Project Title:
# Functional Neuromics of the Barrel Cortex
***Elucidating the Molecular Basis of Neuronal Functional Heterogeneity through Combined Highly Multiplexed Gene Expression Profiling and Calcium Imaging***

Project Description:
This collaborative project between the Laboratory of Prof. Carl Petersen and the one of Prof. Gioele La Manno seeks to investigate the diversity and functional heterogeneity of all neurons in the barrel cortex by integrating cutting-edge techniques from both laboratories.

Understanding the neuronal circuits and synaptic mechanisms underlying context-dependent sensory perception and reward-based sensorimotor learning in the barrel cortex is crucial to unravelling the complexities of behavioural decisions and goal-directed motor output. The project will establish a *functional neuromics* approach to study the problem, which combines highly multiplexed spatial gene expression profiling using HybISS (hybridization in situ sequencing) with in vivo GCaMP calcium imaging during a behavioral task, employing two-photon microscopy to record from large populations of neurons.

The main technical aim of this project is to develop a robust method for combining highly multiplexed spatial gene expression profiling using HybISS with in vivo GCaMP calcium imaging. This will involve advanced histological preparations, performing HybISS on consecutive sections to localize mRNAs for 200 genes for a 3D volume, and registering the 3D volume with GCaMP calcium imaging recordings. As a result, joint measurements of the same cells will be obtained, enabling a comprehensive investigation of the correlation between the functional and molecular heterogeneity of all neurons in the barrel cortex.
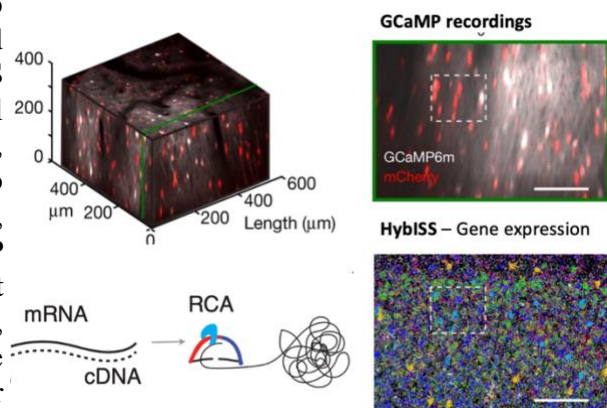


The overarching biological aim is to use the obtained data to understand the relationship between neural activity patterns and gene expression in the context of context-dependent sensory perception and reward-based sensorimotor learning. By investigating the diversity and functional heterogeneity of all neurons in the barrel cortex, this project will contribute to a deeper understanding of the principles governing context-dependent sensory processing and sensorimotor transformation.

Our hypothesis is that the sensory tuning of neurons is determined largely by their transcriptomic subclass, and their state modulation can be predicted to a good approximation from a single transcriptomic axis. We expect to find that most differences in sensory tuning appear at the level of the main neuronal classes, but it is likely that fine subtypes will also have differences in their activity. The innovative technical advancements achieved in this project will have broader applications for the study of other brain areas.

The ideal candidate for this project should have an experimental background, preferably in neuroscience or molecular biology, and be familiar with microscopy and basic image analysis. Experience in computational approaches, including singal processing and registration methods, is a plus but not required.