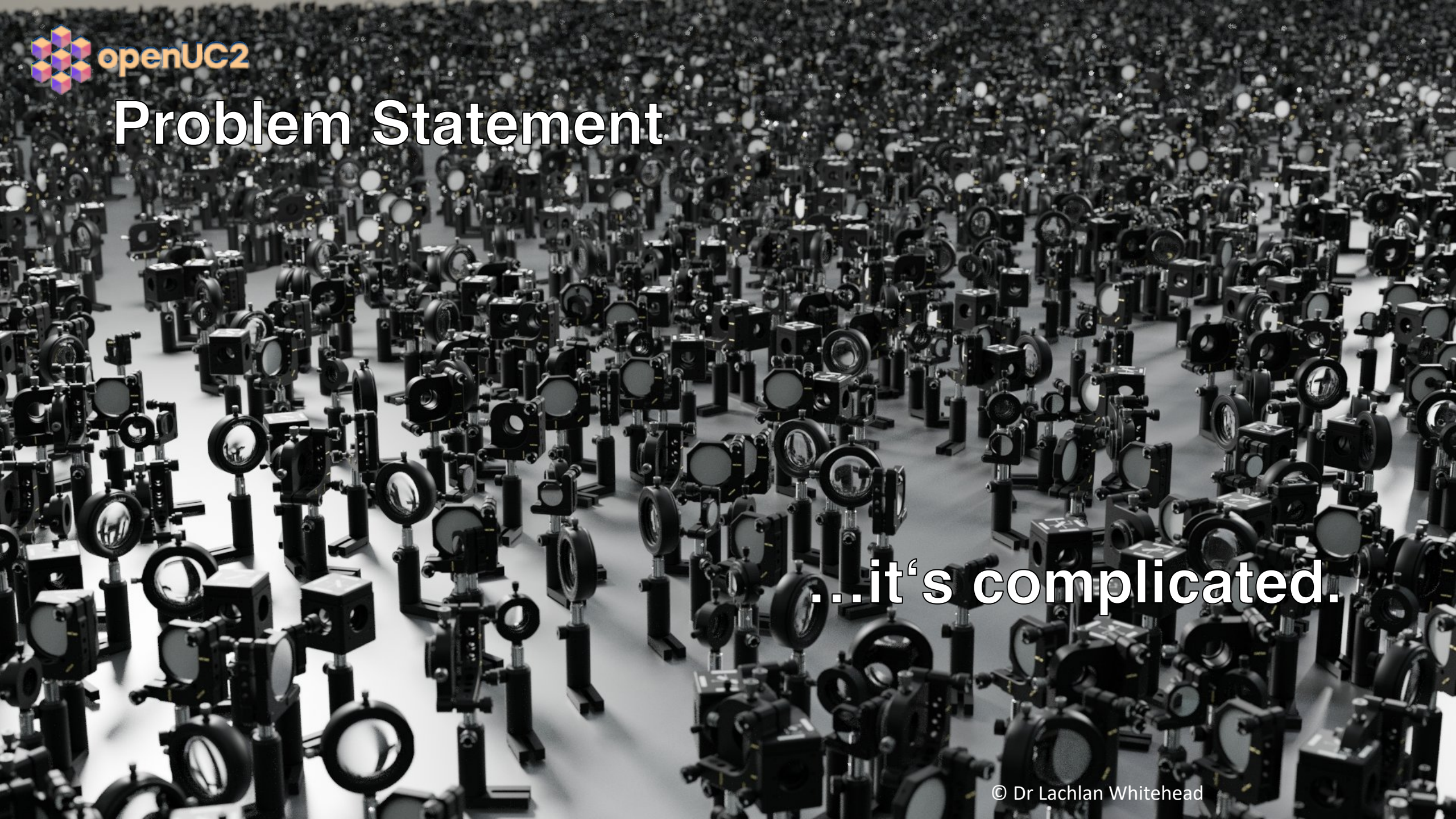


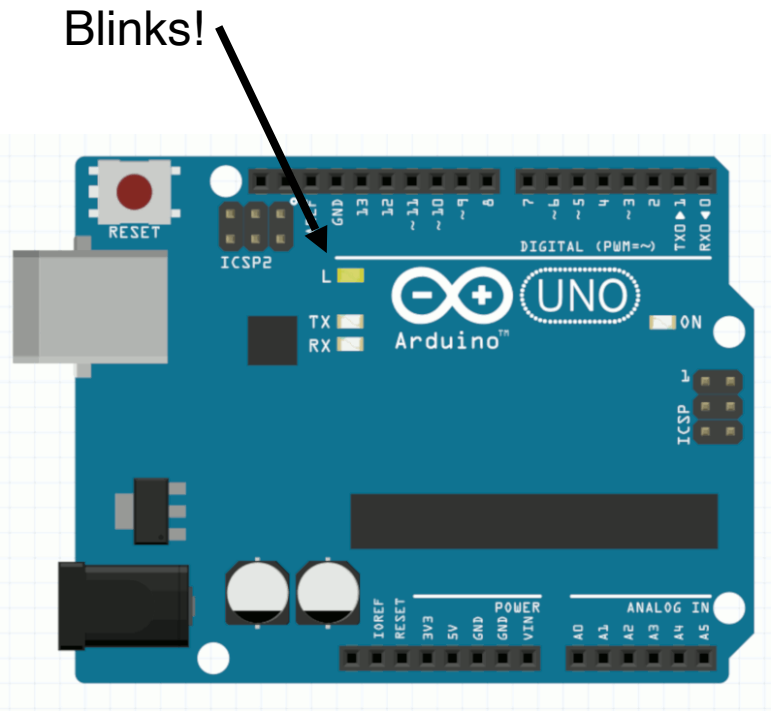
Limited Access to Advanced Microscopy
High costs and proprietary systems make microscopy inaccessible to many researchers, educators, and innovators.

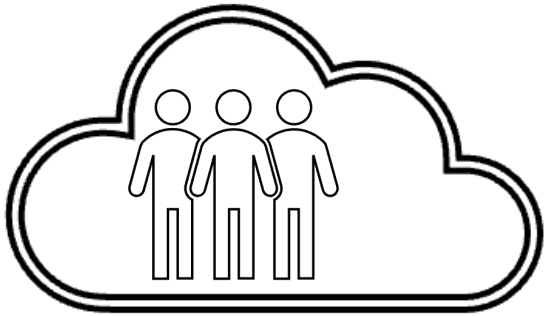


Education & Research Gap
Limited resources in schools and labs hinder STEM education and innovation in underfunded regions.

Closed Technology Slows Down Progress:
Traditional microscopy and optical systems restrict modifications and customization, limiting research flexibility and deeper insights


openUC2
Problem Statement
...it‘s complicated.
© Dr Lachlan Whitehead

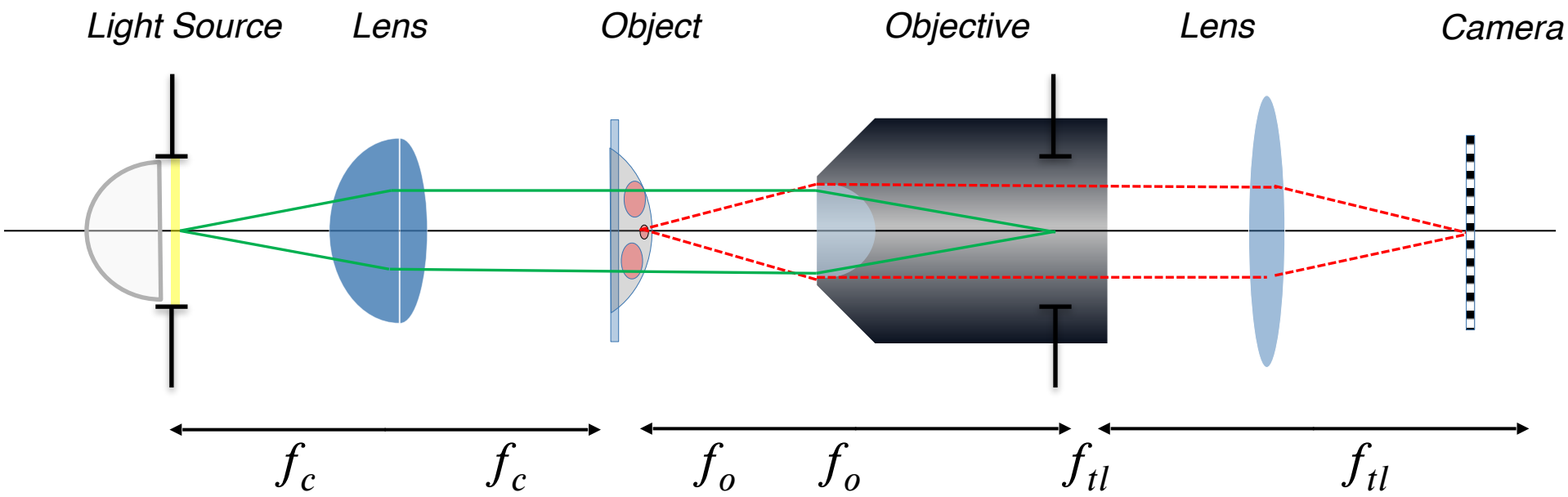




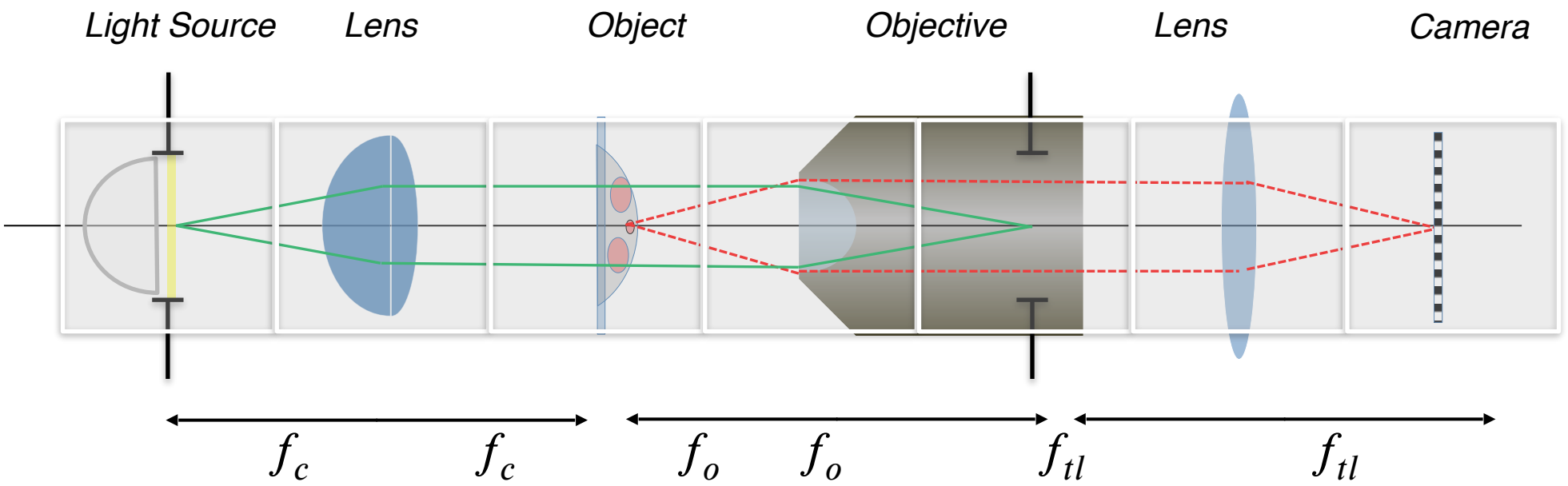
Community-driven

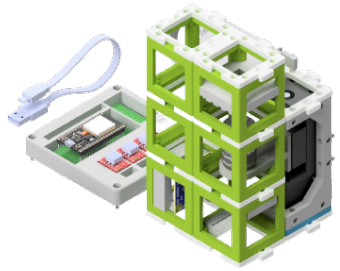
- Huge Codebase
- Knowledgebase
- Ecosystem of Parts + Code

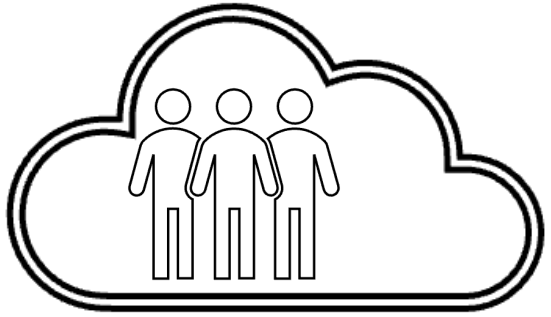
2-3 Minutes


Light Source
Lens
Object
Objective
Lens
Camera
f_c
f_c
f_o
f_o
f_{tl}
f_{tl}

You.See.Too.



