

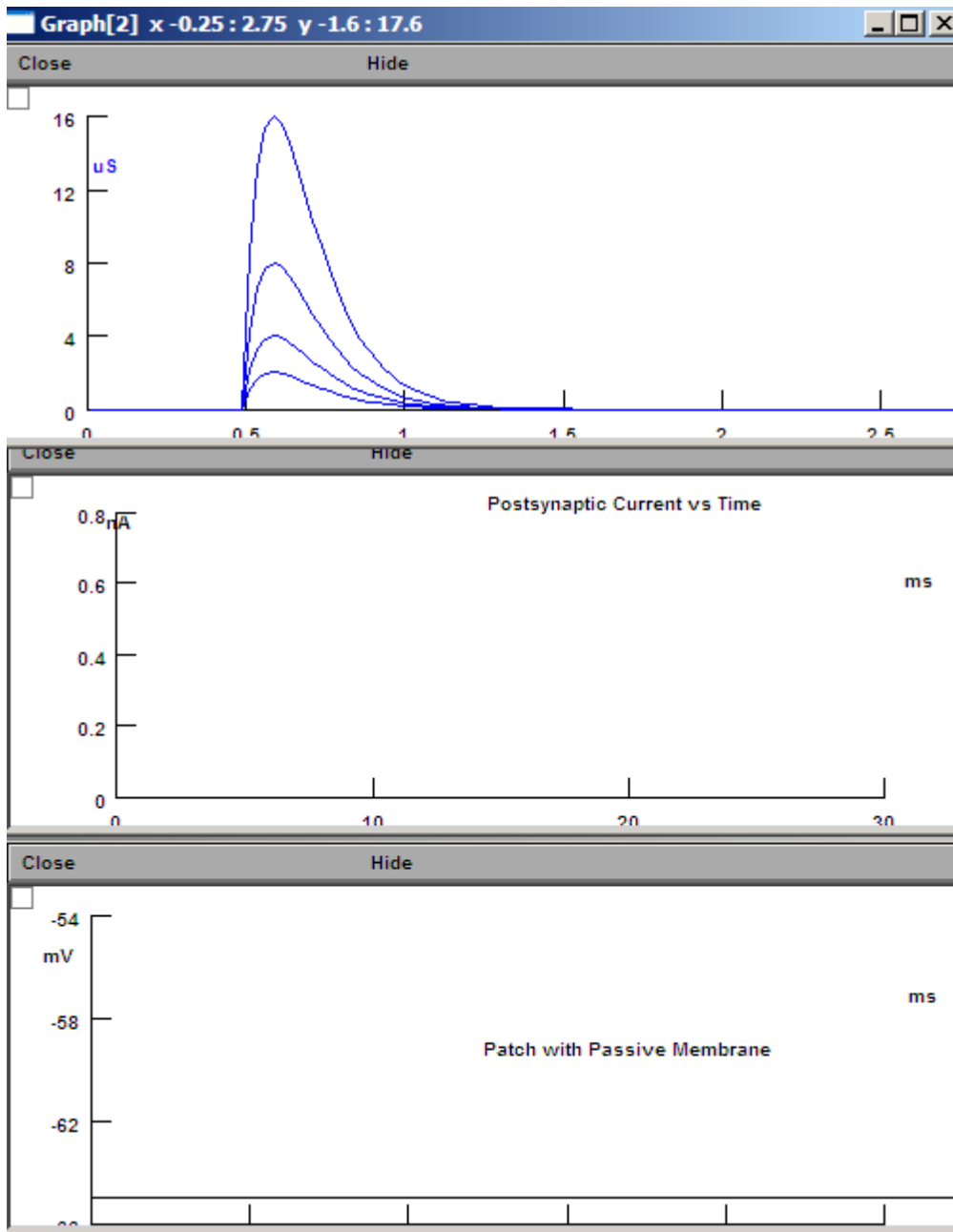
Postsynaptic Inhibition Summary

Phi Pham

Goals of this Tutorial:

