BM3000 Foundations of Natural Intelligence

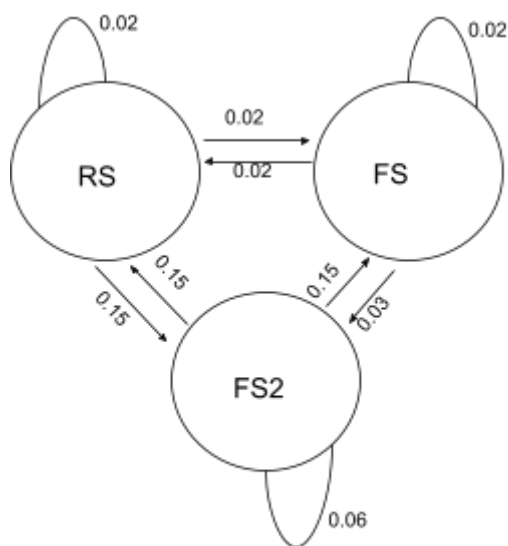*Inhibitory interneuronal Gamma oscillations*

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BM20BTECH11015

Q1) What is the input that stimulates the network? How else can the network be stimulated?
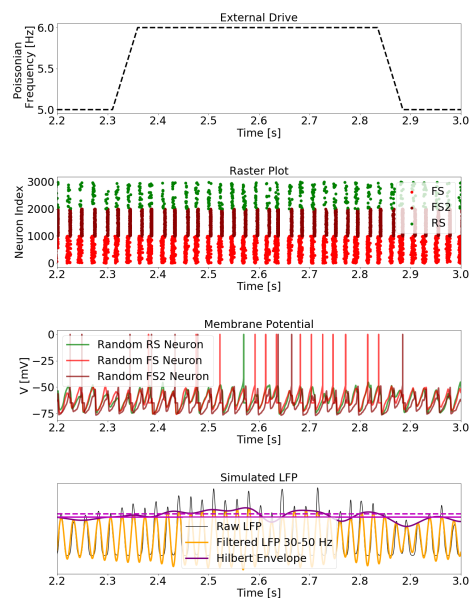
A1) A network is generally stimulated by physical activity or sensory stimulation. In this network the input is an irregular wave like numpy array. It can also be stimulated by Sine wave-like or square wave-like numpy array stimuli.
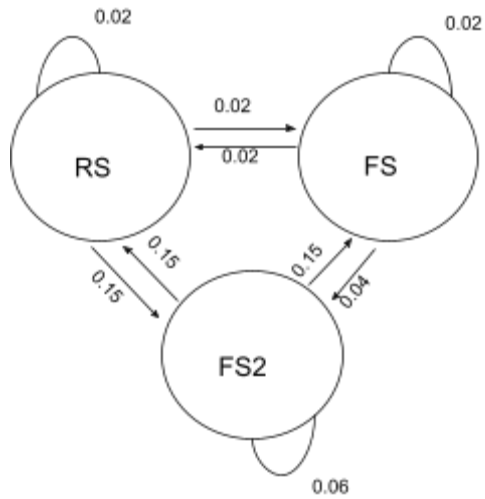
Q2) How does the connection probability between FS and FS2 neurons in the network affect the oscillations?