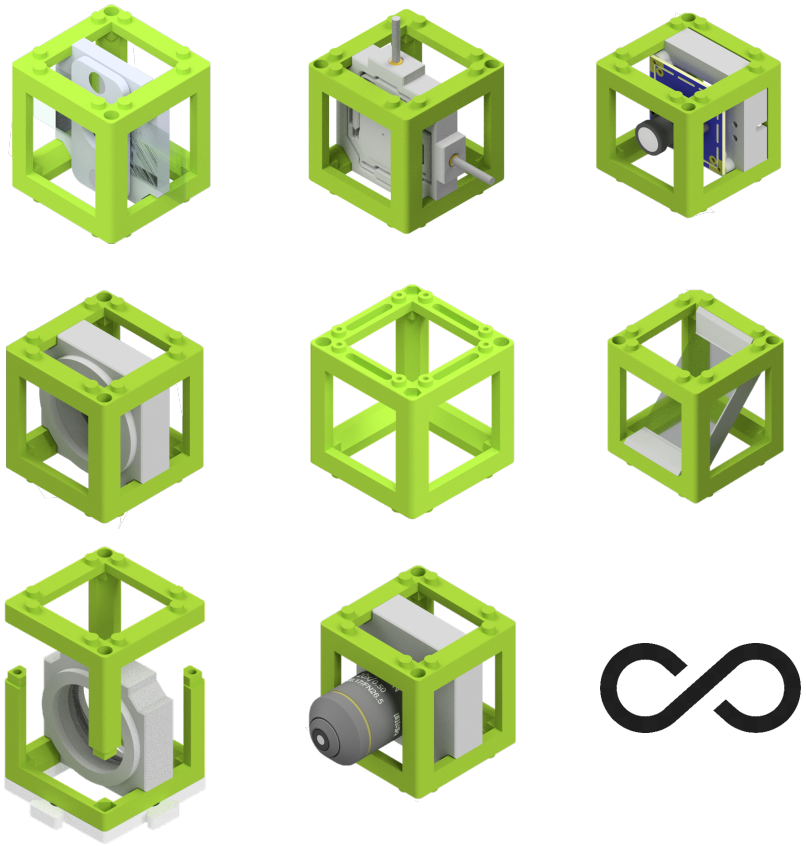




Community-driven
- Huge Modulebase
- Knowledgebase
- Ecosystem of Parts + Code

Diederich et al. 2020
Openuc2.github.io

Our Solution – The OpenUC2 Platform

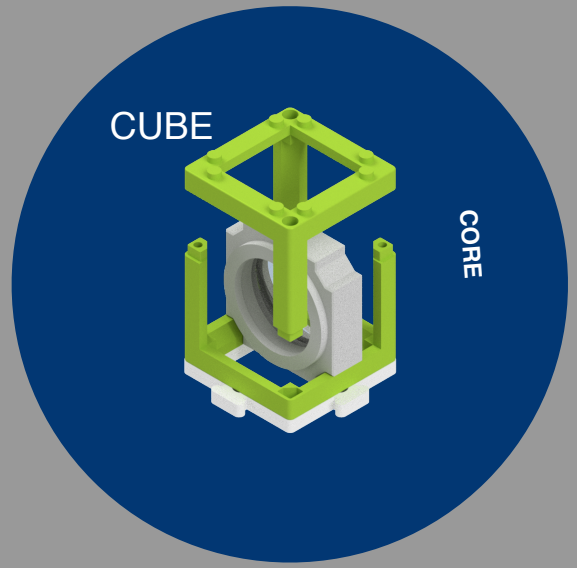


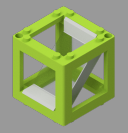
What is OpenUC2?: A modular, open-source microscopy system designed to be affordable, customizable, and easy to use/replicate.

Built for Accessibility and Flexibility: Ideal for use in education, research, and low-resource settings.

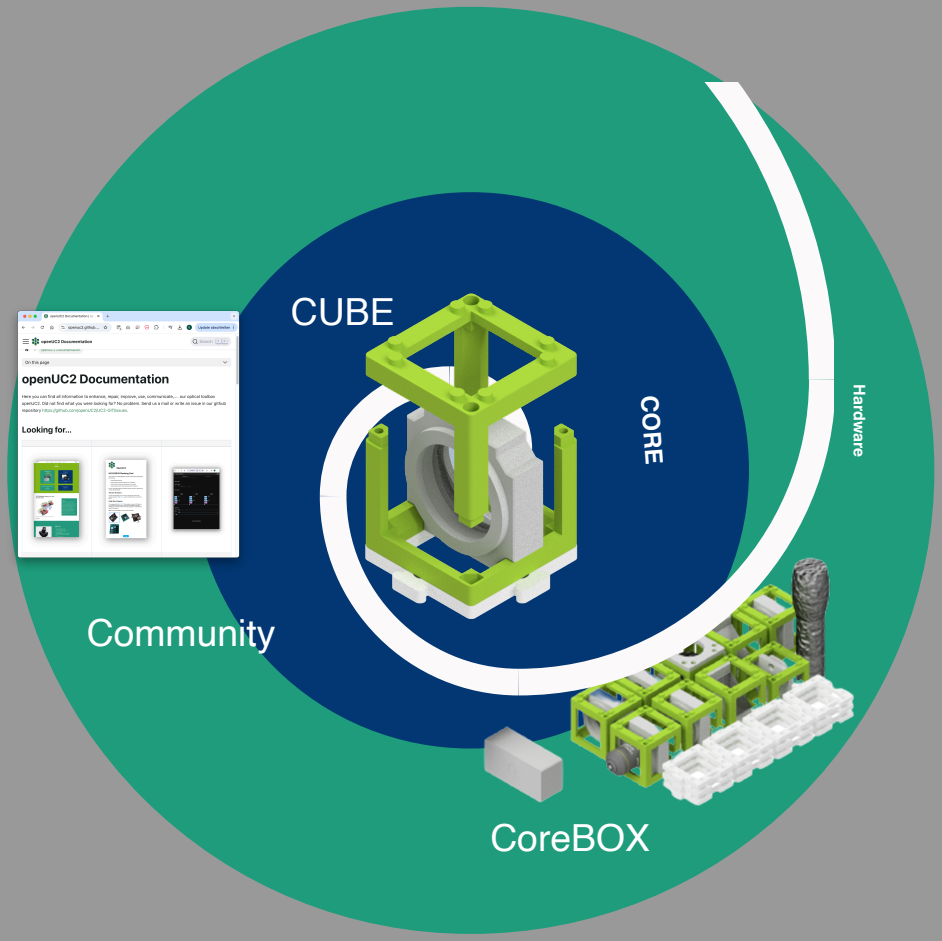
Scalable and Adaptable: Modular cubes, plug-and-play optics, and open-source software allow users to create diverse setups, from basic imaging to advanced techniques.

openUC2

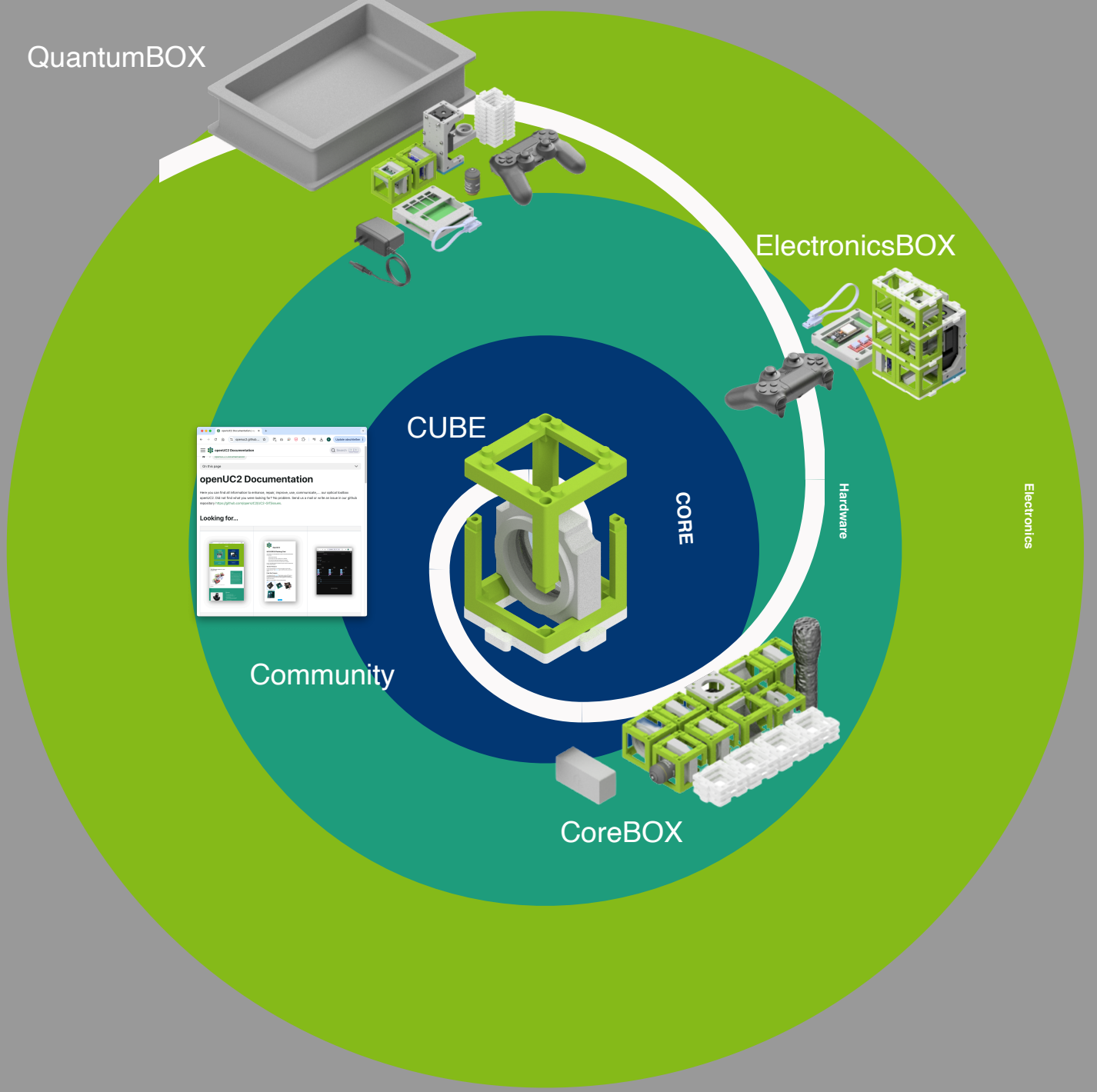




openUC2


CUBE
CORE
Hardware
Community
CoreBOX
openUC2 Documentation
Looking for...

openUC2

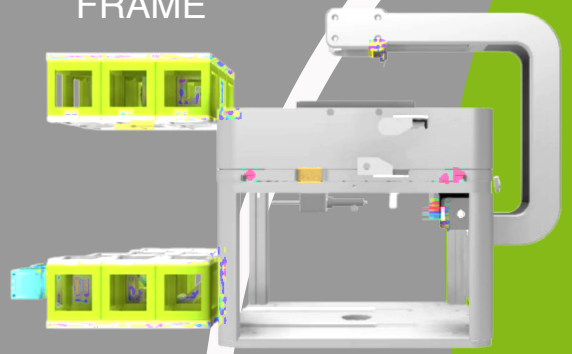

QuantumBOX
ElectronicsBOX
CUBE
CORE
Hardware
Electronics
openUC2 Documentation
Looking for...
Community
CoreBOX

