

Possible Physics BSc and MSc Thesis Projects:

UNIVERSITÄT BONN

Computational approaches for single-molecule microscopy on event-based sensors

The Endesfelder lab performs research in the cross-section of optical and computational physics and microbiology: in our group, we employ advanced microscopy techniques such as single-molecule localization microscopy (SMLM) to look at *in vivo* processes in living cells. For this, we use home-build custom microscopes, and the emission patterns obtained from single molecule is captured on highly sensitive 2-dimensional cameras. The engineering principles of cameras sets a hard limit to temporal accuracy of SMLM, as a full frame needs to be read out by the electronics before a new frame can be recorded.

In a recent publication by another university, a novel event-based sensor was used instead of a traditional camera in SMLM measurements. Instead of measuring incoming light on a 2d-detector, it measures *changes in light* with a much better temporal accuracy. We believe that creating new computational algorithms for using these event-based sensors can heavily improve the accuracy of single-molecule microscopy measurements. These algorithms need to be rooted in the well-known physics of single-molecule microscopy (i.e. point-spread functions, photophysical characteristics of single molecules), and need to account for known event-based sensor aspects.

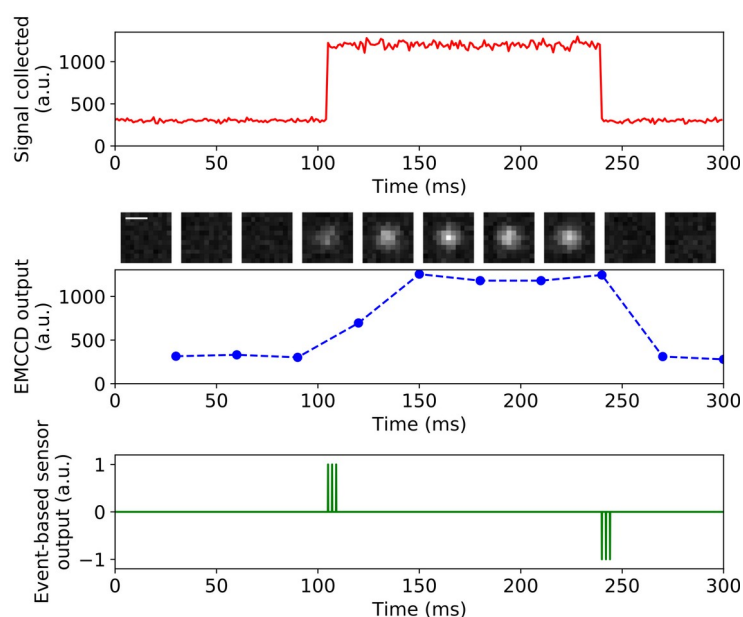


Figure 1: EMCCD camera vs. event-based sensor.

In this project, you will work together with us to create novel computational approaches to simulate and analyse single-molecule, event-based sensor data. More specifically, the goals of this project would be:

- Designing novel physics-based computational algorithms to simulate and analyse emission patterns from single molecules as they would be detected by event-based sensors.
- Testing the analysis algorithms on proof-of-principle data obtained from our custom-made microscopes
- *Possible extension:* Analysing state-of-the-art single-molecule microbiology experiments with this new event-based sensor.
- *Possible extension:* Optomechanical design and alignment of parts of our single-molecule microscope setup.

We are open to change this project to your specific interests, please do not hesitate to contact us!

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References:



Event-based sensor



SMLM review