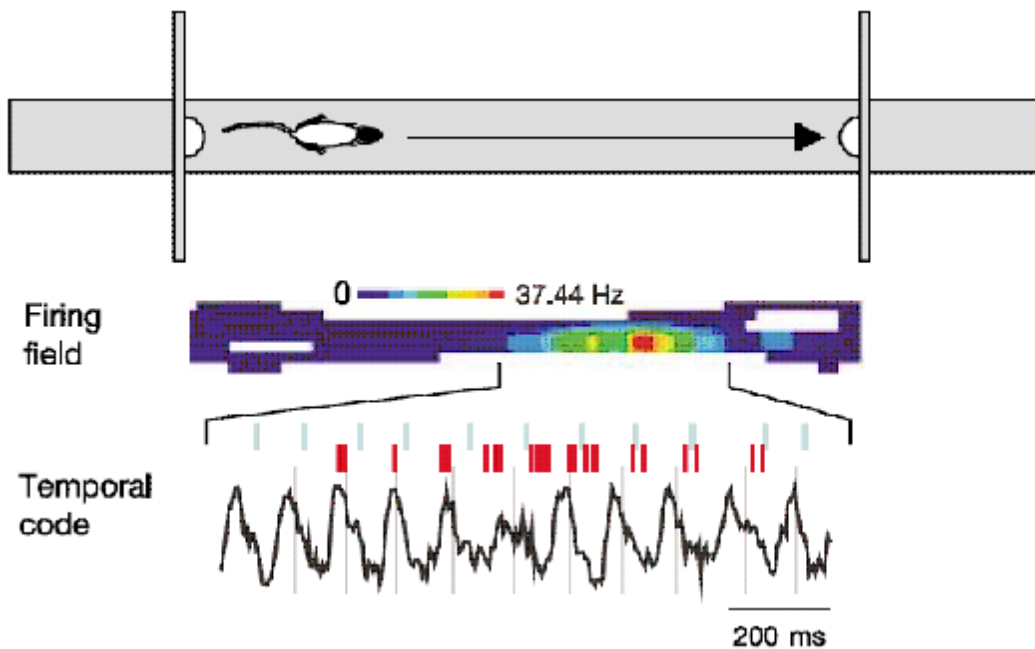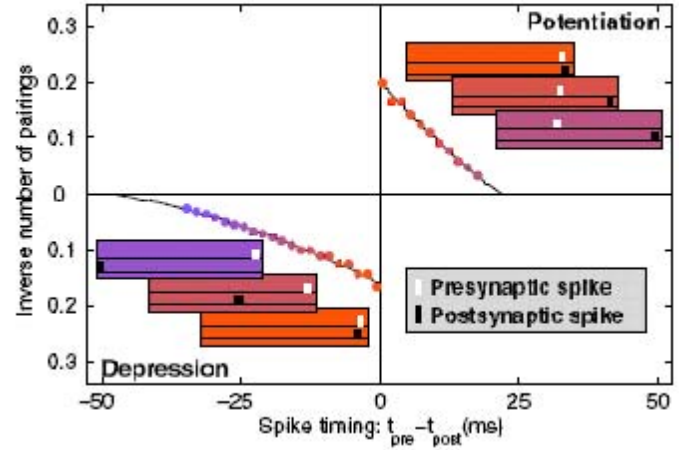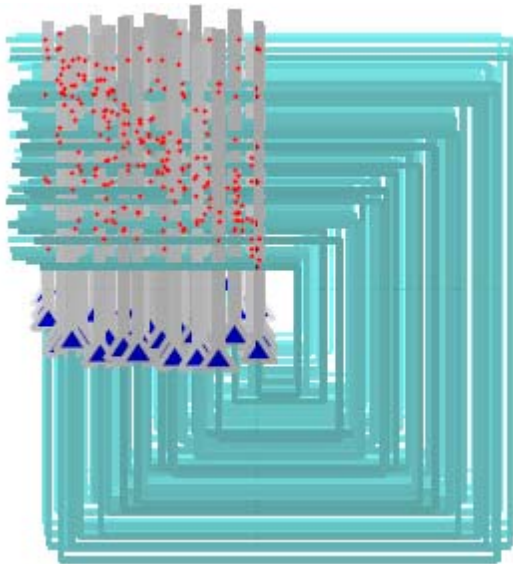# Enhancing Synchrony

