<u>PROJECT TITLE</u> : **MODELLING THE MUSHROOM BODY CIRCUITRY TO UNDERSTAND THE ROLE OF FEEDBACK MECHANISMS FROM THE ALPHA AND BETA LOBES TO THE CALYX**

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Presented by :
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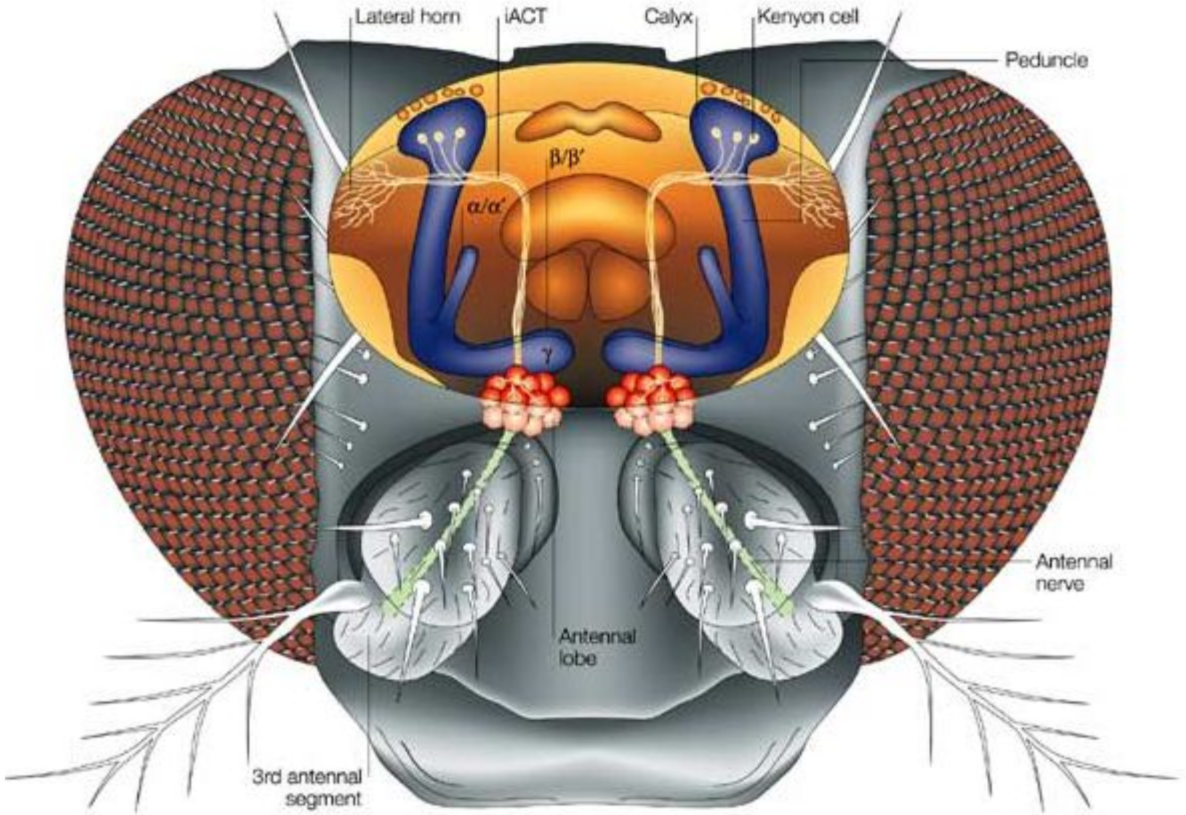
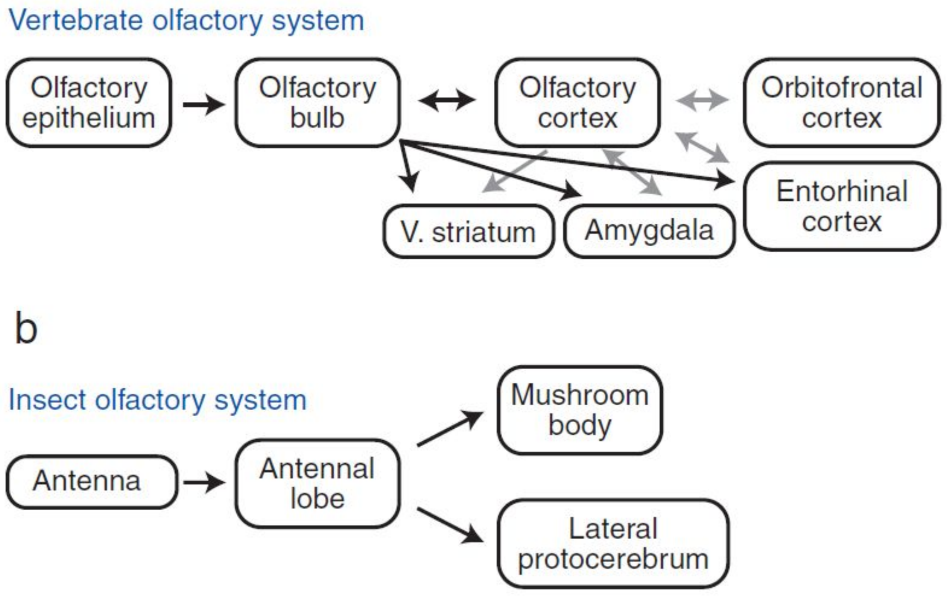
INTRODUCTION





Gross anatomy of the olfactory system. Olfactory receptor neurons in primary sensory organs project to a single region of the brain: (***a***) the olfactory bulb (in vertebrates) or **(*b*)** the antennal lobe (in insects). From there, second-order olfactory neurons send direct projections to higher brain regions involved in multimodal sensory integration, learning, and higher cognitive function. This implies that much olfactory processing occurs in the olfactory bulb or antennal lobe. Panel *a* after Haberly (2001).

(Rachel etal, 2006)

MUSHROOM BODY: CALYX , ALPHA AND BETA LOBES

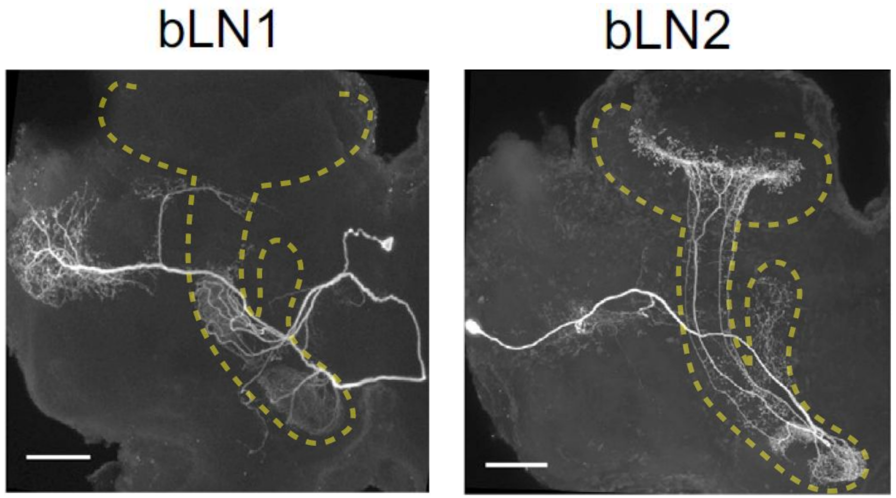


Fig. Morphologies of bLN1 and bLN2 neurons

(Nitin Gupta, Mark Stopfer,2014)

bLN1: output –LH ; bLN2 : output - Alpha Lobe , Beta Lobe and KC

Undense spike patterns, KCs are nearly silent at rest, respond like PNs which show spontaneous activity and selectively to odors with very few spikes. These responses are thought to be advantageous for distinguishing odors and learning associations.

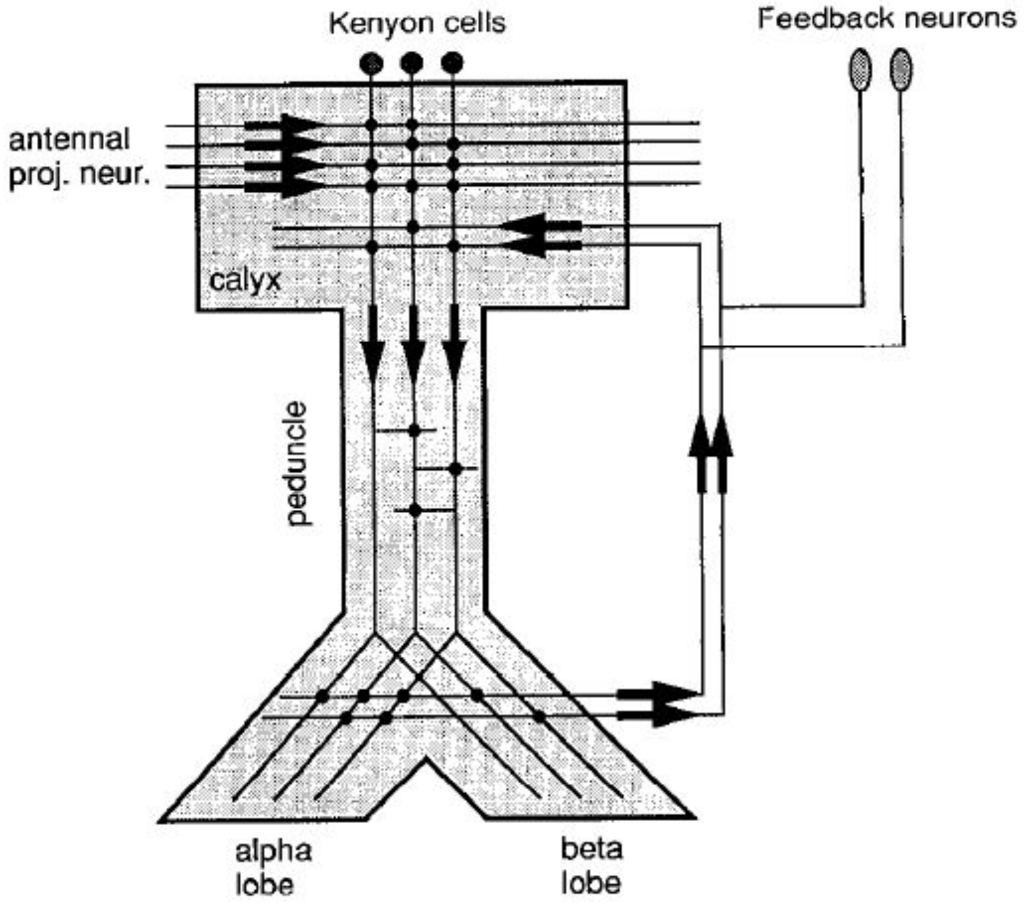
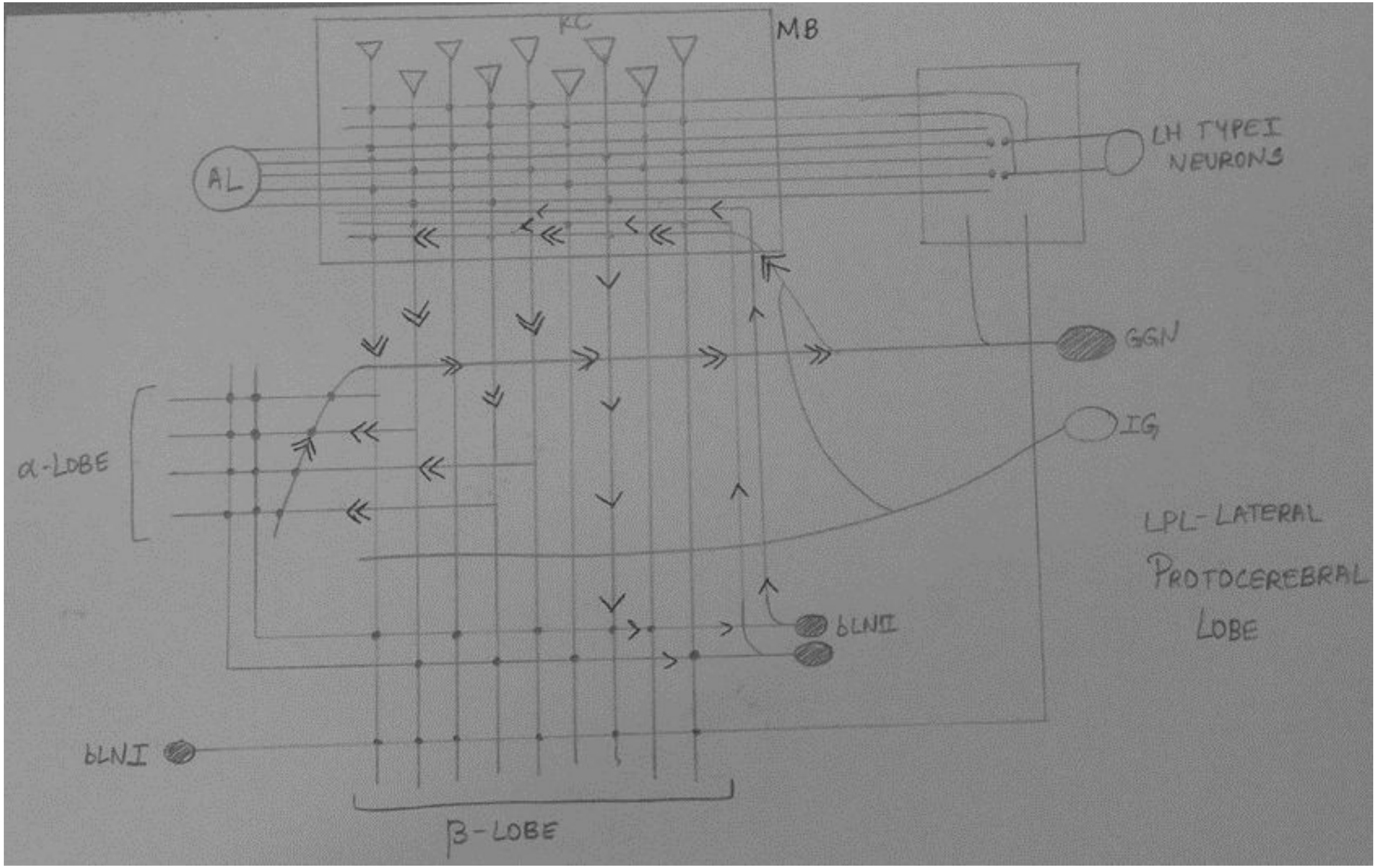


