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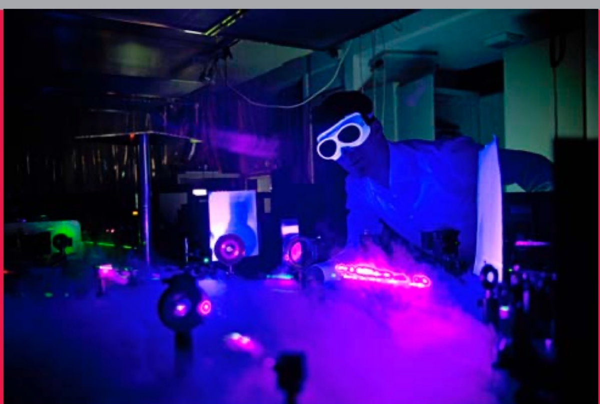
September 9th & 10th, 2026

Mini-Symposium

IAP Professor in

"Translational Medicine & Precision Engineering"



Mini-Symposium

Professor in „Translational Medicine & Precision Engineering“

September 9 & 10, 2026

Hauptgebäude, Room 101 & 106, Hochschulstrasse 4, 3012 Bern

Wednesday, Sept. 9, 2026	08:15 – 08:30	Welcome: Prof. Jean-Louis Reymond (Dean), Prof. Adrian Cavalieri (IAP)
	08:30 – 09:20	Prof. Daniel Ahmed, University of Bern **Engineering with Sound: Ultrasound Microrobotics and Microtechnologies toward Clinical Translation**
	09:20 – 10:10	Prof. Anupam Sengupta, University of Luxembourg **The Physics of One Health: Translating Biological Physics into Lab-to-Life Innovations**
	10:10 – 10:30	Coffee break
	10:30 – 11:20	Prof. André Stefanov, University of Bern **Single Photon Optics : Fundamental Physics Meets Applications**
	11:20 – 12:10	Prof. Mihaela Žigman, Ludwig-Maximilians-Universität München **Reading Health with Light: From Infrared Molecular Fingerprints to Dynamic Phenotypes**
Thursday, Sept. 10, 2026	08:15 – 08:30	Welcome: Prof. Jean-Louis Reymond (Dean), Prof. Adrian Cavalieri (IAP)
	08:30 – 09:20	Dr. Jan Rothhardt, Helmholtz Institute Jena **Exploring Nanoscale Structure, Composition, and Dynamics of Matter with Extreme Ultraviolet Microscopy**
	09:20 – 10:10	Dr. Rajmund Mokso, Technical University of Denmark **From Precision Imaging to Precision Medicine: Building Translational Engineering Platforms in Bern**
	10:10 – 10:30	Coffee break
	10:30 – 11:20	Prof. Çağlar Ataman, University of Freiburg **Biomedical Imaging Enabled by Novel Optical Microsystems: From Idea to Real-World Deployment**
	11:20 – 12:10	Dr. Fabian Voigt, Harvard University **Expanding the Bag of Optical Tricks for Biomedicine**

Meetings
ExWi
Sidlerstr. 5

Kommission	ExWi 013 (Fakultätszimmer)
Mittelbau	ExWi A4
Studierende	ExWi B116 (Wednesday), ExWi A97 (Thursday)

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Engineering with Sound: Ultrasound Microrobotics and Microtechnologies toward Clinical Translation

Prof. Daniel Ahmed
ARTORG Center for Biomedical Engineering Research, University of Bern

Abstract: Ultrasound provides a powerful means to actuate and control miniature devices deep within the body without direct physical connections. In this talk, I will present my vision and progress toward translating ultrasound microrobotics and microtechnologies from fundamental concepts to clinically relevant systems. In the first part of the talk, I will present a family of biologically inspired ultrasound microrobots, including neutrophil-inspired navigators that move against flow, starfish-larva-inspired ciliary microrobots and bacteria-inspired double-helical devices, and discuss their use in targeted therapy. Key applications include selective blood–brain barrier opening for tumour therapy and a non-invasive microrobotic strategy for aneurysm stabilization. Critically, we have moved these systems beyond benchtop experiments, progressing from acoustic microrobot control in zebrafish vasculature to the first demonstration of acoustic microrobot manipulation in the brain vasculature of living mice. I will then discuss ultrasound-driven artificial muscles, soft robots, and bio-integrated devices for mechanical actuation and localized drug delivery in the heart and bladder.

