Björn Hellenkamp, Dr.

Assistant Professor of Physics

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Google Scholar

I was recently appointed Assistant Professor of Physics at Florida International University, after previously working as Associate Research Scientist and Postdoctoral Research Scientist at Columbia University. I am passionate about conceptualizing and developing new **single-molecule biophysical approaches** and **nanoscale biosensors** to make the invisible visible and to understand the molecular mechanisms that drive and regulate living systems. Challenges and limitations are my driving force for creation and innovation. My creativity, curiosity, and continuity, paired with a deep understanding of math and physics are my key to solve challenging and complex experimental problems. I led international research teams in scientific and innovative topics, published in several high-impact journals with more than 1200 citations, reviewed numerous high-impact publications, and significantly contributed to fund-raising programs.

EDUCATION

Ph.D. in Biophysics, Technical University of Munich (TUM), Germany — 2017
- Awarded with highest honors (summa cum laude)
- Thesis title: Dynamic structure of a multi-domain protein
- Committee: Prof. Hugel (TUM), Prof. Zacharias (TUM), Prof. Schuler (University of Zurich)

M.S. in Applied Physics (Micro- and Nanotechnology), Munich University of Applied Sciences, Germany — 2009
- Thesis title: Development of a low-noise spectrometer for controlled force measurements – lifetime measurements of the silicon-carbon bond
- Supervisor: Prof. Clausen-Schaumann

Diplom-Ingenieur (equivalent to M.S.) in Electrical Engineering, Osnabruck University of Applied Sciences, Germany — 2007
- Thesis title: Sensory analysis of the kinematics of a novel piezo-electronic motor system
- Collaboration with Siemens AG, research and development lab
- Supervisor: Prof. Ruckelshausen

PROFESSIONAL EXPERIENCE

Assistant Professor of Physics (Tenure-Track), Florida International University, USA — 2025 – now
- Appointed since August 2025

Associate Research Scientist, Columbia University, USA — 2022 – 2025
- Developing novel nanoscale electronic devices for label-free detection and characterization of single biomolecules and biomolecular interactions
- Revising and co-revising publications with topics around bioelectronics, sensing technologies, nanotechnology, and single-molecule techniques
- Supervising PhD student in electrical & biomedical engineering; contributing to grant writing

Postdoctoral Research Scientist, Columbia University, USA — 2017 – 2022
- Developed nanoelectronics for biophysical and biomedical applications
- Gained profound experience in nanofabrication, electronic circuit design, electrochemistry, biomolecular engineering, and advanced data analysis
- Created interdisciplinary collaborations (engineering, chemistry, and biology)
- Supervised 2 PhD students in electrical engineering and biophysics
- Contributed to grant writing (DARPA grant received by Prof. Kenneth Shepard)

- Significantly contributed to "Technology Innovations for Urban Living in the Face of COVID-19" award received by Prof. Kenneth Shepard
- Revised and co-revised numerous high-impact publications

Research & Teaching Assistant, University of Freiburg, Germany 2016 – 2017
- Led a seminar on Principles of Physical Chemistry
- Assisted in setting up new laboratory spaces; designed and built the optics lab

Research Assistant, Technical University of Munich, Germany 2010 – 2016
- Conceived & developed novel optical methods for single-molecule biophysics
- Developed computational tools for obtaining kinetic and structural models
- Developed microfluidic systems for detecting transient molecular interactions
- Established diverse biophysical and biochemical assays
- Gained in-depth knowledge and hands-on experience in single-molecule techniques
- Supervised one PhD student and 3 master students, two of which are now pursuing their PhD
- Contributed to ERC grant by Prof. Thorsten Hugel
- Co-revised high-impact publications with biophysical topics
- Organized workshops with research and lab activities as part of an exchange program with the University of Illinois (UIUC), funded by Center for Integrated Nano Science (CeNS) & Center for the Physics of Living Cells (CIPSM)

Research Assistant, Munich University of Applied Sciences, Germany 2008 – 2009
- Designed and implemented mechanics, electronics, and control software for a low-noise atomic force microscope with real-time force feedback
- Performed lifetime measurements of the silicon-carbon bond

