Cellular compartmentalization, cell growth, cell repairing and synaptic transmission is requiring targeted and regulated membrane fusion. This intracellular membrane fusion is mediated by SNARE proteins, and constitute one example of active transport that is occurring constantly in cells. There are over 30 SNARE family members in mammalian cells and each is found in a distinct subcellular compartment. It is likely that SNAREs encode aspects of membrane transport specificity, but the mechanism by which this specificity is achieved remains controversial, in particular for synaptic transmission which is the most studied biological process.

Recently, a new method was proposed by H. Bayley et al.[1] which allows producing very stable planar lipid bilayer by contacting two water droplets in a surrounding oil phase (droplet interface bilayer). This approach provides an improved platform to measure ionic transport properties of membrane proteins in a more realistic non-supported environment. Based on the concept of droplet interface bilayer we present a droplet based microfluidic approach that proofed to be a versatile platform to resolve the kinetic pathway of fast SNARE mediated fusion events between individual neurosynaptic vesicles (Ø ~ 50 nm) and a phospholipid bilayer with exceptional time resolution of ~ 0.1 milliseconds. In contrast to standard techniques using supported bilayer or vesicle-vesicle fusion, our microfluidic method is presenting the unique advantage to reveal the entire dynamic pathway of a single fusion event from the docking time to the pore opening. Then we will demonstrate that this microfluidic approach is also suitable to study a wide variety of passive transport phenomena resulting from interactions between individual nano-object and a phospholipid bilayer

[1] H. Bayley et al. Mol Biosyst. 2008 Dec; 4(12): 1191–1208.