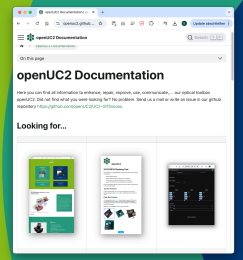
openUC2

QuantumBOX

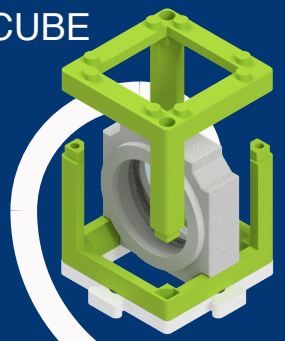
ElectronicsBOX

FRAME





CUBE



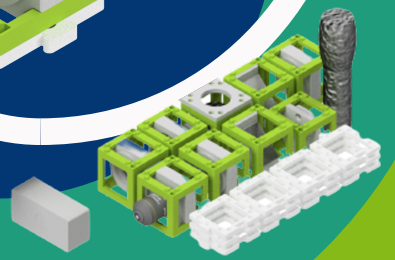
CORE

Hardware

Electronics

Software

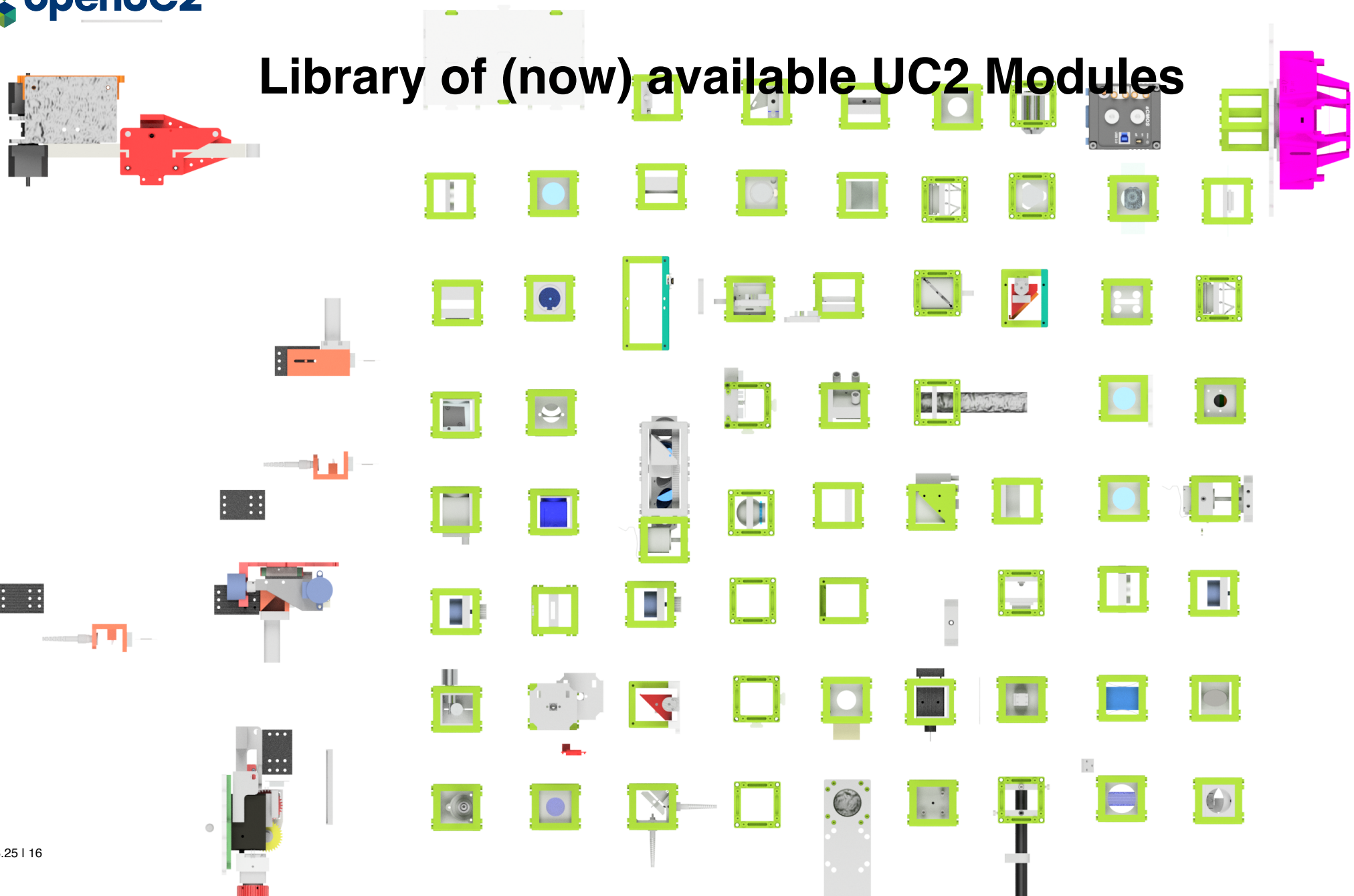
Community



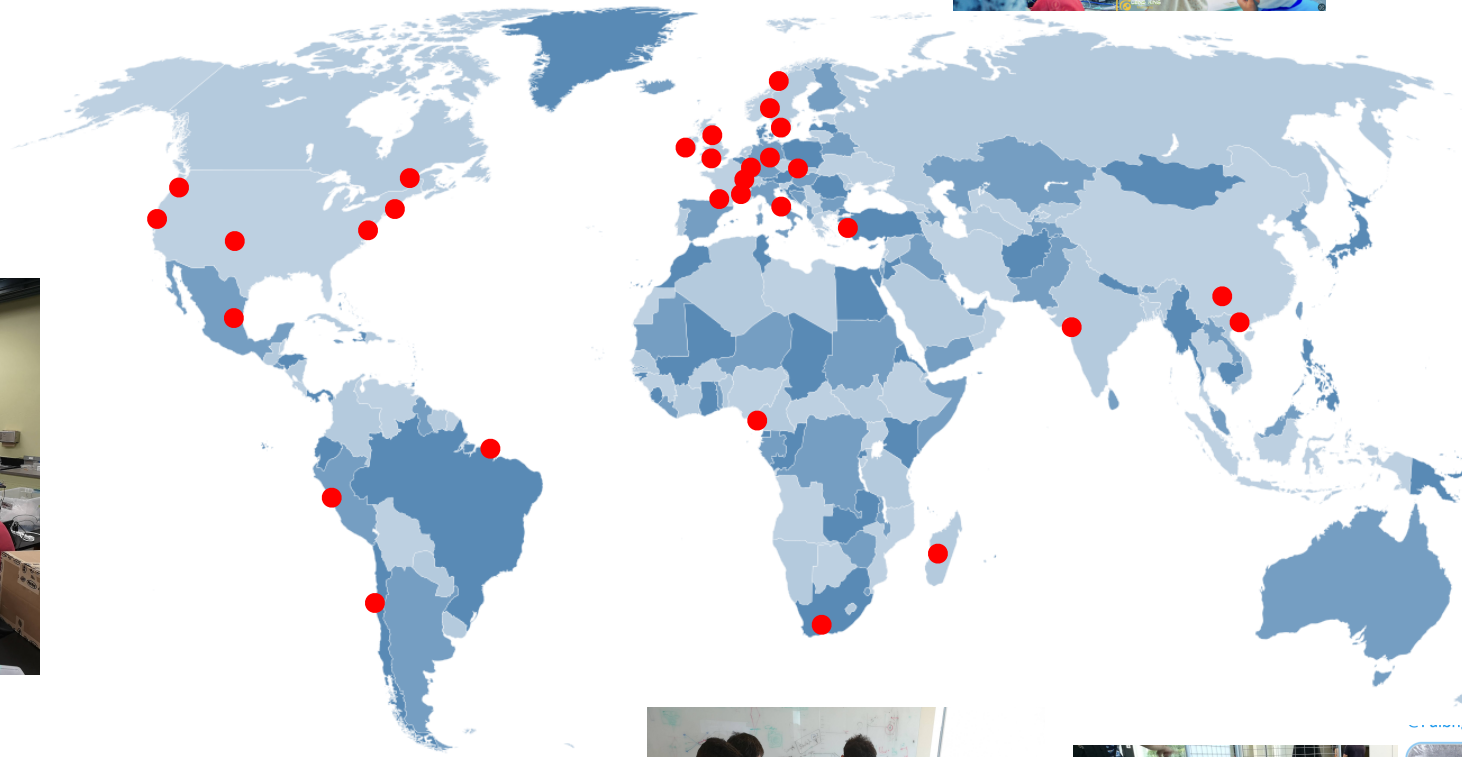
CoreBOX

openUC2

Library of (now) available UC2 Modules



openUC2

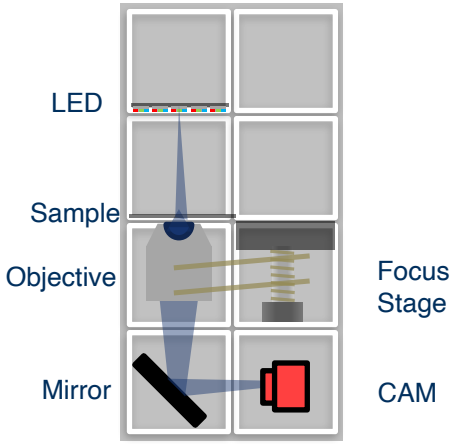


1:54 PM · Apr 12, 2024 · **7,709** Views

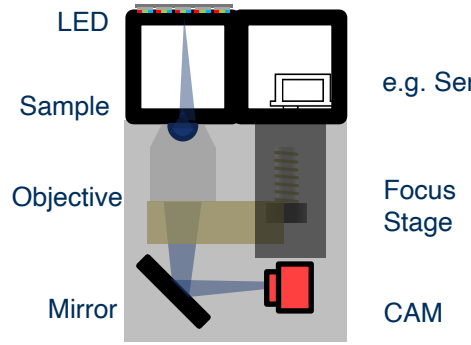
You know your method is robust when it works 6000 km far away from home..

📢 Open hardware is revolutionizing education! 🎓✨ Take the case of #OpenUC2, a game-changer in classrooms. 🌍🔬 Thanks to #BioRTC and Mboalab.
@OpenUc2
@BioRTCNig
@LabMboa
@USEmbYaounde
@IREXintl
@FulbrightPrgrm

openUC2
Rapid Prototyping



openUC2xSeeed



Problem Statement

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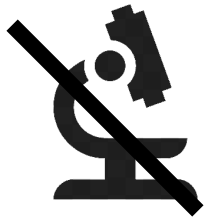

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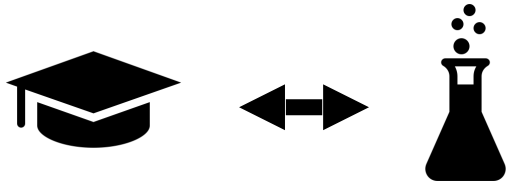
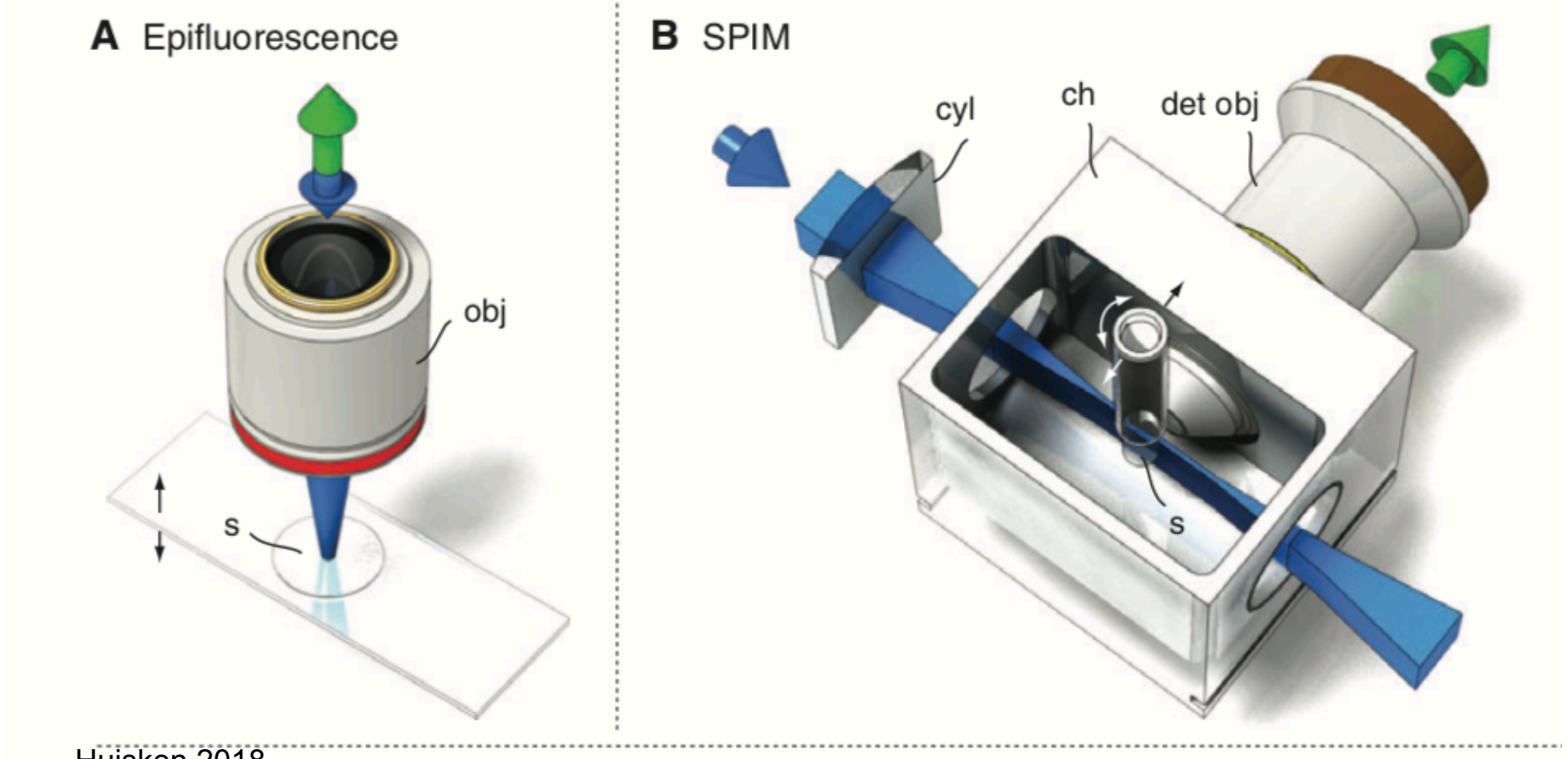


Education & Research Gap
Limited resources in schools and labs hinder STEM education and innovation in underfunded regions.