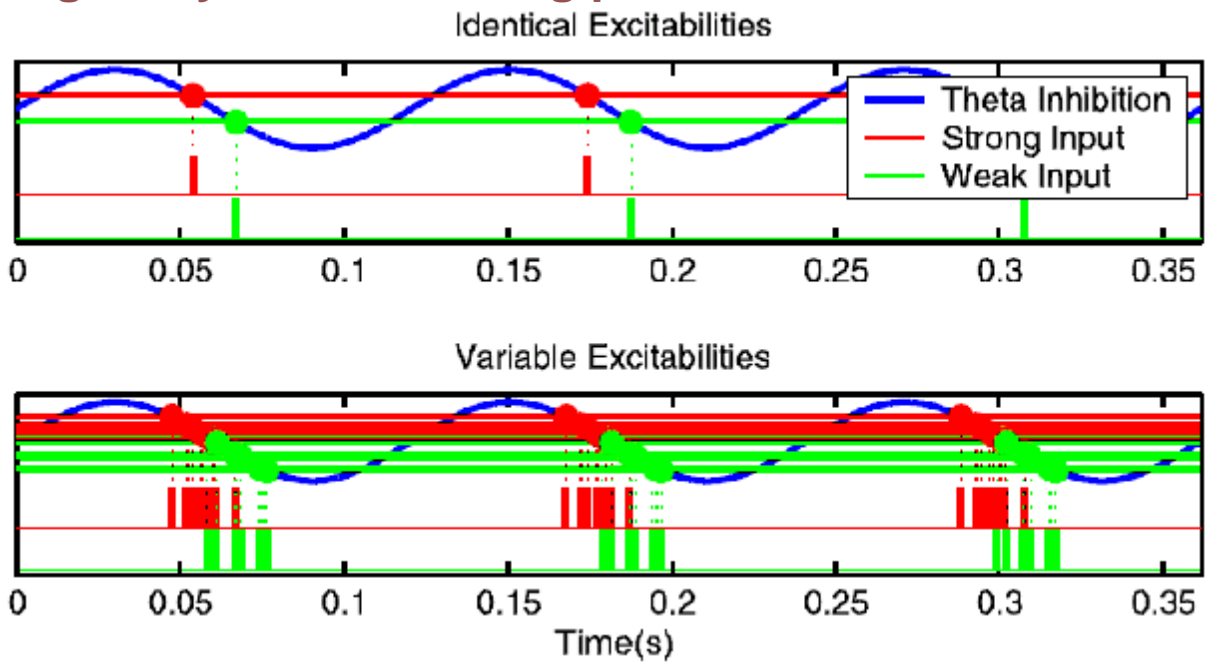Hippocampal place cells' rate (middle) and timing (bottom) codes [O'Keefe'03]

Hippocampal neurons have precise spike timing (~10ms).
How they overcome heterogeneity is unclear.
Hypothesis: Plasticity enhances phase-coding.