Fig . Schematic diagram of the circuits formed by KCs in MB

(Laurent etal 1994)

Fig. MUSHROOM BODY CIRCUIT



STDP(Spike Timing Dependent Plasticity): process by which strength of the connections between neurons is dependent on the relative timings of particular neuron's output and input action potentials

OBJECTIVES

- To construct a model of mushroom body network taking into account all feedback mechanisms known by incorporating connectivity , plasticities , physiology of each neuron type

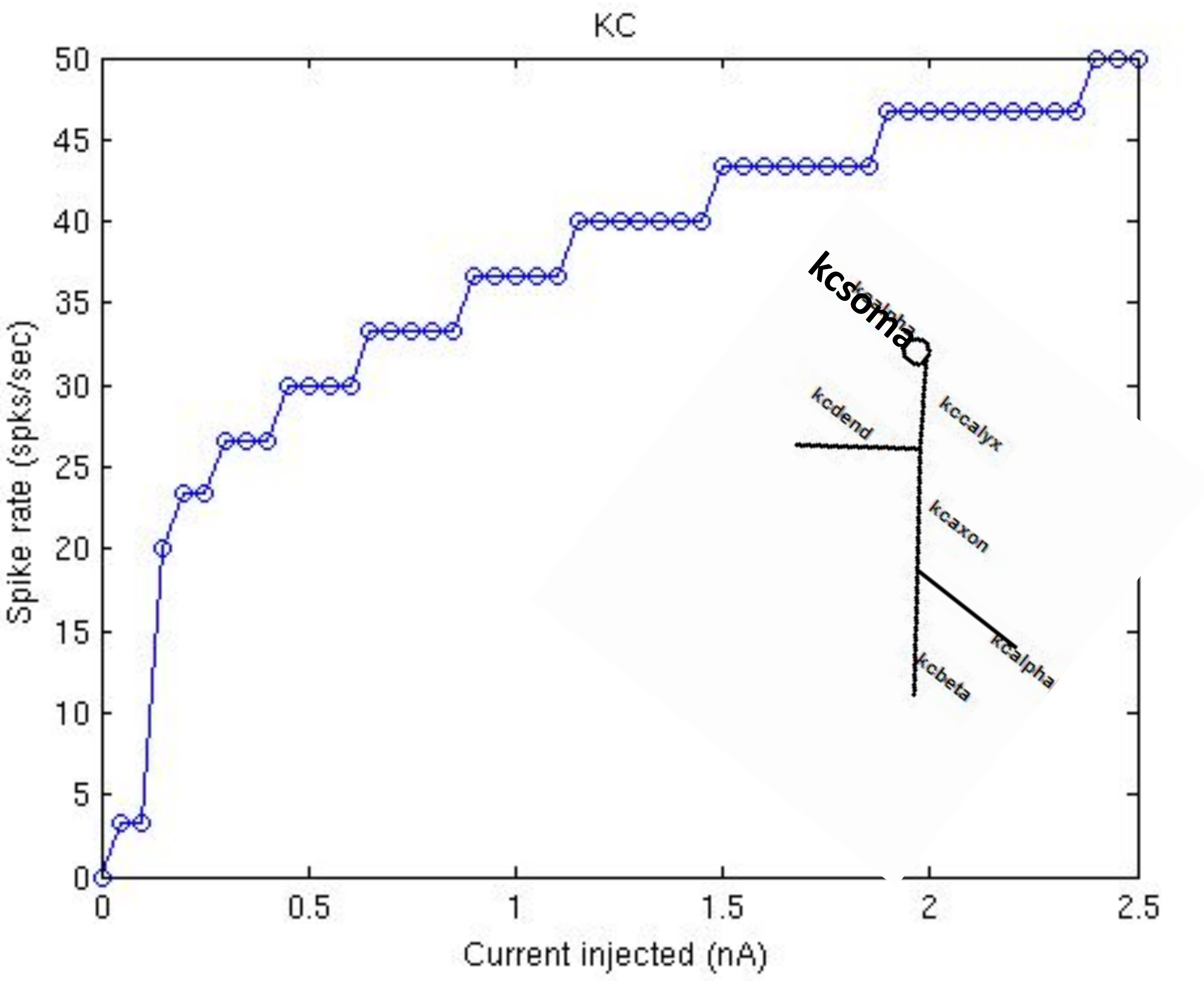
- To predict the behavior and role of this circuit

- To understand how the mushroom body network is involved in olfactory associate memory

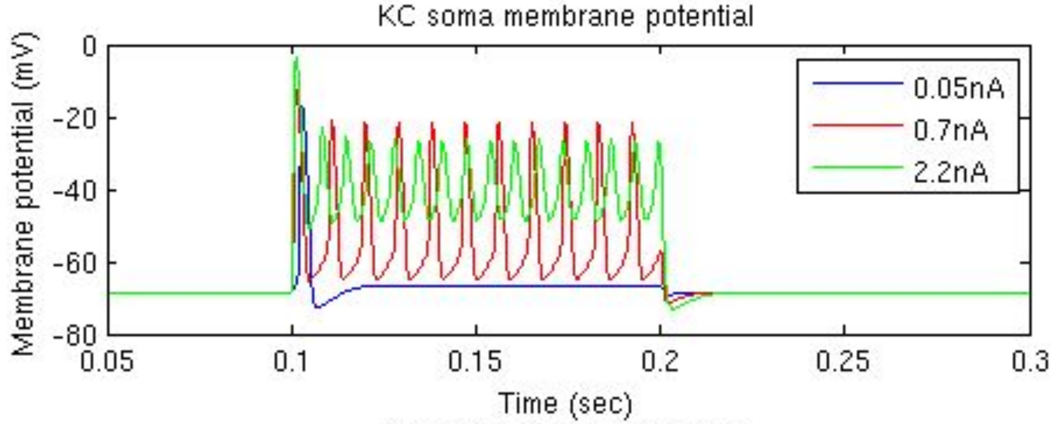
PROCEDURE

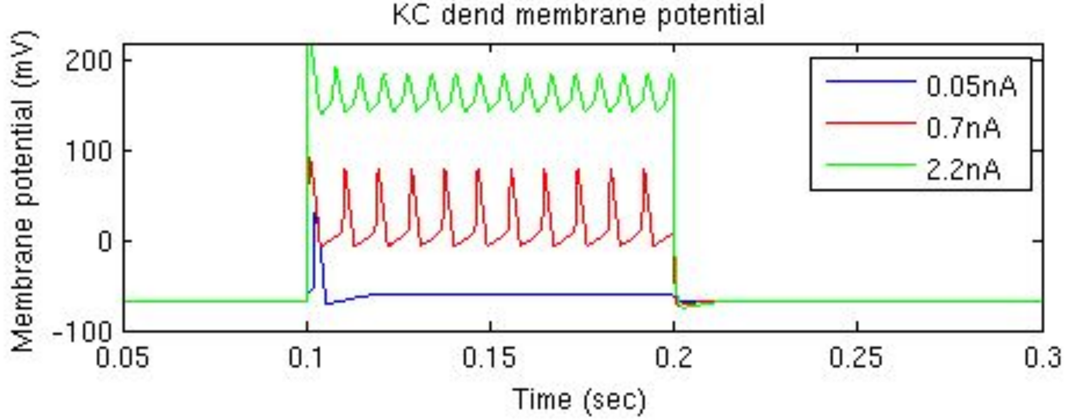
- Morphology was constructed in NEURON simulator.
- Measured the voltages in different sections using hoc.
- Each simulation in NEURON lasted for 400 msec. 100 msec – delay ; current injected for 100 msec.
- The data was processed in MATLAB to get the figures.

HOW DOES KC BEHAVE ?

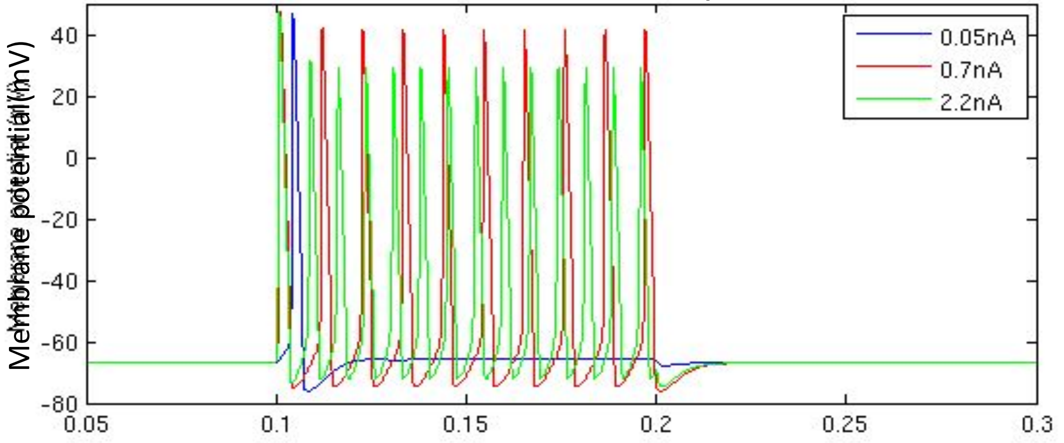


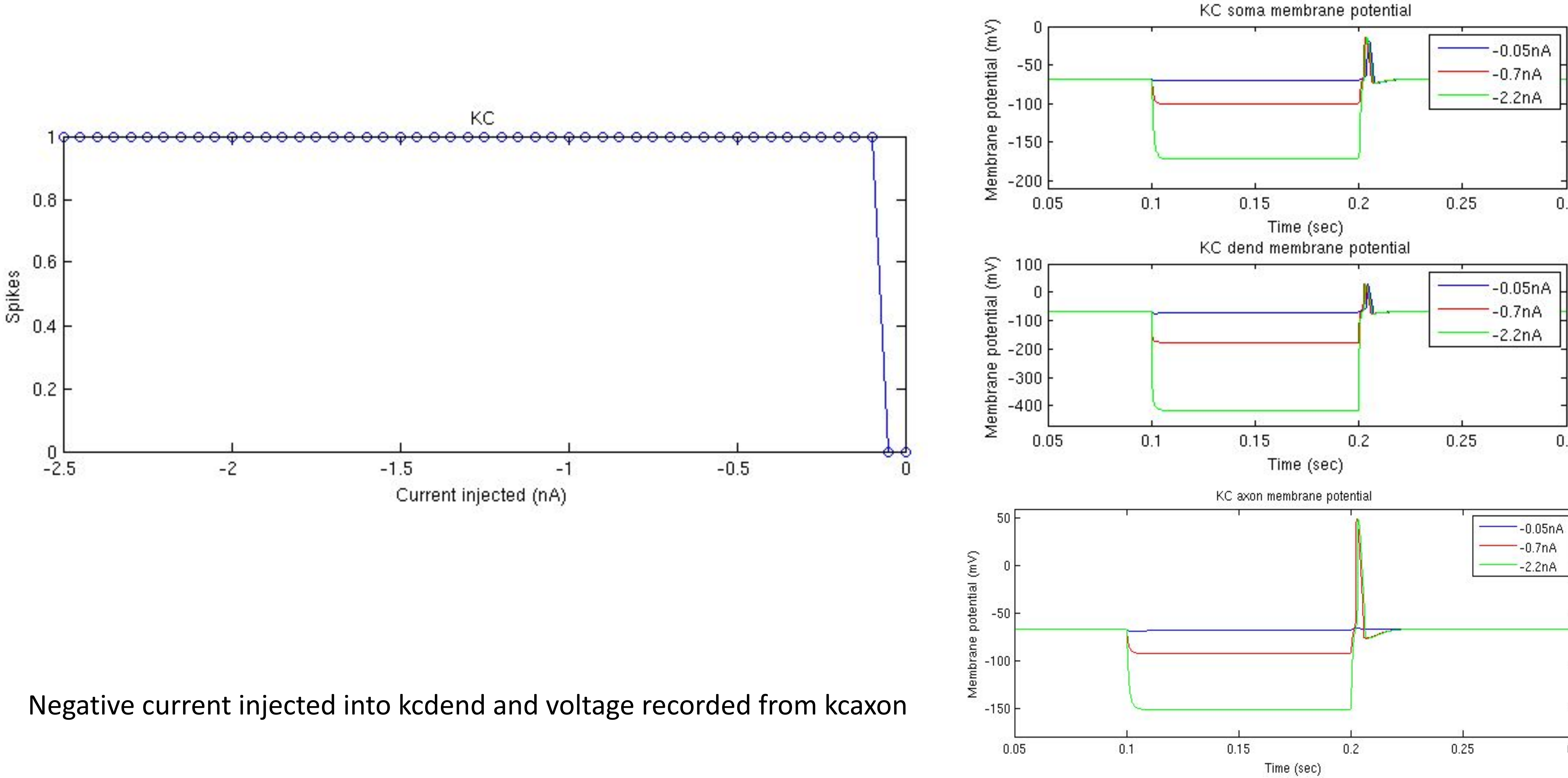
Positive current injected into kcdend and voltage recorded from kcaxon