Closed Technology Slows Down Progress:
Traditional microscopy and optical systems restrict modifications and customization, limiting research flexibility and deeper insights

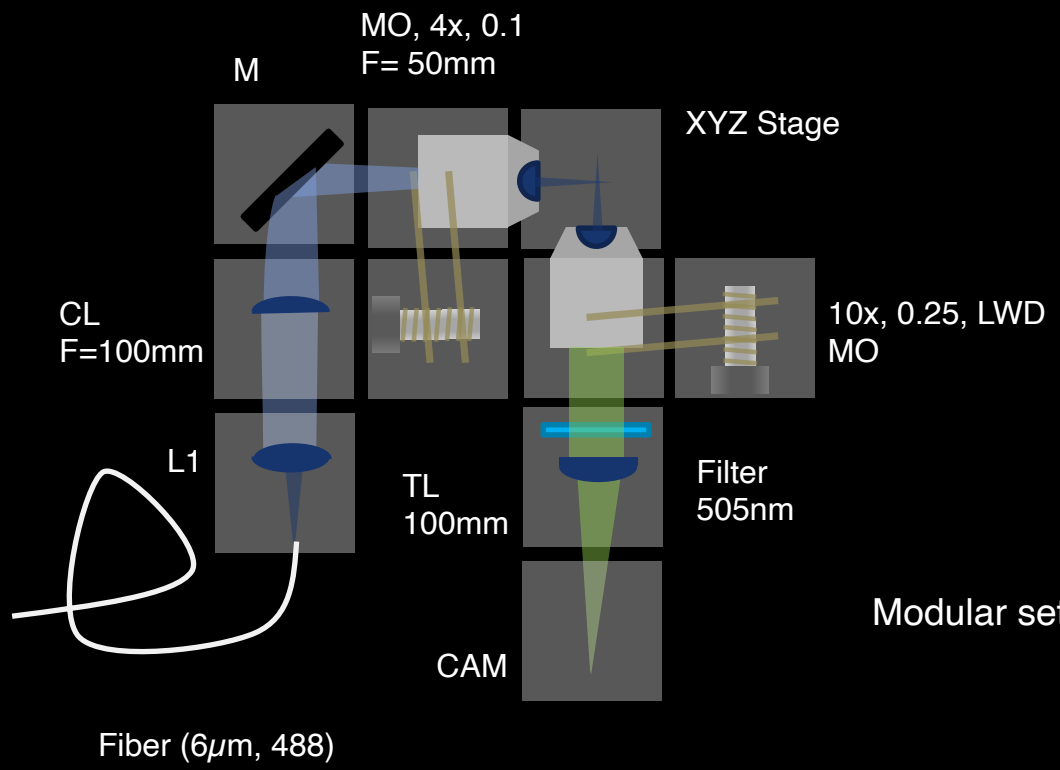
Volumetric Imaging: Light-sheet microscopy



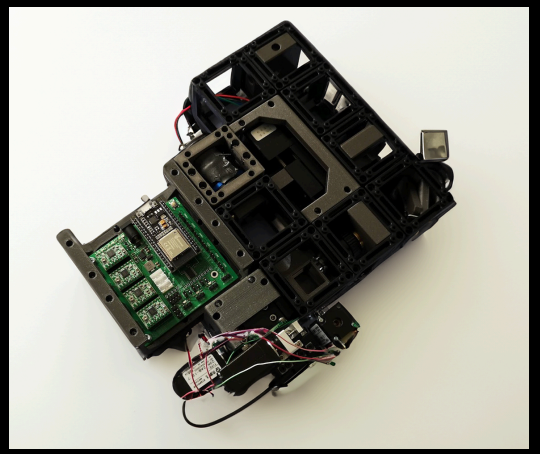
Huisken 2018

Light-sheet Microscopy

Optical Diagramm



Optical Setup



Modular setup

Result

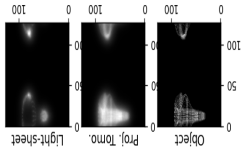
HoLiSheet - Tomographic-based Light-Sheet Microscopy