Finally, I will discuss our progress toward clinical translation, including our ultrasound catheter platform, capable of disrupting thrombi in less than two seconds without thrombolytic drugs, with preliminary in vivo validation in mouse and porcine models. We are integrating fragment capture and aspiration into the platform to reduce downstream embolization and microvascular obstruction during percutaneous coronary intervention. I will also present ultrasound-enabled urinary stents designed to remove biofilm and encrustation without frequent replacement. I will highlight ultrasound-assisted bioprinting strategies for controlling cellular alignment and creating functional multi-tissue constructs. I will conclude by discussing how integrating ultrasound with photonic sensing and imaging could enable closed-loop technologies for precision medicine.

The Physics of One Health:
Translating Biological Physics into Lab-to-Life Innovations

Prof. Anupam Sengupta
Physics of Living Matter, Institute for Advanced Studies, University of Luxembourg

Abstract: Global challenges at the human-animal-environmental interface — One Health — are traditionally viewed purely through biomedical or ecological lenses. This approach frequently overlooks the physical principles governing complex living systems. This talk will introduce the Physics of One Health framework, demonstrating how condensed matter physics, non-equilibrium thermodynamics, and fluid mechanics can delineate critical bottlenecks bridging planetary and human health. At the center of this framework are microorganisms, which constitute a continuum that links the aquatic and terrestrial ecosystems to the human microbiome through shared evolutionary histories, functions, and dynamic exchange of genetic information. While microbes adapt rapidly to environmental changes across scales, the underlying mechanisms remain poorly understood. Our research bridges this gap by integrating physics and systems engineering with micro- and cell biology. Leveraging 3D microfabrication, automation, biophotonics, quantitative imaging, and machine learning, we investigate how microbes, as active living systems, couple individual behaviors with collective organization. Drawing on recent studies—including light-responsive bacteria, algae, and bacteria-associated tumors—I will show how microbes adapt to perturbations and actively remodel their surroundings. A focal example is the Lago di Cadagno, a Swiss Alpine lake where our decade-long research has revealed how spatial-temporal organization and metabolic activity of sulfur bacteria emerge from a delicate interplay of collective dynamics, physical gradients and biological constraints. I will contrast this with anoxic microbes which influence tumorigenesis in humans, within the context of the recent inclusion of microbiome as one of the Hallmarks of Cancer. By treating these as active complex systems, we uncover predictive biophysical interrelations, which we are currently leveraging to drive scalable, lab-to-life innovations in public health risk mitigation, cancer management, and bio-regenerative circular material solutions for space applications.

Keywords: One Health, Biological Physics; Condensed Matter Physics; Biophotonics, Microbial Engineering; Theranostics; Circular material solutions, Sustainability

Single Photon Optics : Fundamental Physics Meets Applications

Prof. André Stefanov
Institute of Applied Physics, University of Bern

Abstract: Modern single-photon detectors are a good example of how modern optical technologies shape the research landscape. They enable the detection of light at extremely low intensity levels while providing outstanding temporal resolution. We present applications of single-photon detectors, in combination with polarimetric measurements, for observing the temporal propagation of light in diffuse media such as biological tissues.

However, single-photon detectors are much more than highly sensitive detectors of classical light, they also enable the observation of higher-order correlations of light. When combined with quantum light sources, they allow the implementation of novel measurement schemes. We show how the correlations present in entangled photon pairs can be exploited to surpass classical limits in imaging and spectroscopy.

The nonlocal nature of these correlations is not only fundamental for testing the foundations of modern physics, but also opens the way to applications such as secure communication. We present our current efforts to distribute entangled photons over long-distance free-space links, both between ground stations and between ground stations and flying platforms, including drones and high-altitude balloons. These experiments provide an important step toward the realization of large-scale quantum communication networks and future satellite-based quantum links.

