

Cell Reports, Volume 25

Supplemental Information

**Origin of Gamma Frequency Power
during Hippocampal Sharp-Wave Ripples**

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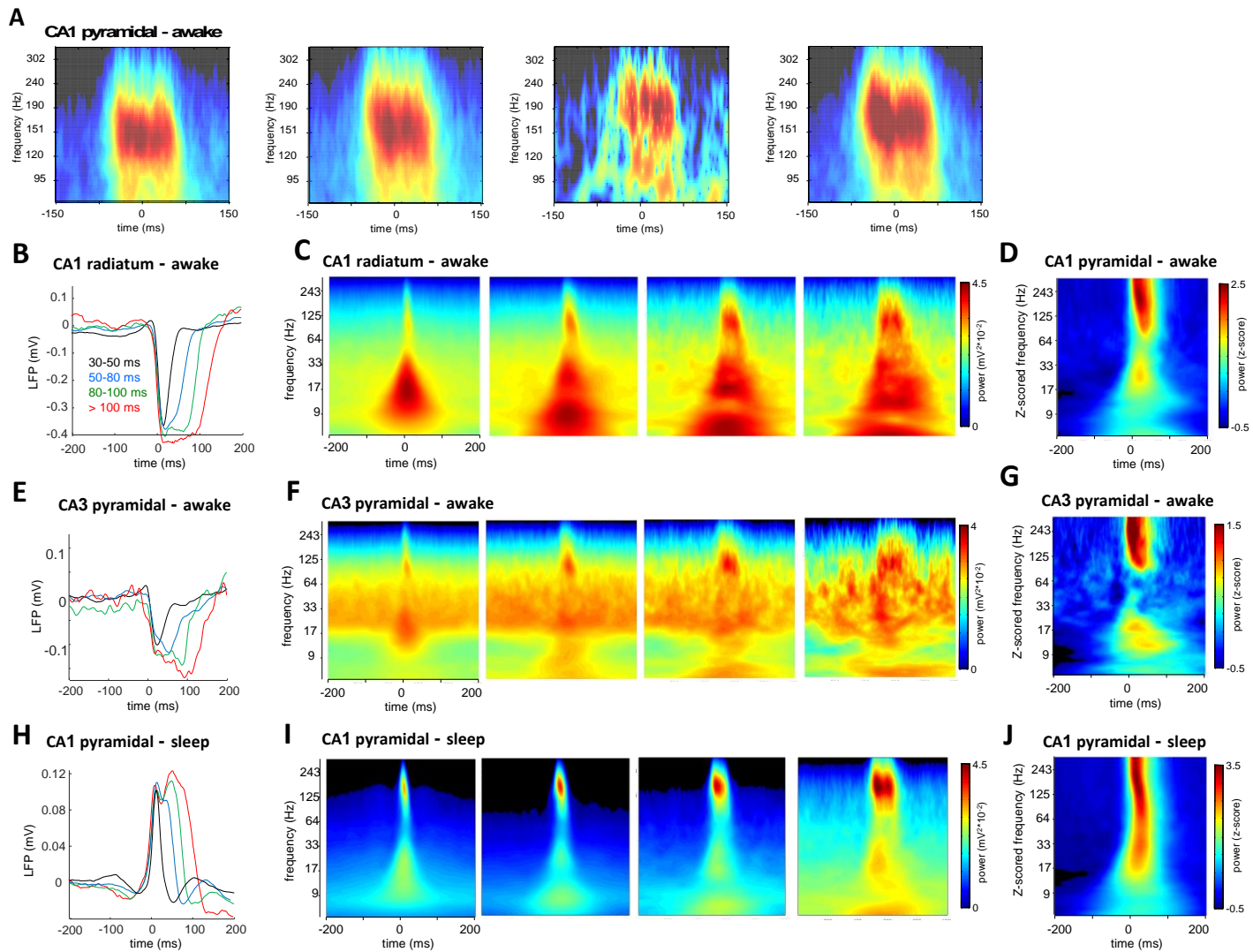


Figure S1 (related to Figure 1):

A) Example average spectrograms of longer SPW-Rs (duration > 100 ms) from different sessions. **B)** Wide-band peri-SPW-R str. radiatum LFP averages for awake events of different duration. **C)** Average spectrograms from str. radiatum of all SPW-R events of different duration detected during awake (n = 15,564 in 12 rats). **D)** Average z-scored spectrogram from CA1 pyramidal layer LFP of all awake SPW-Rs. **E), F), G)** same as in B, C and D but with CA3 pyramidal layer LFP. **H)** Wide-band peri-SPW-R CA1 pyramidal layer LFP averages for events of different duration during non-REM sleep (n = 110,414 in 12 rats). **I)** Average spectrograms of CA1 pyramidal layer LFP for all SPW-R events of different duration detected during non-REM sleep. **J)** Average z-scored spectrogram from str. radiatum LFP of all sleep SPW-Rs.