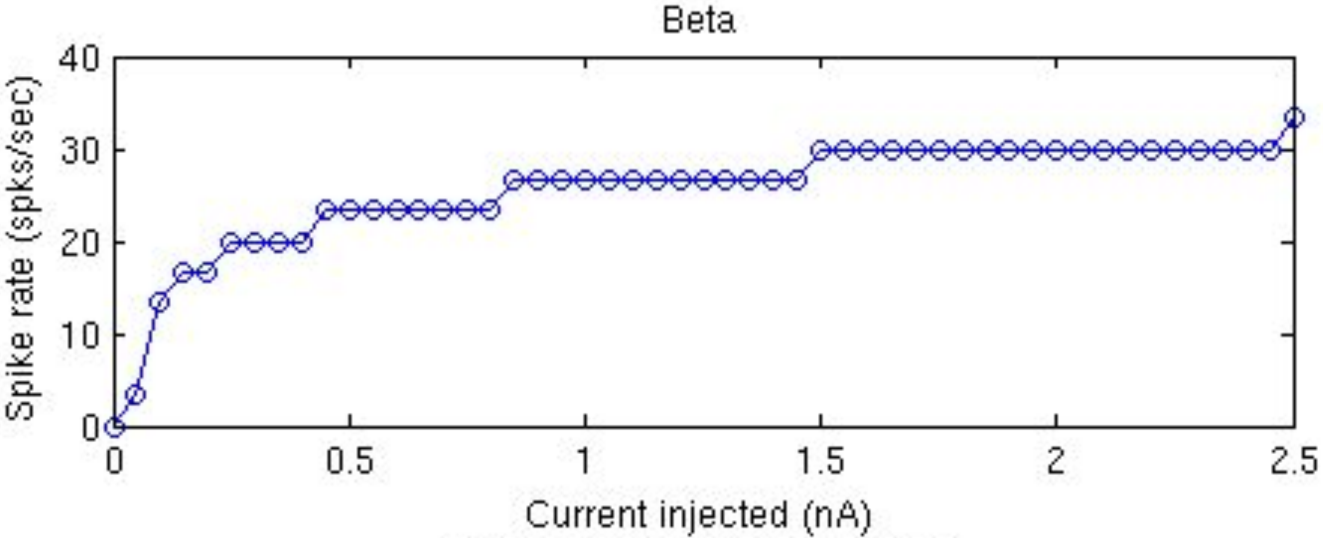
KC axon membrane potential

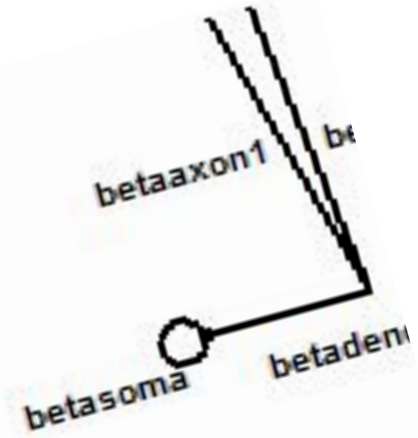


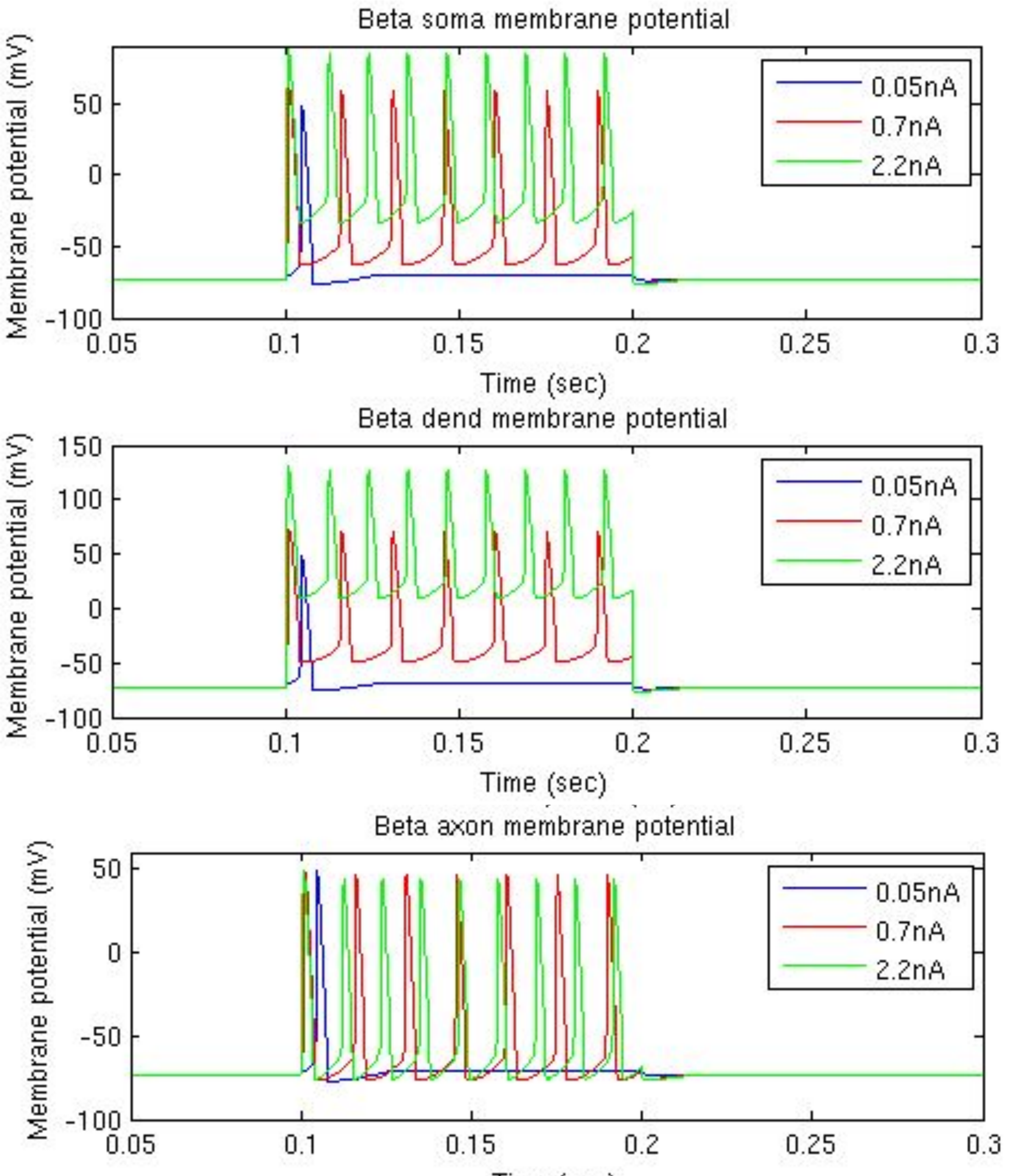


Negative current injected into kcdend and voltage recorded from kcaxon

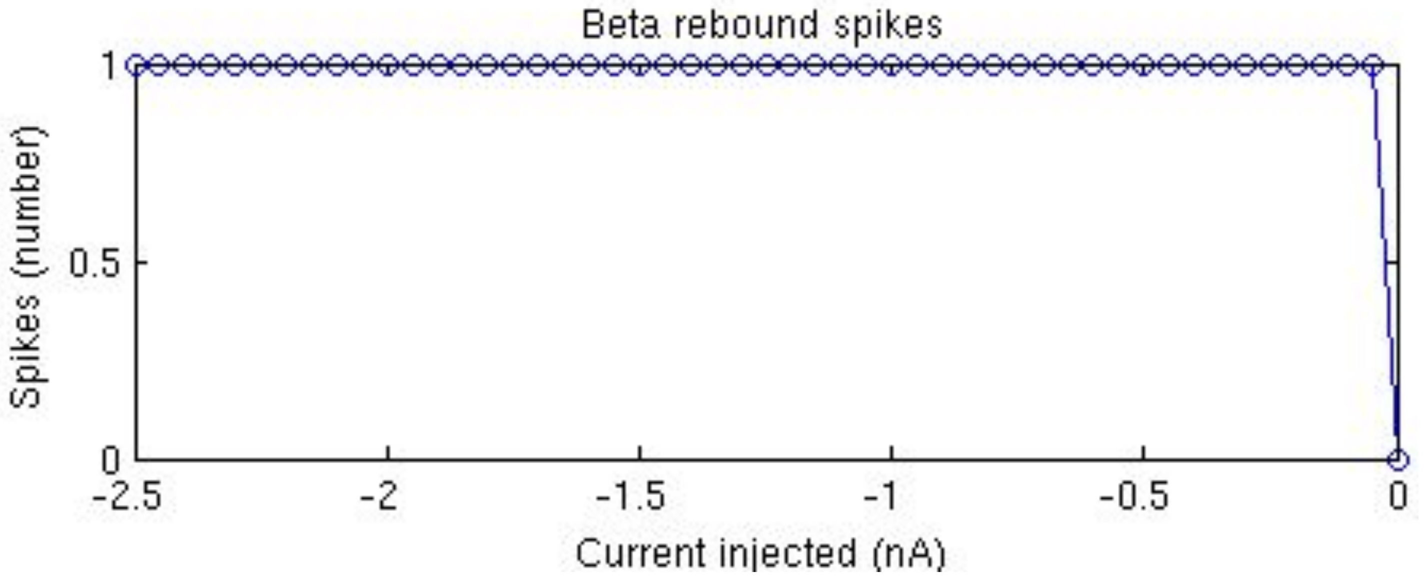
HOW DOES bLN2 BEHAVE?