Research Intern, Siemens AG München CT PS 6, Germany 2006 – 2007
- Developed and implemented electronic analysis tools for near-infrared gas-sensors together with senior researchers

SKILLS

Biophysics & Optical Instrumentation
- Conceptualization and design of novel biophysical measurement methods
- Development of custom optical setups for single-molecule experiments
- Biophysical & biochemical assay development
- Single-molecule fluorescence and FRET techniques
- Fluorescence spectroscopy, time-resolved methods, and FLIM

Bioelectronics, Circuit Design & Signal Processing
- Conceptualization and design of next-generation biosensor systems
- Conceptualization and fabrication of nanoscale electronic devices
- Analog and mixed-signal circuit design and prototyping
- High-throughput experimental automation and data acquisition
- Signal processing, data modeling, and statistical analysis
- Development of algorithms for high-bandwidth data analysis

Nanotechnology & Microfabrication
- Micro- and nanofabrication, cleanroom processing, and nanotechnology
- Fabrication of nanomaterials, in particular carbon nanotubes and nanopores
- Microfluidic system design and prototyping
- Electrochemistry and biointerface surface functionalization
- Lab-to-product translational research and prototyping

Leadership, Communication & Grant Writing
- Mentoring graduate students and leading interdisciplinary research teams
- Grant writing and collaborative proposal development
- Scientific presentation and public speaking

Professional & Analytical Skills
- Understanding and solving complex experimental challenges
- Identifying interdisciplinary concepts, methodologies, and applications
- Creating cooperation and leading intercultural and international projects
- Communicating science and supervising in-depth analytical examination

Software
- MATLAB
- Python
- C++
- COMSOL
- Cadence Allegro
- Cadence Virtuoso
- Cadene PSpice
- LabVIEW
- VMD
- NAMD

Languages
- German (native speaker)
- English (fluent)
- Spanish (very good command)
- French (good command)

PUBLICATIONS (see also google scholar)

In Preparation for Peer Review / In Revision

1) Hellenkamp B*, Arslan V, Shepard K*. Real-time measurements of DNA conformational dynamics with single-nucleotide resolution using nanoconfined field-effect transistors. In preparation for **Science**.
   - *I conceptualized, designed, and implemented a novel measurement platform integrating hundreds of nanoscale electronic signal transducers to capture single-molecule dynamics with unprecedented temporal resolution.*
   - *The temporal bandwidth of the measurement platform (nanoseconds to days) outperforms other up-to-date single-molecule methods by several orders of magnitude. The first time-resolved measurements of unperturbed, ultra-fast DNA conformational dynamics are expected to expand fundamental biophysical knowledge and may pave the way for a new platform to detect point mutations in individual DNA molecules.*

2) Hellenkamp B*, Martin T, Dietz H, Hugel T. Ratiometric confocal fluorescence spectroscopy resolves dynamic oligomer size distributions of alpha-synuclein in solution. ***Communications Biology***, in revision.
   - *I created interdisciplinary collaborations and conceptualized, designed, and implemented a novel fluorescence spectroscopy method that disentangles molecular brightness from fluorescence intensity.*
   - *The presented fluorescence-based method can be used for obtaining accurate size distributions of protein oligomers in a heterogenous ensemble in solution. In addition, the presented oligomer size distribution of alpha synuclein with unprecedented size resolution might help biologists to further narrow down the mystery of oligomer formation related to neurodegenerative diseases.*

Peer-Reviewed Articles

1) Lee Y, Buchheim J, Hellenkamp B, Lynall D, Young E, Yang K, Penkov B, Stojanovic M, Shepard K*. Single-molecule aptamer-ligand binding kinetics resolved with a carbon nanotube field-effect transistor. ***Nature Nanotechnology*** 19, 660-667 (2024)
   - *I designed, performed, and analyzed biophysical experiments combining electronic and optical single-molecule measurements of aptamer-ligand binding kinetics in a label-free manner.*
   - *Nanoscale electronics-based aptamer sensing holds strong potential for portable diagnostics. In addition, it offers high temporal resolution, single-molecule sensitivity, and the unique ability to tune binding behavior through electrostatic control of aptamer conformation. Moreover, insights into the structural dynamics of the serotonin aptamer will guide the development of new classes of aptamer sensors.*