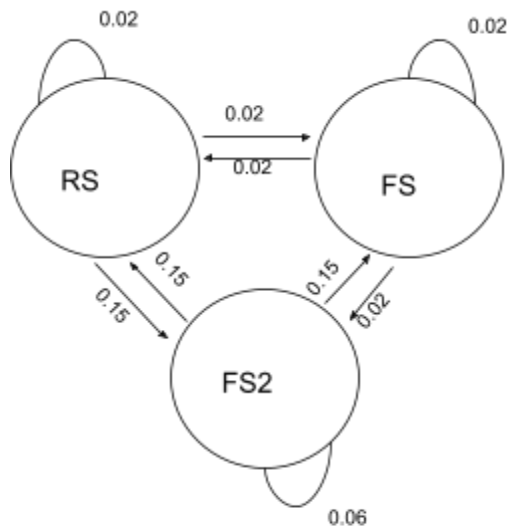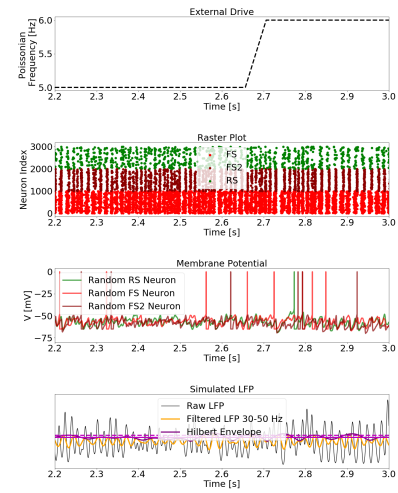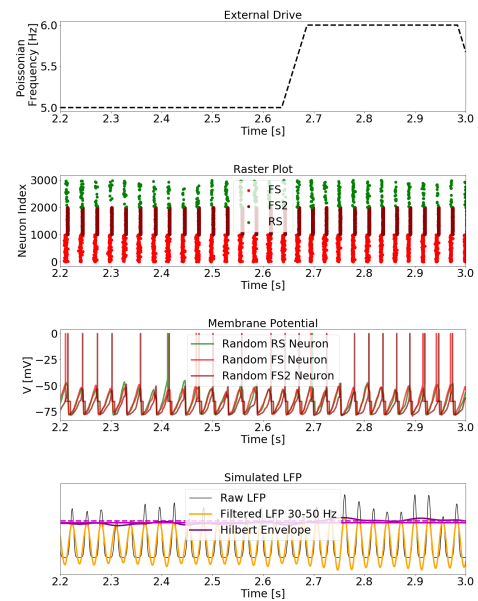A2) Below are the models and their respective graphs.
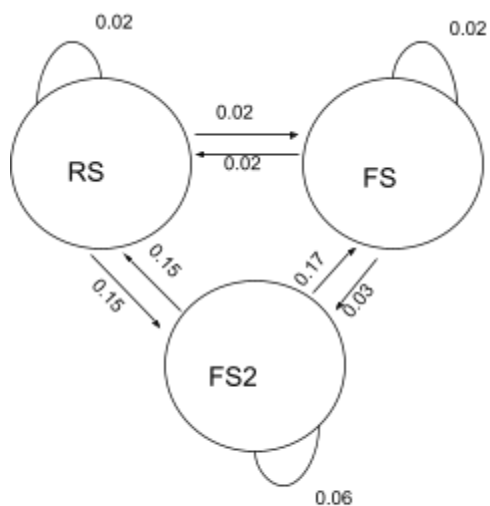