Recurrent CA3 network

STDP has been found in CA3-CA1 synapses; presumed to apply to CA3-CA3.
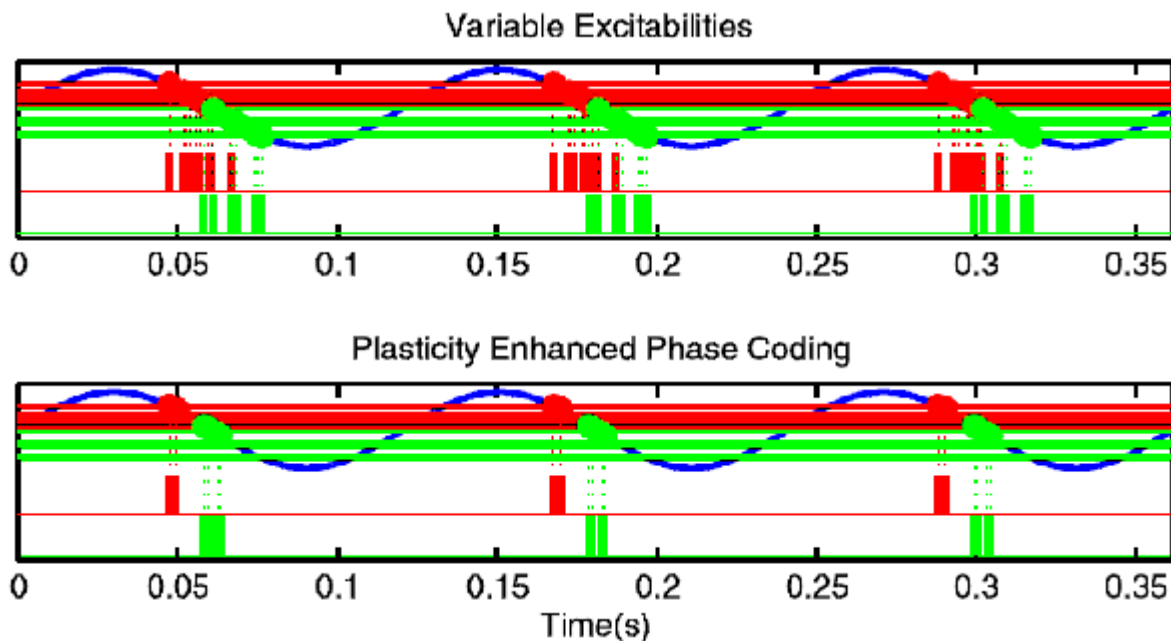
Heterogeneity reduces timing precision

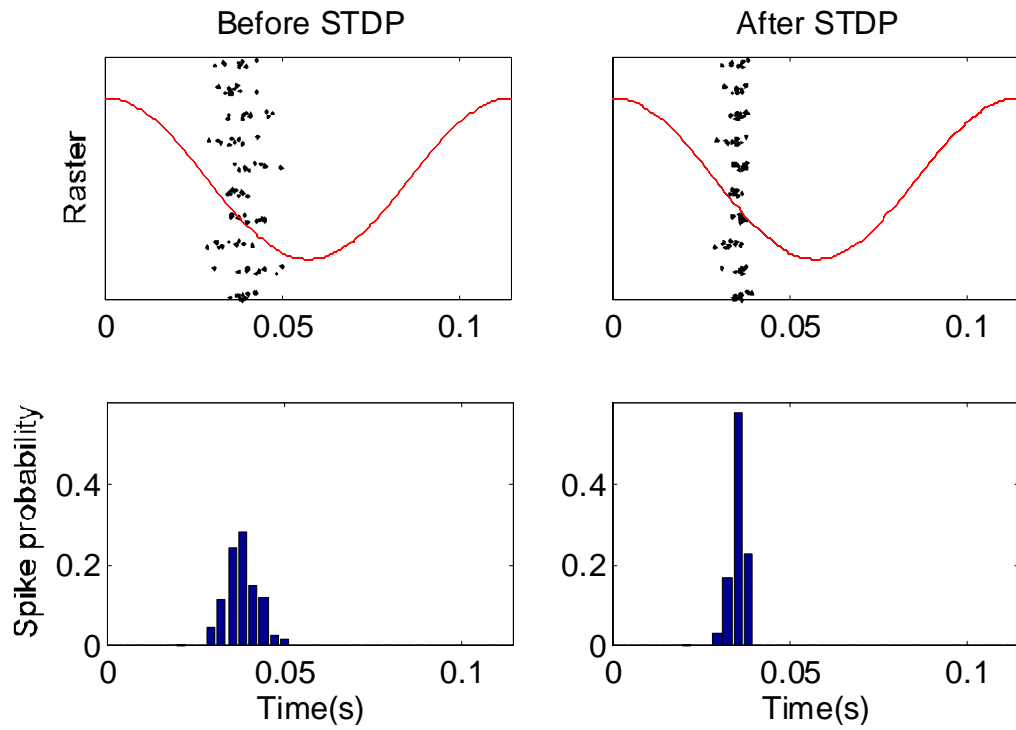Phase encodes input strength (top); but not when excitability varies (bottom).

