Master’s thesis project

Automated UV/Vis–IR microscope for protein crystal detection

- Supervision by Eike Schulz (HARBOR) & Roland Thünauer (CSSB)
- Start: immediately
- Duration: typical Master thesis length (6–12 months), flexible to fit your program
- Location: HARBOR / CSSB (Hamburg)

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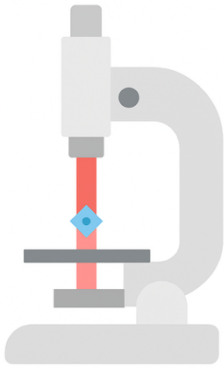

Quick facts

Interdisciplinary project at the interface of biophysics & structural biology:

- build, program and benchmark a UV/VIS – IR microscope for automated detection of protein micro-/nanocrystals.
- support time-resolved X-ray and electron crystallography by screening samples and automatically identifying crystals suitable for pump–probe and other time-resolved measurements.
- Ideal for **students** in **physics, nano-science, molecular life-science** (MLS) or STE (MINT) with interest in optics, automation and image analysis.
- Skills in Python, MATLAB or Micro-Manager are a plus.

Core tasks / main aims

- Optical/mechanical assembly and alignment of the microscope.
- Hardware interfacing and automation (motorized stage, cameras, illumination sources).
- Software development for instrument control and data acquisition.
- Image processing pipeline for crystal detection; optional ML model training/testing.
- Experimental validation with protein crystals and thorough documentation.

Who we're looking for?

- Master student in Physics, Nano-science, MLS, or a closely related field.
- Strong interest in experimental instrumentation, automation and structural biology.
- Basic programming ability in Python; experience with Micro-Manager is a plus.
- Advantage: experience with microscopy, optics, image processing (ImageJ/Fiji, OpenCV), or basic electronics.

What will you learn?

- Practical optical design and microscope assembly.
- Instrument control and automation (software ↔ hardware).
- Image analysis and automated detection workflows for real biological samples.
- Exposure to time-resolved crystallography workflows and collaboration with structural biology teams.

Project description

We seek a motivated Master student to assemble, program and benchmark a combined UV/Vis – IR (infrared) microscope for automated detection of protein micro-/nanocrystals. The instrument will integrate optical modalities (UV/Vis and IR) with motorized sample handling and machine-assisted image analysis to detect and rank crystals for downstream time-resolved X-ray and electron crystallography. The interdisciplinary project combines hands-on optics and electronics, instrument control and automation, image processing, and biological sample handling.

Why is time-resolved crystallography important?

Time-resolved crystallography enables direct observation of transient structural states of macromolecules during reactions or after excitation. Instead of a single static snapshot, time-resolved experiments capture a sequence of structural intermediates on timescales ranging from femtoseconds to seconds. These experiments provide mechanistic insight into enzyme catalysis, conformational changes, photochemistry, ligand binding and other dynamic processes that cannot be inferred from static structures alone.

Why do we need a specialized microscope?

Selecting suitable crystals for time-resolved experiments is a bottleneck: crystals must be of sufficient quality, display the desired photochemical or kinetic response, and be compatible with the delivery and timing schemes used at XFELs, synchrotrons or electron microscopes. An automated UV/Vis–IR screening microscope that can rapidly identify and classify crystals according to optical response and morphology will accelerate sample preparation, increase throughput, and reduce the amount of beamtime required per project. Automation also reduces user bias, standardizes selection criteria, and enables systematic studies across many conditions or constructs.