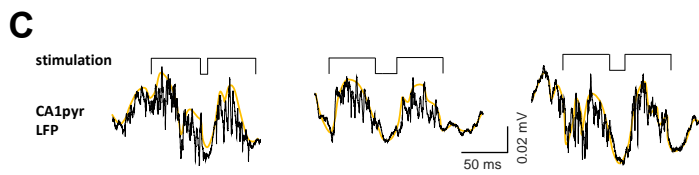
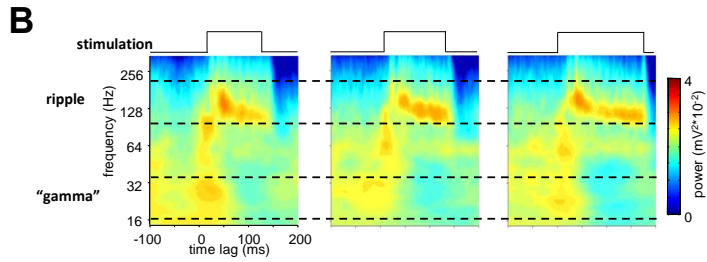
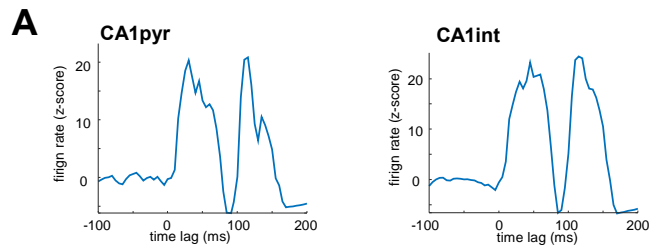


Figure S2 (related to Figure 2):

A) Peri-pulse average firing rate curve for CA1 pyramidal cells (pyr) and interneurons (int) in one example session (n = 62 / 18 cells). **B)** Average wavelet spectrograms of responses in CA1 pyramidal layer to pulses of longer duration (105, 140 and 175 ms). **C)** Example raw LFP traces (wide-band, 20 kHz sampling rate) from the CA1 pyramidal layer of optogenetically induced ripple doublets. Orange traces are 20-50 Hz filtered LFPs