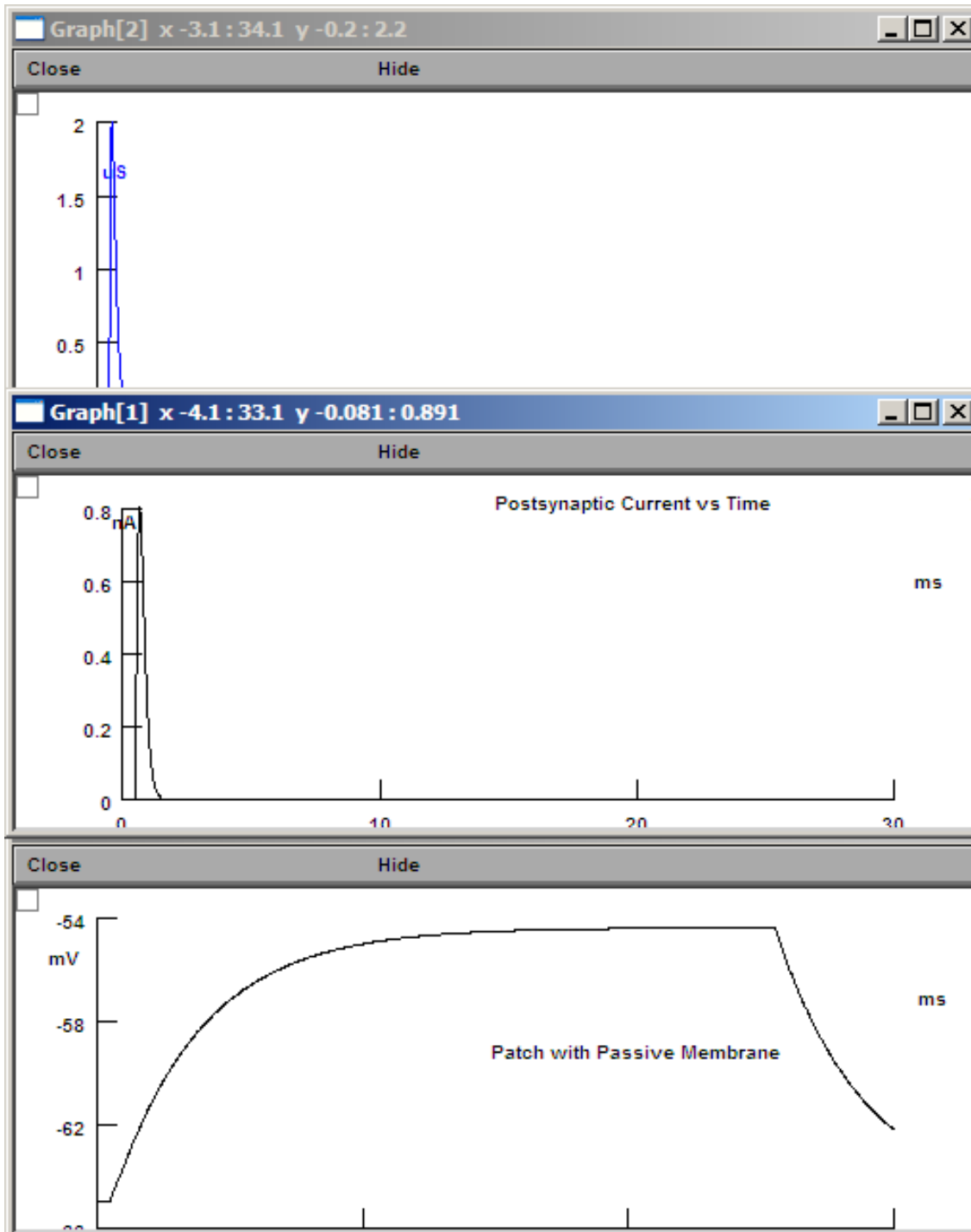
- To understand how an IPSP "clamps" the membrane voltage
- To understand disinhibition
- To probe what happens to membrane excitability following an IPSP

Exp 1: Observe the conductance, current, and voltage change (IPSP) in response to a pulse of inhibitory transmitter.



GABA pulse with no stimulating electrode