More generally, modern optical technologies, or photonics, constitute one of the pillars of today's technological landscape, with applications ranging from biomedicine to space. The Swiss photonics ecosystem is exceptionally diverse, including fundamental research laboratories, innovative start-ups, and well-established industrial companies. The SBPE can benefit greatly from this environment by positioning itself as a center of competence in photonics and by actively involving students in state-of-the-art research and development activities.

Reading Health with Light: From Infrared Molecular Fingerprints to Dynamic Phenotypes

Prof. Mihaela Žigman
Institute of Pathology, Faculty of Medicine, Ludwig-Maximilians-Universität München

Abstract: Can light detect molecular deviations in human physiology before they become clinically evident? This question has increasingly shaped my research at the interface of photonics, biology, and translational medicine. I develop physical measurement approaches that turn complex biological signals into robust and interpretable molecular phenotypes. Building on our broadband infrared fingerprinting of human biofluids, large clinical cohorts, and computational methods for addressing biological and instrumental variation, we have established a trajectory from population-scale molecular profiling toward increasingly resolved measurements of dynamic biological states.

We are extending these capabilities by combining infrared vibrational spectroscopy with microfluidics, precision instrumentation, and data-driven analysis to detect subtle physiological shifts, resolve molecular heterogeneity between cells and individuals, and follow phenotypes as they evolve within the same biological system.

I will discuss the common thread connecting these efforts: how advances in physical measurement paradigms can uncover biologically meaningful insights and mechanisms, and how that understanding can be translated into information that ultimately becomes clinically actionable.

Exploring Nanoscale Structure, Composition, and Dynamics of Matter with Extreme Ultraviolet Microscopy

Dr. Jan Rothhardt
Helmholtz Institute Jena
Institute of Applied Physics, Friedrich-Schiller-Universität, Jena
Fraunhofer Institute for Applied Optics and Precision Engineering (IOF), Jena

Abstract: The extreme ultraviolet (EUV) spectral region offers unique opportunities for high-resolution imaging. Its short wavelength enables resolutions below 20 nm, while its micrometer-scale penetration depth allows imaging inside complex samples and revealing their internal nanoscale structures. In addition, many atomic absorption edges lie within or near the EUV spectral region, enabling element-specific imaging with high contrast.

This talk will summarize our recent achievements in this field. By combining coherent, high-average-power laser-driven high-harmonic sources with structured EUV illumination and advanced phase-retrieval algorithms, we achieved a record-high spatial resolution of 16 nm while maintaining quantitative imaging and wavefront sensing with high amplitude and phase accuracy. Furthermore, we successfully demonstrated nanoscale elemental identification, which has been applied to both microelectronic devices and biological samples. Our results show that tabletop EUV imaging provides unique opportunities complementary to existing microscopy techniques and can benefit numerous applications in physics, materials science, and the life sciences. It also opens the door to exploring phenomena that occur on short time and length scales, such as nanoscale charge, spin, and heat transport.

Building on my expertise, I aim to extend precision engineering to the nanoscale and toward fundamental quantum limits. This includes the precise measurement and control of EUV light fields, the exploration of their interactions with nanostructures, and nanoscale materials processing driven by EUV radiation. Furthermore, I intend to develop multispectral imaging techniques to fully exploit the potential of element-specific imaging for nanoscale materials science. In addition, my research program seeks to explore interdisciplinary applications of EUV radiation in high-resolution biological imaging and medical diagnostics.

