PhD THESIS DEFENSE: New multi-modal neuroimaging approaches combining photonics and electrophysiology to study the basics of neurovascular coupling

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10:00

ICFO Auditorium and Online (Teams)

Brain is a crucial organ that controls all body functions. Its health is influenced by multiple factors, and any abnormality in them can negatively impact its smooth and seamless functioning, causing pathological conditions. So, tools and techniques have also been developed in order to explore its structure and functions. Due to the complexity of the brain, its study comprises of a highly diverse field of research. This doctoral work is based on a particular category of this field that focuses on development and usage of neuromonitoring tools to visualize its activity and status.

Optical imaging is an ever growing and robust neuromonitoring methodology that includes a range of techniques, which monitor brain activity by tracking cerebral hemodynamics, which is known to form a close relationship with neural activity due to 'neurovascular coupling'. The primary focus of this doctoral study is to develop new multi-modal neuroimaging modalities to explore the complex activities that occur within the brain. Undoubtedly, 'neurovascular coupling' is a fundamental concept that depicts the link relating neural activity and hemodynamics, and this link needs to be fully understood in order to interpret on brain status or function during health or pathology. This coupling has always been a crucial aspect for exploration by the neuroscientists. In this doctoral study, investigation of the neurovascular coupling was carried out during a specific brain state when slow wave activity prevails in the cerebral cortex, which is observed during non-repetitive eye movement sleep or deep anesthesia. This cortical activity is related to vital functions of the brain to maintain its health, and its disruption leads to pathologies related to sleep and cognition.

In this doctoral study, cortical slow wave activity was investigated by simultaneously monitoring neural activity and hemodynamics, by building a platform that consists of synchronized electrophysiology and optical imaging systems for experiments on rodents. Spatial and temporal assessment of neurovascular relationship was carried out during both spontaneous unperturbed cortical state during slow wave activity and during externally perturbed state. It was observed that the neuronal firing periods of this cortical activity lea to a hike in the cerebral blood flow during both spontaneous and evoked states, and thi response was quantified in detail. In addition, hemodynamic response function was plotte for further understanding. Note that both electrophysiology and optical imaging were able t continuously and simultaneously monitor brain activity at multiple cortical locations over large region of the rodent brain, and so, helped in carrying out spatial comparisons

In addition to this project, this doctoral study also involved development of a hybrid diffus optics-based tomographic system that can simultaneously monitor both cerebral blood flo and cerebral blood oxygenation. It can execute tomographic monitoring as both hig density-speckle contrast optical tomography (HD-SCOT) and high density- diffuse optica tomography (HD-DOT) systems in parallel. This The high density-speckle contrast optica tomography and diffuse optical tomography (HD-SCOT/DOT) device was developed t explore brain activity and address complex brain functions related to the neurovascular uni during preclinical experimental studies in small animal models. It is a novel hybrid diffus optics-based device, and its development during this doctoral study included all relate tasks ranging from building the device instrumentation to developing its control system an user-device interface. The functionality of this device was also tested through experiment on tunable tissue-mimicking liquid phantoms and through in-vivo experiments on rodents This device has the potential for usage in studies focused on investigation of oxyge metabolism in the brain in future

Monday June 10,10:00 h. ICFO Auditorium and Online (Teams)

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