NeuroSeeker Partners

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  Germany
- Interuniversitair Micro-Electronica Centrum vzw (imec)
  Belgium
- Università degli Studi di Parma
  Italy
- Universiteit van Amsterdam
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- Radboud Universiteit Nijmegen
  The Netherlands
- University of Lethbridge
  Canada
- Hungarian Academy of Sciences
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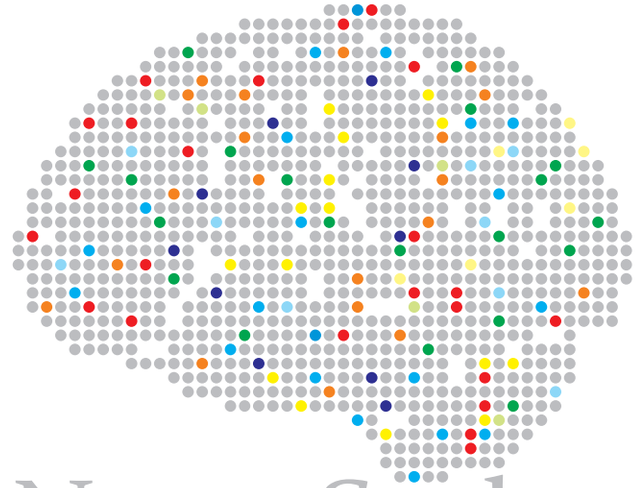
www.neuroseeker.eu



NeuroSeeker

Investigation of local and global cortical circuits with advanced neural probes for high-resolution electrophysiological monitoring and optogenetic stimulation

Investigation of local and global cortical circuits with advanced neural probes for high-resolution electrophysiological monitoring and optogenetic stimulation

NeuroSeeker aims at tackling the structure and function of cortical modules in very different functional and cognitive contexts in order to understand the basic laws of multi-scale interactions between various cortical areas. Our research program is grouded in a theoretical background based on dynamical systems theory, electrophysiology, and expertise in the development of high-density neural probe arrays. It aims at bringing the level of detail in the analysis of brain circuits usually found in “pure physiology” experiments to the realm of cognition and behavior, by analyzing freely behaving animal and human subjects during the execution of a variety of cognitive and perceptual tasks.

Objectives

Provide a new functional picture of cortical micro-circuits

We want to elucidate how different cortical layers encode and process information about a stimulus, or an upcoming action. Moreover, we aim at exploring different roles of cortical laminae in the formation, consolidation and retrieval of memories. Last, we plan to assess how different interneuronal types are involved in regulating and pacing neural activity, favouring the emergence of information carrying activity configurations (e.g. ‘cell assemblies’).

Describe the interaction of cortical micro-circuits with the global state of the brain

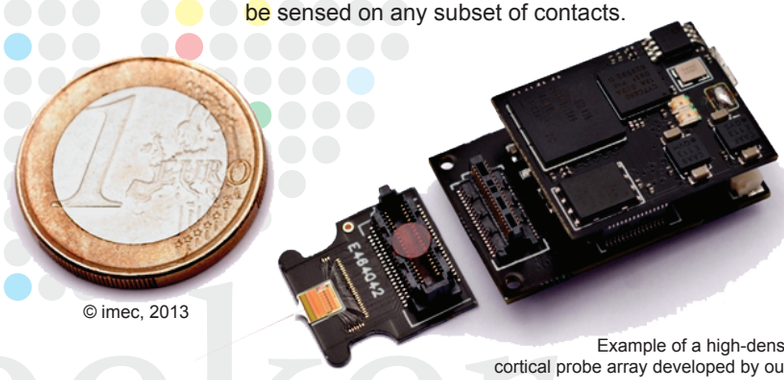
Based on the knowledge about local cortical circuits, we will combine large scale, high specificity monitoring of neural ensembles in one brain area with similar characterizations in tightly related areas. We will also combine local ensemble recording with large-scale pictures of the global brain state as they may be collected with e.g. electrocorticography (eCoG) or in depth recordings (stereo EEG).

Formulate a dynamical theory of micro-circuits and interactions with the rest of the brain

The wealth of new data obtained will allow for the mechanistic understanding of fundamental computations underlying cognitive processing in sensorimotor integration, memory and visual decision making. Based on cortical anatomy we shall concentrate on three candidate mechanisms that map onto common cognitive processes, i.e. (i) the combination of feedforward (bottom-up) and feedback (top-down) inputs that corresponds to an across layer integration, (ii) the within-layer combination of activity, mediated by horizontal projections, and (iii) the integration of activity arriving in the same layer from different cortical areas.

Develop a high-yield, high specificity software/hardware platform for circuit analysis

We will produce ultra-high density, programmable silicon-based probes for extracellular electrophysiological recording, and probes for laminar-specific optogenetics stimulation. These probes will have a modular design allowing combinations in any desired configuration, and will be packaged for recording in rodents, non-human primates, and human patients. Taking full advantage of these probes will involve the development of new algorithms and software for online optimization of probe configuration, and for detecting and sorting spike waveforms which may be sensed on any subset of contacts.



Example of a high-density intracortical probe array developed by our project partner imec. A similar system architecture providing an increased electrode count is addressed in NeuroSeeker.