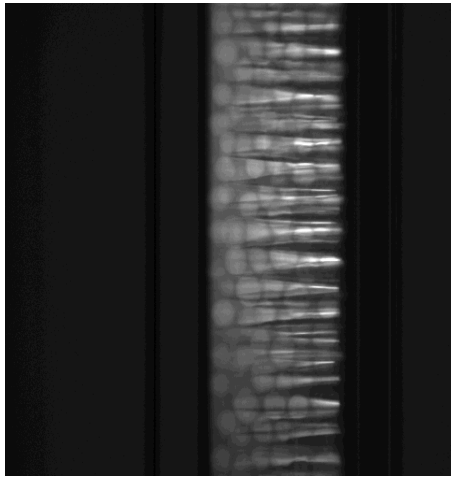
openUC2

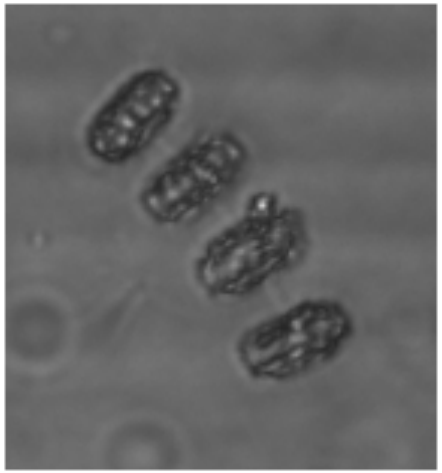
Simulation

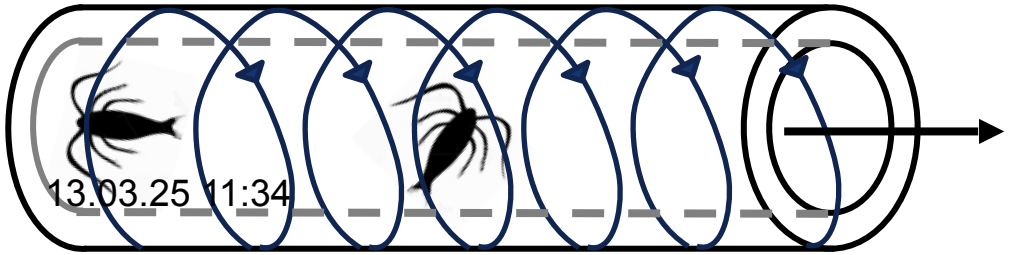
HOlography

LIghtSHEET

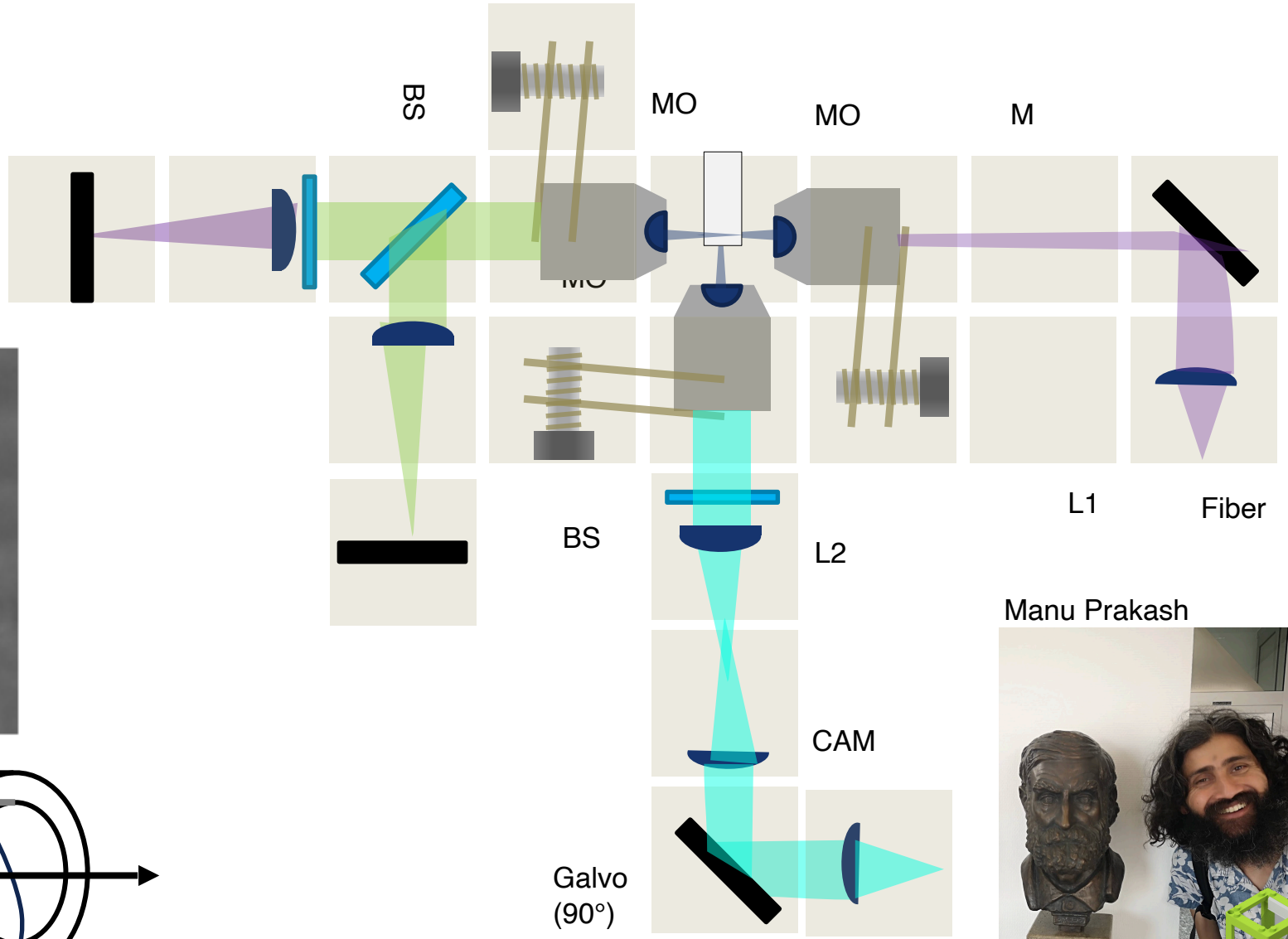








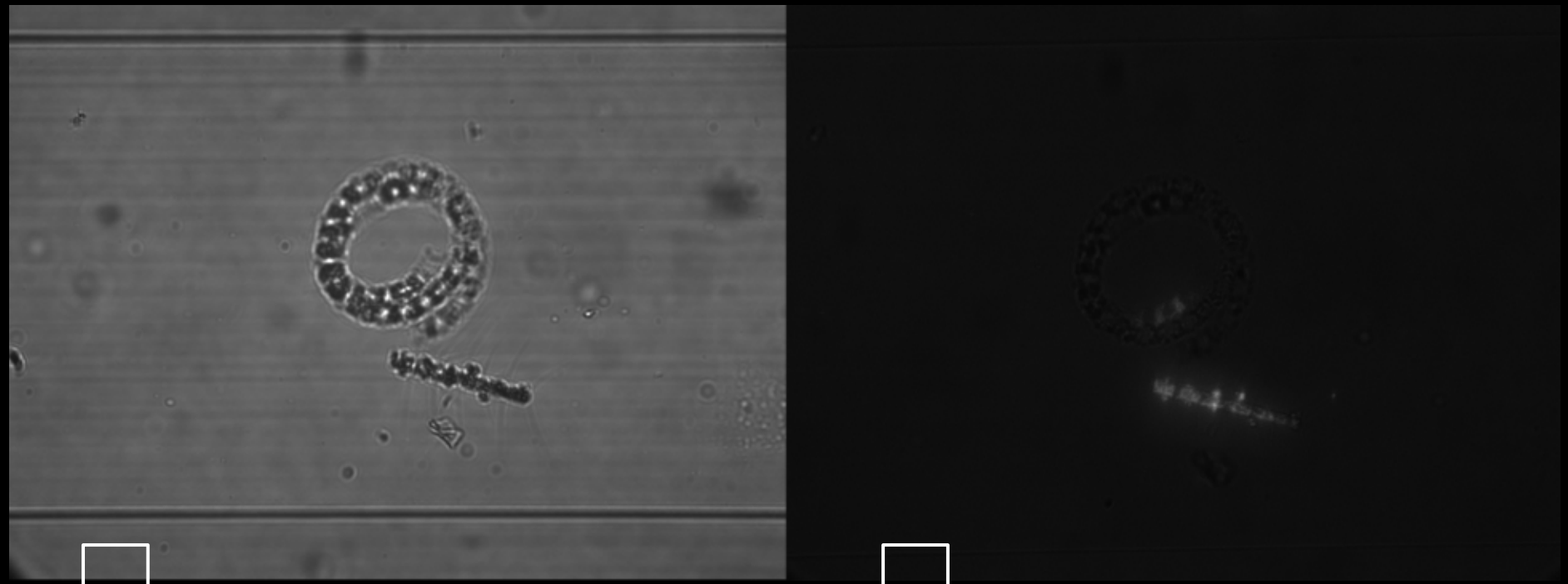
Setup



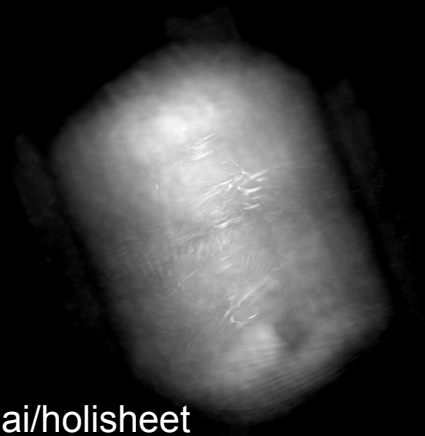
https://github.com/beniroquai/holisheet

Manu Prakash

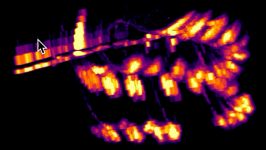
HoLiSheet – Holy shi…



Holo

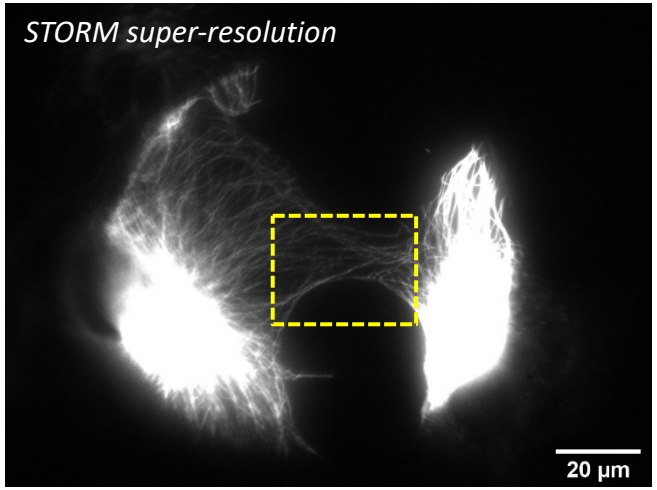


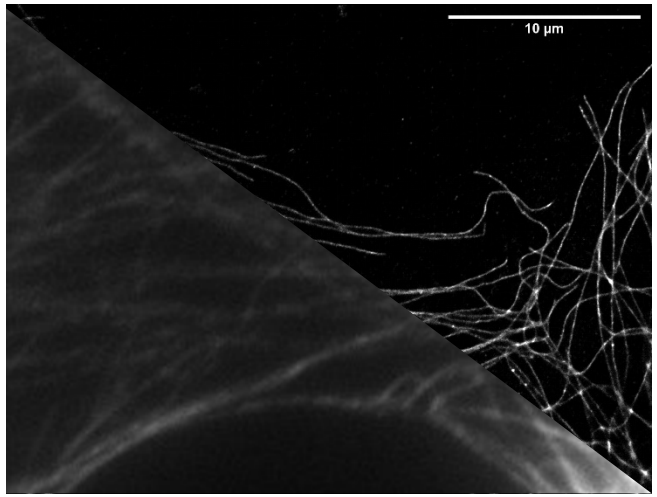
Lightsheet

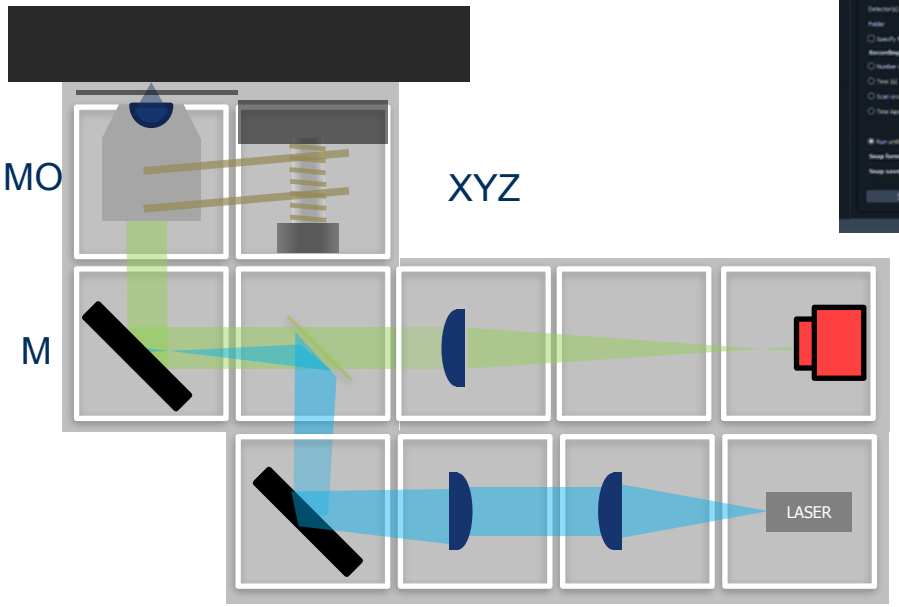


https://github.com/beniroquai/holisheet

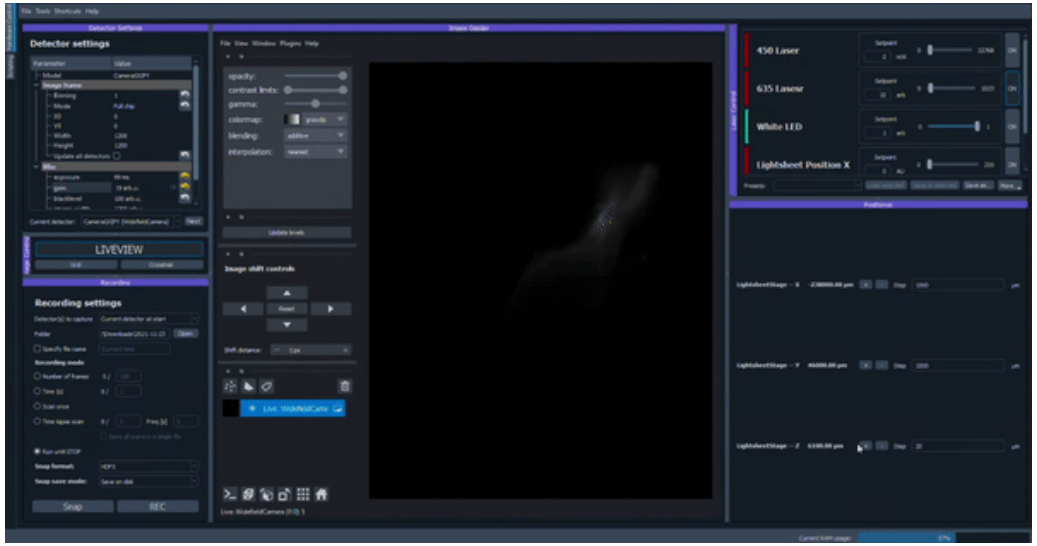
(Incubator-contained) Microscope with fluorescence and STORM



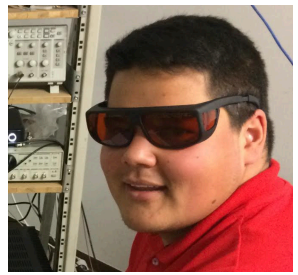




ImSwitch for Control and Reconstruction



Ando Zehrer
AG Helge Ewers FU Berlin



10.7554/eLife.89826.2

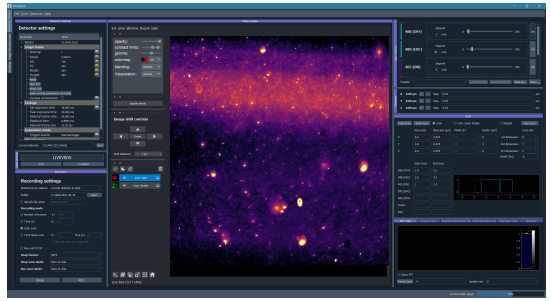
We need control! openUC2 Electronic – ESP32

Input Interface

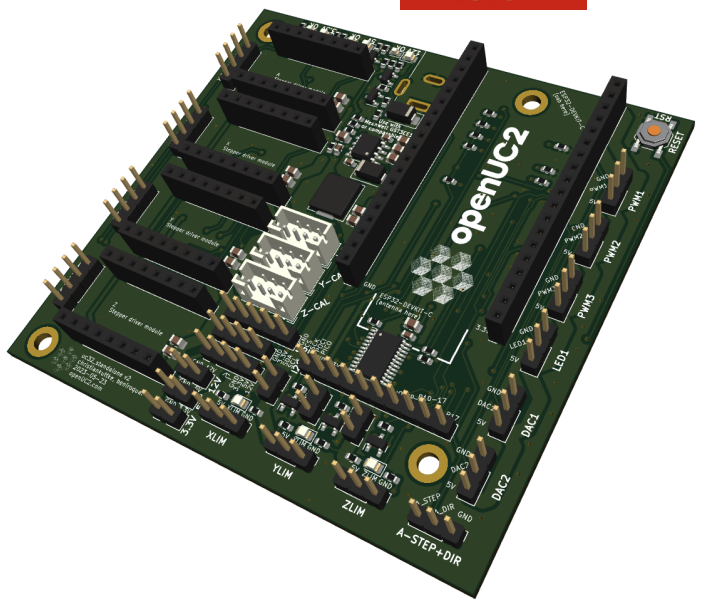
Touchscreen (Wifi)

PS Controller (Bluetooth)

ImSwitch (USB)