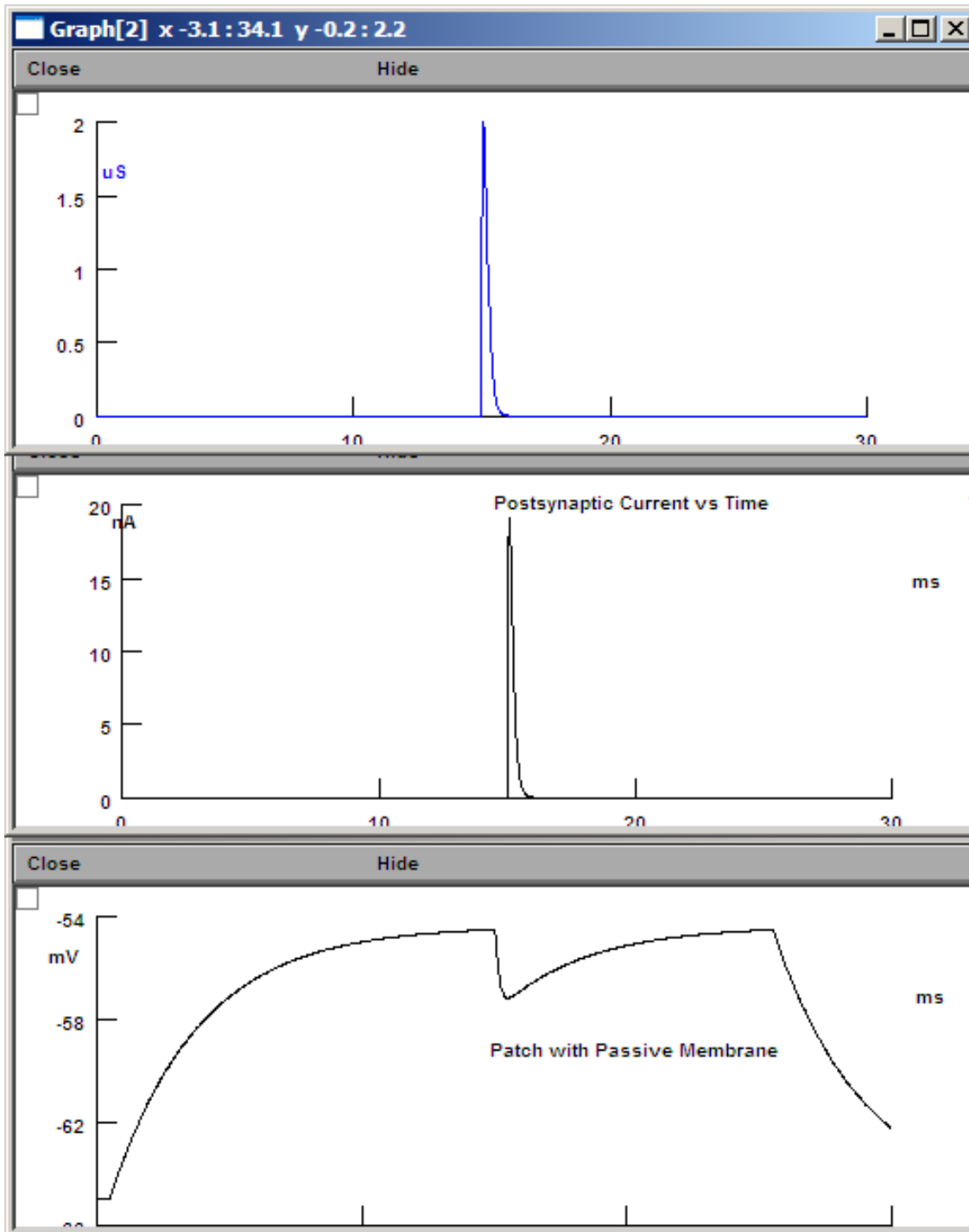
- Initial pulse of GABA with increasing amounts by μS from 2, 4, 8, 16
- Membrane and reversal potential are at -65 mV. Thus there is no driving force, no current, and no voltage change.
- Driving force = $[V_m - E(\text{ion})]$
- $I(\text{ion}) = g(\text{ion}) * [V_m - E(\text{ion})]$



