

Building the Microscopes of the Future

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Would you like to build a microscope rather than simply use one? This PhD project offers the opportunity to develop and construct next-generation deep-tissue microscopy systems, combining advanced physics with hands-on engineering and biomedical applications. Our ambition is to combine high-end research with future practical clinical applications—always keeping a clear vision of the clinical tool our research could ultimately deliver. From ultrafast lasers to superconducting detectors, you will help create the microscopes of the future, always keeping **a clear vision of the practical clinical tool** these advances could ultimately deliver for doctors and surgeons.

Our focus

Shortwave infrared (SWIR) imaging offers opportunities for deeper tissue penetration, reduced autofluorescence, and improved contrast. We aim to translate these advantages into microscopes for investigating structures and processes deep within biological tissue, supporting cancer research, and exploring future applications in oncology clinics.

Clinical relevance guides the project from the outset, with future clinical needs shaping the vision for each instrument. You will turn optical concepts into functioning systems, connecting technology development with the needs of potential clinical users. The goal is not simply an impressive laboratory microscope, but the foundations of a future clinical imaging tool.

Your project

You will work with advanced hardware:

- **Ultrafast tunable lasers** for developing and optimizing confocal and two-/three-photon microscopy.
- **Superconducting nanowire single-photon detectors (SNSPDs)** for advanced SWIR photon detection.
- **SWIR cameras** for developing and evaluating complementary imaging configurations.

Your work will span optical design, microscope construction, alignment, hardware integration, and testing. You will tackle excitation delivery, weak-signal collection, component coordination, and imaging performance. Testing ideas, diagnosing unexpected results, and refining your instruments will be central to your research.

An international, interdisciplinary research environment

Our research is built on active, close local and international collaborations with chemists, physicists, clinicians, and surgeons. Our network includes Stanford University and Dartmouth College (USA), Imperial College London (UK), and Dresden's University Hospital, TU Dresden Physics of Life, and MPI-CBG.

You will see the big picture of research, from fundamental physics and chemistry through instrument development to biomedical applications and potential clinical translation. Engaging with potential clinical users will help you understand doctors' and surgeons' imaging challenges and connect decisions at the optical bench with **future clinical needs**.

Our offer

This is an exciting, genuinely hands-on PhD at the intersection of physics, engineering, and biomedical imaging. You will build rather than simply operate instruments, solve technical challenges, and see your designs produce their first images, while developing interdisciplinary skills and staying connected to those who could ultimately use your technology.

Are you the right fit?

A solid knowledge of physics and a strong interest in engineering and problem solving are essential.

We seek curiosity, creativity, persistence, enthusiasm for experimental work, and a willingness to learn. A collaborative attitude and an interest in communicating across physics, chemistry, and medicine will help you thrive.

Bring your curiosity and enthusiasm for building things, and help us create microscopy systems of the future.

Selected publications

1. In vivo NIR-II fluorescence imaging for biology and medicine.
Feifei Wang, Yeteng Zhong, Oliver T. Bruns, Yongye Liang, Hongjie Dai.
Nature Photonics. 2024 DOI: 10.1038/s41566-024-01391-5
2. Shortwave-Infrared Line-Scan Confocal Microscope for Deep Tissue Imaging in Intact Organs.
Jakob G. P. Lingg, Thomas S. Bischof, Bernardo A. Arús, Emily D. Cosco, Ellen M. Sletten, Christopher J. Rowlands, Oliver T. Bruns, Andriy Chmyrov.
Laser & Photonics Reviews. DOI: 10.1002/lpor.202300292
3. Targeted multicolor in vivo imaging over 1,000 nm enabled by nonamethine cyanines.
Bandi VG*, Luciano MP*, Saccomano M*, Patel NL, Bischof TS, Lingg JGP, Tsrunchchev PT, Nix MN, Ruehle B, Sanders C, Riffle L, Robinson CM, Difilippantonio S, Kalen JD, Resch-Genger U, Ivanic J, Bruns OT*, Schnermann MJ*.
Nature Methods. 2022. PMID: 35228725 DOI: 10.1038/s41592-022-01394-6
4. Shortwave infrared polymethine fluorophores matched to excitation lasers enable non-invasive, multicolour in vivo imaging in real time.
Cosco ED, Spearman AL, Ramakrishnan S, Lingg JGP, Saccomano M, Pengshung M, Arús BA, Wong KCY, Glasl S, Ntziachristos V, Warmer M, McLaughlin RR, Bruns OT*, Sletten EM*.
Nature Chemistry. 2020. PMID: 33077925 DOI: 10.1038/s41557-020-00554-5
5. Development of a shortwave infrared sinuscope for the detection of cerebrospinal fluid leaks.
Klein TW, Yang S, Tusty MA, Nayak JV, Chang MT, Bruns OT*, Bischof TS*, Valdez TA*.
J Biomed Opt. 2023. PMID: 37188003 DOI: 10.1117/1.JBO.28.9.094803
6. Shortwave infrared fluorescence imaging of peripheral organs in awake and freely moving mice.
Arús BA, Cosco ED, Yiu J, Balba I, Bischof TS, Sletten EM, Bruns OT.
Frontiers of Neuroscience. PMID: 37274204 DOI: 10.3389/fnins.2023.1135494
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