UC2-ESP Board

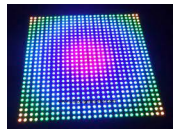


https://youseetoo.github.io/

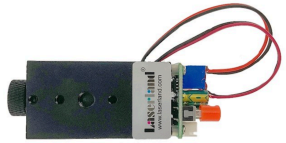
Actuator/ Sensor

- Stepper

- LED Matrix



- Laser/LED



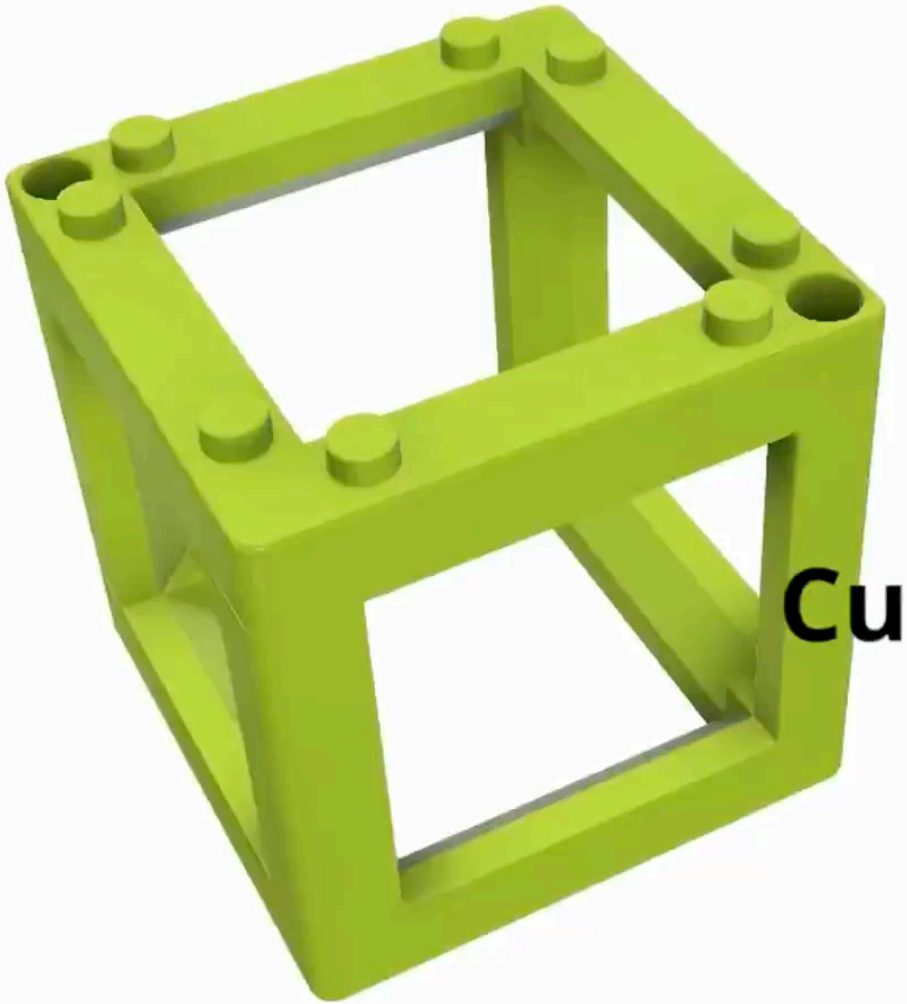
- DAC/ Galvos

- Encoder

- Trigger

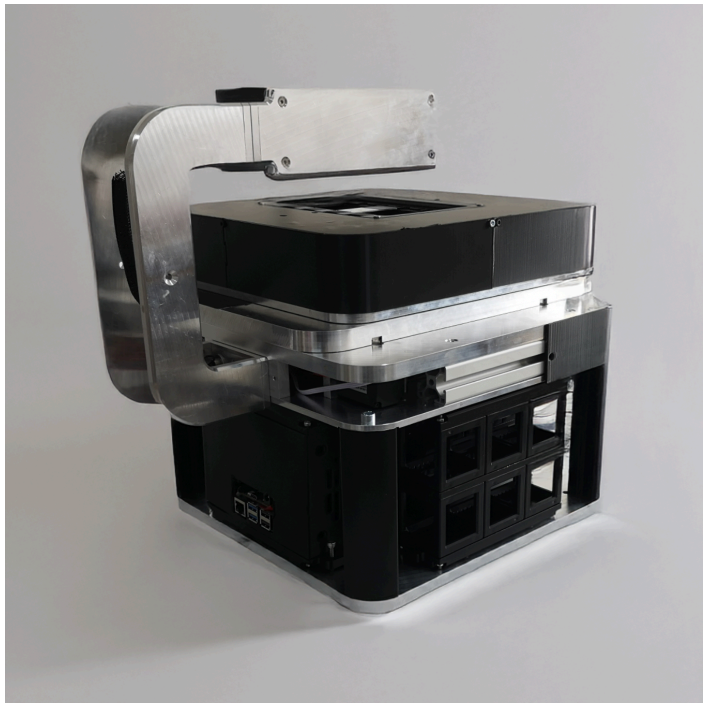
Member of the Leibniz Association

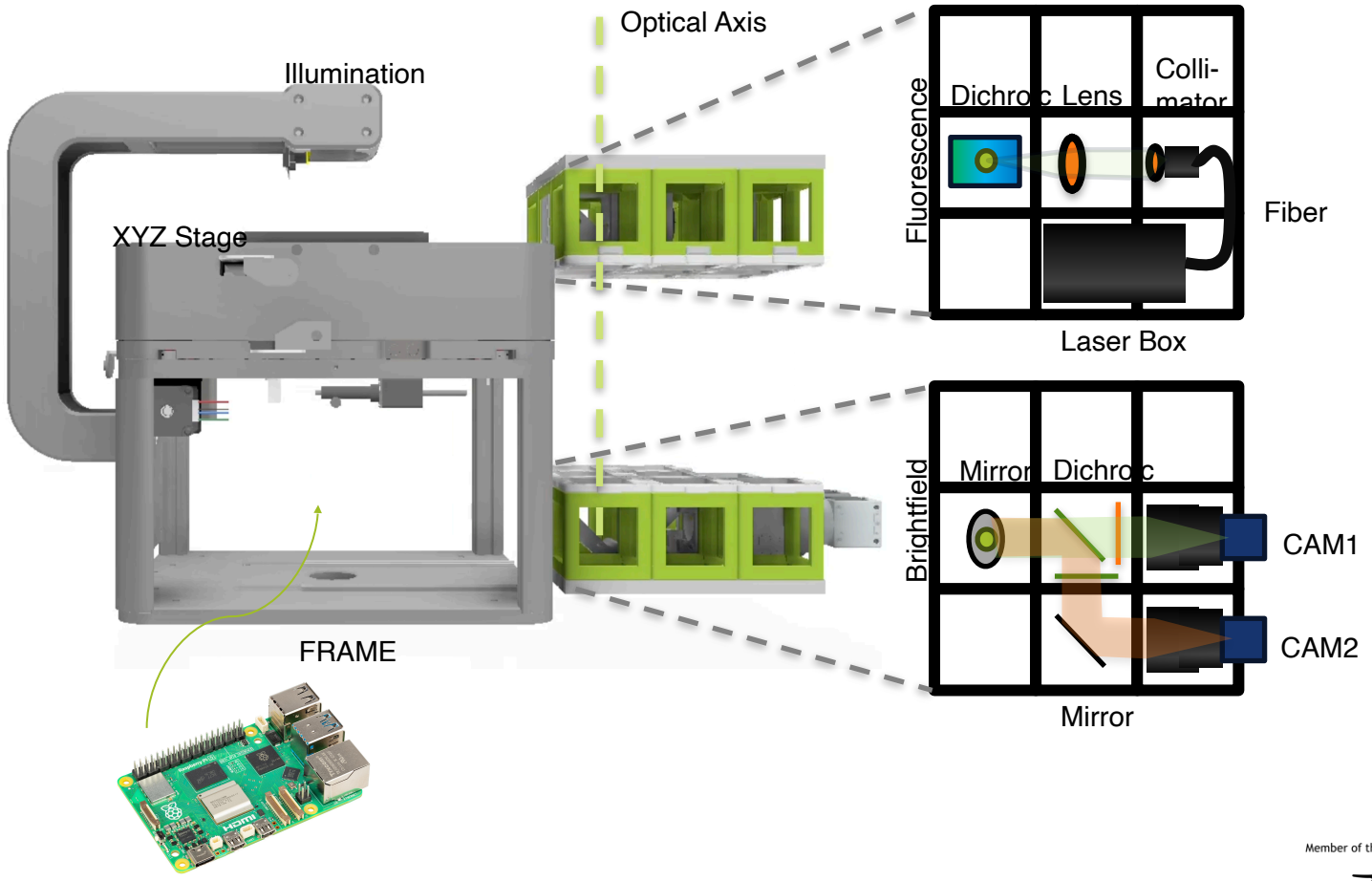
From Cube to Microscope in Minutes…



Cube

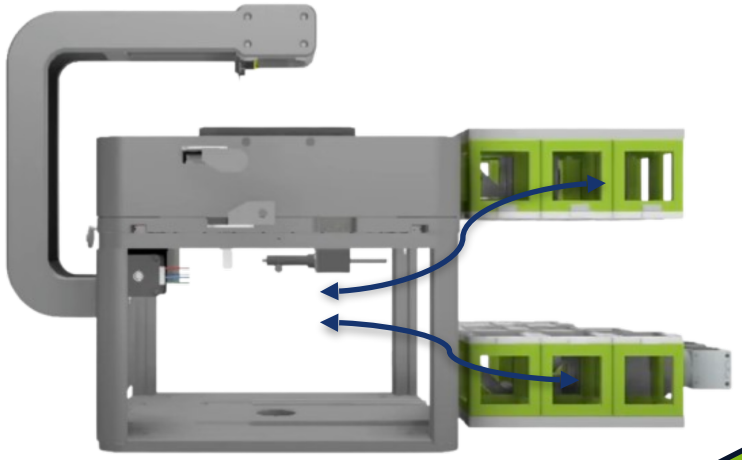
The FRAME – all batteries included



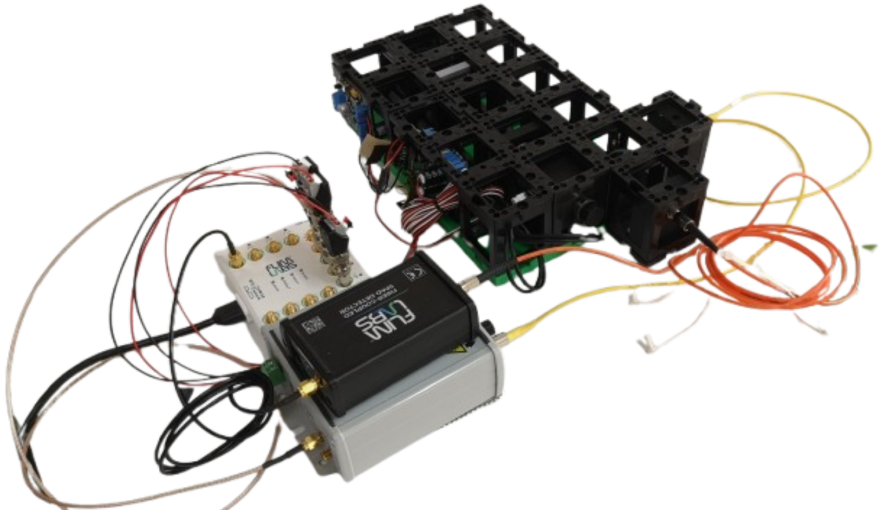


As Easy as (Raspberry) Pi

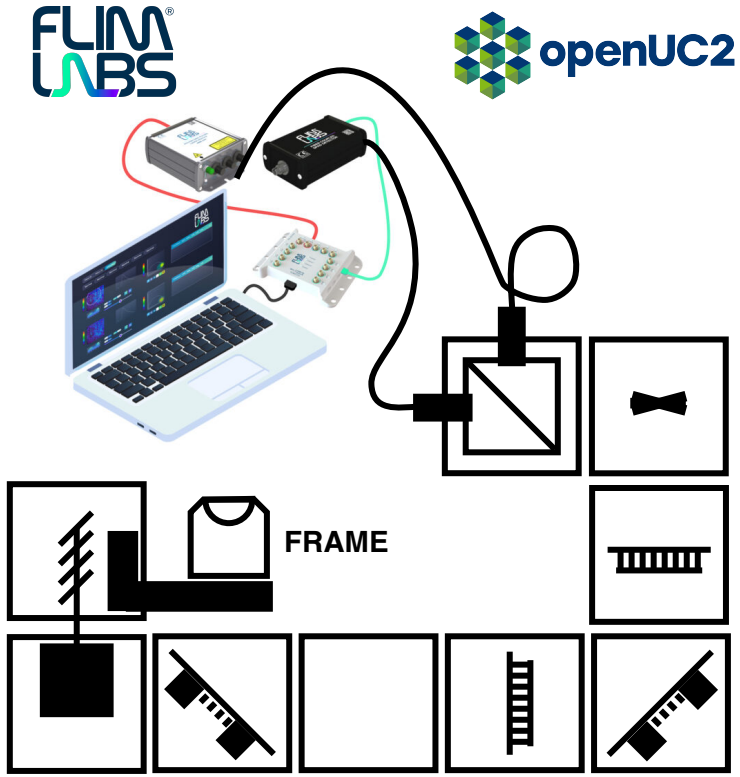
Democratizing FLIM Imaging with open-source technology



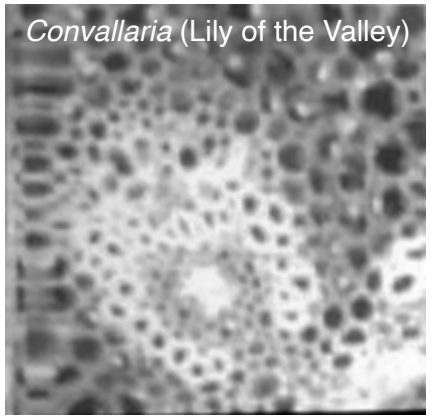
openUC2 FRAME
Fast and Rigid Auomated Microscopy Engine