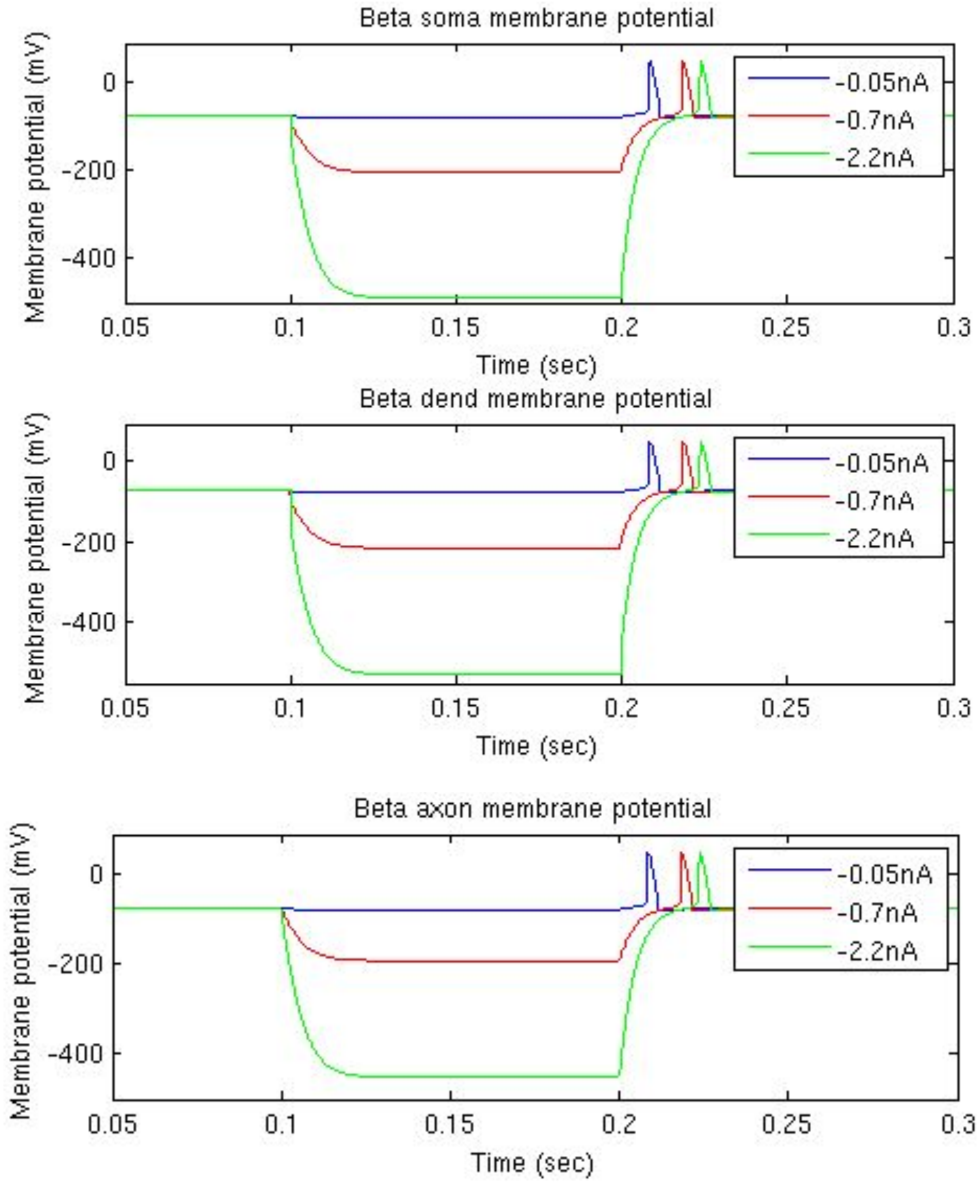






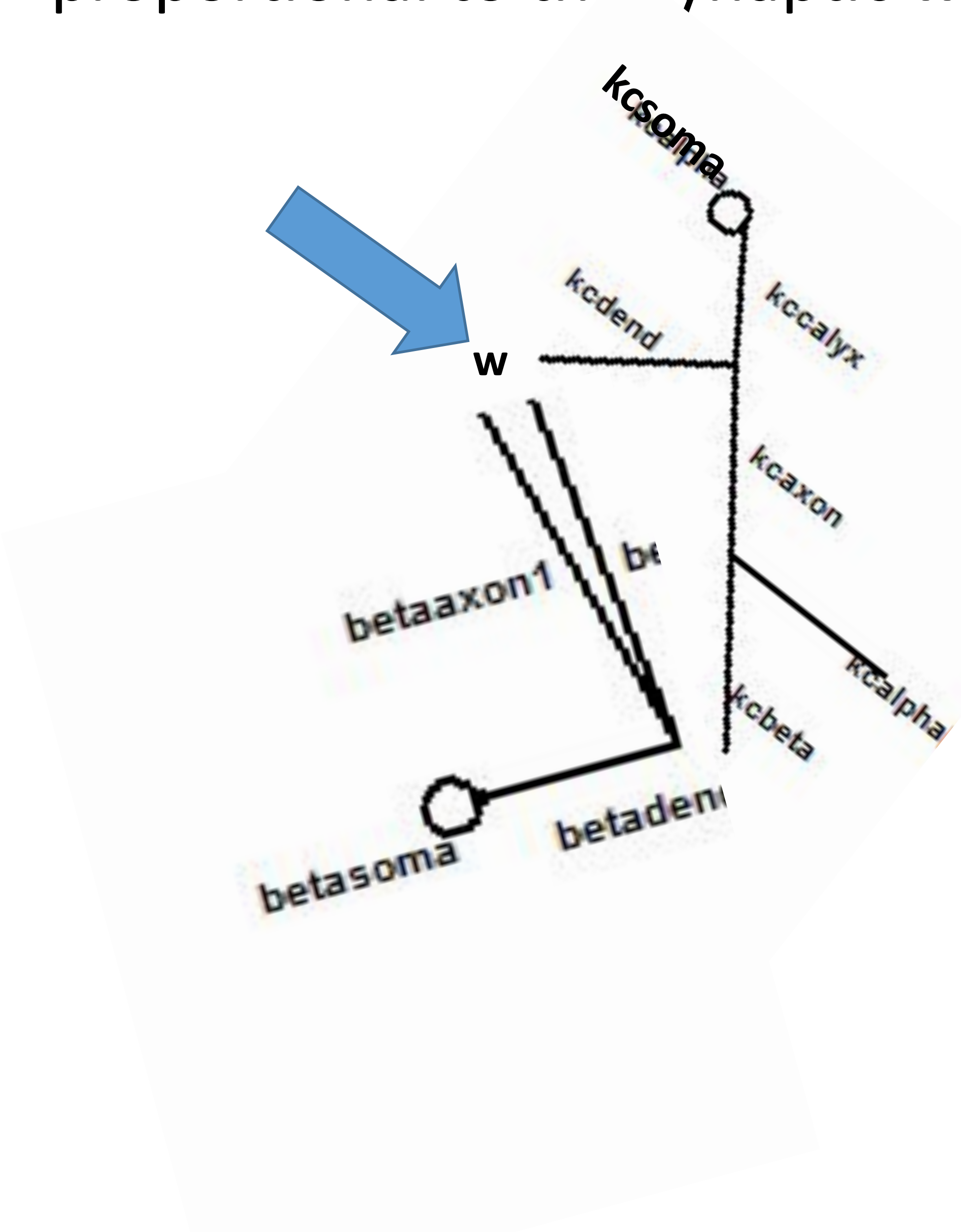
positive current injected into betadend and V recorded from betaaxon

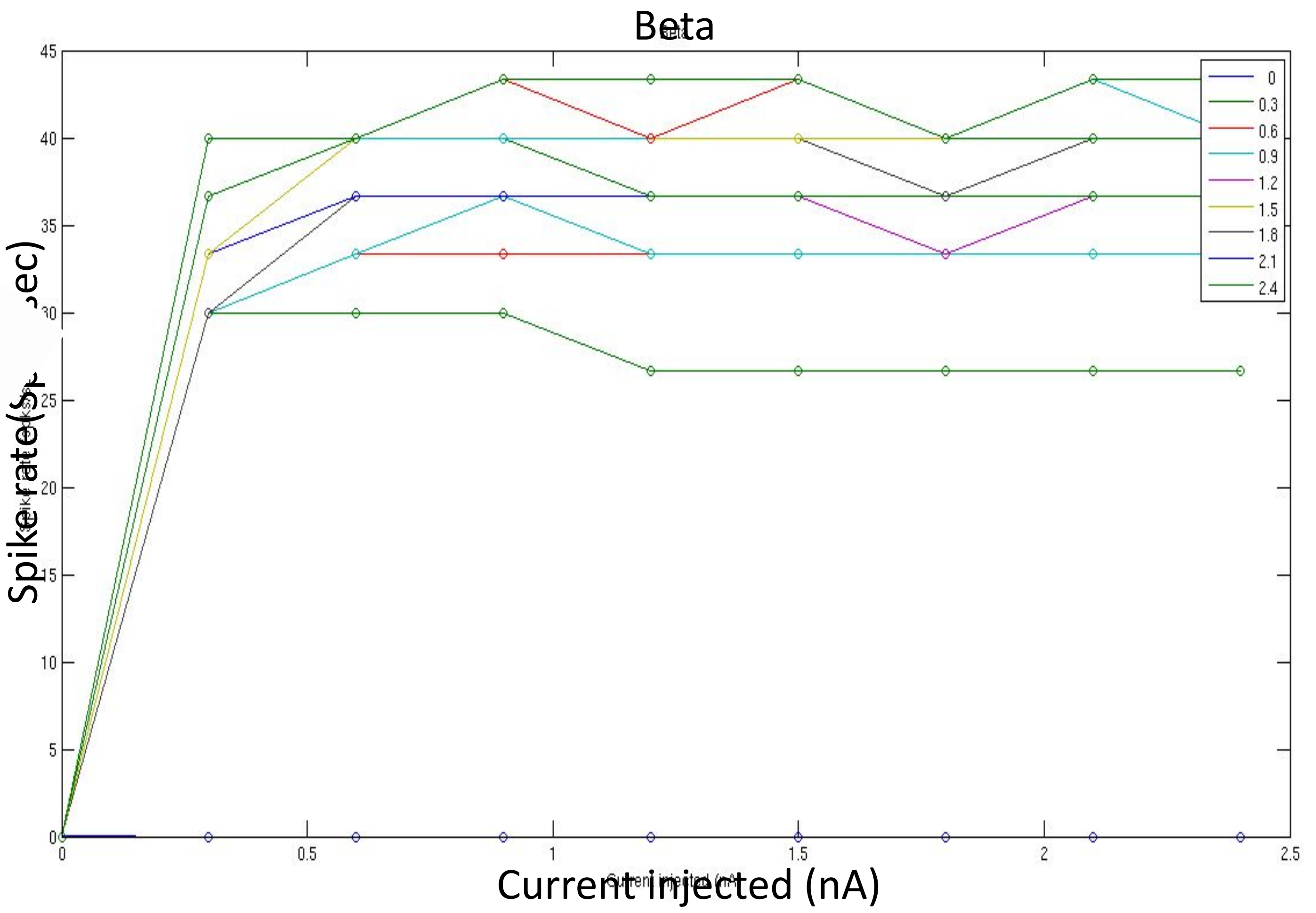




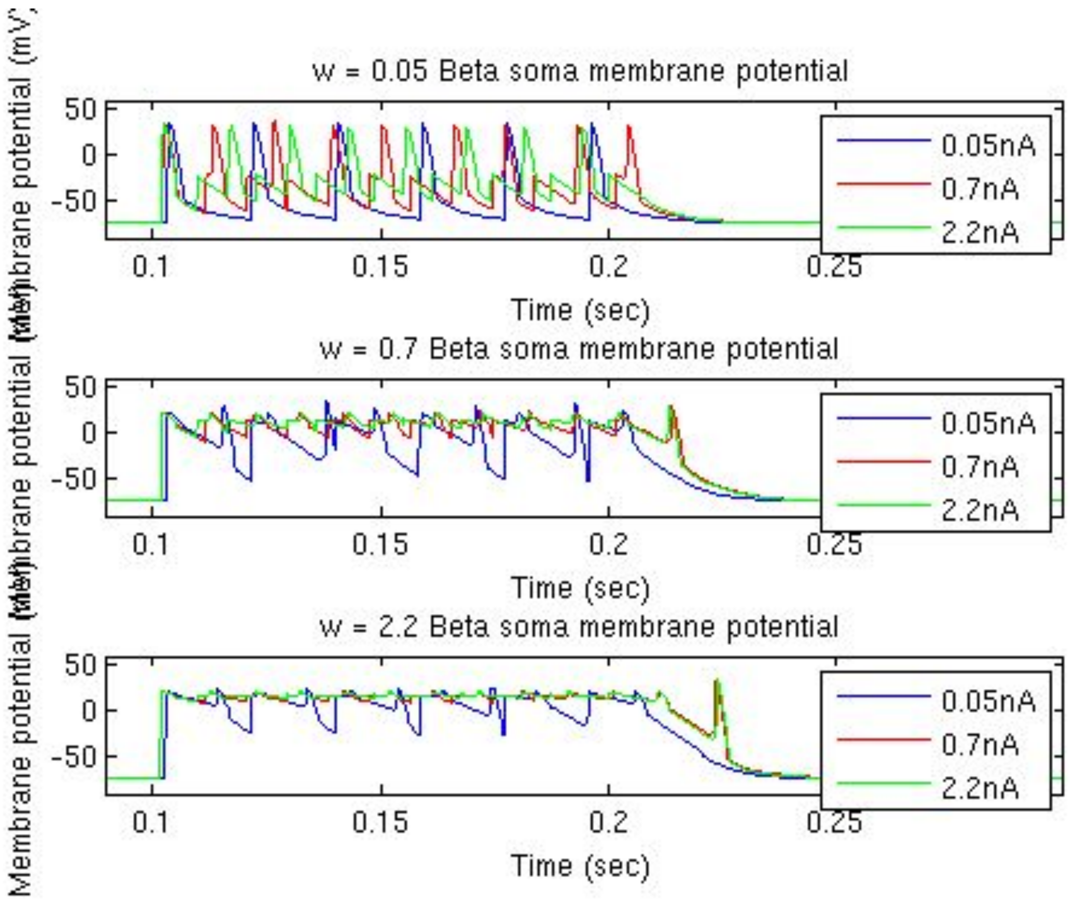
Negative current injected into dend and voltage recorded from axon