Plasticity enhances phase-coding

STDP potentiates synapses from excitable to lethargic neurons, advancing their firing.
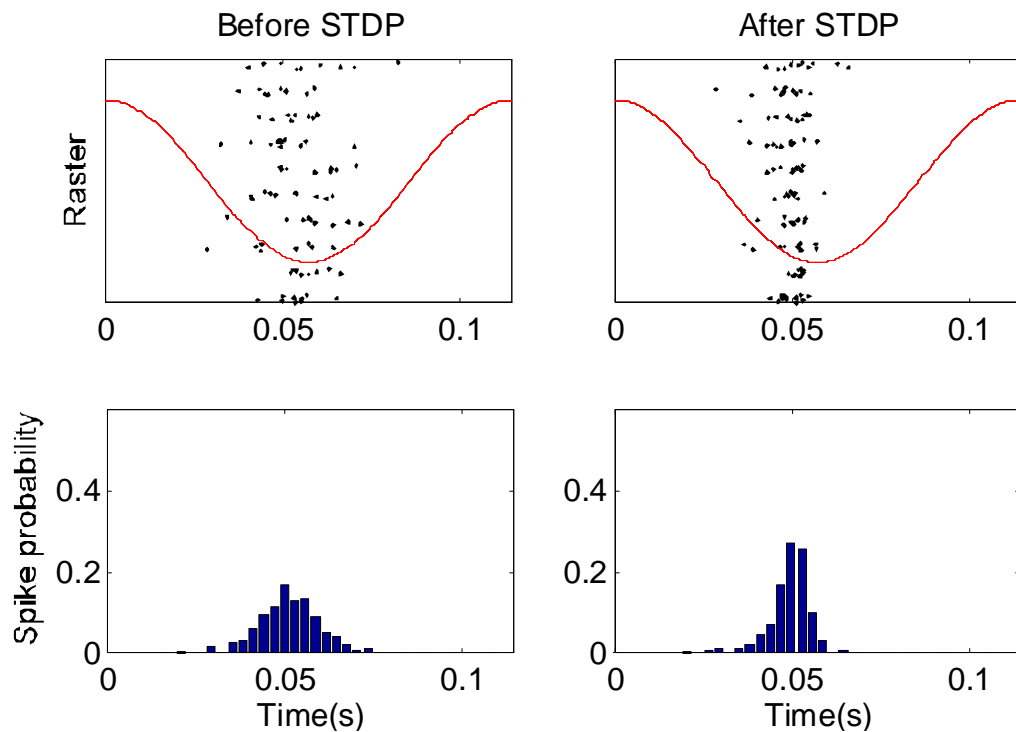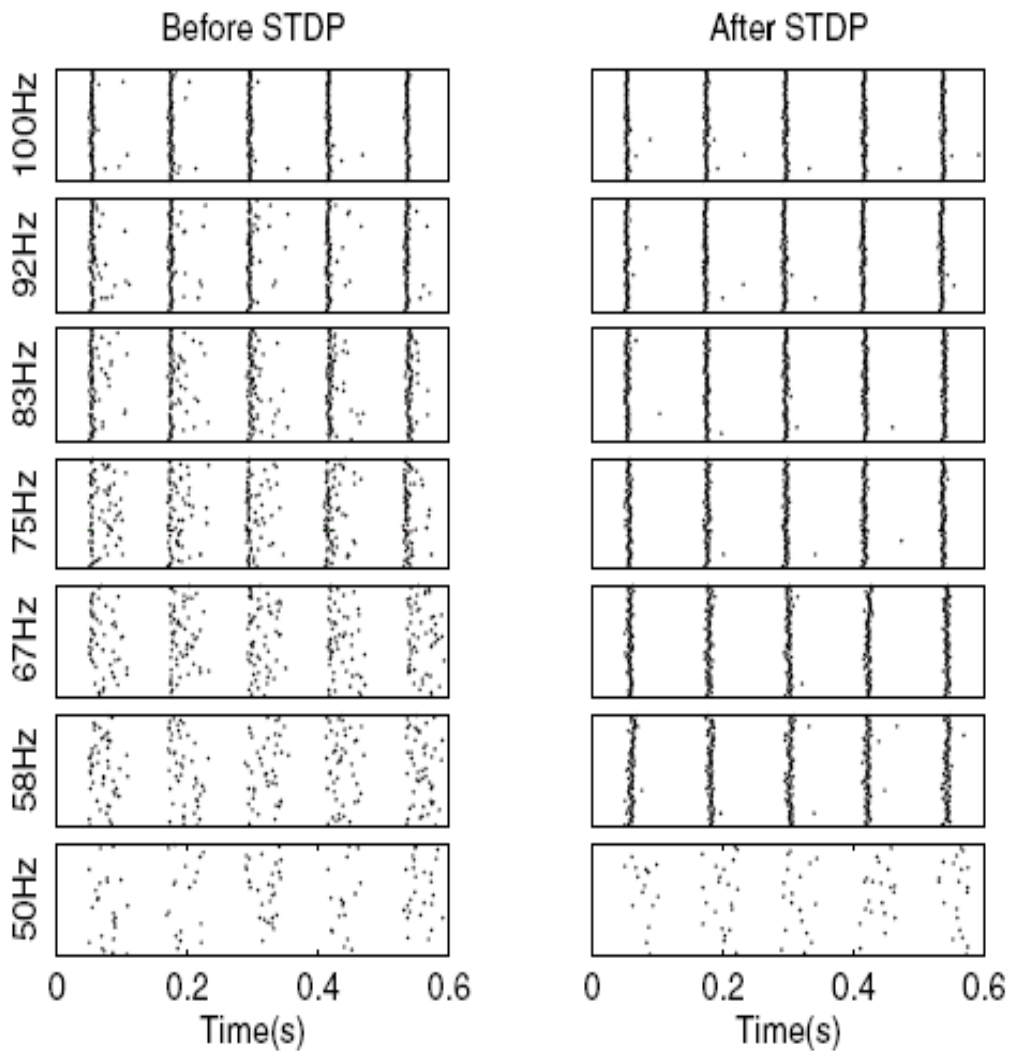
STDP compensates for variable excitability