Exp 2: Reveal the IPSP

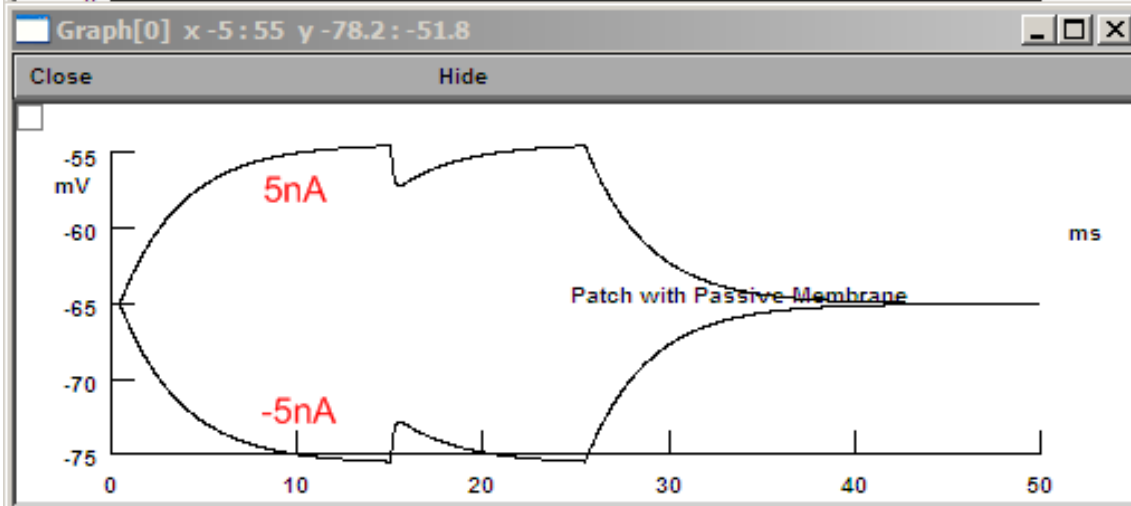
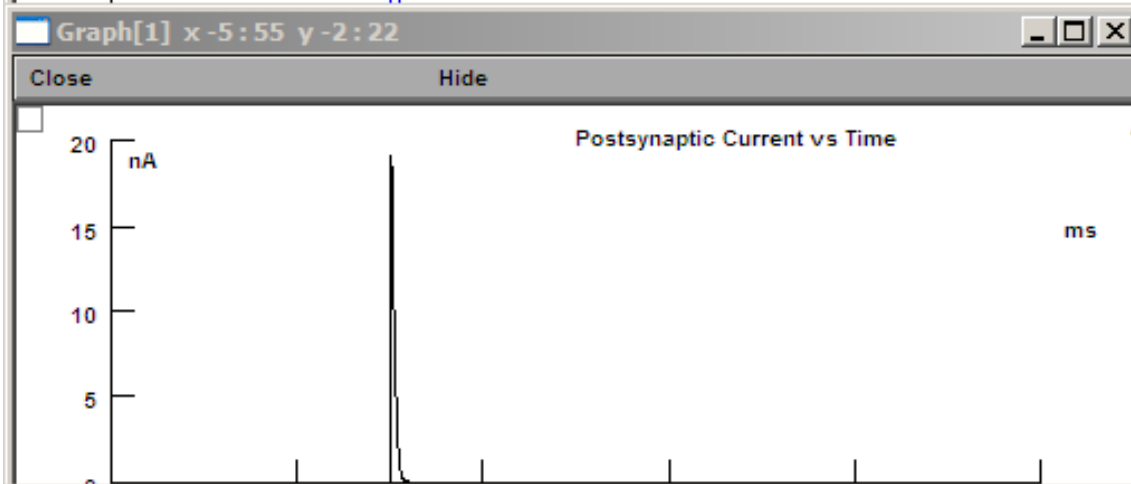
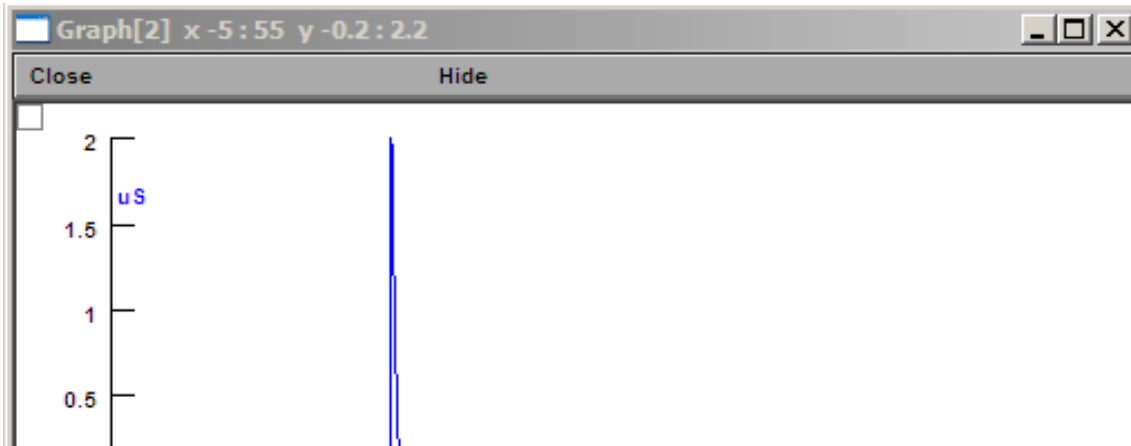
Before onset of IPSP

