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Application Note

fMCI:Functional Multineuronal Calcium Imaging Technique

The neuronal network is a computing system that transforms input to output. This computation involves complex nonlinear processes through polysynaptic feedforward and feedback microcircuitry, and thus cannot be addressed either with isolated neuron responses or averaged multineuronal responses. Functional multineuron calcium imaging (fMCI) is promising to solve this problem.

The fMCI is a large-scale recording technique that simultaneously monitors the firing activity of more than a thousand neurons through their somatic Ca^{2+} signals.

Because of several advantages, including i) simultaneous recording from numerous neurons, ii) single-cell resolution, iii) identifiable location of recorded neurons, and iv) detection of non-active neurons during the observation period, fMCI attracts attention as a new-generation large-scale recording method.

In vitro fMCI is made more sophisticated by using multipoint illumination and scanning with the CSU in combination with low-intensity lasers and an EM-CCD (electron-multiplying charge-coupled device) camera.

This CSU system allows to achieve ultra-high-speed and high-resolution fMCI in hippocampal slices; the Ca^{2+} fluorescent intensity of a large number of neurons can be monitored at the speed of up to 2,000 frames per second. This is one of the applications that make best use of the high-speed performance of the CUS Confocal Scanner Unit.
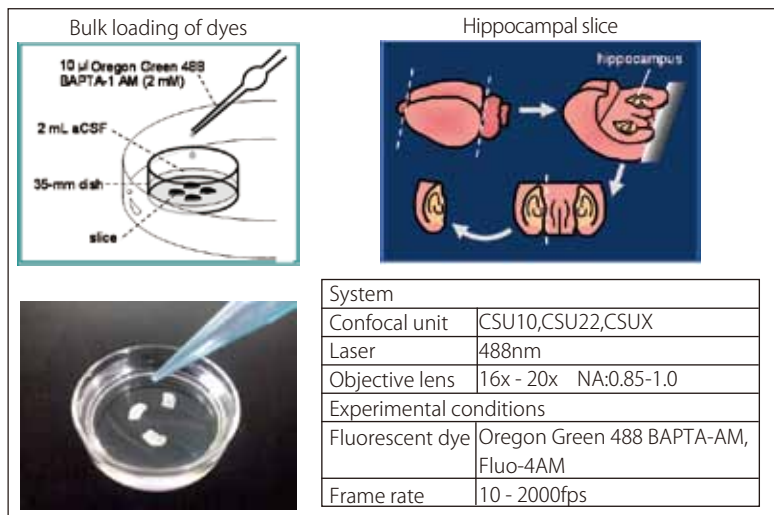

Figure 1: CSU system

System	
Confocal unit	CSU10,CSU22,CSUX
Laser	488nm
Objective lens	16x - 20x NA:0.85-1.0
Experimental conditions	
Fluorescent dye	Oregon Green 488 BAPTA-AM, Fluo-4AM
Frame rate	10 - 2000fps

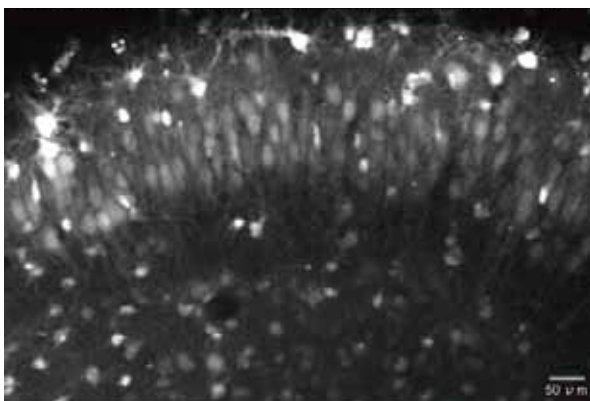Figure 2: fMCI:Functional Multineuronal Calcium Imaging

Figure 3: Spontaneous firing activity visualized as the Ca^{2+} fluorescence signals of a large number of neurons in a cultured hippocampal slice (CA3 region)
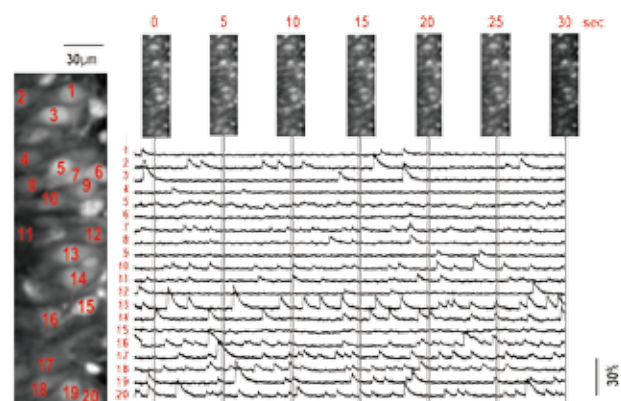

Figure 4: Example of a raster plot of the activity of many neurons in the CA3 region