

Bioelectronics and Bioimaging - New Approaches for the Investigation of Brain Microcircuits

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Bioelectronics and bioimaging are new approaches for the investigation of the brain and its microcircuits. They complement each other, as bioelectronics investigates the function, whereas bioimaging is mainly concerned with the morphology of the brain. For the study of neuronal microcircuits, neurons in rather opaque brain slices have to be visualized. This allows the recording of the electrical potentials of these neurons with microelectrodes. The development of the necessary optical techniques will be described. By using these techniques, electrophysiological phenomena, which may be the basis of information storage in the brain, could be studied. A new approach for nonlinear correlation analysis revealed unknown synchronization phenomena between nerve cells, which can lead to the generation of epilepsy.

The wiring of neurons in neuronal networks could be investigated by laser stimulation of single neurons. We found that the connectivity in neuronal networks is dependent on external information input. To visualize neurons in the intact brain we started to inject quantum dots into nerve cells and detect them by their fluorescence. This approach offers new perspectives for the visualization of neurons in the intact brain.

A technique was developed to visualize brain microcircuits in 3-D with high resolution which renders fixed mouse brains by chemical means completely transparent. The method was combined with a new kind of microscopy. With this combination the neuronal network could be visualized with cellular resolution.

The results from these different approaches should help to understand the microcircuits of the brain and may ultimately allow the implementation of the underlying principles in technical solutions.