Before STDP	After STDP

STDP (5sec) improves timing precision (SD) from 8.9ms to 4.0ms.

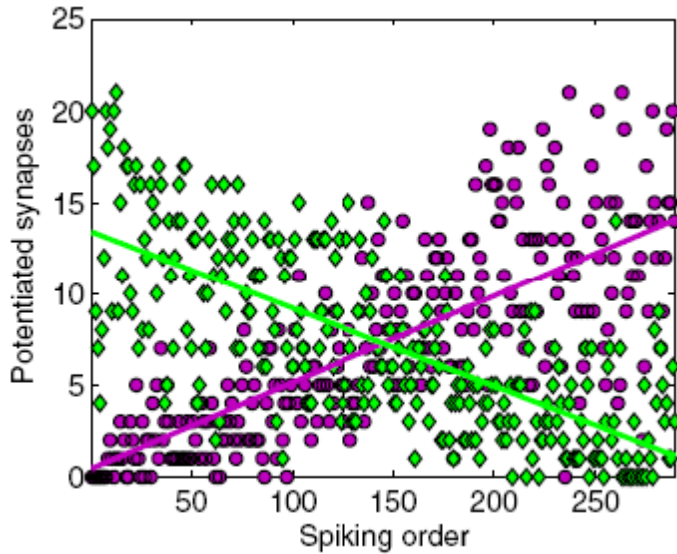# STDP compensates for noisy inputs too

STDP (5sec) improves timing precision (SD) from 16.7ms to 10.5ms.
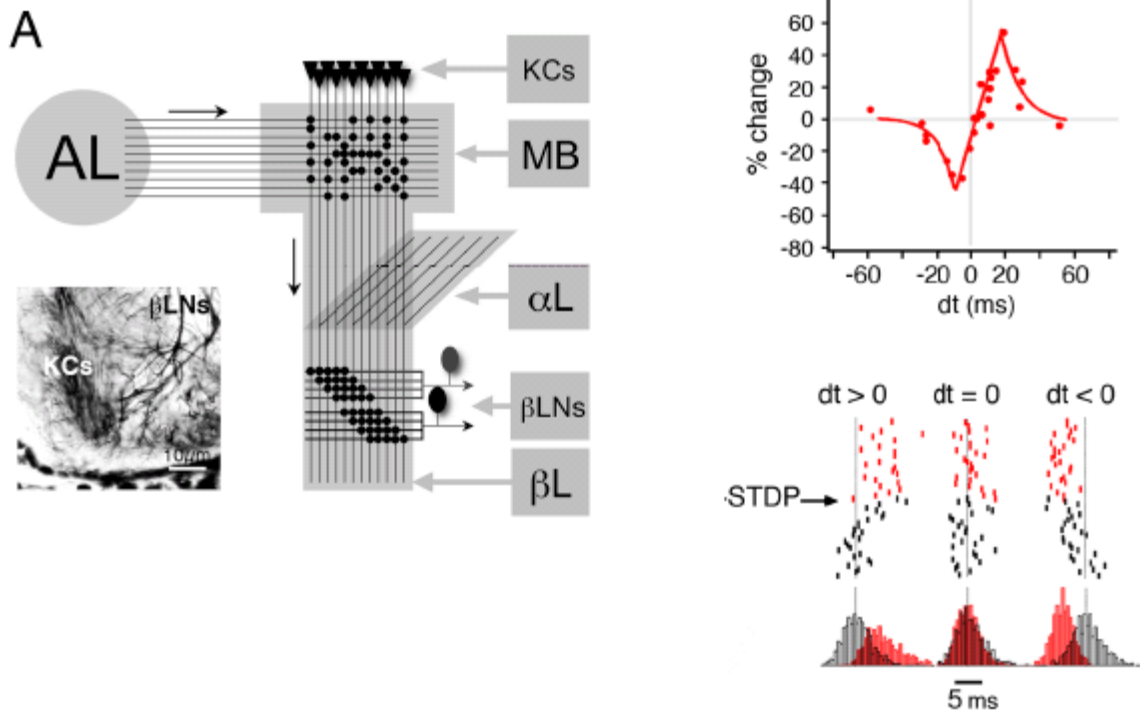
Input noise can vary severalfold

Timing precision is independent of input noise—except for weakest inputs (< 70Hz).