Model 1

Model 2

Model 3

External Drive

Raster Plot

Membrane Potential

Simulated LFP

Model 4

External Drive

Raster Plot

Membrane Potential

Simulated LFP

Model 5

External Drive

Raster Plot

Membrane Potential

Simulated LFP

Model 6

External Drive

Raster Plot

Membrane Potential

Simulated LFP
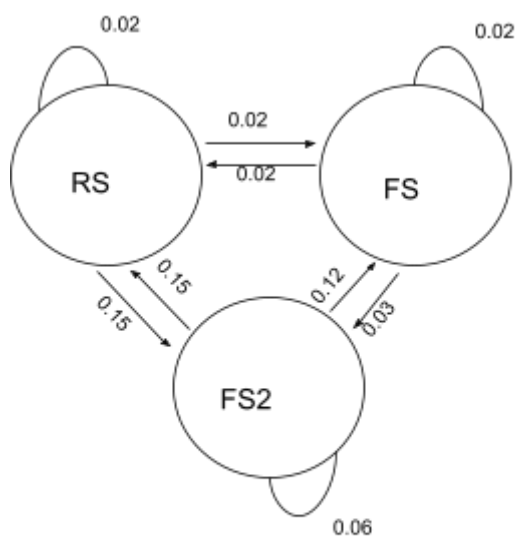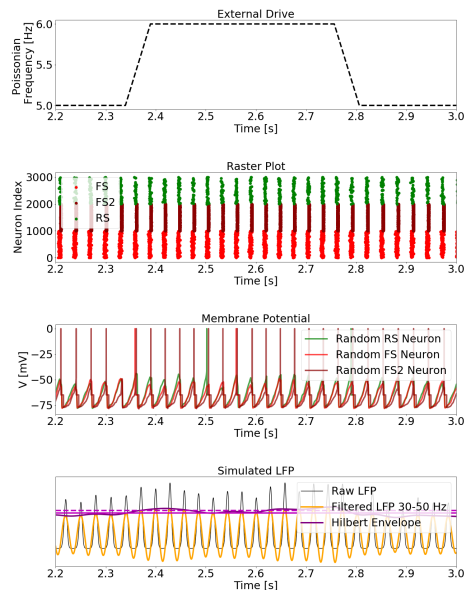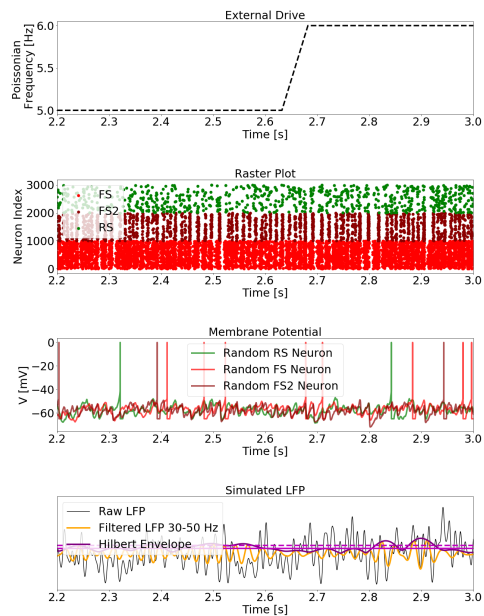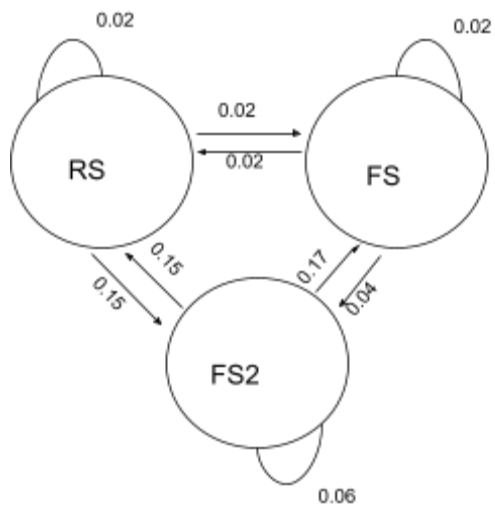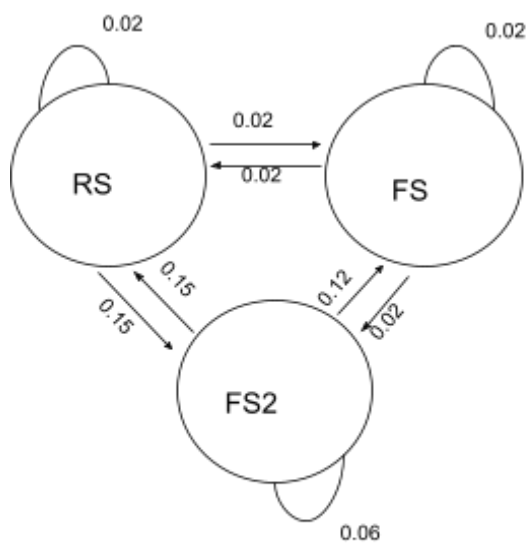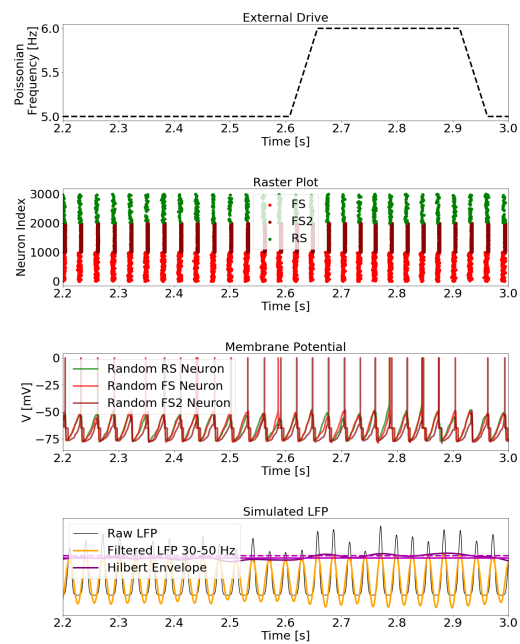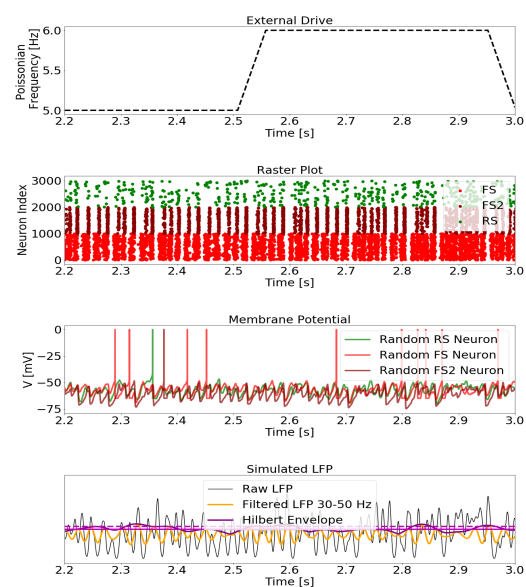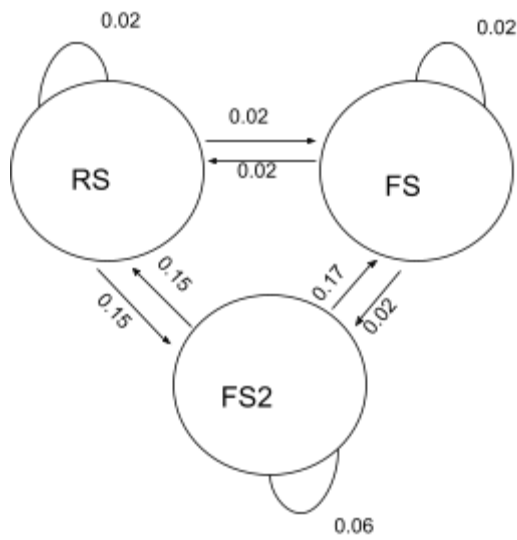
Model 7