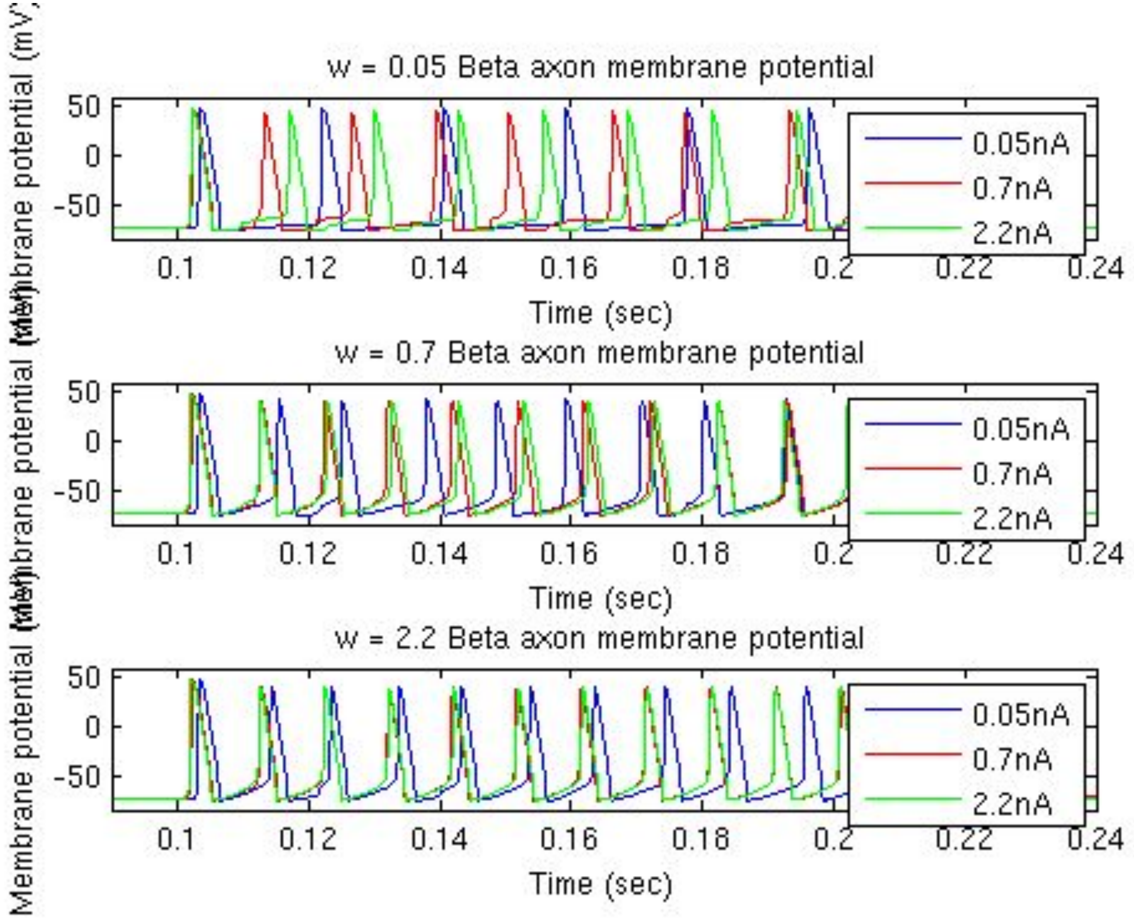
With increasing currents injected into KC, bLN2 firing rate increases proportional to the synaptic weights

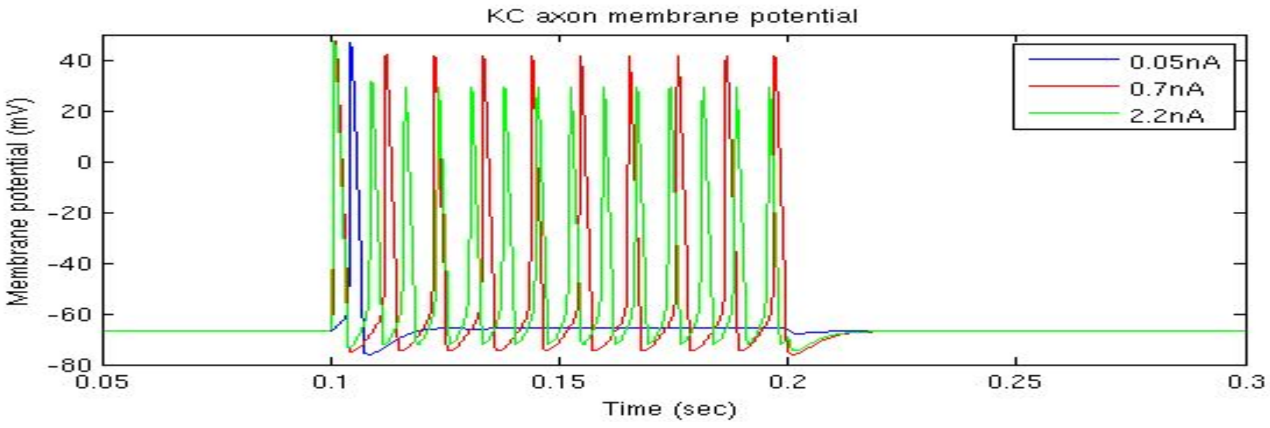




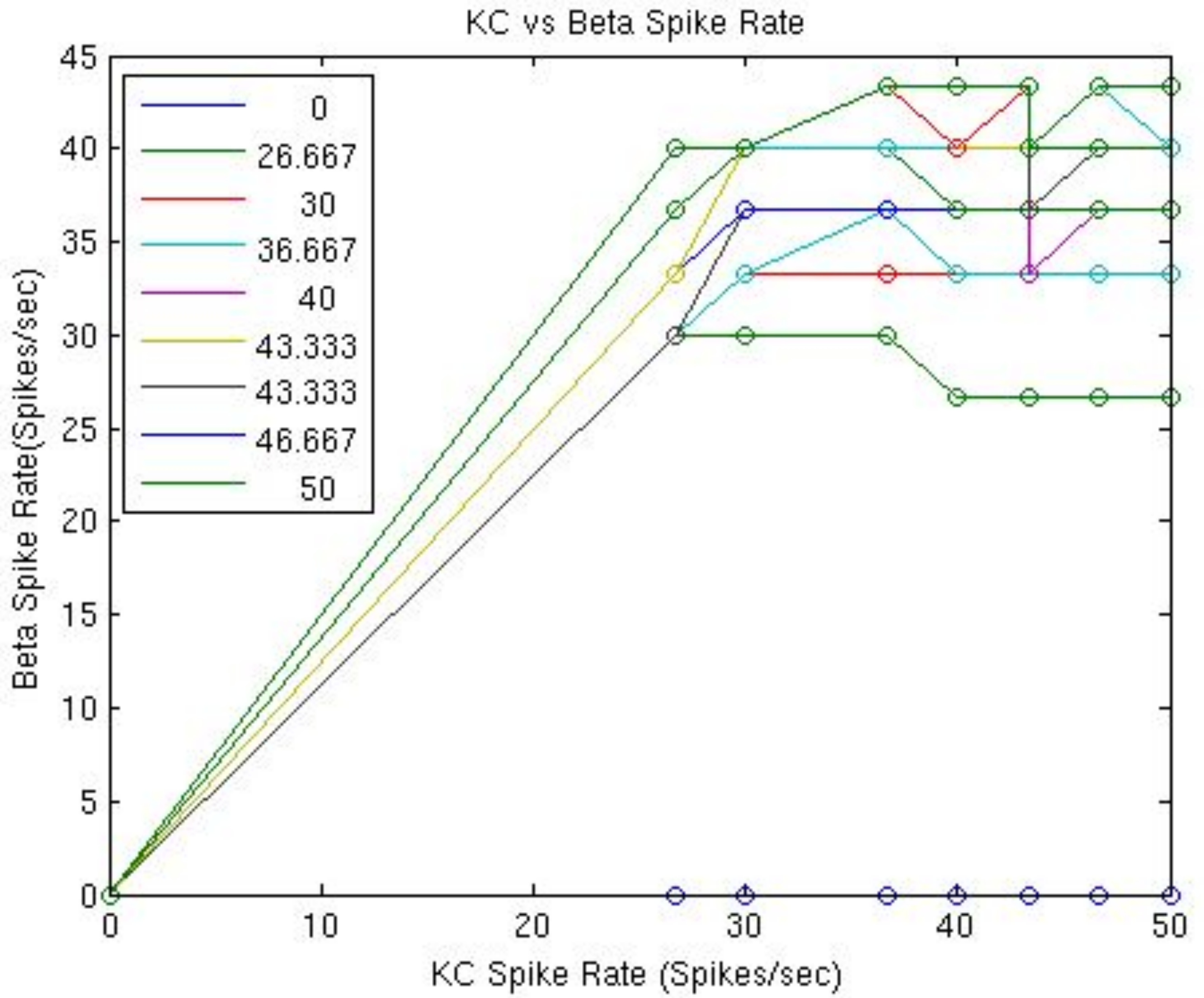
Traces of Membrane Potential at bLN2soma and bLN2axon



