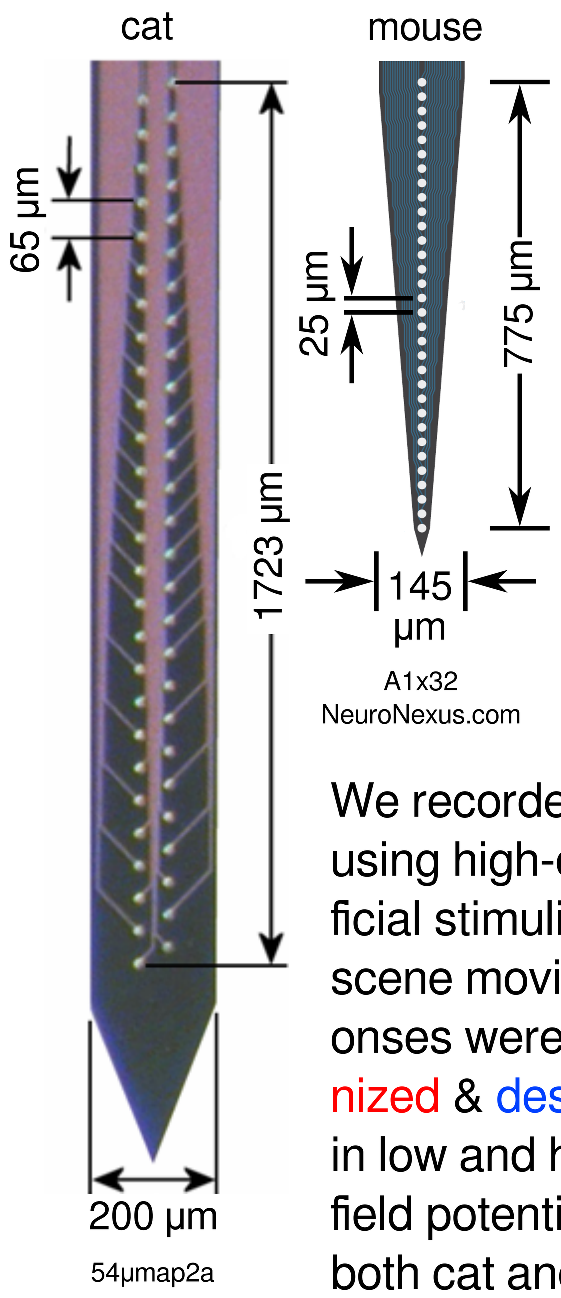
# Cortical state and natural movie responses in cat & mouse visual cortex

Martin A Spacek[1-3], Matilde Fiorini[3], Laura Busse[2,3], Nicholas V Swindale[1]