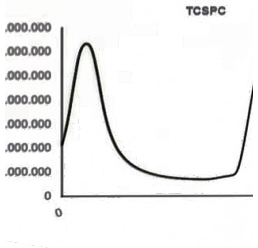
FLIM Layer



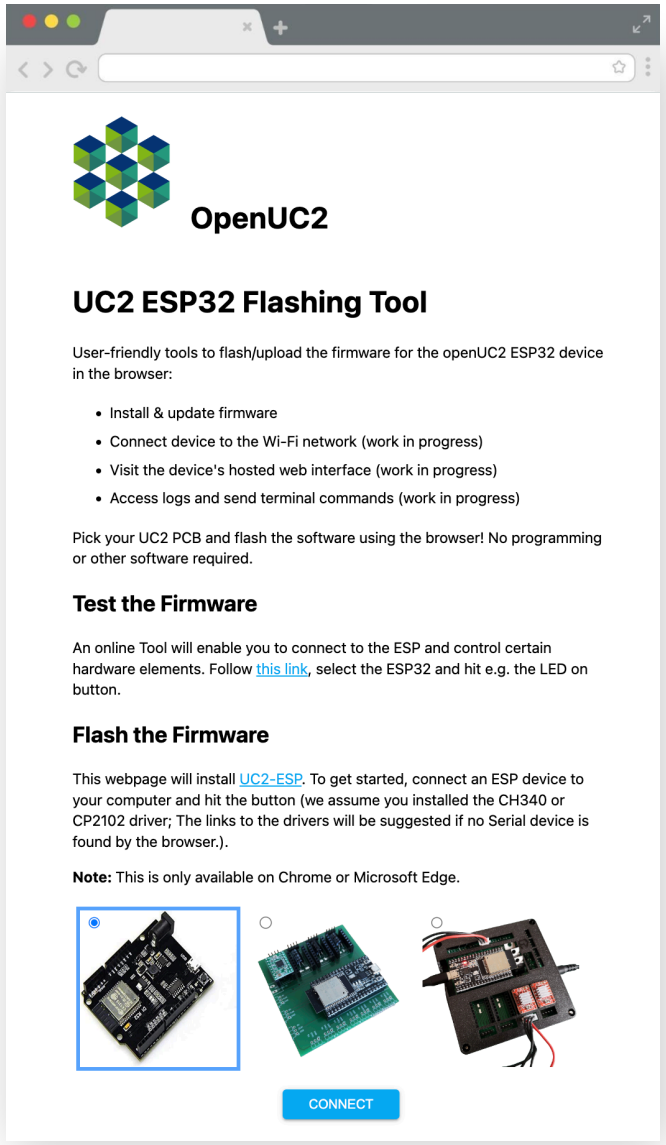
FLIM Image

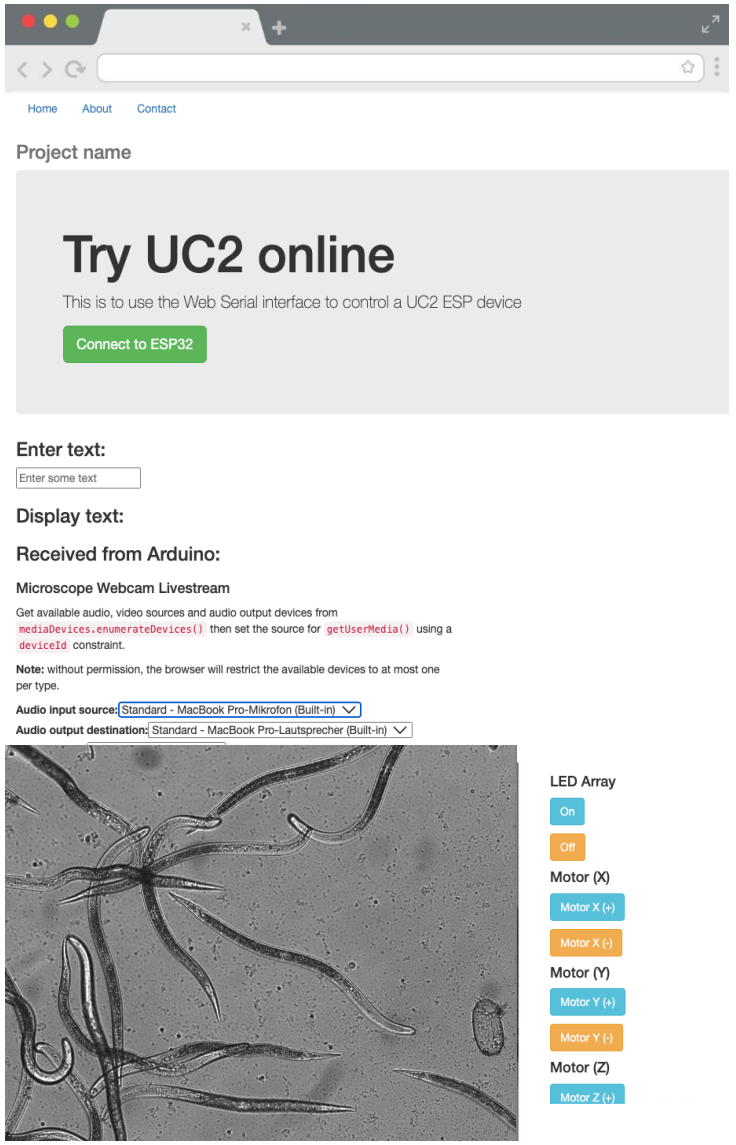


Spectrum



Web-based Microscopy

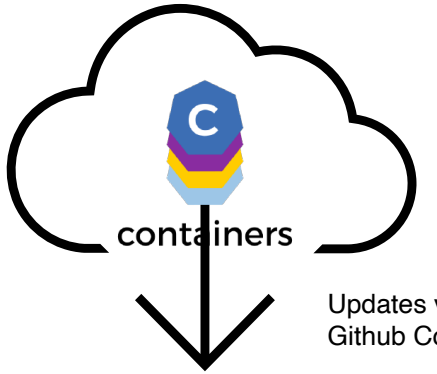




https://youseetoo.github.io/

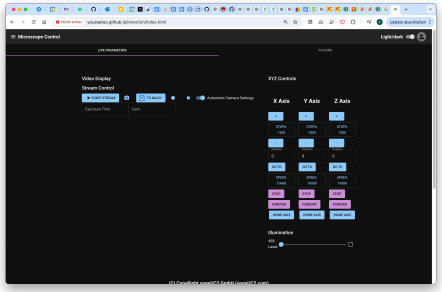
https://youseetoo.github.io/

CI for Microscopy

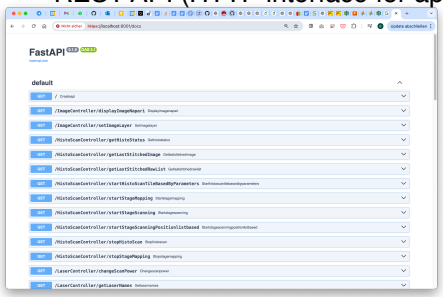


Updates via Docker
Github Containers

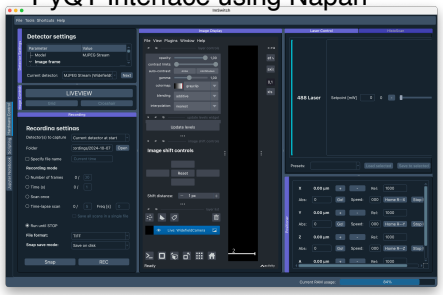
React APP (browser, phone, laptop, etc.)

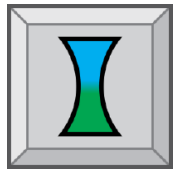


REST API (HTTP interface for applications)



PyQT Interface using Napari





ImSwitch Server

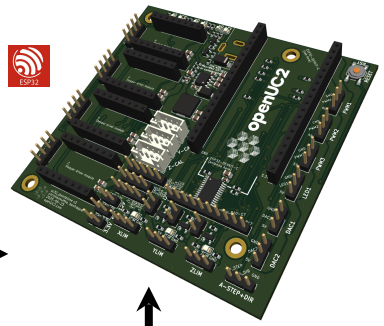
Arkitekt APP

QT Egine

Hardware Drivers

USB-
Serial

UC2-ESP Firmware on
UC2-Standalone v3 board
Via USB Serial



USB-3 Camera via
USB3

Raspberry Pi 5 running docker and connecting
Different hardware components
(alternatively one can use a laptop instead)

OpenUC2's Smart Microscopy OS – ImSwitch OS

- **Built on Raspberry Pi OS**, customized with preinstalled apps & drivers for OpenUC2 microscopes.
- **Inspired by PlanktoScope OS**, which abstracts hardware into a web-based GUI, integrates essential software, and operates in offline environments.
  - **Preinstalled drivers** (cameras, motion controllers, sensors.)
  - **Preinstalled Docker + Containers** ImSwitch runs out of the box
  - **Web-based GUI access** for remote control and automation.
- **Uses Forklift**, a system for composing and managing OS configurations, software modules, and updates in a structured and reversible way.

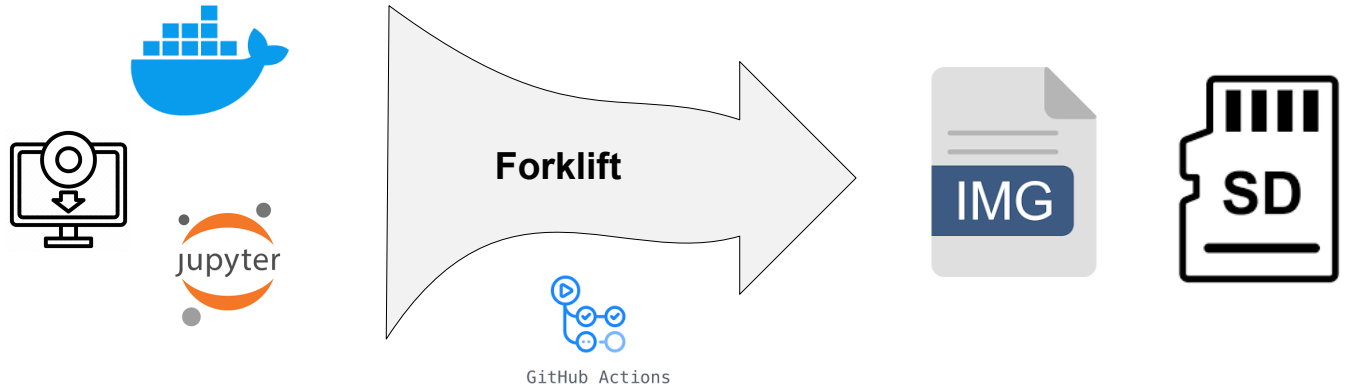
Ethan Li

GitHub Actions

PlanktoScope

How Forklift Powers ImSwitch OS

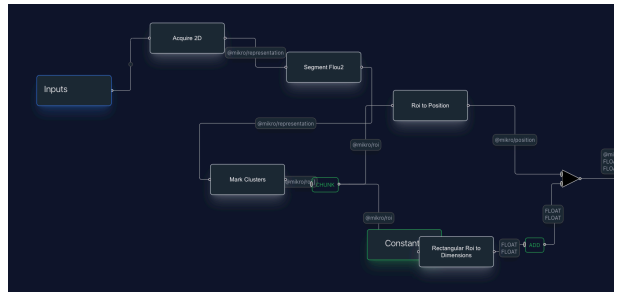
- **Forklift's Role:**
  - **Manages OS & software updates** with version-controlled BOMs („Bill of Materials" – similar to Docker Compose but on system level).
  - **Allows easy upgrades/downgrades** via Git-based pallet switching.
  - **Ensures reproducibility** by using pre-configured modules.
  - **Supports air-gapped environments** for labs without internet access.
- **Benefits for OpenUC2:**
  - Rapid **deployment** of a **preconfigured OS** for microscopy.
  - **Preconfigured: Network, Drivers, Docker, Settings, Storage, Docker compose**



Bridging the gaps: Interface microscopes with robots using Arkitekt

Arkitekt Orchestrator
- Configure Workflow
- Schedule experiments
- Organize Dataflow
- Datamanagement
- Smart feedback

Helmholtz HPC
- Run Docker Cluster/ Kubernetes?
- Run Arkitekt Server
- Globally Accessible

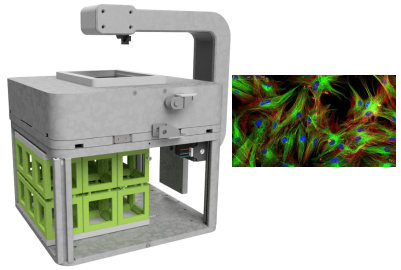


Arkitekt Service
- Start Protocol
- Stop Protocol
- Upload Protocol

docker

Opentrons REST Interface
- Start Protocol
- Stop Protocol
- Upload Protocol

Opentrons OT2
- Perform Pipetting Steps
- Automated Labelling
- Cell feeding…

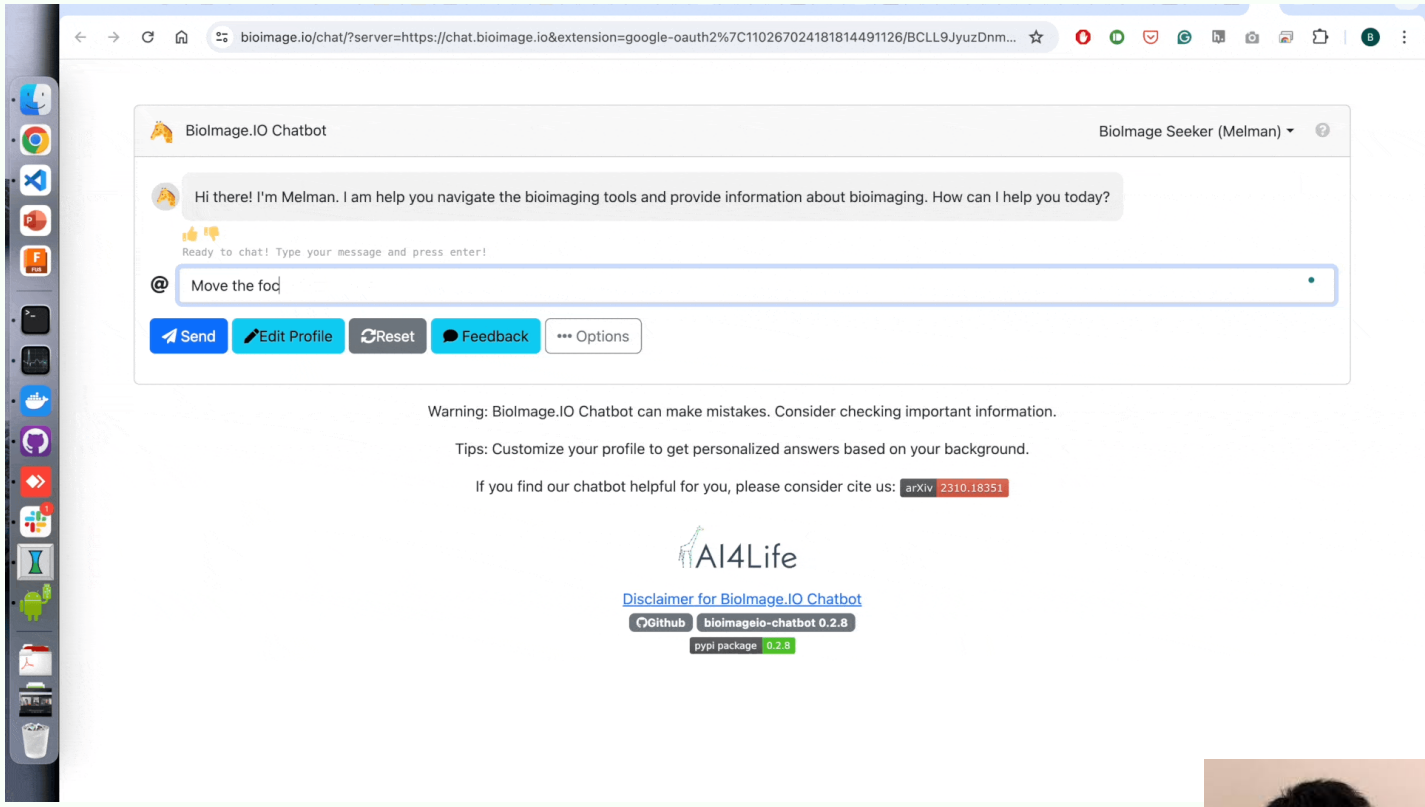


openUC2 FRAME
- Fully automated xyz microscope
- Multichannel fluorescence imaging
- ROI scanning /w different magnifications

Image Processing (e.g. Ilasik) App
- Process Images
- Docker-based Service
- Accept images
- Report Results