- Current Clamp is now inserted into the cell
- Displaces membrane potential away from resting value (reversal potential)



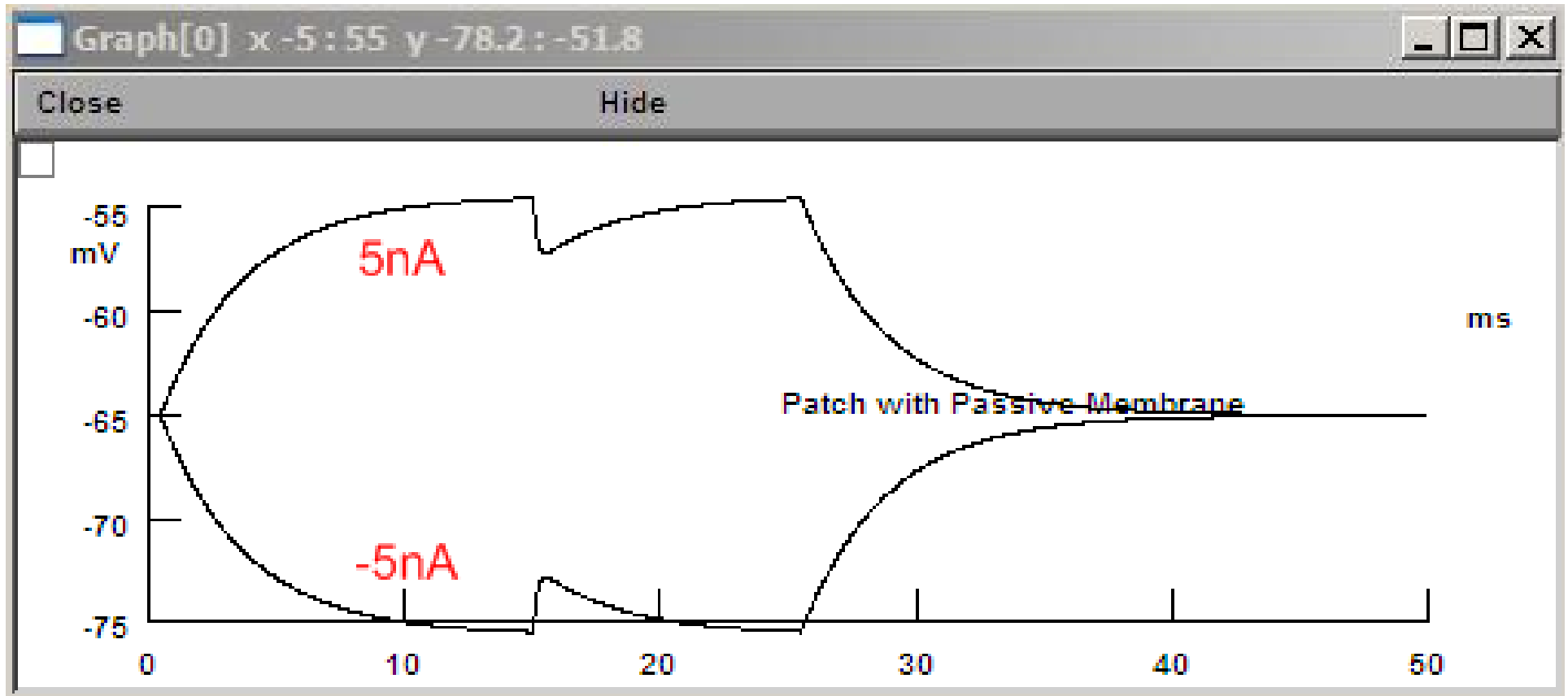
IPSP onset at 15ms

It can be seen that there is an IPSP at the 15ms time period



- Comparing stimulus impulse of 5nA and -5nA
- Reverse IPSP can be seen when stimulating pulse is hyperpolarized

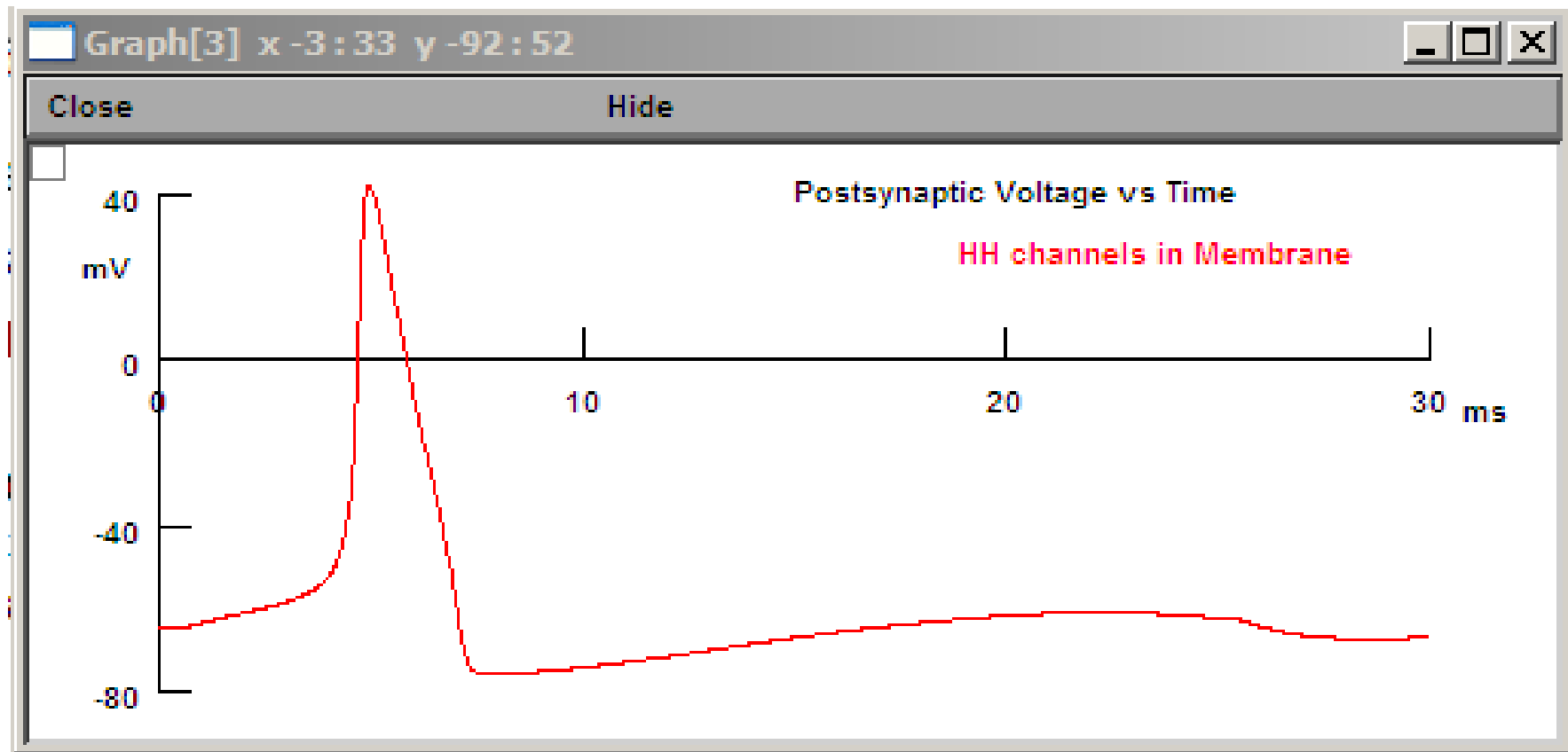
Closer look...