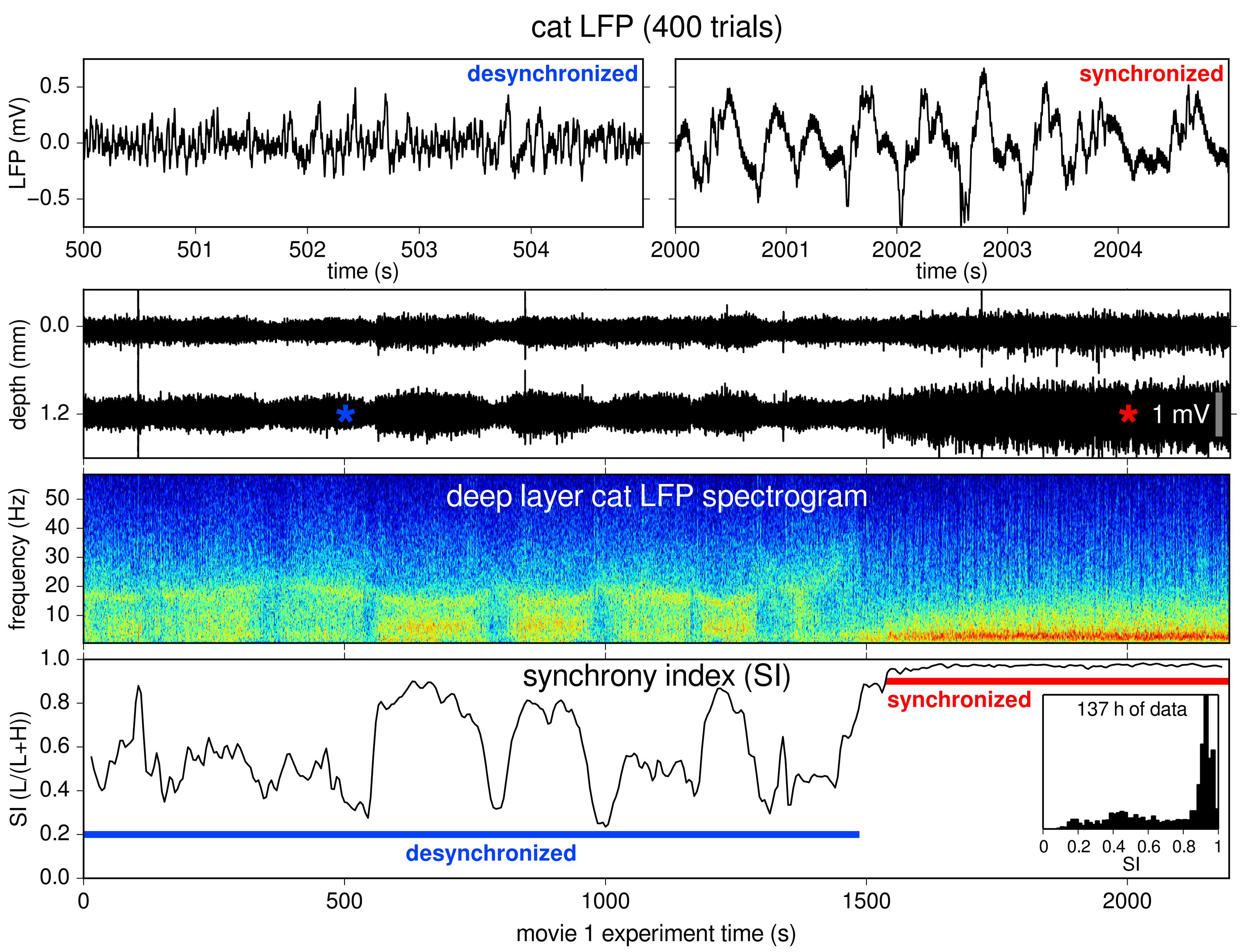
1. Ophthalmology and Visual Sciences, University of British Columbia 2. Biology II, LMU München 3. Werner Reichardt Centre for Integrative Neuroscience, University of Tübingen

**Summary:** Global brain state changes spontaneously over time, and can be characterized along a spectrum from slow synchronized activity to fast desynchronized activity[1]. This spectrum is similar in awake, asleep and anesthetized animals, but is its effect on neural responses the same in all cases? Here we show that neural responses to natural movies in anesthetized cat V1 are more precise, reliable and sparse during synchronized activity, contrary to existing reports in anesthetized rodents[2-5] and our own preliminary results in awake mouse V1. We suggest this difference may be due to the greater columnar organization of cat V1. Furthermore, in awake attending animals, brain state is desynchronized and responses are enhanced[6], contrary to our result in anesthetized cat. We therefore suggest that similar brain states in awake and anesthetized animals may not be functionally analogous.