2) Jang S, Dubnik S, Hon J, Hellenkamp B, Lynall D, Shepard K, Nuckolls C*, Gonzalez R*. Characterizing the conformational free-energy landscape of RNA stem-loops using single-molecule field-effect transistors. ***JACS*** 145(1), 402-412 (2023)
   - *I designed and fabricated nanoscale electronic devices for single-molecule sensing and assisted graduate students.*
   - *The nanoscale electronic devices used in this single-molecule approach have proven to be highly useful for capturing fast equilibrium dynamics of small biomolecules in real time. Future enhancement of temporal bandwidth and signal-to-noise ratio will push this method into a new area of unexplored molecular dynamics.*

3) Taal A, Lee C, Choi J, Hellenkamp B, Shepard K*. Toward implantable devices for angle-sensitive, lens-less, multi-fluorescent, single-photon lifetime imaging in the brain using Fabry-Perot and absorptive color filters. ***Light Sci. Appl.*** 11, 24 (2022)
   - *I supervised graduate students assisting them with expertise in biophysics and fluoresce lifetime imaging.*
   - *By adding an orthogonal physical parameter to an existing method, we progressed the field of multimodal neural imaging.*

4) Wolf S*, Sohmen B, Hellenkamp B*, Thurn J, Stock G, Hugel T*. Hierarchical dynamics in allostery following ATP hydrolysis monitored by single molecule FRET measurements and MD simulations. ***Chem. Sci.*** *12:3350* (2021)
   - *I initiated and co-designed an interdisciplinary study and supervised graduate students assisting them with biophysical analysis methods.*
   - *By bridging the gap between the short timescale achievable in simulations and what can be measured experimentally via smFRET, we were able to uncover hierarchical dynamics following ATP hydrolysis. The approach will help scientists understand the function of ATP hydrolysis in complex protein machines where energy conversion is not directly measurable – in contrast to processes involving large-scale translational motion.*

5) Hellenkamp B*, Thurn J, Stadtmeier M, Hugel T*. Kinetics of transient protein complexes determined via diffusion-

independent microfluidic mixing and fluorescence stoichiometry. ***J. Phys. Chem. B*** 122(49): 11554-11560 (2018)
- *I conceptualized, designed, and implemented a novel microfluidic device for fluorescence-based single-molecule measurements of low-affinity biomolecular complexes.*
- *This method enables the measurement of binding kinetics and stoichiometries of low-affinity protein complexes, overcoming the challenge of low concentrations required for single-molecule detection.*

6) Hellenkamp B et al. Precision and accuracy of single-molecule FRET measurements – a worldwide benchmark study. ***Nature Methods*** 15:669-676 (2018)
   - *I initiated, designed, and evaluated a worldwide benchmark study for fluorescence-based single-molecule experiments while creating numerous international collaborations.*
   - *The presented toolbox is a practical resource for scientists using single-molecule FRET for structure determination, providing quantitative guidance for selecting optimal analysis methods and classifying results.*

7) Hellenkamp B, Wortmann P, Kandzia F, Zacharias M, Hugel T*. Multidomain structure and correlated dynamics determined by self-consistent FRET networks. ***Nature Methods*** 14(2):174-180 (2017). Highlighted in News and Views
   - *I designed and implemented the method and developed analytical tools.*
   - *This method, that is based on a global analysis of time-resolved FRET and anisotropy data, has proven highly practical not only for determining global structural arrangements of dynamic multidomain proteins but also for identifying nested local dynamics of structural elements that may act as allosteric regulators.*

8) Kracke B et al. Thermoswitchable Nanoparticles Based on Elastin-like Polypeptides. ***Macromolecules*** 48(16):5868-5877 (2015)
   - *I performed single-molecule measurements – including fluorescence correlation spectroscopy, two-color coincidence detection, and single-molecule FRET – to characterize biophysical properties of single nanoparticles.*
   - *The presented results can be useful, for example, for the future design of drug delivery systems.*