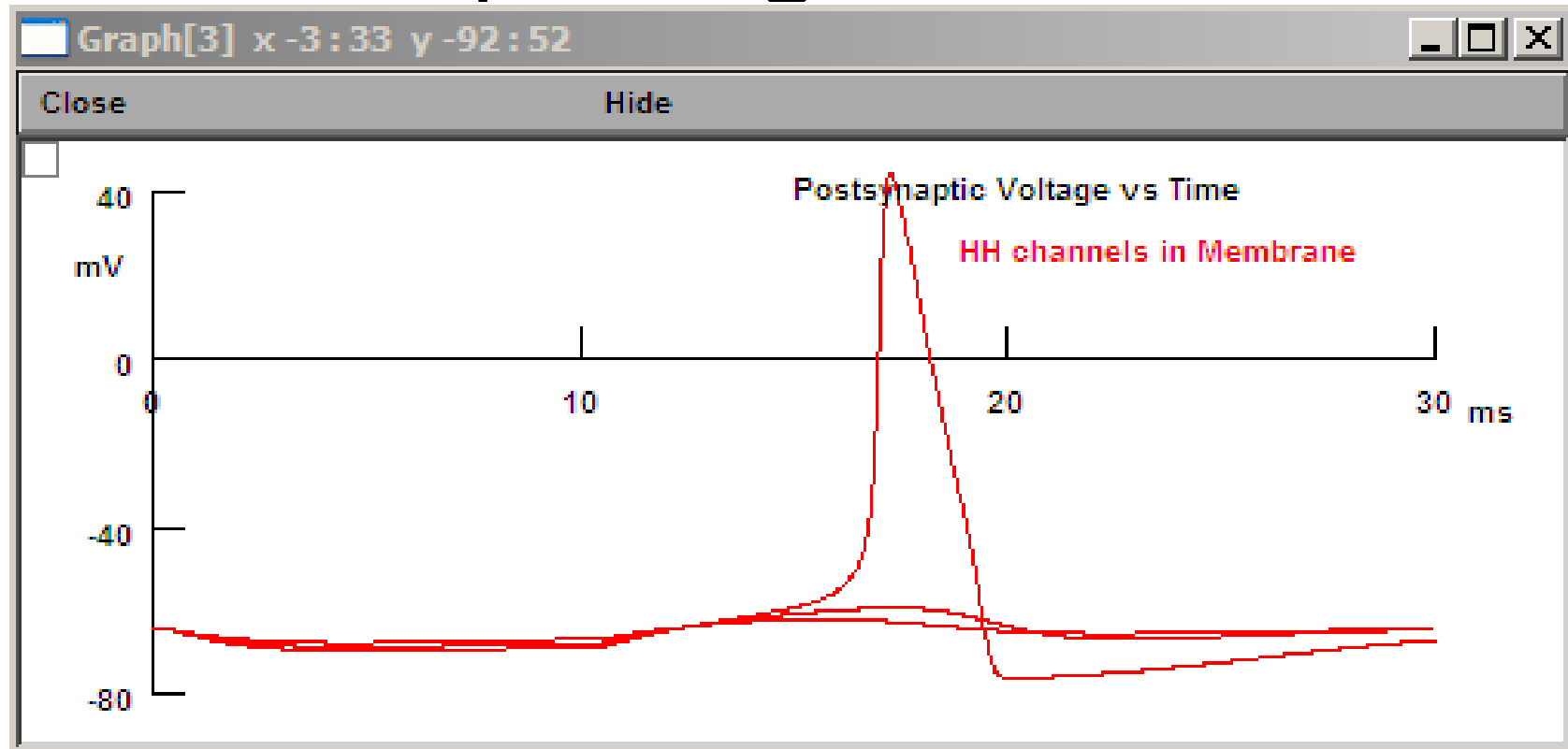
Exp 3: Excite a cell by disinhibiting it