Model 8

Model 9

From the above models and simulations we can clearly see that, when the probability of FS -> FS2 increases, the RS neurons reach the membrane potential after a certain delay, and the number of times the FS and FS2 neurons reach the membrane potential in a 3s interval decreases, whereas, if the probability of FS ->

FS2 decreases, the RS neurons reach the membrane potential earlier the number of times the FS and FS2 neurons reach the membrane potential i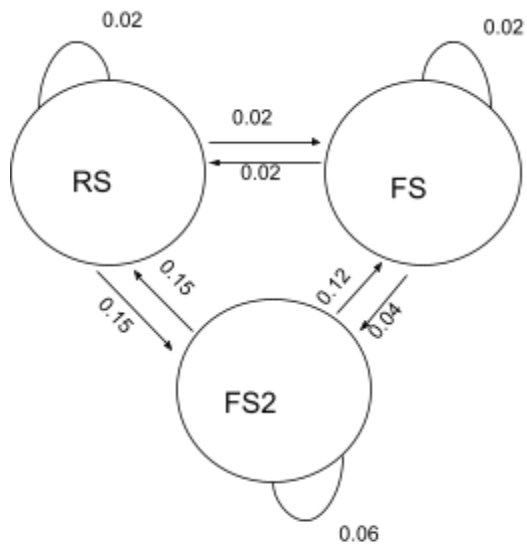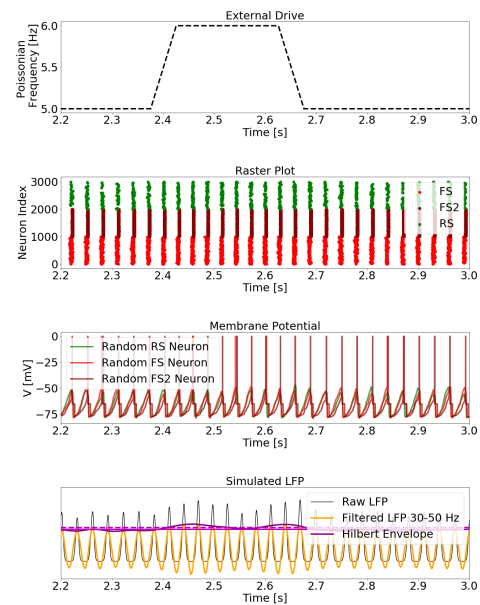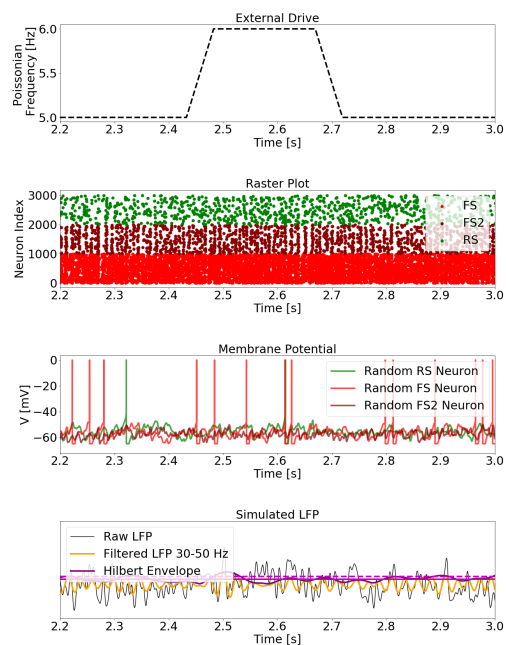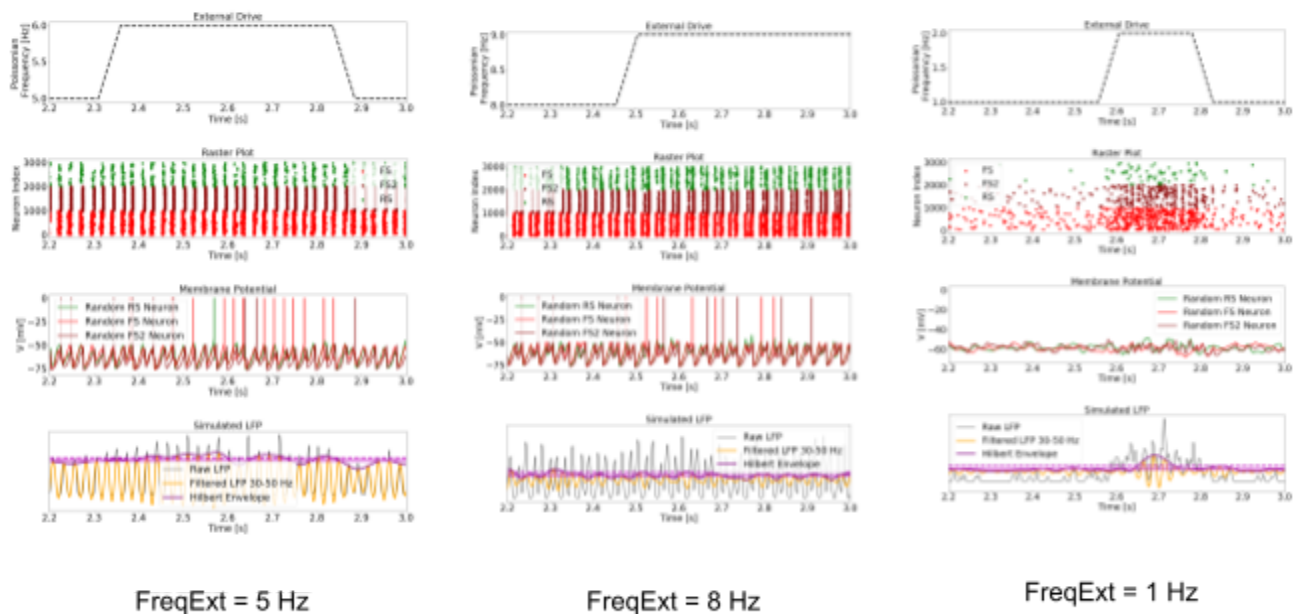n a 3s interval increases. Additionally, as the probability of FS -> FS2 increases, the frequency of the raw LFP increases and it decreases when the probability of FS -> FS2 decreases.

Q3) What would happen to the oscillations when the frequency of the external drive is increased/decreased?

A3)

FreqExt = 5 Hz   FreqExt = 8 Hz   FreqExt = 1 Hz

As seen in the above plot, as the external frequency increases, the LFP increases and as it decreases the LFP decreases.