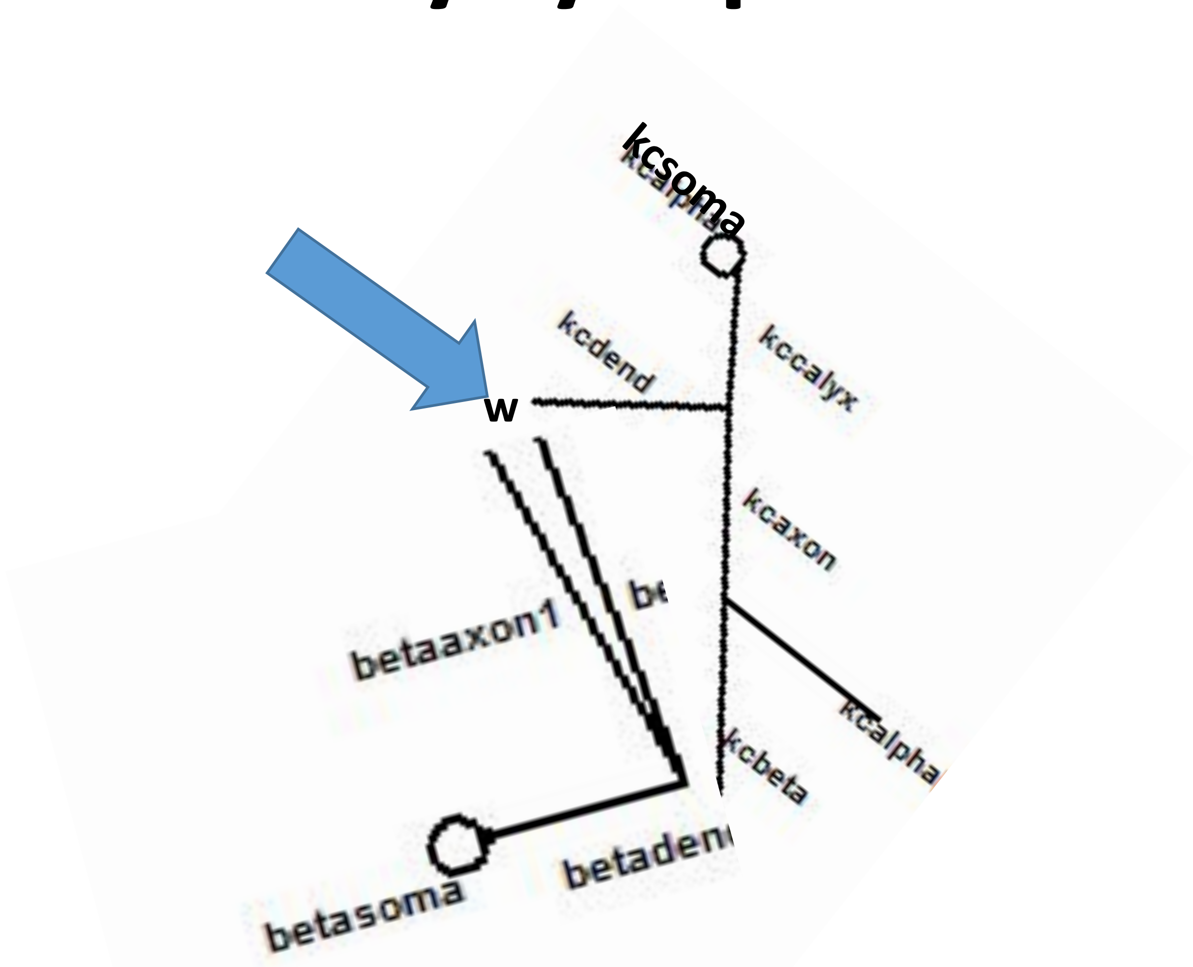


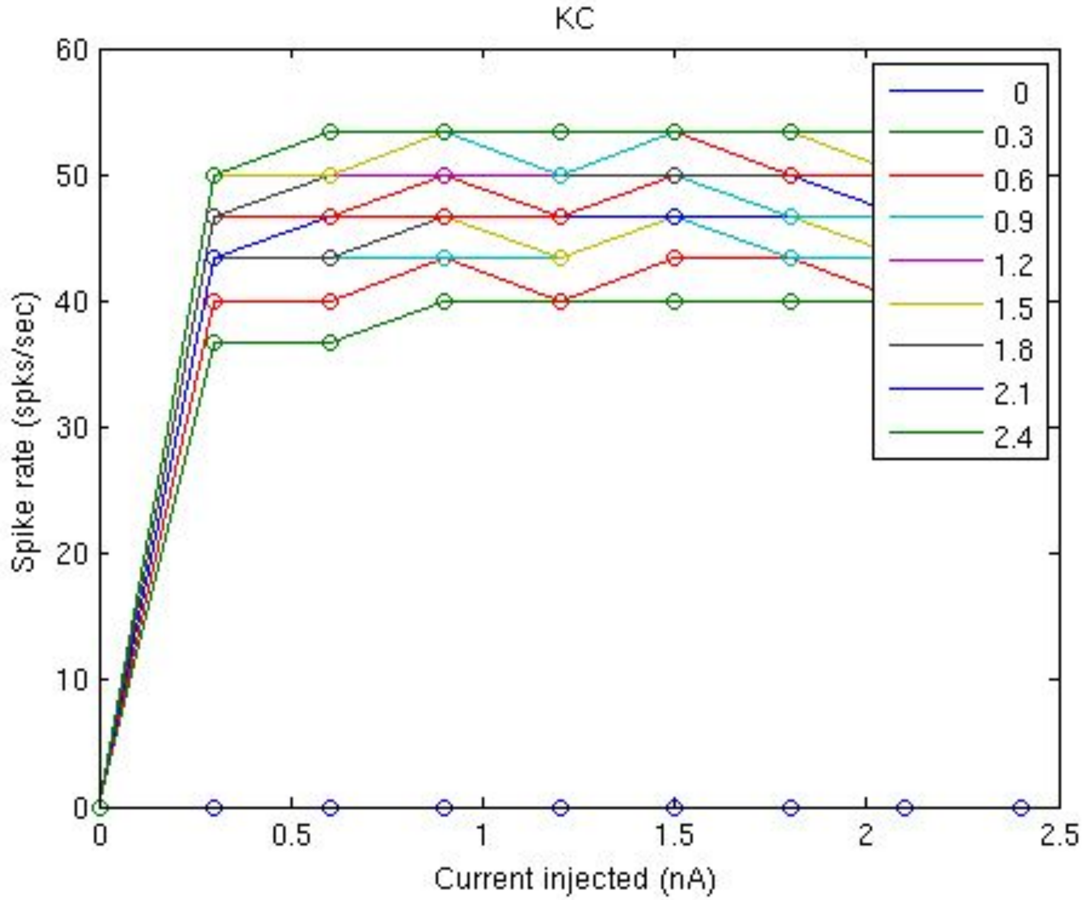


KC vs Beta Spike Rate



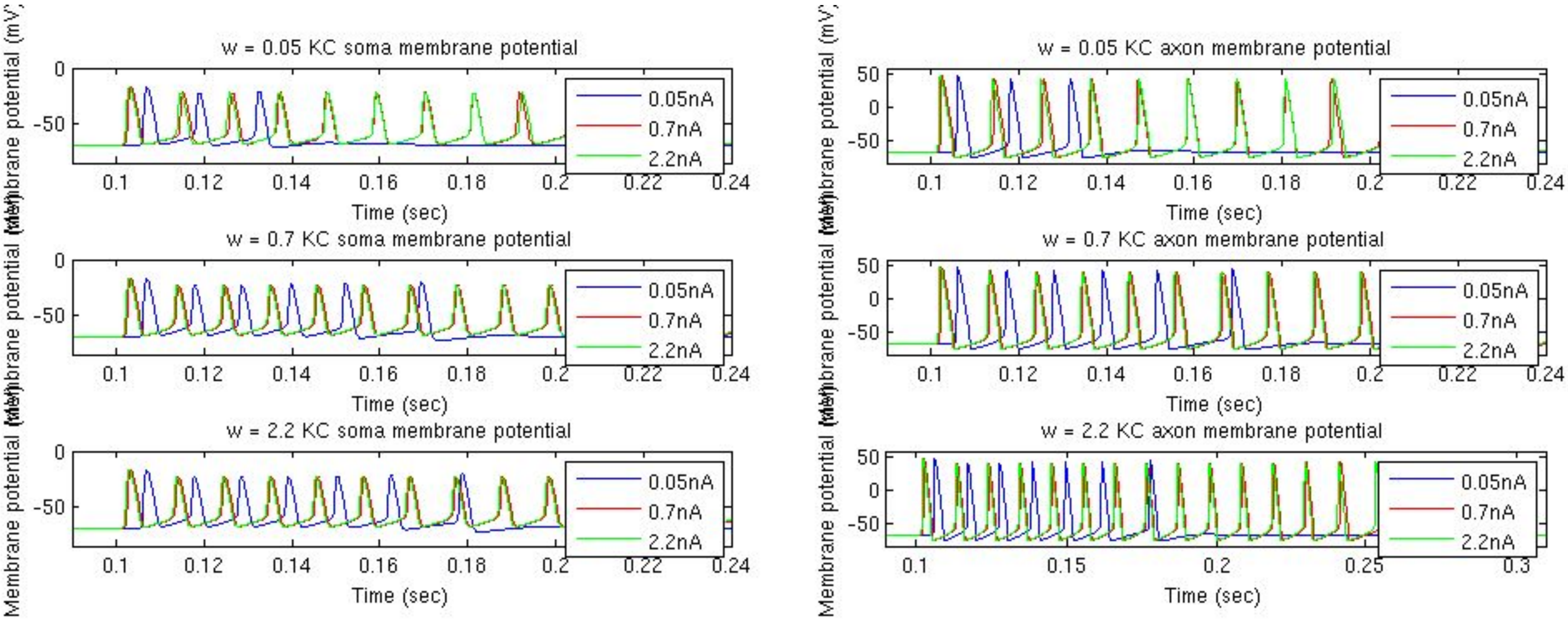
Excitatory synapse between bLN2 and KC



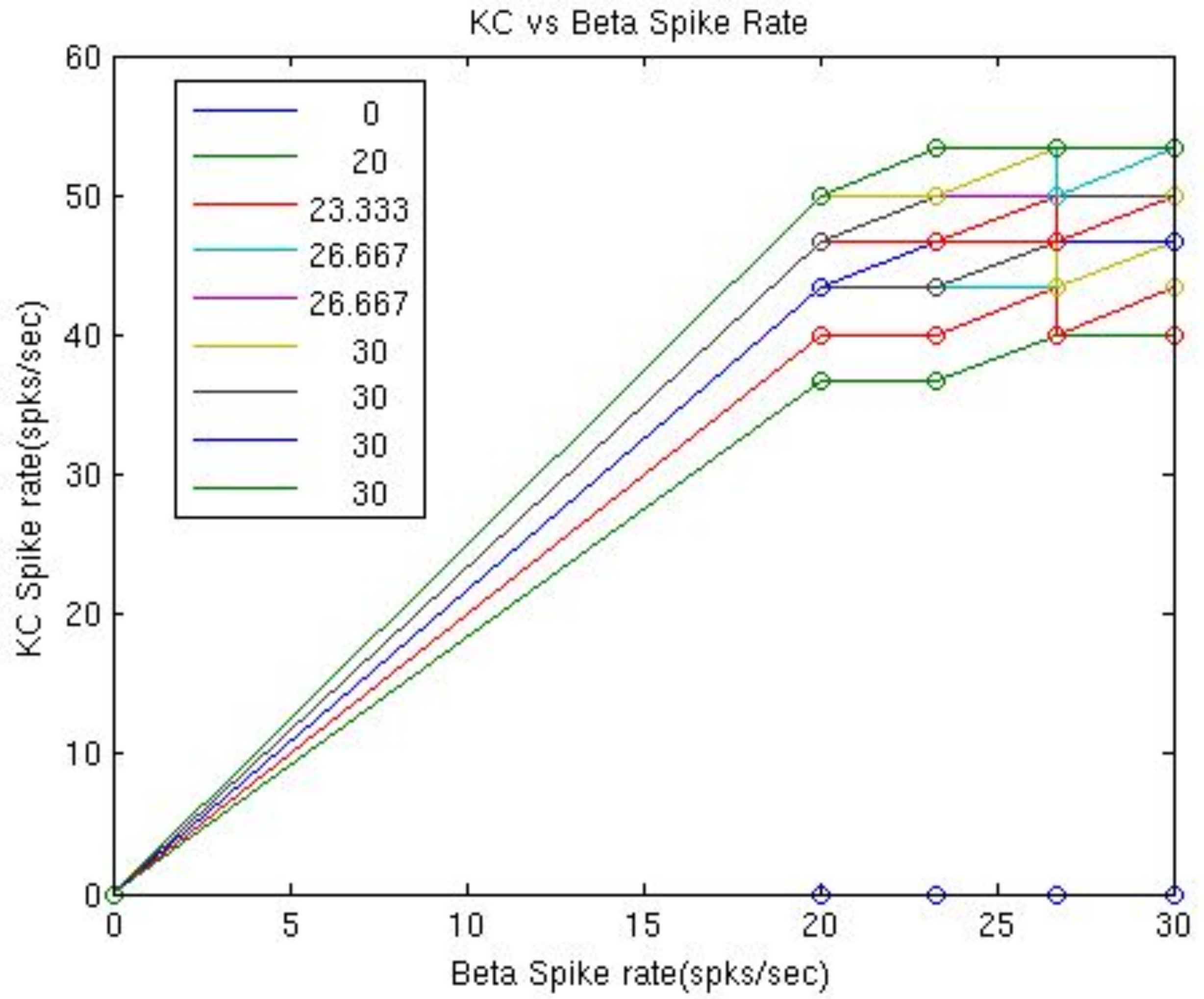


Positive current injected into betadend and voltage recorded from kcaxon, syn.e = +ve

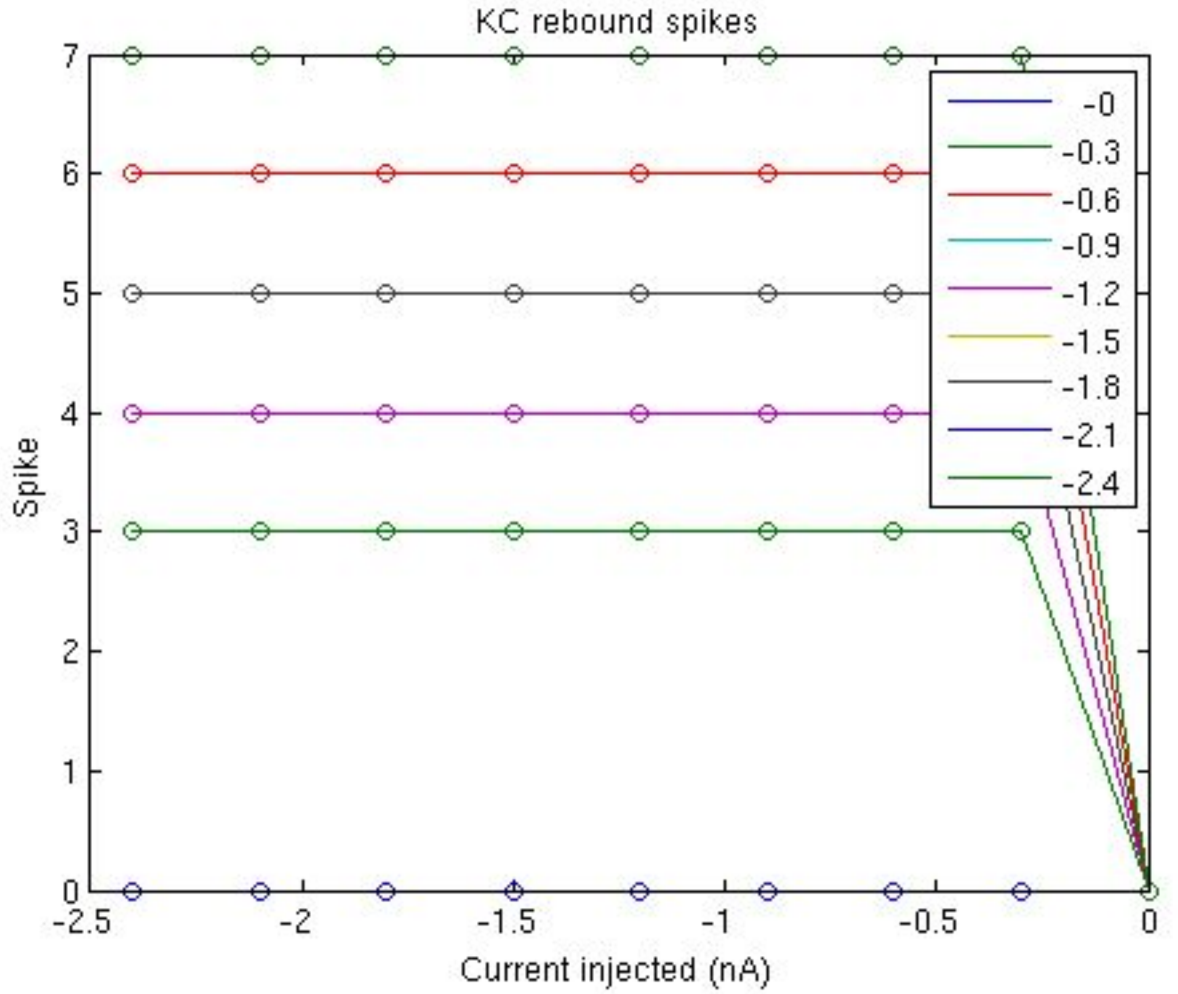
Traces of Membrane Potential at KCsoma and KCaxon



