Dr. Hayder Amin

German Center for Neurodegenerative Diseases (DZNE)
Research Group Leader
Site Dresden |Tatzberg 41|01307 | Dresden
E-Mail: hayder.amin@dzne.de
Web: www.dzne.de/amin
www.digs-bb.de/research/research-groups/hayder-amin

Available Master thesis/Projects at the PLASTICITY NEUROELECTRONICS (PLASTRONICS) LAB

Project 3:

Investigating neuronal functional consequences of environmental enrichment using a high-density CMOS-chip biosensors

The project explores the application of large-scale bioelectrical recordings using CMOS-MEA biosensors[1] to investigate the impact of environmental stimulation and enrichment[2] on the brain functions. The hippocampus in adult brains generates new neurons throughout life with no clear evidence for the primary purpose and how this would impact the information processing of the existing brain network. The aim is to perform bioelectrical imaging based on recording from acute brain slices, the extracellular field potentials generated by the superposition of local transmembrane currents passing through multiple neurons. To achieve that, the student will exploit the high spatiotemporal resolution capability of our complementary metal oxide semi-conductor multi-electrode array CMOS-MEA based monolithic chip combined with wild-type mice exposed to 6 weeks environmental enrichment[3] (i.e., a large multicompartment mouse housing unit including toys and tunnels that showed to induce the generation of new neurons in the dentate gyrus of the adult hippocampal formation). The project aims to characterize simultaneous large-scale hippocampal processing microcircuits in spanning spatial scales from single neurons up to the entire slice network upon environmental enrichment.

Project field:

Neuroscience, bioengineering, biosensors, adult-neurogenesis, and electrophysiology

Project requirements:

knowledge in neurobiology, extracellular electrophysiology, data analysis, and signal processing.

References

1. Amin, H., Nieus, T., Lonardoni, D., Maccione, A. & Berdondini, L. High-resolution bioelectrical imaging of Aβ-induced network dysfunction on CMOS-MEAs for neurotoxicity and rescue studies. *Sci. Rep.* **7**, 2460 (2017).

2. Givre, S. Kempermann g. why new neurons? possible functions for adult hippocampal neurogenesis. *J. Neurosci.* **23**, 635–638 (2003).

3. Kempermann, G., Kuhn, H. G. & Gage, F. H. More hippocampal neurons in adult mice living in an enriched environment. *Nature* vol. 386 493–495 (1997).

DZNE
Deutsches Zentrum für
Neurodegenerative Erkrankungen
in der Helmholtz-Gemeinschaft

Project 4:

Decoding the rejuvenating hippocampal microcircuit to assess the contribution of adult-neurogenic information processing

The project exploits the combination of high-resolution chip-based technology[1], and chemogenetics (i.e.using Designer Receptors Exclusively Activated by Designer Drugs - DREADDs)[2] to investigate encoded information by newly generated neurons in a Cdk4/cyclinD1 (4D) mouse model[3] that showed the expansion of the neural stem cell in the developing cortex and adult hippocampus. This unique technology combination will provide answers to how and why new neurons change brain circuitry, activity, and hippocampal network responses and function, causing positive gain on cognitive behaviors. The goal of a 6-8 month student project is to learn the recording of large-scale neuronal firing activity using CMOS-MEAs. Then, employing chemogenetic circuit manipulation (i.e., activate and silence only the new-born labeled neurons in the dentate gyrus of the hippocampal formation) and record the neuronal response from 4096-microelectrode array simultaneously. Finally, analyze the recorded data sets (before and after circuit modulation) to infer the spatiotemporal dynamic changes in the hippocampal circuit in 4D and wild-type mouse models.

Project field:

Neuroscience, bioengineering, biosensors, circuit manipulation (chemogenetics), electrophysiology

Project requirements:

knowledge in Neurobiology, and neurophysiology/electrophysiology, data analysis, and signal processing

References

1. Amin, H., Nieus, T., Lonardoni, D., Maccione, A. & Berdondini, L. High-resolution bioelectrical imaging of Aβ-induced network dysfunction on CMOS-MEAs for neurotoxicity and rescue studies. *Sci. Rep.* **7**, 2460 (2017).

2. Urban, D. J. & Roth, B. L. DREADDs (Designer Receptors Exclusively Activated by Designer Drugs): Chemogenetic Tools with Therapeutic Utility. *Annu. Rev. Pharmacol. Toxicol.* **55**, 399–417 (2015).

3. Lange, C., Huttner, W. B. & Calegari, F. Cdk4/CyclinD1 Overexpression in Neural Stem Cells Shortens G1, Delays Neurogenesis, and Promotes the Generation and Expansion of Basal Progenitors. *Cell Stem Cell* **5**, 320–331 (2009).