Karlsruhe Institute of Technology

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Speaker Karlsruhe Days of Optics & Photonics 2023

Abstract: Advanced Fluorescence Microscopy for Bioimaging

Prof. Dr. Gerd Ulrich Nienhaus

Optical fluorescence microscopy has been firmly established as a key enabling technique in life sciences research, allowing researchers to acquire quantitative, spatially and temporally resolved information on biological processes, both in vitro and in vivo. Based on the impressive advances in optics and photonics technologies, a variety of powerful fluorescence microscope designs have emerged over the years, and are continually being further refined to meet the diverse requirements (e.g., sample size, spatial and time resolution) of specific imaging experiments. Of similar importance for fluorescence bioimaging is the ever-growing toolbox of labeling techniques that allow researchers to introduce, with molecular precision, luminescence emitters into their samples.

After a general introduction, I shall focus on raster-scanning (confocal) laser scanning microscopy (CLSM), widefield (epi-illumination) microscopy and selective plane illumination microscopy (SPIM), including their super-resolution extensions, stimulated emission depletion (STED) nanoscopy and single-molecule localization microscopy (SMLM). Pros and cons of the methods for particular imaging applications will be discussed, as well as recent progress in the development of genetically encodable fluorescence markers.

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Biography:

Nienhaus studied Physics and Physical Chemistry at the University of Münster. He received his Diploma in Physics in 1983, and his PhD in 1988 with a dissertation entitled (translated from German) „Investigation of protein structure and dynamics: x-ray and γ-ray scattering with spatially sensitive proportional counters“. After brief postdoctoral stints at the Universities of Münster and Mainz, Nienhaus moved to the Physics Department of the University of Illinois at Urbana-Champaign as a Feodor Lynen Fellow of the Alexander von Humboldt Foundation in early 1990.

In Illinois, he was promoted to Research Assistant Professor (1991), Assistant Professor of Physics (1992) and Biophysics (1993), and Associate Professor with tenure (1996), and has been an Adjunct Professor at the Physics Department since 1997. In 1996, he was appointed Head and Professor of the Department of Biophysics at the University of Ulm. In 1999, he was a Visiting Professor at Stanford University. Since 2009, he has been at the Institute of Applied Physics, Karlsruhe Institute of Technology (KIT).

Research in the Nienhaus lab ranges from the development and application of advanced, quantitative optical microscopy techniques via luminescence marker development to fundamental molecular and cellular biophysics, including structure determination and optical/infrared spectroscopy.