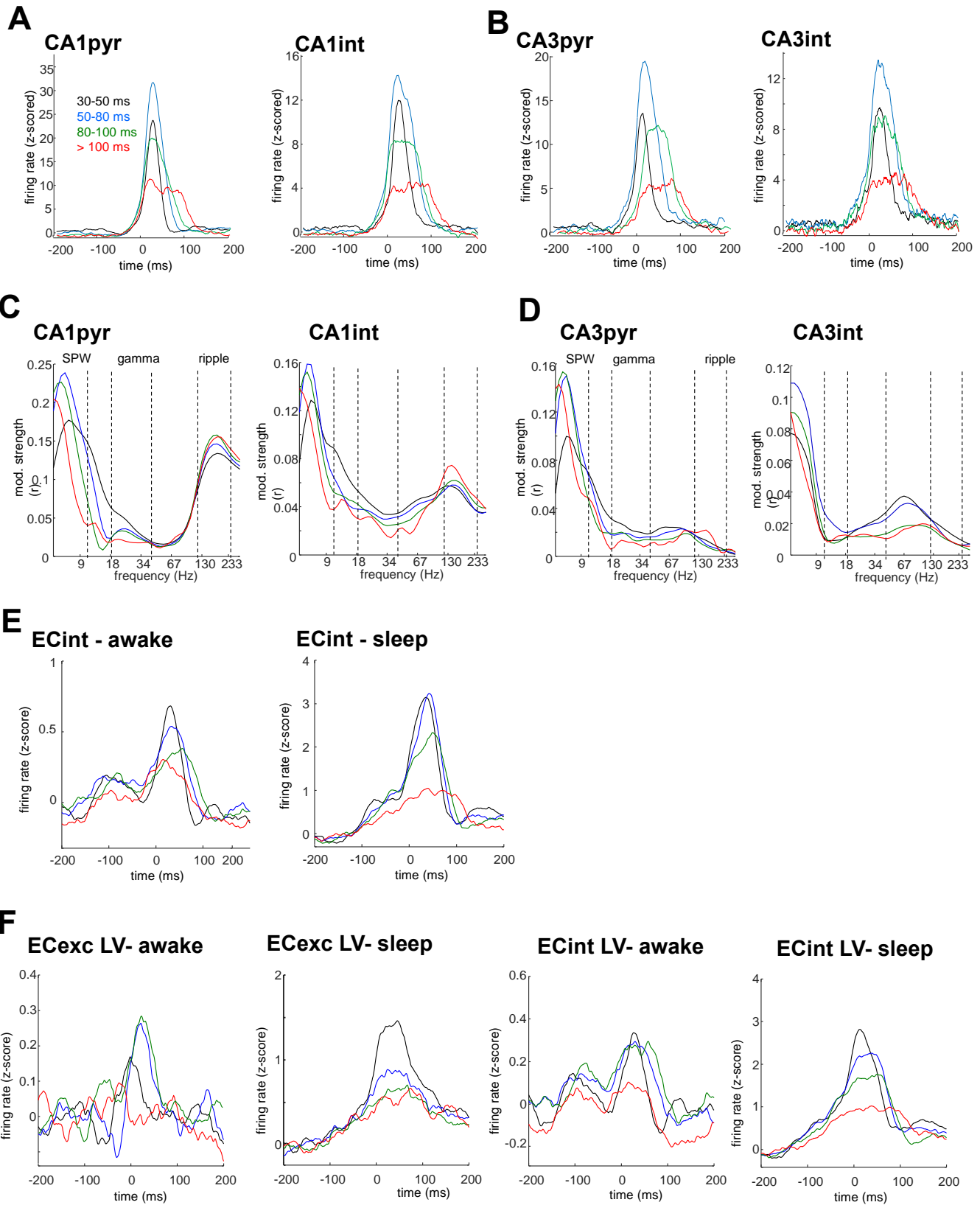


Figure S3 (related to Figure 4):

A) Discharge patterns of CA1 pyramidal cells (pyr) and interneurons (int) firing during non-REM sleep SPW-Rs of different durations (n = 1052 / 171 cells in 12 rats). **B)** Same as in A) but for CA3 pyramidal cells and interneurons (n = 646 / 77 cells in 8 rats). **C)** Distribution of the modulation strengths of CA1 and CA3 **(D)** pyramidal cells and interneurons spikes by the LFP phase in different frequency bands (5 to 300 Hz) during sleep. Vertical dashed lines indicate boundaries of SPW, gamma and ripple bands. **E)** Discharge patterns of EC interneurons from layers II and III firing during awake state and non-REM sleep SPW-Rs of different durations. **F)** Discharge patterns of EC layer 5 excitatory (exc) and inhibitory cells (n = 90 / 15 in 9 rats) during sleep and awake SPW-Rs.

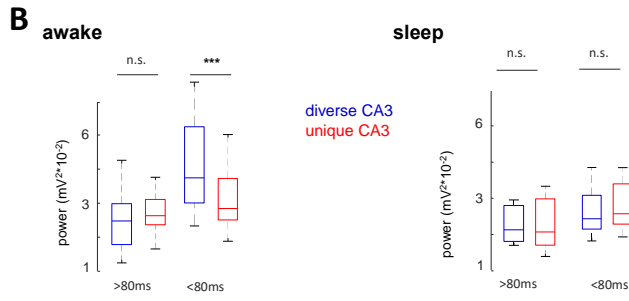
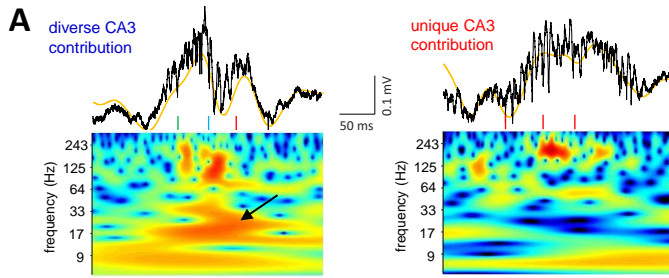


Figure S4 (related to Figure 4):

A) Left: example SPW-R in which cells from only one CA3 site fired. Right: example SPW-R in which CA3 pyramidal cells from 3 different sites fired (color ticks). Upper traces are wide-band LFP and gamma filtered LFP (orange) from CA1 pyramidal layer. Color plots are wavelet spectrum from the LFP fragment above. Note the presence of a strong gamma power in the first SPW-R (black arrow) but not in the second. **B)** SPW-R associated slow gamma power was quantified separately for short (30-80 ms) and long (> 80 ms) events that contained spikes from CA3 cells from only one shank (unique CA3, red) or more than one (diverse CA3, blue). Long awake SPW-Rs that contained spikes from different CA3 recording sites had significantly more associated gamma power than those with only spikes from one shank. *** $p < 0.001$, ranksum test.