

OPTICAL RECORDING OF ELECTRICAL ACTIVITY IN INTACT NEURONAL NETWORKS WITH RANDOM ACCESS SECOND-HARMONIC GENERATION MICROSCOPY

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One of the main challenges in understanding the central nervous system is to measure the network dynamics of neuronal assemblies, while preserving the computational role of individual neurons. However, this is not possible with current techniques. In this work, we combined the advantages of second-harmonic generation (SHG) with a random access (RA) excitation scheme to realize a new microscope (RASH) capable of optically recording fast membrane potential events occurring in a wide-field of view. The RASH microscope, in combination with bulk loading of tissue with FM4-64 dye, was used to simultaneously record electrical activity from clusters of Purkinje cells in acute cerebellar slices. Complex spikes, both synchronous and asynchronous, were optically recorded simultaneously across a given population of neurons. Spontaneous electrical activity was also monitored simultaneously in pairs of neurons, where action potentials were recorded without averaging across trials. These results show the strength of this technique in describing the temporal dynamics of neuronal assemblies, opening promising perspectives in understanding the computations of neuronal networks.

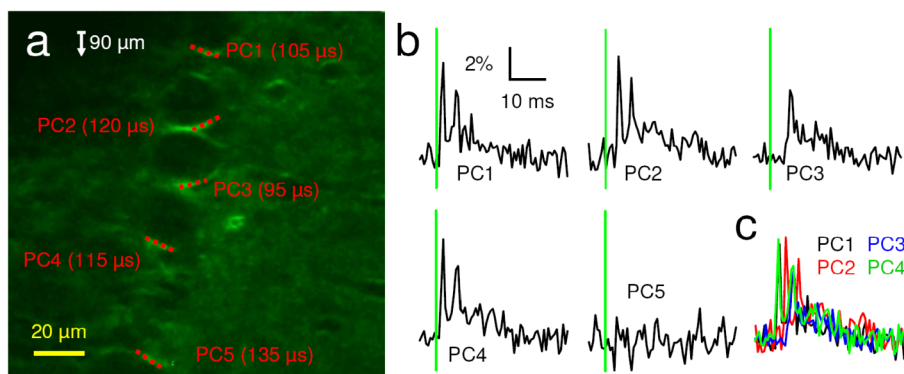


Figure: Optical multi-unit recording of stimulated electrical activity. a) SHG image of a cerebellar slice taken at a depth of 90 μm . b) Multiplexed recording of APs from the 5 PCs following stimulation of climbing fibers (green lines). c) Superposition of SHG traces corrected for multiplex delay is shown. PC5 is not shown since it was quiescent.