KC vs Beta Spike Rate

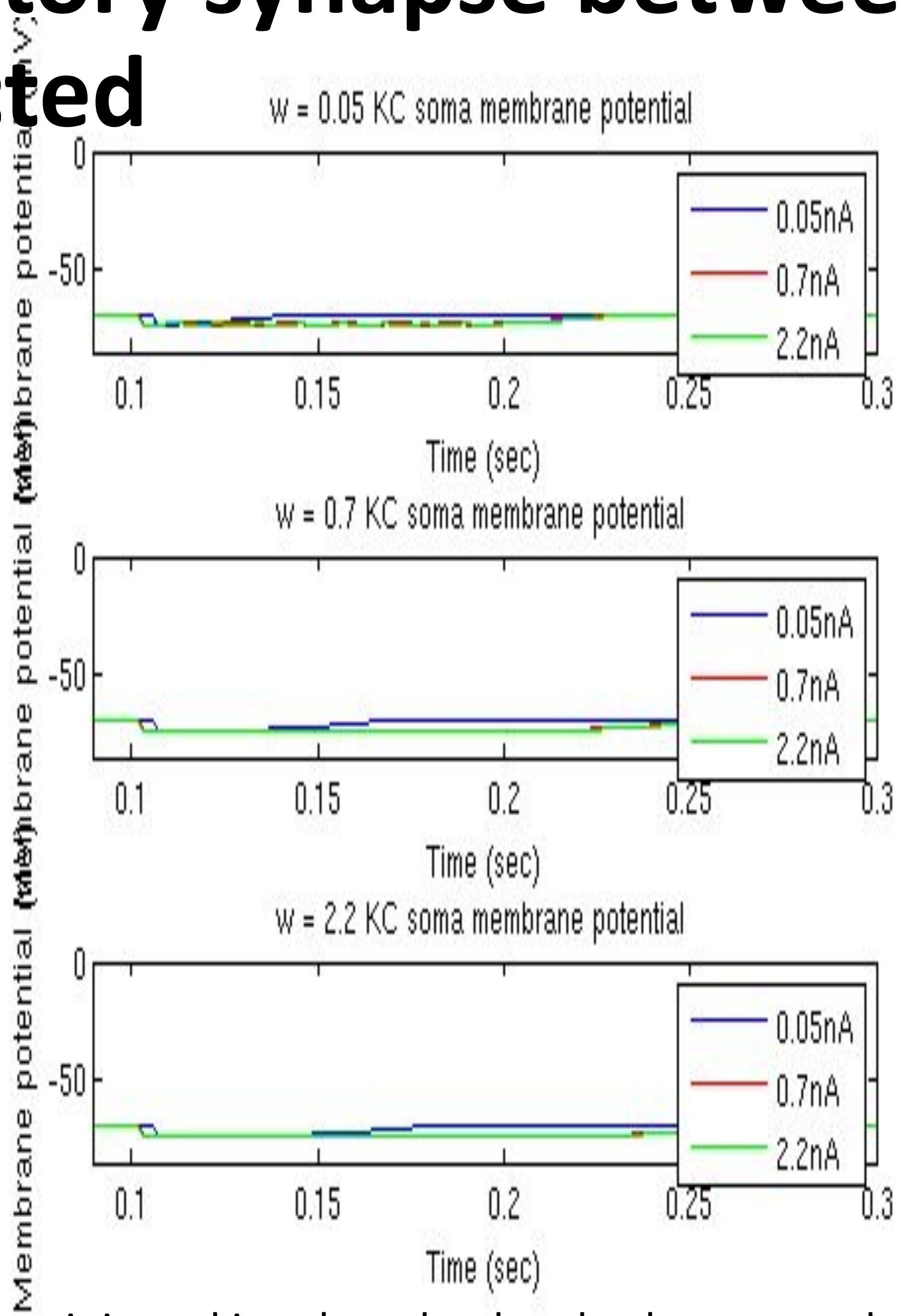


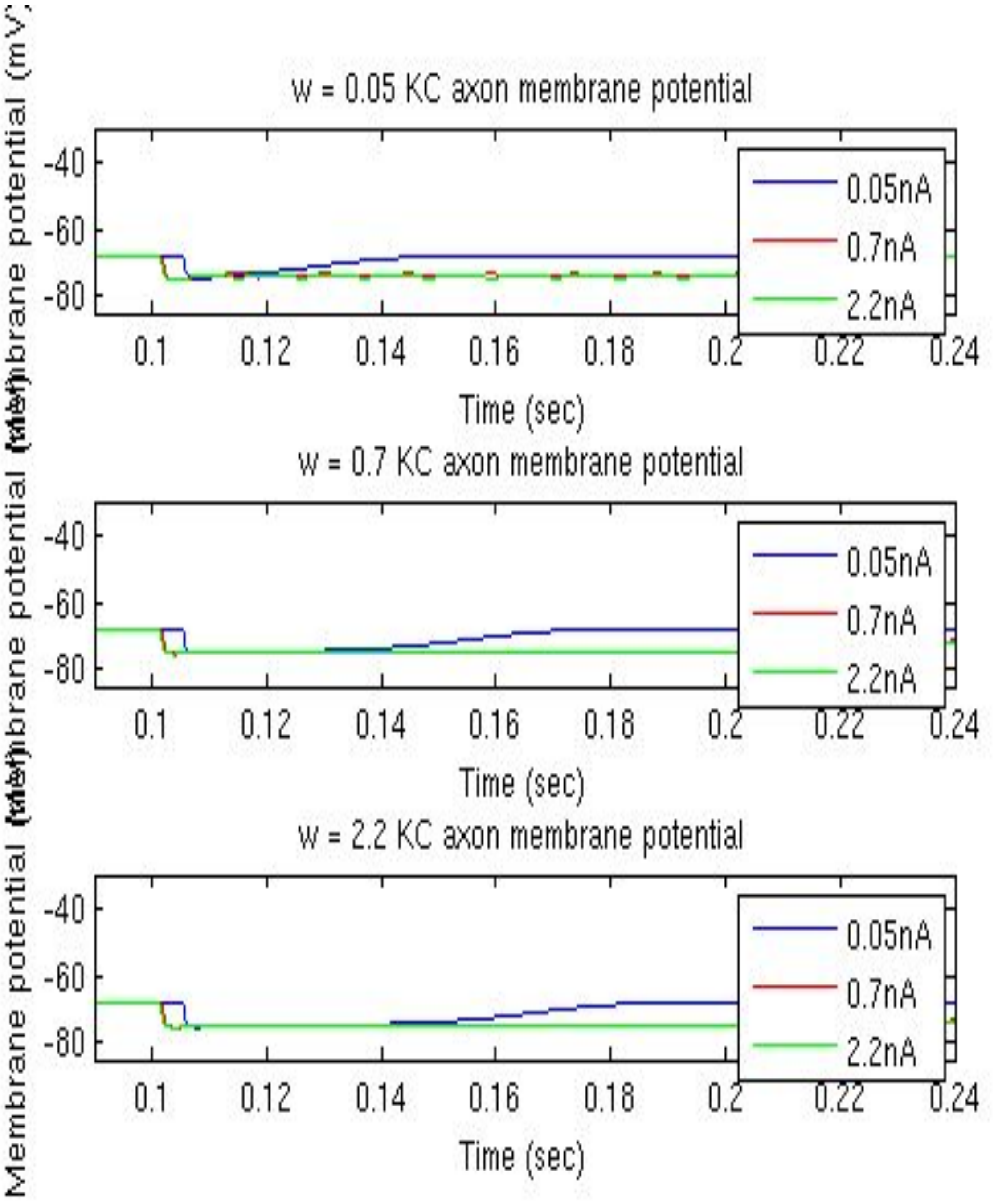
Inhibitory current from bLN2 to KC



Negative current injected into betadend and voltage recorded from kcaxon, syn.e = +ve

Inhibitory synapse between bLN2 and KC works as expected





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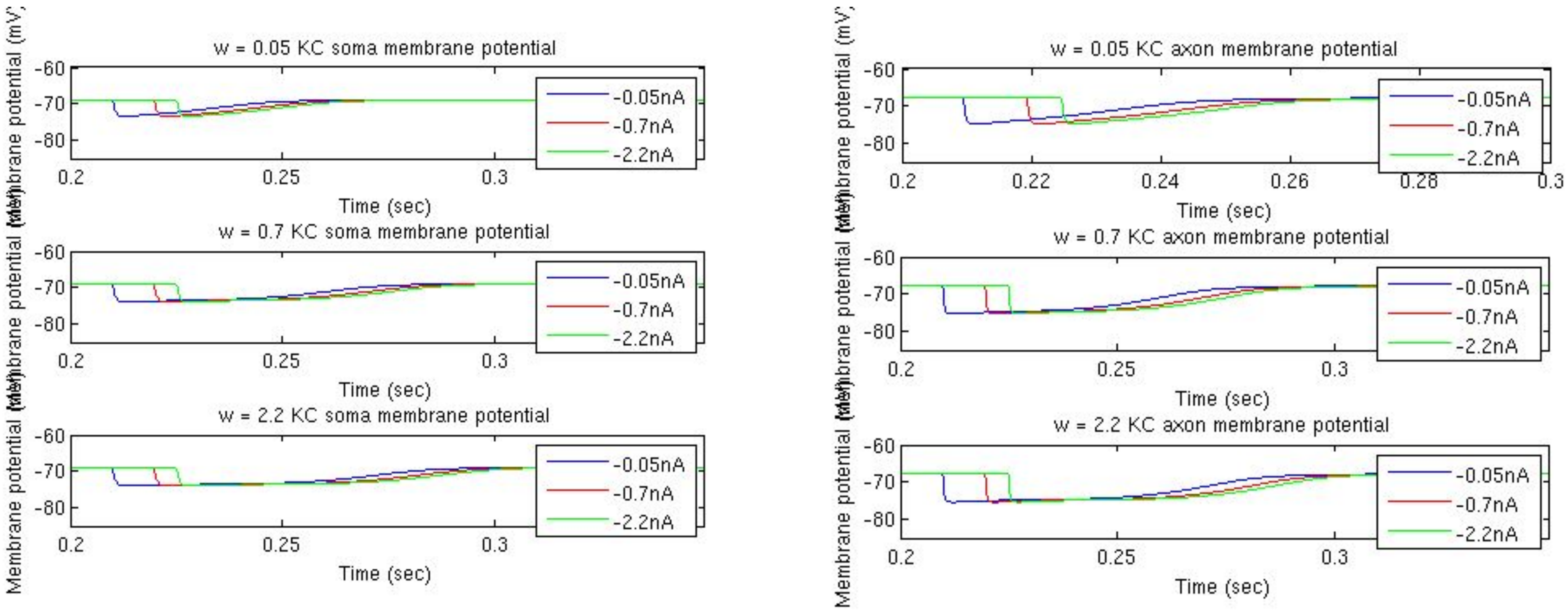
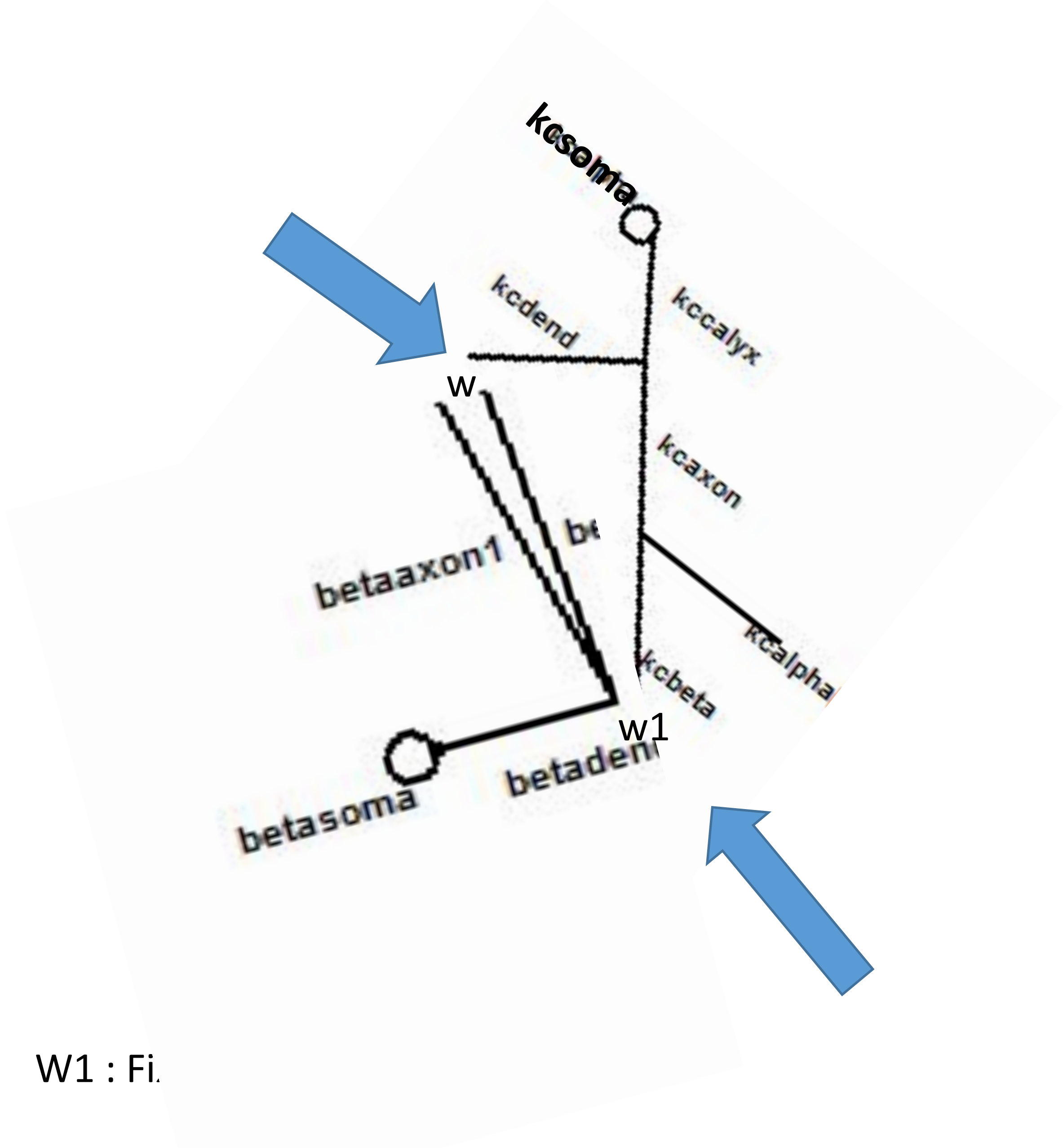
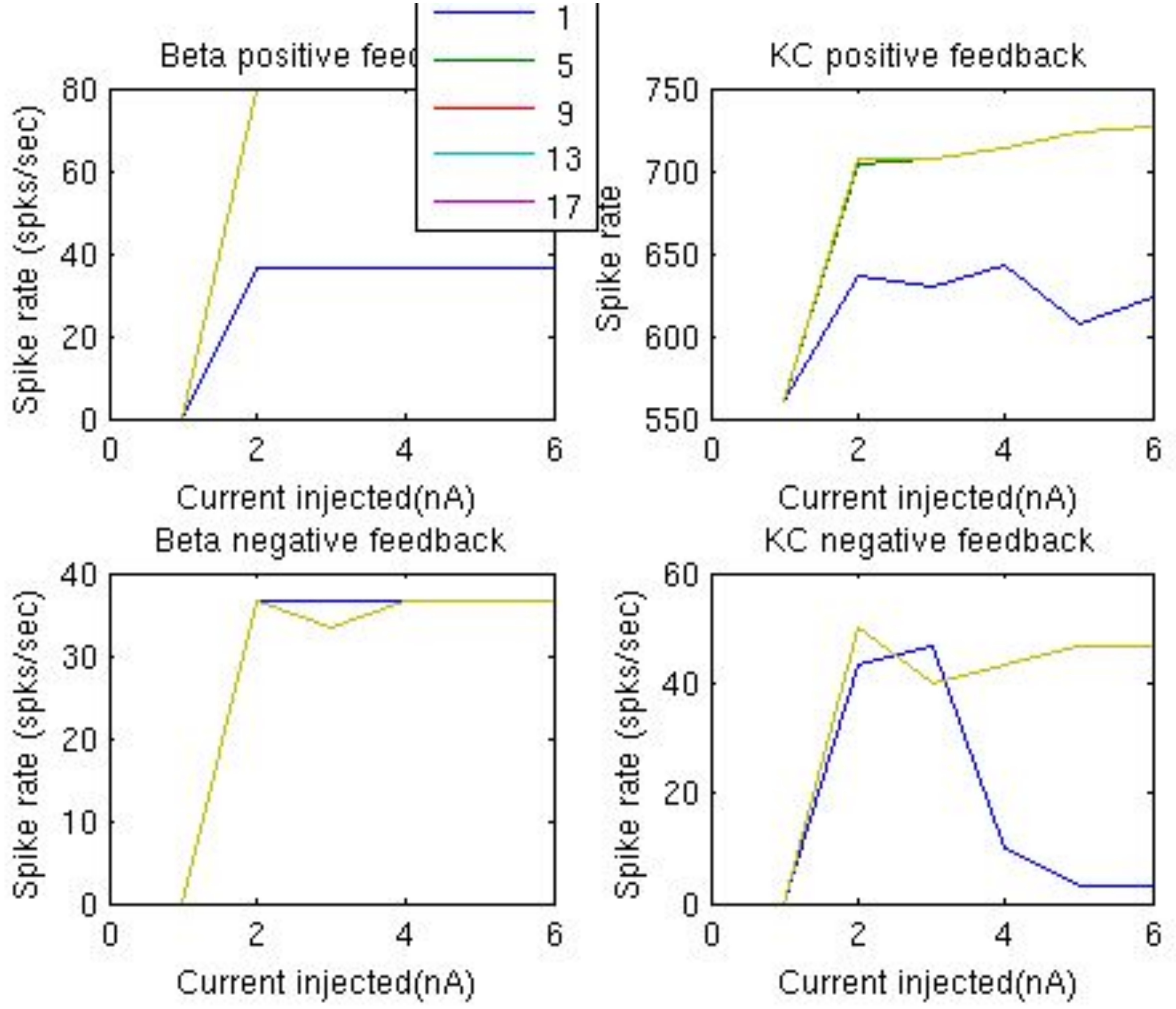


