Scope of the symposium

We at Bruker would like to spark engagement and invite you to join us and a renowned panel of experts in an international mini-symposium on viruses. Our experts will share their knowledge and provide insights into their work and research. They will speak on themes ranging from the mechanisms involved in viral assembly and disassembly, virus binding events, (supra)-molecular cellular processes, and single particle infectious viruses such as HIV-1, Zika, and the recent SARS-CoV-2. The role of advanced optical imaging techniques like fluorescent light and confocal microscopy as well as Atomic Force Microscopy will also be discussed.

Program

Chair: Heiko Haschke, Head of Applications, JPK BioAFM, Bruker Nano GmbH

5:00 pm  Welcome address
Carmen Pettersson, Senior Product Manager, JPK BioAFM, Bruker Nano GmbH

5:05 pm  Imaging live infectious viruses with the JPK-Bruker NanoWizard 4 BioAFM
Delphine Muriaux: CNRS-CEMIPAI, IRIM Institut de Recherche en Infectiologie de Montpellier, France
Sébastien Lyonnais: CNRS-CEMIPAI, Centre d’étude des Maladies Infectieuses et Pharmacologie Anti-Infectieuse, Montpellier, France

5:45 pm  From self-assembly to mechanics of viral particles
Wouter Roos: Zernike Institute for Advanced Materials (ZIAM), Rijksuniversiteit Groningen, Netherlands

6:15 pm  Probing ligand binding to native membrane receptors in physiologically relevant conditions using AFM
David Alsteens, NanoBiophysics Lab, Louvain Institute of Biomolecular Science and Technology (LIBST), Université catholique de Louvain (UCLouvain), Belgium

6:45 pm  Open forum discussion
Heiko Haschke

6:55 pm  Closing
Carmen Pettersson
Talk abstracts

5:05 pm - Imaging live infectious viruses with the JPK-Bruker NanoWizard 4 BioAFM

Atomic Force Microscopy coupled with fluorescent light microscopy provides a cutting-edge “tool kit” for exploring the nano-world of viruses in native conditions, from single particles to the infected cells. Using the JPK-Bruker Bio-AFM, recently installed in the CEMIPAI biosafety level-3 laboratory, we will present our data on single particle infectious viruses such as HIV-1, Chikungunya, Zika, and the recent SARS-CoV-2, as well as the exciting perspectives that such an instrument can bring to modern virology.

Funding: CNRS, Montpellier University of Excellence (MUSE and REDSAIM program), Campus France, Région Occitanie.

About the speakers

Sébastien Lyonnais, Ph.D. is a biophysicist and virologist at CNRS CEMIPAI. He is currently responsible for the BSL-3 CEMIPAI microscopy platform (which has several microscopes dedicated to live super resolution microscopy). In particular, he is an expert on AFM imaging of small organic molecules, and more recently on infectious viruses and infected cells.

Delphine Muriaux, PhD, is a virology expert on molecular and cellular biology, in particular, on RNA enveloped viruses. She leads a virology team investigating membrane nano-domains and virus assembly at IRIM, CNRS, Montpellier, France. She is also the director of the CEMIPAI laboratory, which is equipped with a 300 m² BSL3 lab, and is open to any academic or industrial projects and collaborative partners dedicated to antiviral screening (small molecules, drugs, antibodies etc.) and super resolution microscopy studies including BioAFM, EM and biophotonic SRM.
5:45 pm - From self-assembly to mechanics of viral particles

Using Atomic Force Microscopy imaging and force spectroscopy we are now making big steps towards the elucidation of the mechanisms behind (supra)-molecular cellular processes. Here I will discuss the mechanics and material properties of viruses. Furthermore, recent studies on viral assembly and disassembly will be discussed.

About the speaker

Wouter Roos received a PhD in Biophysics in Heidelberg and, after a post-doc period at the Max Planck Institute for Metals Research (Stuttgart) and Institute Curie (Paris), he went on to the Vrije University Amsterdam to focus on Physical Virology techniques and approaches. In particular, he studied (and still studies) the material properties of viruses using Atomic Force Microscopy (AFM). In 2015, he accepted the chair in Molecular Biophysics at the Zernike Institute, Rijksuniversiteit Groningen. Here, Roos heads a research group focusing on mechanics and dynamics, from molecular to cellular length scales, including studies on viral self-assembly and mechanics, extra-cellular vesicles and membrane proteins. By using techniques such as (High Speed-) AFM, Optical Tweezers and Fluorescence Microscopy, the lab aims to describe and unravel the physical principles of (sub)cellular mechanics and dynamics, and to elucidate the mechanisms behind protein and supramolecular assembly functionality.

6:15 pm - Probing ligand binding to native membrane receptors in physiologically relevant conditions using AFM

In the last three decades, a series of key technological improvements have turned Atomic Force Microscopy (AFM) into a nanoscopic laboratory, which enables the direct observation and chemical characterization of molecular and cellular biological systems under physiological conditions. I will present the key technological improvements that enable the application of AFM as an analytical laboratory for the observation and quantification of living biological systems at the nanoscale. I will report on the use of advanced FD-based technology combined with chemically functionalized tips to probe the localization and interactions of chemical and biological sites on single native proteins and on living cells at high-resolution. I will present how an atomic force and confocal microscopy set-up allows the surface receptor landscape of cells to be imaged and the virus binding events within the first millisecond of contact with the cell to be mapped at high resolution (<50 nm). I will also highlight theoretical approaches to contour the free-energy landscape of early binding events between virus and cell surface receptors.
Key publications:

- M. Koehler et al., Nat. Commun. 10 (2019) 4460
- M. Eubelen et al., Science (2018) eaat1178
- R. Newton et al., Nat. Protoc. 11 (2017) 2275-2292

Combination of AFM and fluorescence microscopy image showing an AFM tip functionalized with a single virus while mapping virus binding sites on living mammalian cells

Contact details: David.alsteens@uclouvain.be; Nanobiophysics lab, Université catholique de Louvain, Croix du sud 4-5, bte L7.07.07, 1348 Louvain-La-Neuve, Belgium

About the speaker

David Alsteens received his Ph.D. in nanobiotechnology at the Institute of Condensed Matter and Nanosciences of the UCLouvain in 2011 under the supervision of Yves Dufrêne. He spent two years at ETH Zurich in Basel as a post-doc in Daniel Müller's lab. He was awarded an ERC starting grant in 2017 and serves on the editorial board of the Journal of Structural Biology and Scientific Reports. He has published over 70 papers and holds two patents.

Dr. David Alsteens is currently a Research Associate at the Fund for Scientific Research (FNRS) and a full professor at the Faculty of Bioscience Engineering at Université catholique de Louvain (UCLouvain). David’s current research interests cover the development of new analytical methods based on Atomic Force Microscopy, with the aim of achieving an improved understanding of the biophysical properties of the mammalian cell surface receptors involved in ligand binding at the single-molecule level.

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