

Three-dimensional population measurement in complete hippocampal preparations during rhythmic oscillations

Klaudia Spitzer¹, Attila Kaszás^{1,4}, Gergely Szalay¹, Róbert Nagy², Gergely Katona¹, Pál Maák³, Máté Veress³, Dénes Pálfi², Balázs Chiovini¹, Christophe Bernard⁴, Balázs Rózsa^{1,2}

¹ : Two-Photon Imaging Center, Institute of Experimental Medicine, Hungarian Academy of Sciences, Budapest, Hungary

² : Two-Photon Imaging Laboratory, The Faculty of Information Technology, Pázmány Péter Catholic University, Budapest, Hungary

³ : Department of Atomic Physics, Budapest University of Technology and Economics, Budapest, Hungary

⁴ : Faculté de Médecine de la Timone, INSERM UMR1106, Marseille, France

Neurons receive thousands of inputs from other neighbouring and distant neurons, and it has long been a question how these connections form assemblies or neuronal networks of synchronously working units. This assembled function has long been proposed of being a key component in how neurons compute in the neuronal networks. GABAergic interneurons are presumed to control the synchronization of pyramidal cell activity. In this study, we aimed to investigate network activity during spontaneous rhythmic oscillation in complete (*in toto*) hippocampal preparations. We have developed a high-resolution, acousto-optic (AO) two-photon microscope with continuous three-dimensional (3D) trajectory and volumetric random-access scanning modes that reaches near-cubicmillimeter scan range (up to $700 \times 700 \times 1.400 \mu\text{m}^3$) which allows calcium imaging of spontaneous activity from hundreds of neurons with submillisecond temporal resolution. We saw correlated LFP and Ca^{2+} activity in area CA1 during spontaneous rhythmic activity, and found an increased role of interneurons in network oscillations of hippocampus. Nevertheless, whether interneurons are driven by local network activity or their long-range inputs is still unclear. What's more, their connection to the local network is still to be investigated and their connectivity patterns are to be elucidated.