From Precision Imaging to Precision Medicine: Building Translational Engineering Platforms in Bern

Dr. Rajmund Mokso
Department of Physics, Technical University of Denmark

Abstract: Conventional histopathology relies on micrometre-thin slices cut from standardized formalin-fixed paraffin-embedded (FFPE) tissue blocks. Routinely, only about 1% of the tissue in these blocks is assessed and the three-dimensional organisation can only be extrapolated. Emerging X-ray phase contrast imaging systems enable visualization of tissue microstructure with a level of detail approaching cellular resolution, while providing rapid, non-destructive, and intrinsically three-dimensional assessment of intact specimens. I will discuss how advances in precision engineering, imaging science, and computational analysis are enabling a new generation of quantitative tissue characterization tools. By making previously invisible features measurable, X-ray microtomography has the potential to complement conventional histopathology and support precision medicine through the discovery of new digital biomarkers. I will illustrate this vision through ongoing work on three-dimensional assessment of tumor resection margins and the detection of microvascular invasion, two clinically important challenges where access to complete tissue architecture may improve diagnosis and patient stratification.

Realizing such innovations requires educational programs that train engineers capable of developing technologies and methodologies for the quantitative characterization, prediction, and control of complex biological and technical systems. Throughout my career, many of the most successful projects emerged from connecting people with complementary expertise who would not otherwise have collaborated. I will discuss how such interdisciplinary collaborations can generate new research directions, accelerate technology translation, and create enriching educational experiences for students and teachers. I would like to embrace this collaborative culture at the School of Biomedical and Precision Engineering in Bern. Building on IAP's strengths in photonics, ultrafast science, precision measurement, and advanced instrumentation, I envision SBPE as a place where engineers, physicists, computer scientists, clinicians, and entrepreneurs work together on real-world challenges in healthcare and technology. I believe Precision Engineering is increasingly evolving from the design of precise instruments toward the extraction of quantitative information from increasingly complex systems. SBPE is uniquely positioned to educate engineers who can navigate this transition. The Creative Engineering Lab should play a central role by engaging students early with open-ended challenges originating from hospitals, research laboratories, and industry. Working in interdisciplinary teams, students could transform promising ideas into research projects, Master's theses, prototypes, start-up activities, or clinical pilot studies and by this help creating a distinctive culture of innovation and translation at SBPE.

By combining precision engineering, clinical immersion, and innovation-oriented project work, Bern can offer a distinctive alternative to traditional engineering programmes and attract students seeking closer interaction with clinicians, researchers, and entrepreneurs.

Biomedical Imaging Enabled by Novel Optical Microsystems: From Idea to Real-World Deployment

Prof. Çağlar Ataman
Department of Microsystems Engineering, University of Freiburg, Germany

Abstract: Advanced microsystems enable the development of highly miniaturized optical imaging systems that offer unique opportunities for minimally invasive, functional and potentially real-time imaging at cellular resolution. They therefore enable in vivo assessment of tissue morphology and molecular composition, as well as disease progression and treatment response. However, translating such advanced instruments from concept to the clinic requires a strongly interdisciplinary and problem-driven approach. The process involves multiple fields of engineering, fundamental and applied photonics, and biomedical sciences, while also addressing the constraints imposed by ethics, medical device regulations and health economics. In this talk, I will present an overview of our recent work in this field, with particular emphasis on the strategic adoption of emerging technology platforms, including optofluidics, 3D micro-/nano-printing, and photonic integrated circuits. These technologies serve as enablers for translating new biomedical imaging concepts into compact imaging instruments with clinical relevance. Using examples from our research, I will discuss how these technologies expand the design space of miniature imaging systems. Finally, I will discuss how the interdisciplinary ecosystem at the University of Bern can foster further advances in this field and contribute to shaping the future of biomedical imaging through innovative optical microsystems.

Expanding the Bag of Optical Tricks for Biomedicine

Dr. Fabian Voigt
Department of Molecular and Cellular Biology, Harvard University
Max Planck Center for Physics and Medicine, Erlangen

Abstract: Seeing is believing and thus, optical imaging techniques are extremely useful in the biomedical community, for example to study brain structure and function in neuroscience. I will present several projects aimed at providing the bioimaging community with better imaging instrumentation, for example open-source light-sheet microscopes for imaging cleared tissue (http://mesospim.org/) and novel multi-immersion microscope objectives that take inspiration from scallops and astronomical telescopes.

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