Adding HH channels

- Changes membrane from a passive to active one

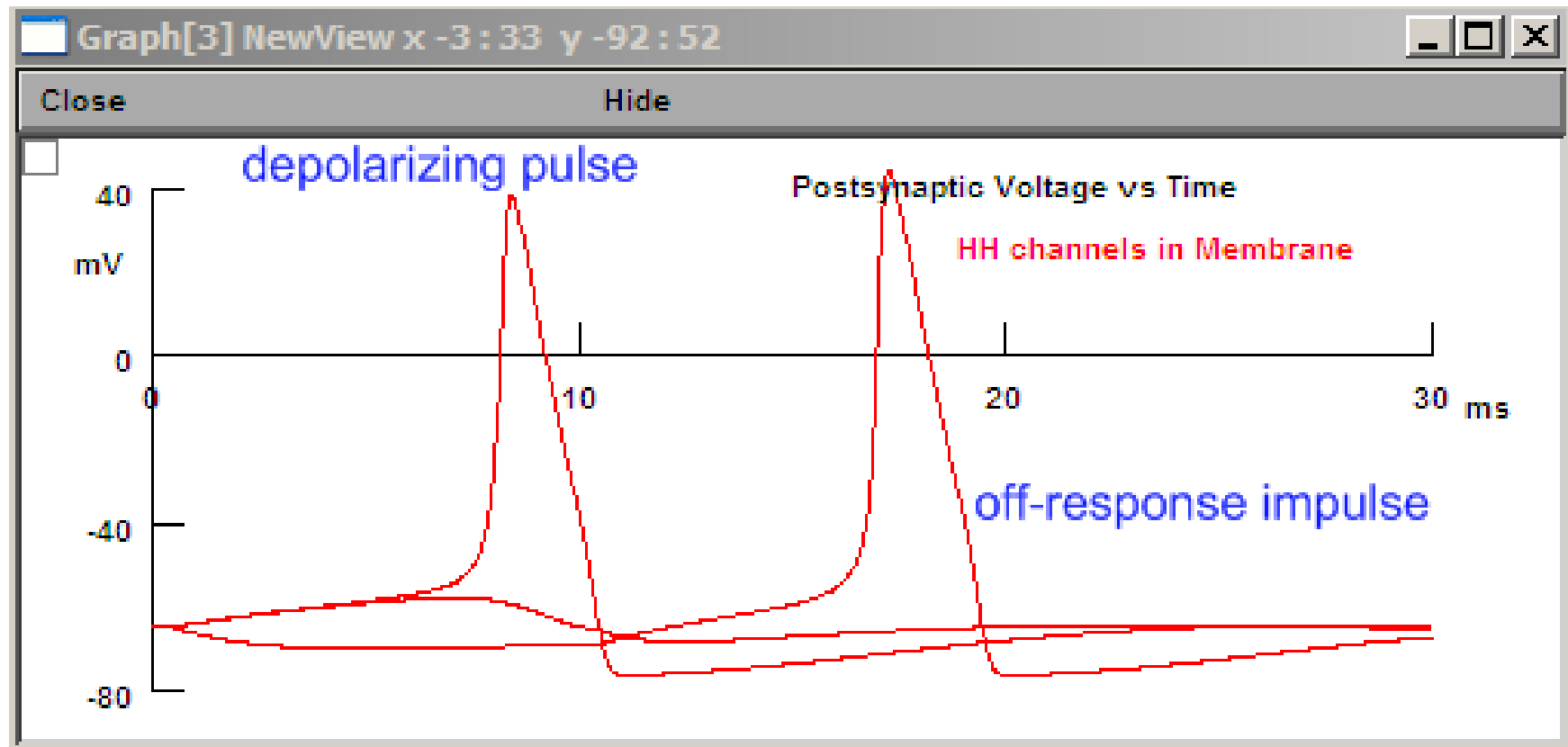


After prolonged inhibition



- Pulse duration is changed to 10ms
- As stimulus amplitude increases from -3, -4, to -5 we observe an impulse after prolonged inhibition
- As the membrane is hyperpolarized by synaptic current or by injected current, channels are driven from their inactivated state to a closed state where they are ready to spring open for any subsequent depolarization. The offset of the hyperpolarizing pulse provides this depolarization. An impulse can be generated by simply returning the voltage to the resting level.

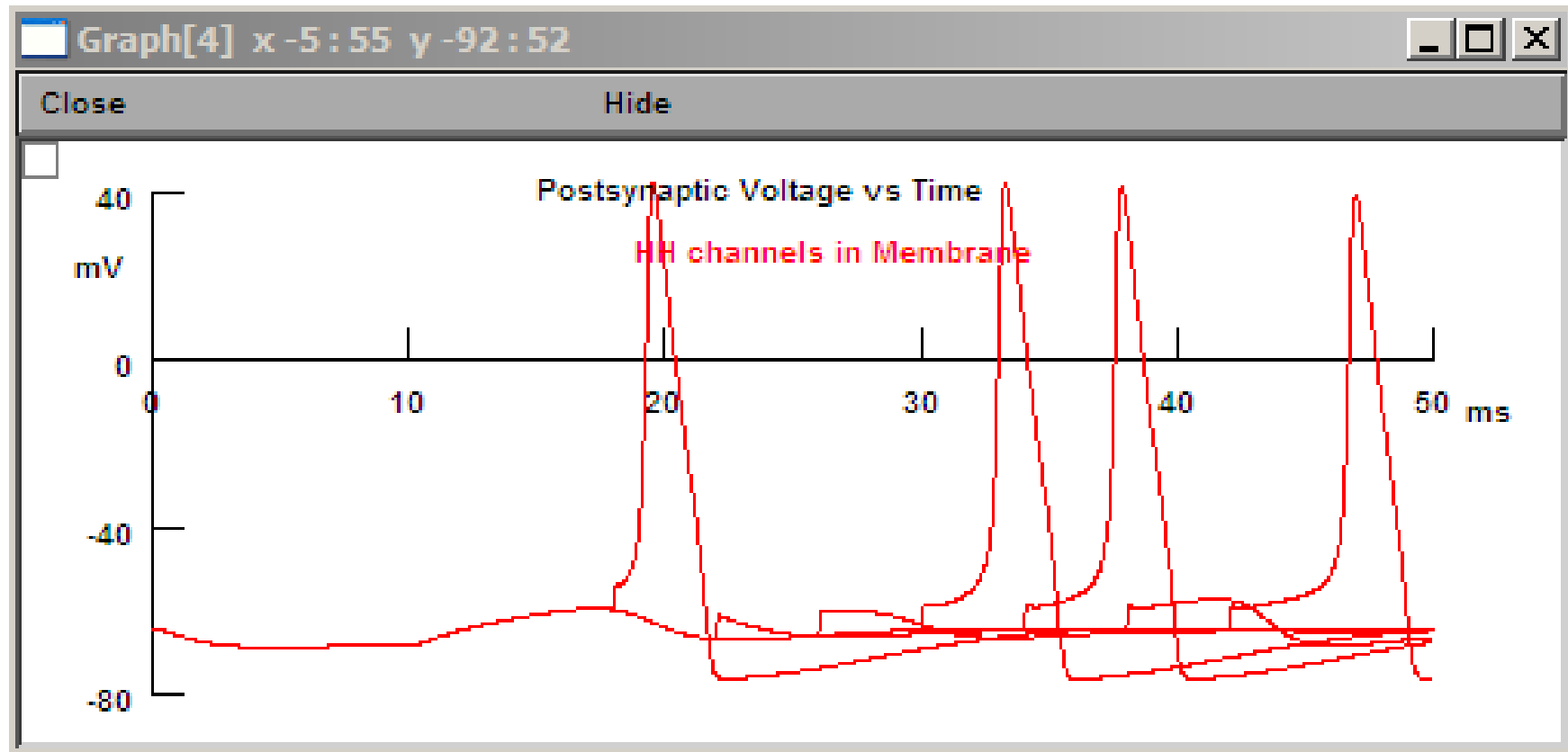
Comparing depolarizing pulse and off-response impulse