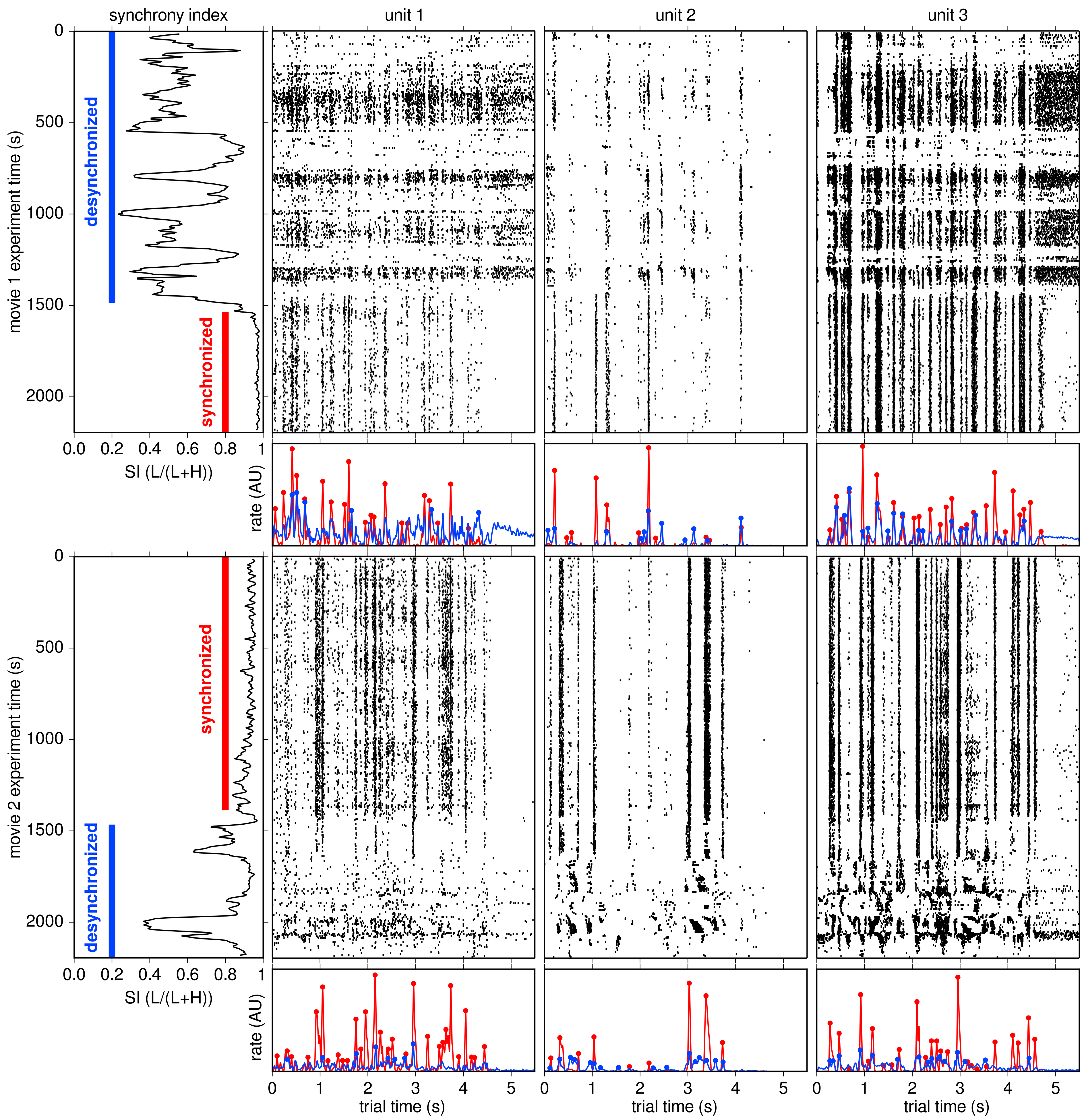




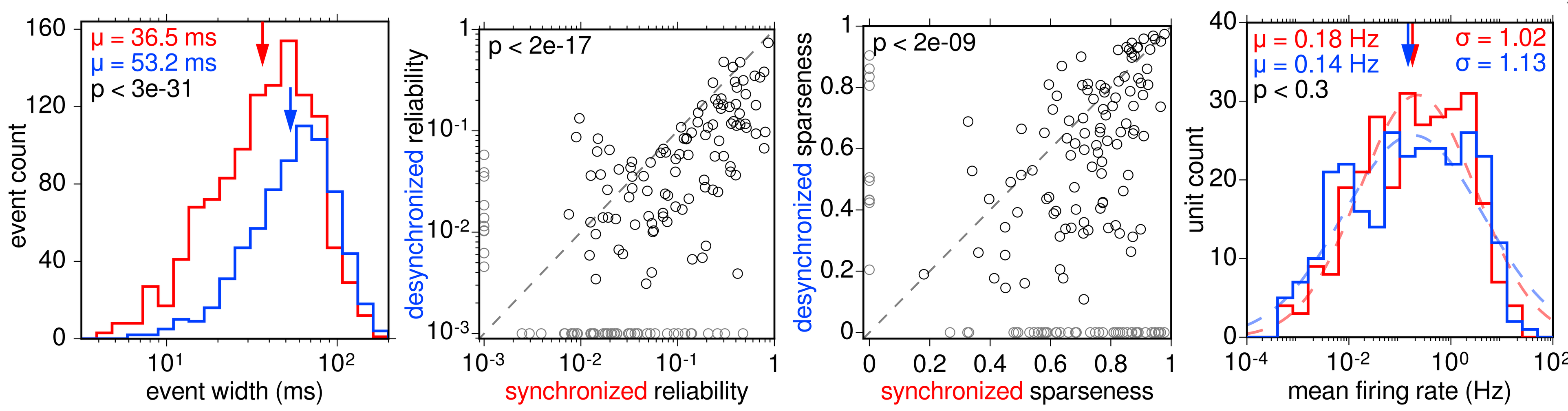
We recorded single unit spikes and LFP from all layers of V1, using high-density silicon polytrodes. Instead of reduced artificial stimuli, we presented short duration wide-field[7] natural scene movie clips hundreds of times each. Spiking responses were divided up according to cortical state (synchronized & desynchronized), determined by the relative energy in low and high frequency components of the deep layer local field potential (LFP). Cortical state switched spontaneously in both cat and mouse.