9) Ratzke C, Hellenkamp B, Hugel T*. Four-colour FRET reveals directionality in the Hsp90 multicomponent machinery. ***Nature Communications*** 5:4192 (2014)
   - *I analyzed kinetic models of TIRF-based single-molecule FRET experiments and performed biochemical assays.*
   - *This method can be applied to many other multi-component protein machines and can elucidate how specific components or cofactors modulate the thermodynamic landscape underlying their function.*

10) Jahn M et al. The charged linker of the molecular chaperone Hsp90 modulates domain contacts and biological function. ***PNAS*** 111(50):17881-6 (2014)
    - *I performed, analyzed, and interpreted single-molecule FRET experiments.*

11) Lumme C et al. Nucleotides and substrates trigger the dynamics of the Toc34 GTPase homodimer involved in chloroplast preprotein translocation. ***Structure*** 22(4):526-38 (2014)
    - *I performed, analyzed, and interpreted single-molecule FRET experiments.*

12) Ratzke C, Mickler M, Hellenkamp B, Buchner J, Hugel T. Dynamics of heat shock protein 90 C-terminal dimerization is an important part of its conformational cycle. ***PNAS*** 107(37):16101-16106 (2010)
    - *I built and established an optical setup for performing confocal-based single-molecule FRET experiments.*

Non-Peer Reviewed Articles

1) Wolf S, Sohmen B, Hellenkamp B, Thurn J, Stock G, Hugel T. Allosteric action of nucleotides on Hsp90 across several time-and length scales **bioRxiv** (2020)

2) Wolf S, Sohmen B, Hellenkamp B, Thurn J, Stock G, Hugel T. Hierarchical coupling between ATP hydrolysis and Hsp90's client binding site **bioRxiv** (2020)

3) Hellenkamp B. Dynamic structure of a multi-domain protein: uncovered using self-consistent FRET networks and time-correlated distance distributions. Dissertation, **Technical University of Munich**, Germany (2016)

Conference Presentations

1) Hugel T, Schmid S, Wolf S, Hellenkamp B, Sohmen B, Thurn J, Stock G. Combining Single-Molecule Fluorescence and MD-Simulations to Delineate the Kinetics and Regulation of Proteins. **Biophysical Journal** 120 (3), 100a-101a (2021)

2) Wolf S, Sohmen B, Hellenkamp B, Thurn J, Stock G, Hugel T. Understanding Allosteric Information Transfer Across Time-and Length Scales. **Biophysical Journal** 118 (3), 169a (2020)

3) Hellenkamp B, Shepard K. Single-molecule FRET meets single-molecule FET. **S3IC** Single-Molecule Sensors and nanoSystems International Conference, Germany (2019)

4) Thurn J, Hellenkamp B, Hugel T. Single-Molecule Fluorescence Measurements of Transient Protein Complexes Determined via Diffusion-Independent Microfluidic Mixing. **Biophysical Journal** 116 (3), 163a (2019)

5) Hellenkamp B, Wortmann P, Kandzia F, Zacharias M, Hugel T. Structural Dynamics of Hsp90 Resolved by a Novel Multi-Pair FRET Approach. **Biophysical Journal** 110 (3), 222a (2016)

Invited Presentations

1) Hellenkamp B, Shepard K. Direct bioelectronic detection of SARS-CoV-2 from saliva using single-molecule field-effect transistor arrays. Launch event for the **New York City Pandemic Response Institute** (2022)

2) Hellenkamp B. Single Molecule FRET-A Multi-Environment Ruler for Determining Structure and Dynamics. **Biophysical Journal** 116 (3), 469a (2019)

3) Hellenkamp B. Single-molecule FRET meets single-molecule FET. Physical Chemistry Seminar at **University of Freiburg**, Germany (2019)

REFERENCES

- Prof. Dr. Thorsten Hugel, University of Freiburg, Germany
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- Prof. Dr. Martin Zacharias, Technical University of Munich, Germany
  - zacharias@tum.de, +49 892 891 2335
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- Prof. Dr. Kenneth Shepard, Columbia University, USA
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Florida, January 15, 2025