Q4) How can the excitatory and inhibitory synaptic strengths and time scales manipulate the nature of oscillations ?
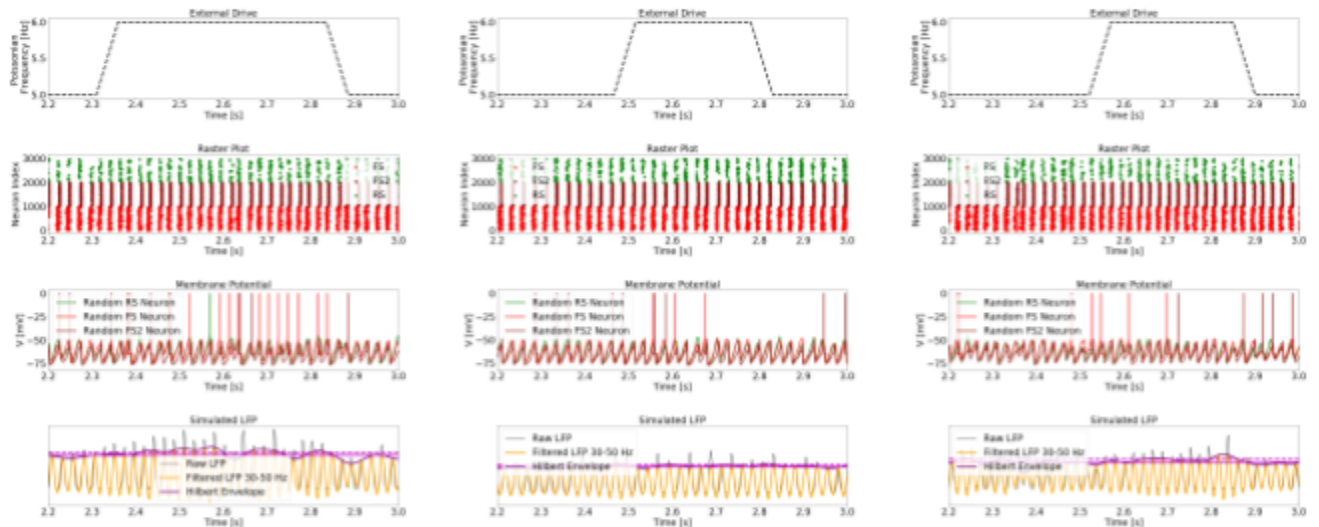
A4) Synaptic Strengths:

As the Inhibitory synaptic strength increases, the uniformity of the LFP with time increases and as it decreases, the LFP doesn't uniformly vary with time. This can be seen in the plot below.
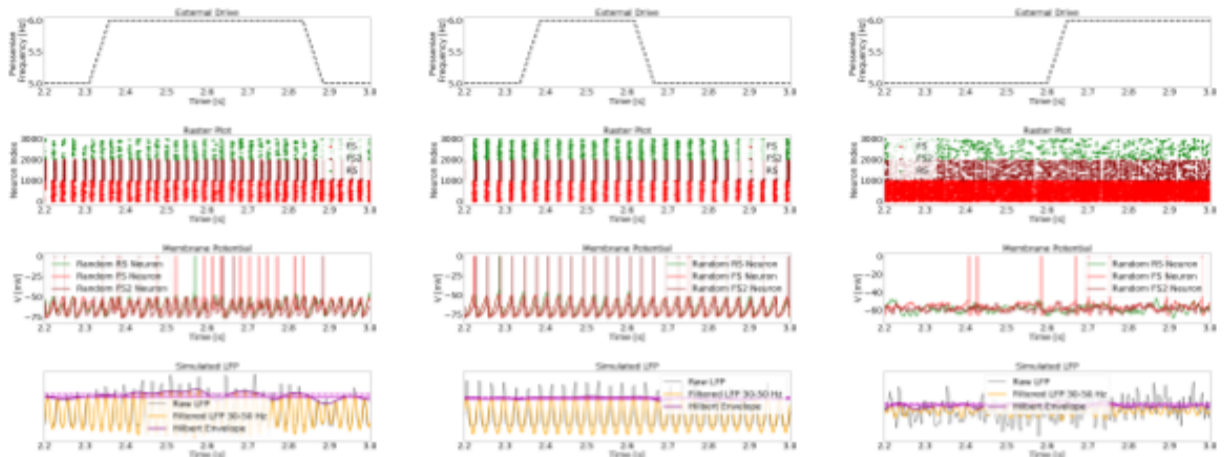
Increased Inhibitory
Synaptic Strength

Decreased Inhibitory
Synaptic Strength

Increased
excitatory
Synaptic Strength

Decreased
excitatory
Synaptic Strength

As the excitatory synaptic strength increases, the LFP values decrease, whereas it increases with the decrease in the synaptic strength.

<u>Timescales:</u>

As the inhibitory time scale decreases, the LFP values increase and become more uniform, and the LFP values decrease and the values become less uniform (

become a sine wave of much lower amplitude as the time passes). Similarly the LFP values increase with an increase in the excitatory timescale and decrease when the excitatory time scale decreases.

Increased Inhibitory timescale

decreased Inhibitory timescale

Increased Excitatory timescale

Decreased excitatory timescale