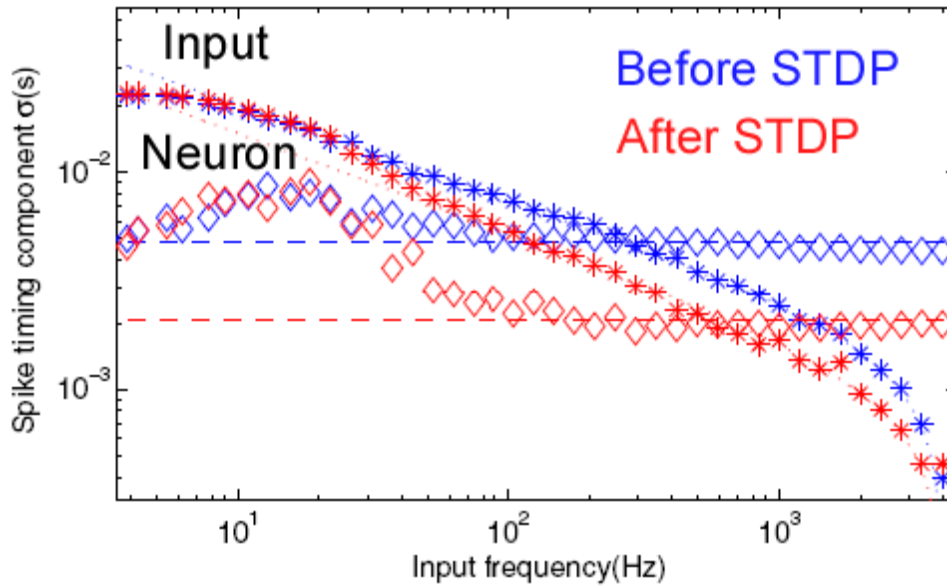
Synapse counts versus temporal order

Early neurons make more synapses (green); late ones receive more synapses (purple).

Feedforward Network: Insect olfaction

Kenyon-cell/beta-lobe-neuron STDP (data) establishes firing phase (model) [Laurent'07]

Next Lecture: Plasticity's limits

Activating the undriven interneurons synchronizes the patches