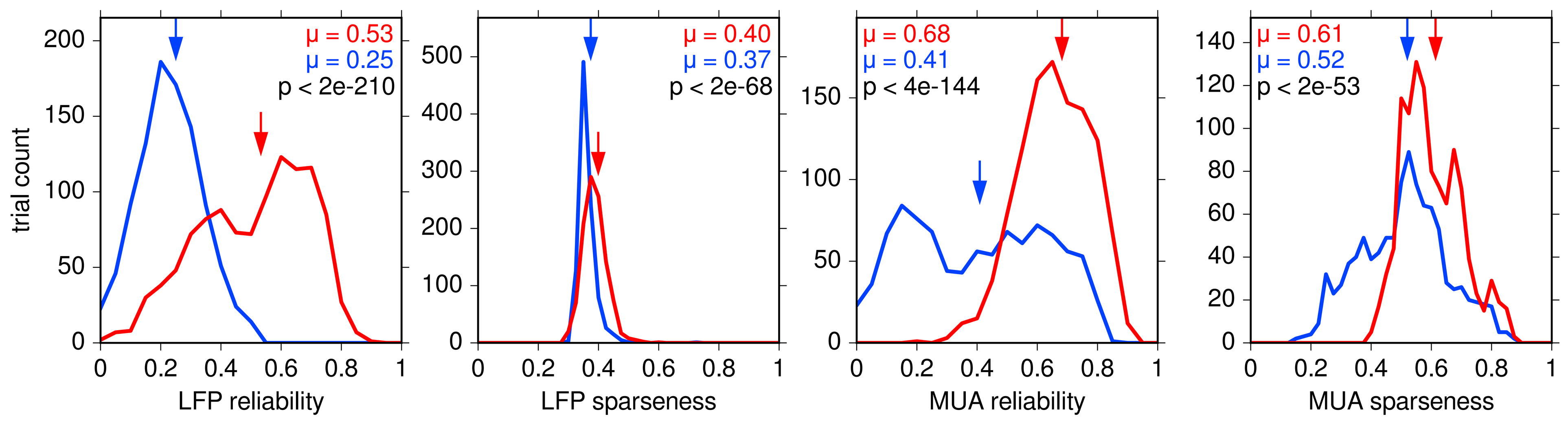

Natural movie responses had temporally precise, reliable and sparse events. In cat, precision was as fine as 10 ms, calculated from the width of response events:



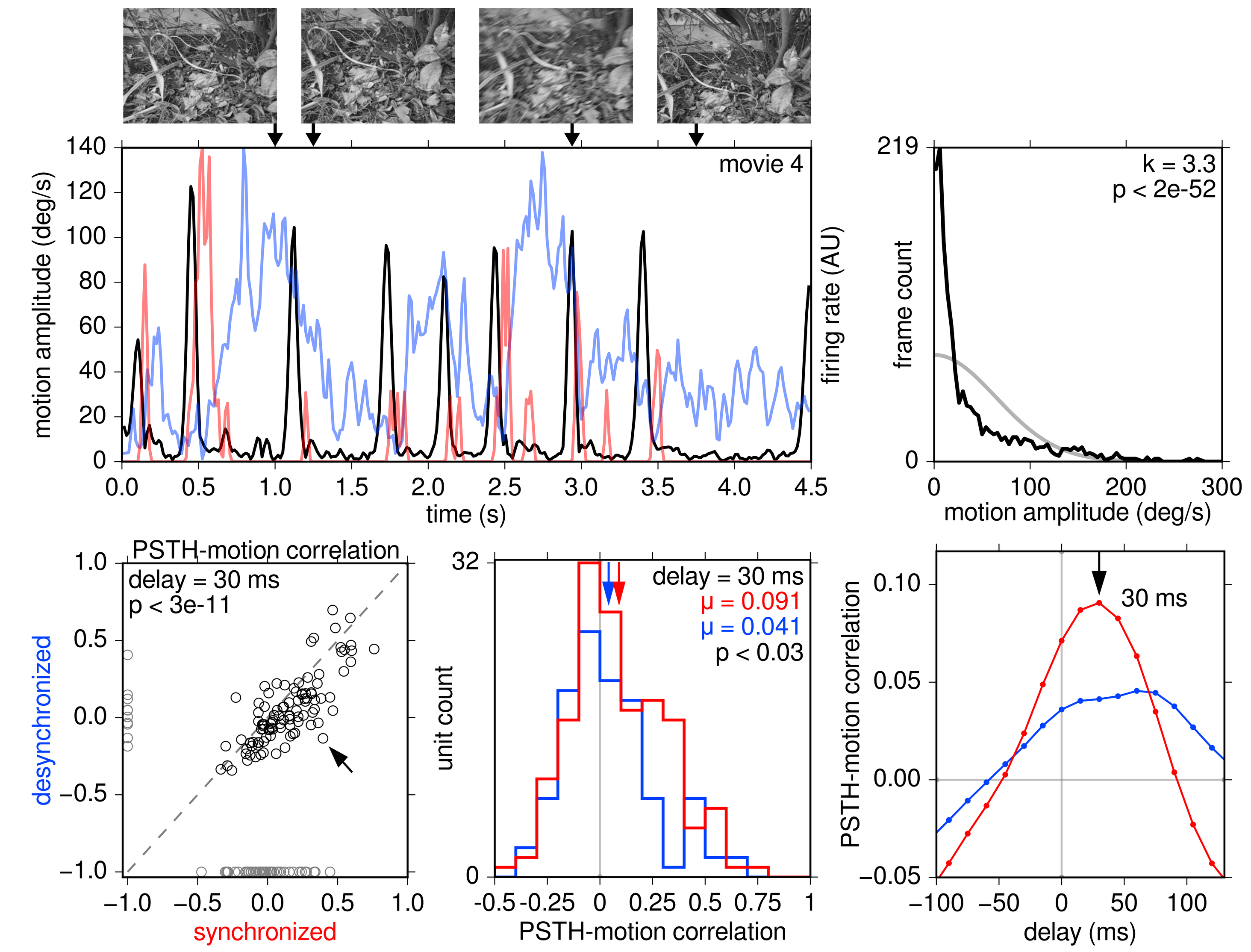

In cat, response events were more precise, reliable and sparse in the synchronized than desynchronized state. Mean firing rates were lognormally distributed in both states:



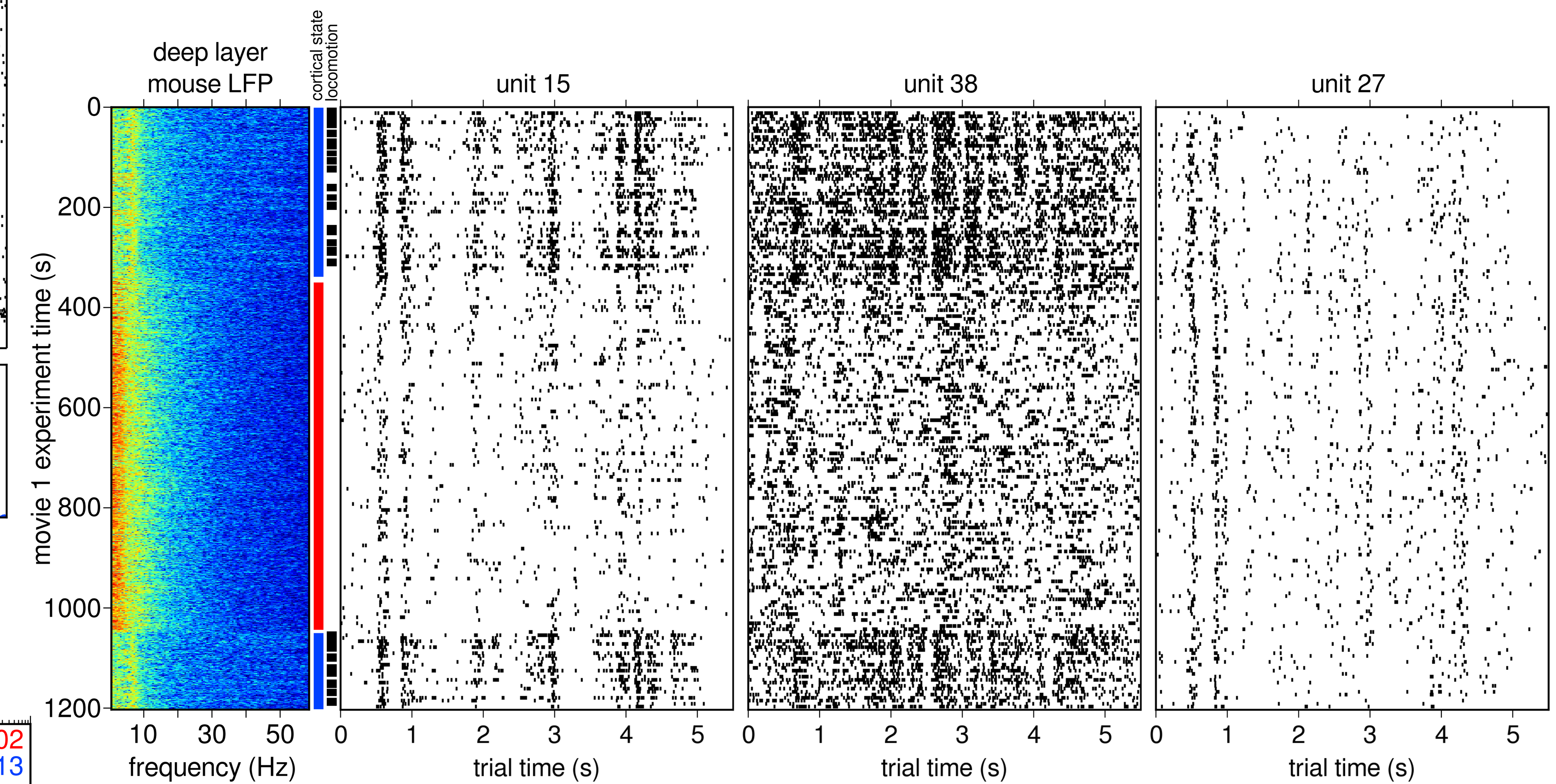

In cat, the same held true for trial-averaged LFP and multiunit activity (MUA) responses, ruling out spike sorting[8] as a potential explanation:




In cat, global movie motion correlated better with trial-averaged responses (PSTHs) in the synchronized state, suggesting better stimulus encoding:




Compared to cat, preliminary results in awake mouse V1 mostly showed the opposite dependence of response precision and reliability on cortical state:




**Discussion:** These results in cat are surprising because the synchronized state under anesthesia is thought to correspond to quiescent periods in awake animals, and the desynchronized state to alert attending periods[1]. Neural responses are stronger for attended than unattended stimuli[6]. Our results in cat therefore complicate the analogy between cortical states in anesthetized and awake animals. One possible reason for this conflicting[2-5] result may be the greater columnar organization of stimulus features in cat V1 than in rodent V1. Standing and travelling waves of activation[9,10] (UP phases) in the synchronized state might therefore interact differently with incoming stimuli in V1 of higher mammals. This hypothesis predicts a similar result in anesthetized ferret and primate V1.

**Manuscript**: http://mspacek.github.io

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**References:**

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