‘Single-Minded’ Physics:

Single Molecules & *Single Colloids*

Biological and Soft Systems

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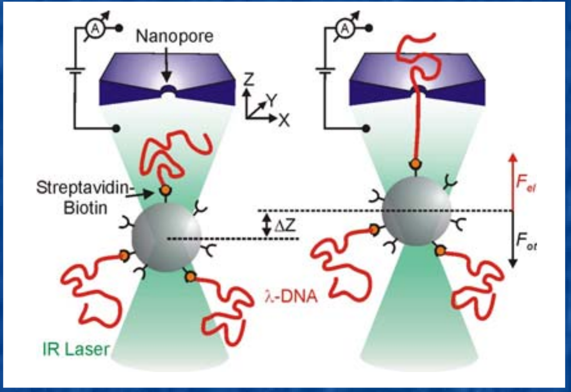
Life depends on the translocation of ions, DNA, RNA and proteins through the cell membrane. The cell has a broad range of nanopores or nanochannels which enable the controlled transport of single molecules through the cellular membrane. We study these translocation processes on the single molecule level. We will build models of natural nanochannels on micrometer length scale to observe and study transport properties of single colloids as model objects for ions or molecules.

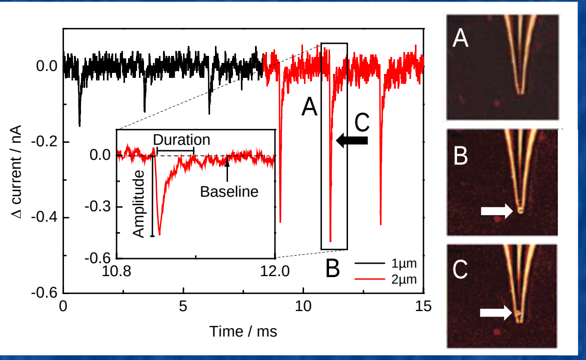
DNA Tug of War – Controlling and understanding DNA translocation



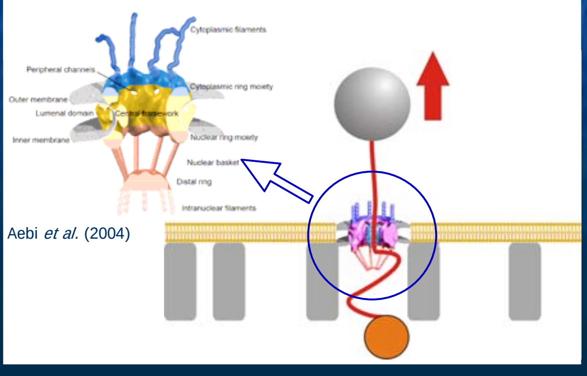
Single DNA molecules can be inserted and controlled in a single solid-state nanopore. The DNA is driven into the pore by an electrical field in the nanopore. We are able to stall and control the translocation by grabbing the end of the DNA strand using optical tweezers. With this novel technique we study the influence of hydrodynamic interactions on the transport of DNA though these nanopores. We are investigating if it is possible to detect proteins bound to the DNA to determine the primary sequence. In addition, we work on extending the technique to single proteins in biological nanopores.

Single colloids in microchannels – Model systems for nanopores

We detect and analyse single colloids with the well-known resistive pulse technique. The size and charge of colloids can be accurately detected by pumping the colloids through microcapillaries and measuring the ionic current signatures. Detection of a few tens of DNA strands is possible – enabling the accurate detection of grafting density. We are also able to control the translocation with optical tweezers. This is the basis for models of nanochannels on a micron scale employing microfluidics, ionic current detection and light microscopy.



Nuclear pore complex – How does gene and protein transfer work ?



The nuclear pore complex is regulating the transport between the cell nucleus and the cytoplasm acting as a highly selective filter. Although most of the biochemical components and pathways of the process are known the exact transport mechanism remains unclear. We are currently developing novel optical tweezers to clarify the translocation/filtering pathway. A cargo complex will be attached to a long linker molecule and then we go fishing with a colloid in the optical trap. Our approach will provide new insight into the highly complex and crucial process of nuclear transport. Our results might guide emerging techniques like gene transfer to repair genetic defects.

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