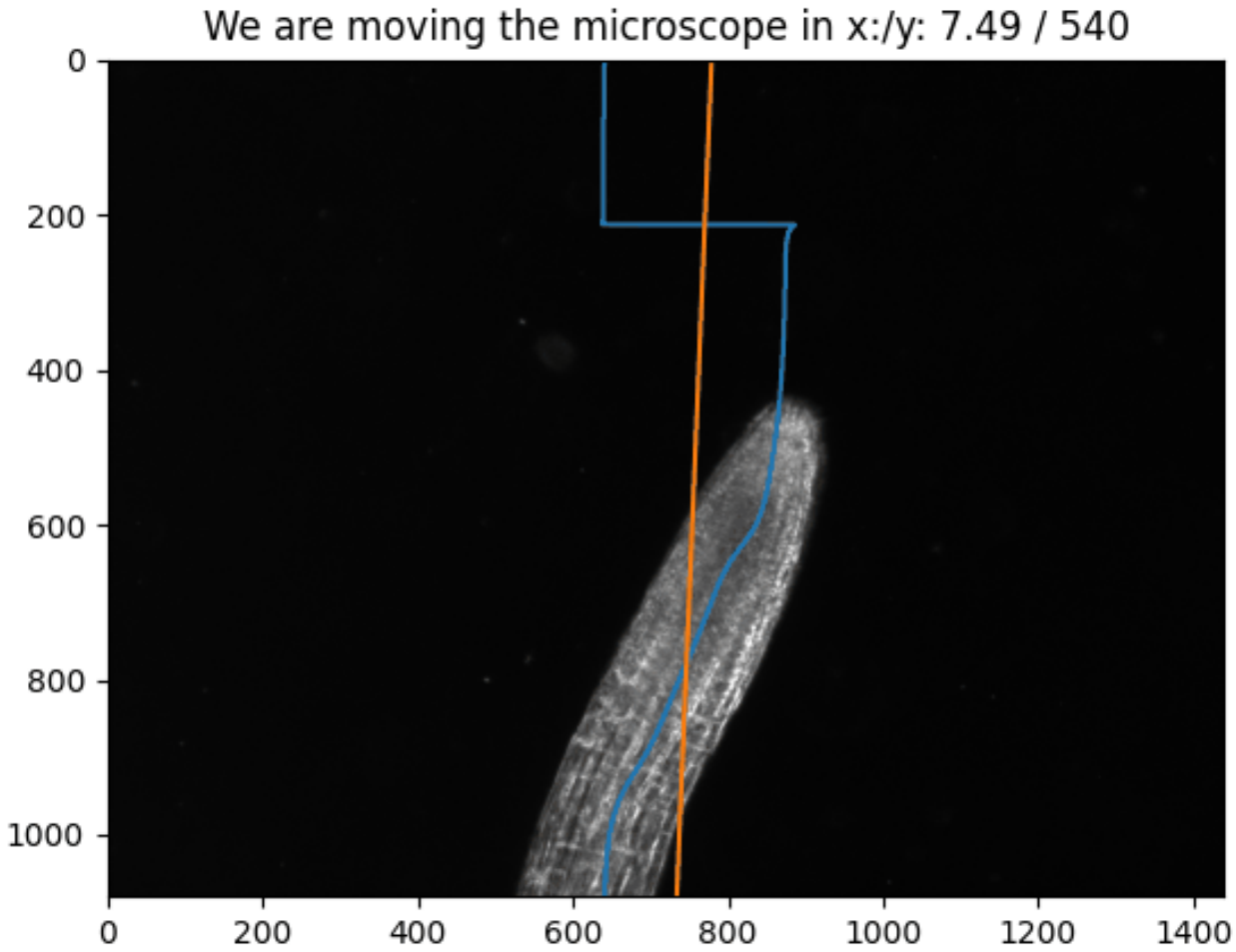
Hackathon: Autonomous Microscopy using Chatbot integration

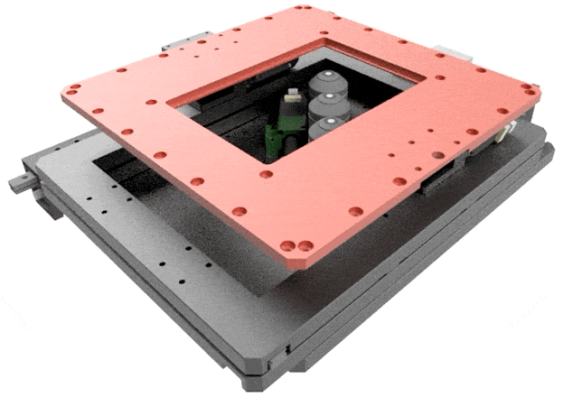
- Bridge LLMs with Microscopy
- „Reason“ the actions of a microscope
- „See“ Using the Vision API
- Modularize using Hypher/ImJoy
- All dockerized



Wei Oyang

„Reactive microscopy“





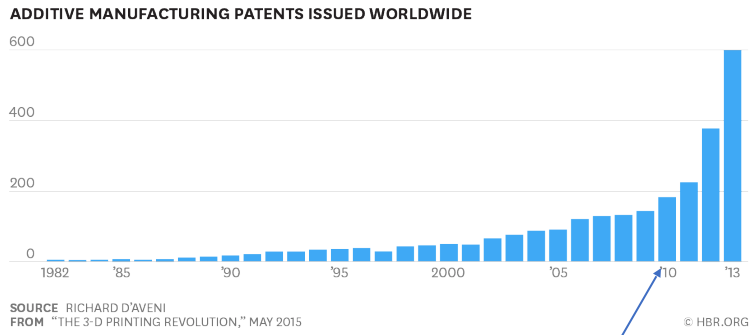
Download on the App Store

Automate 2D Plant Analysis for many samples sequentially OR in parallel

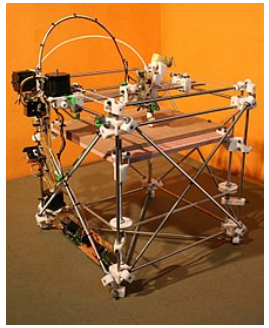
Why Open-Source?

- Proprietary due to platform binding
- Free Marketing
- Community Contributions and Support
- Use Free, open-source software
- Crowdsourcing: Outsource development
- Open Core: Let people tinker; IP on cube design

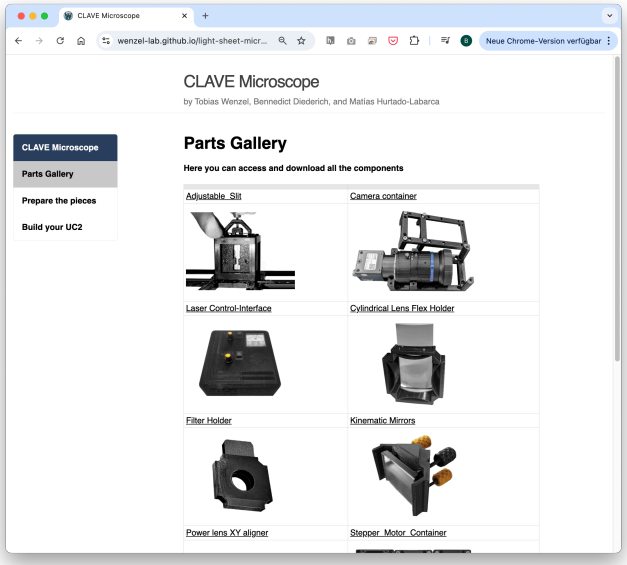
Accelerate Innovation in Optics



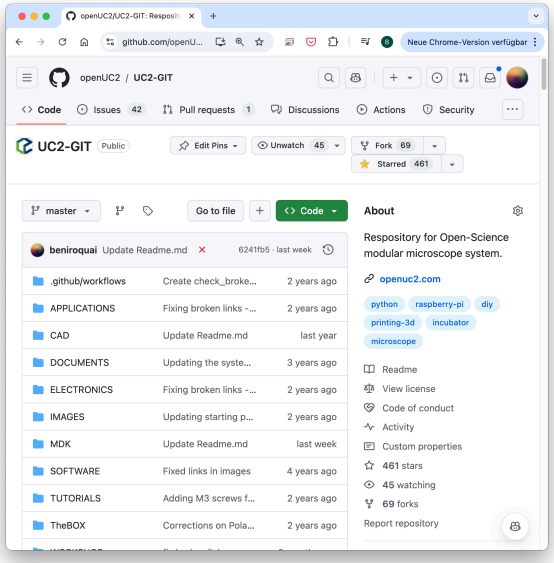
3D printing Patent running out



2012: RepRap



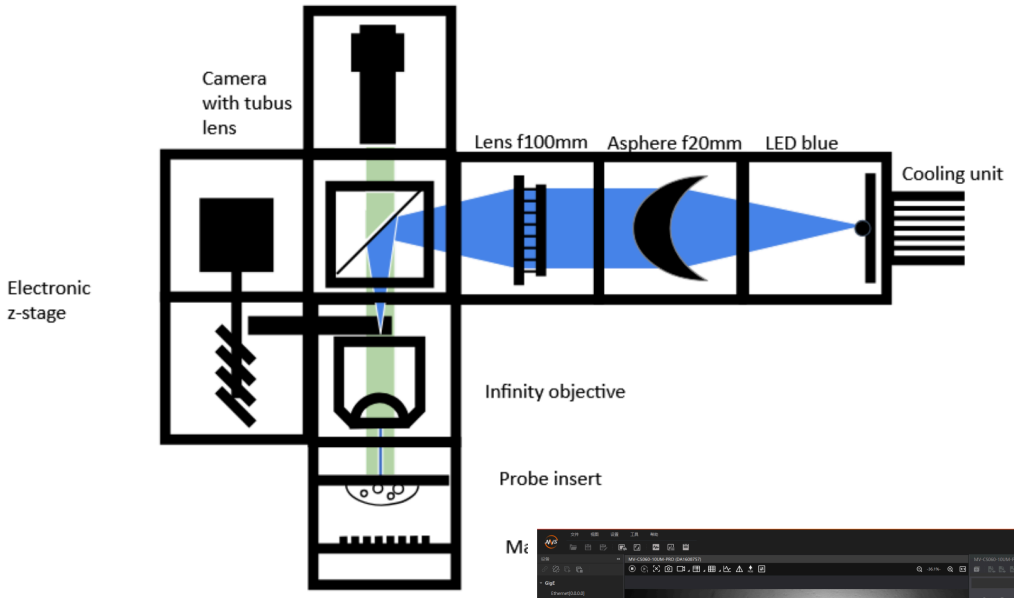
User Created Designs
(LibreHub, Chile)



Huge Visibiility

Workshop today: Build your own Fluorescence Microscope!

Diagram

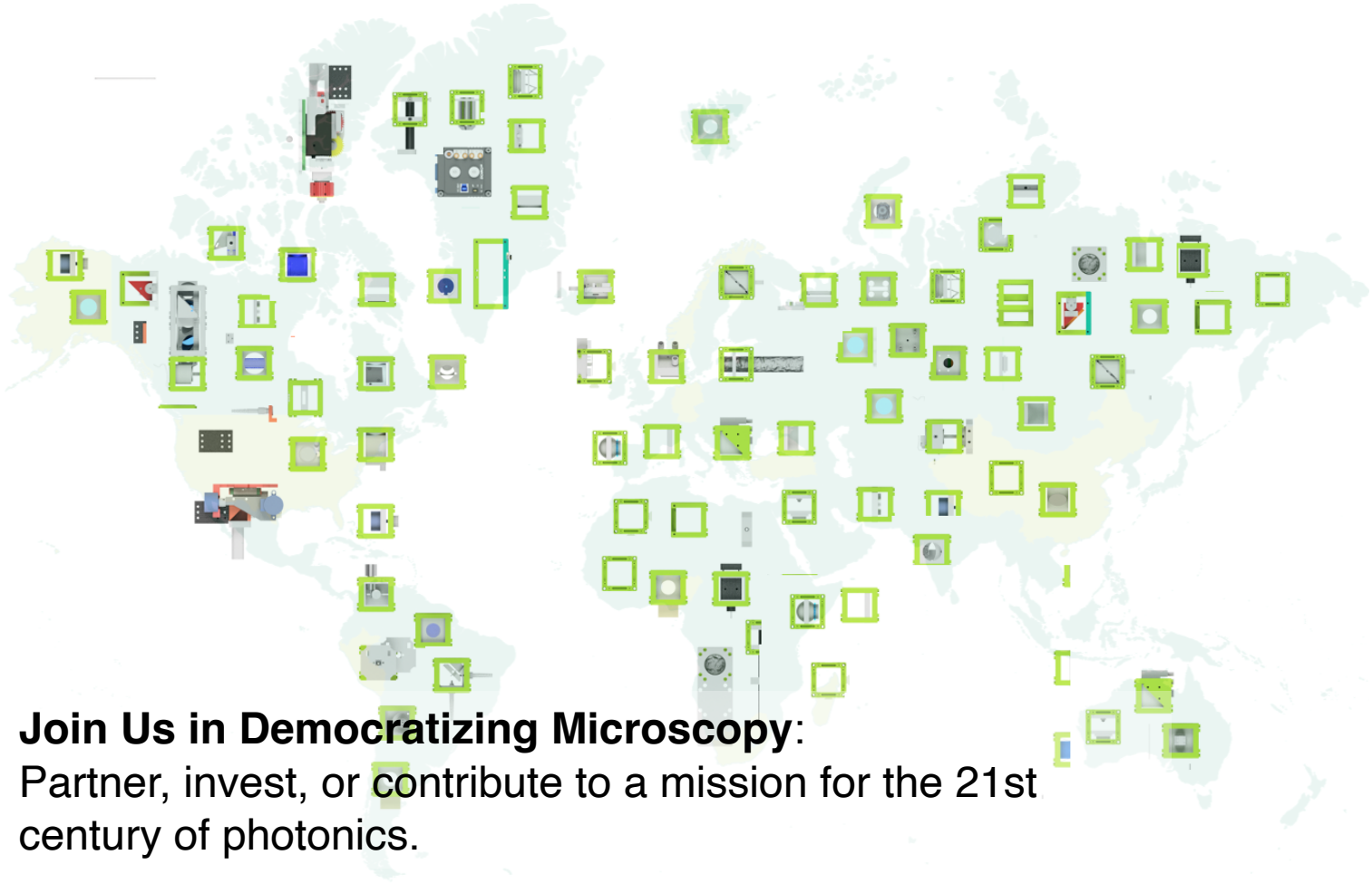


Tutorial: LED-Powered Fluorescence Microscope

openUC2

Fork 68 | Starred 449

Becoming „The Raspberry Pi for Optics“



Join Us in Democratizing Microscopy:
Partner, invest, or contribute to a mission for the 21st century of photonics.

Dr. Benedict Diederich CEO
- Training at Miele, Nikon, Zeiss, Stanford and Leibniz-IPHT
- Open Hardware Enthusiast
- Software-Hardware integration
- Creator of UC2

Haoran Wang CTO
- Expert in Super-Resolution Microscopy
- Experience in Tinkering and chinese supply chain
- Optical System integration

Christian Kuttke Electronics
- Hacker by heart
- Electronics genius
- Video editing and documentation
- Community interaction

Armin Grundmann Mechanics
- Project/Product Manager
- Year-long experience with large technology projects
- Financial Expert