Negative current injected into betadend and voltage recorded from kcaxon, syn.e = -ve

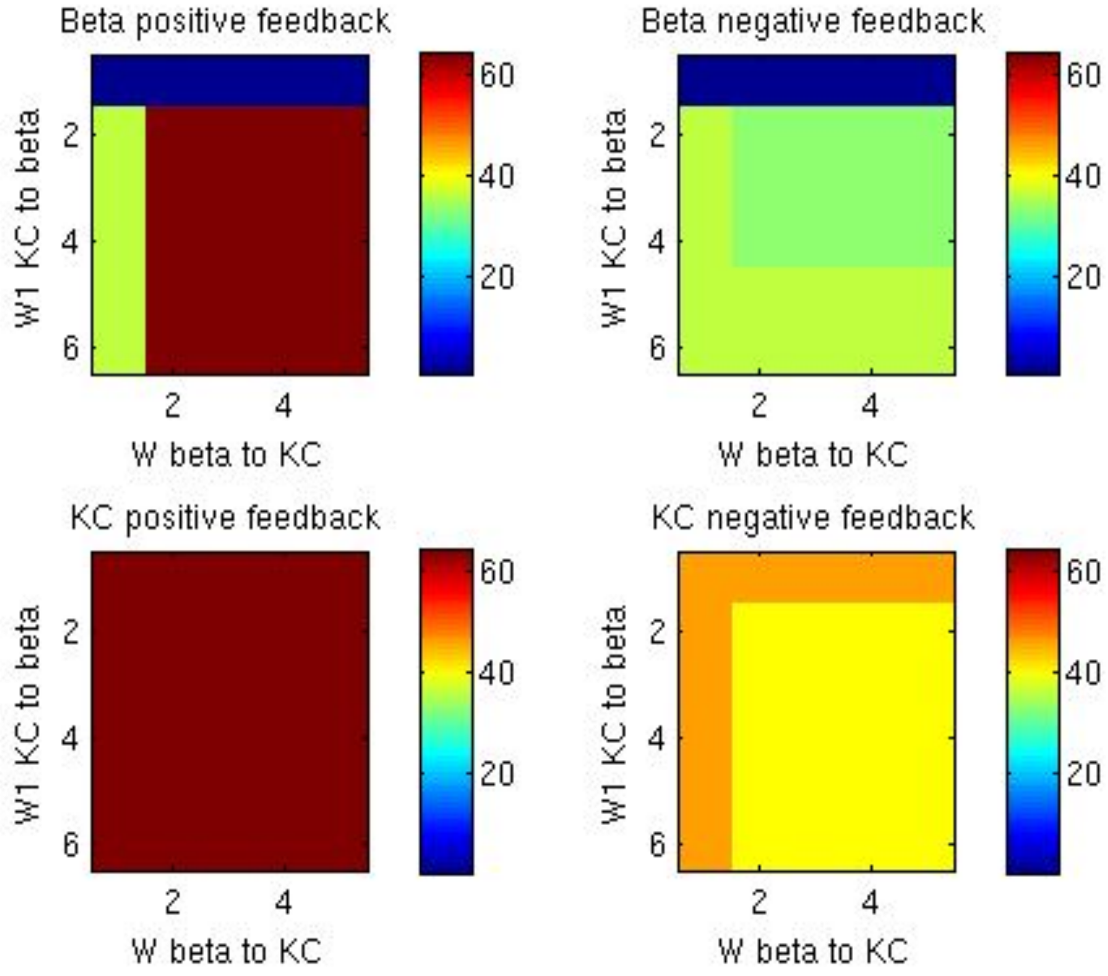
Behavior of KC and Beta with positive and negative feedback



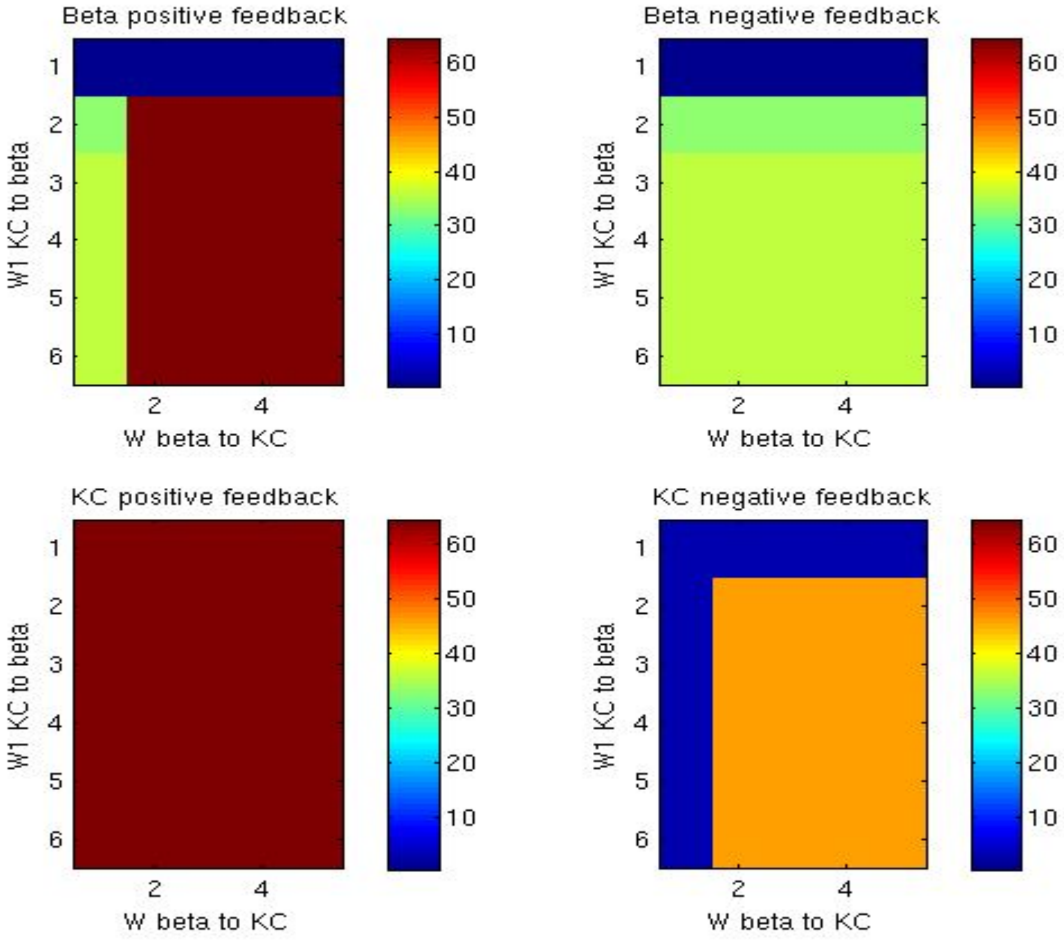


W1 : Fi

How changing w1 and w effects the spike rate?



Current = 3 nA



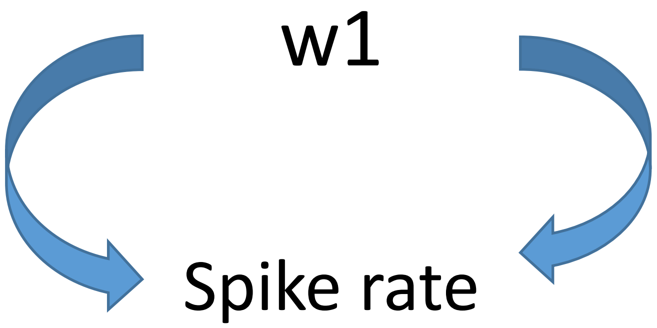
Current = 5 nA

DISCUSSION

- Only for a certain range of currents, negative feedback was observed.

- It is known that w1 has plasticity. We can know how the spike rate changes with different w1 values in positive and negative feedback in KC and Beta.

  However, plasticity is dynamic.



ACKNOWLEDGEMENTS

- I sincerely thank Dr.Joby Joseph for his guidance and constant encouragement throughout the tenure of my project.
- I thank my lab members for their continuous guidance, timely help and valuable suggestions.

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