P1.16.

Roller Coaster Scanning reveals spontaneous triggering of dendritic spikes in CA1 interneurons

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Inhibitory interneurons are considered to be the controlling units of neural networks, despite their sparse number and unique morphological characteristics compared with excitatory pyramidal cells. Although pyramidal cell dendrites have been shown to display local regenerative events — dendritic spikes (dSpikes) — evoked by artificially patterned stimulation of synaptic inputs, no such studies exist for interneurons or for spontaneous events. In addition, imaging techniques have yet to attain the required spatial and temporal resolution for the detection of spontaneously occurring events that trigger dSpikes. Here we describe a highresolution 3D two-photon laser scanning method (Roller Coaster Scanning) capable of imaging long dendritic segments resolving individual spines and inputs with a temporal resolution of a few milliseconds. By using this technique, we found that local, NMDA receptor-dependent dSpikes can be observed in hippocampal CA1 stratum radiatum interneurons during spontaneous network activities in vitro. These NMDA spikes appear when approximately 10 spatially clustered inputs arrive synchronously and trigger supralinear integration in dynamic interaction zones. In contrast to the one-to-one relationship between computational subunits and dendritic branches described in pyramidal cells, here we show that interneurons have relatively small (~14 μm) sliding interaction zones. Our data suggest a unique principle as to how interneurons integrate synaptic information by local dSpikes.