- The removal of Na inactivation in this experiment leads to a greater Na current which in turn leads to a greater spike amplitude for the off-response impulse

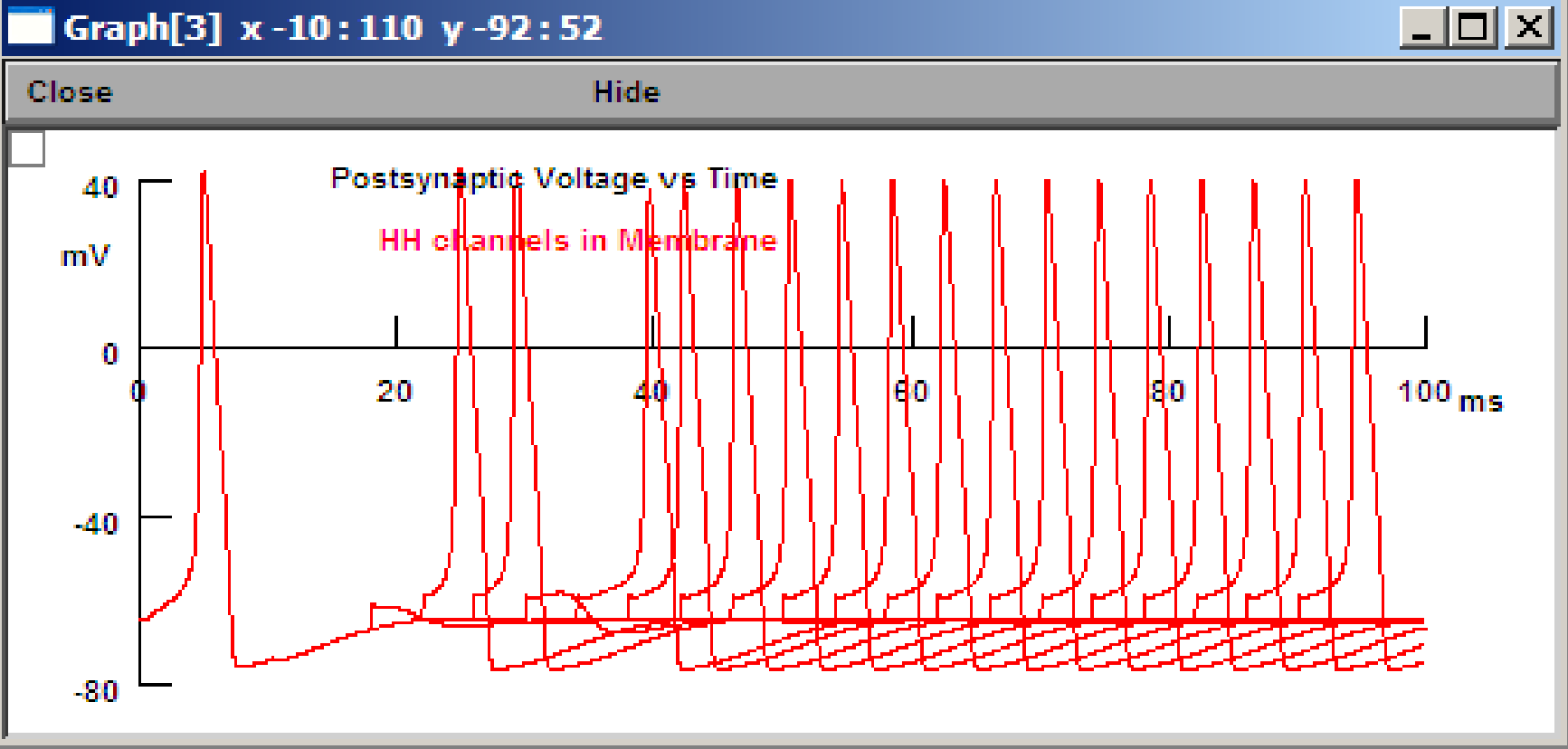
Exp 4: Are there changes in excitability following an IPSP?

Post-stimulus hypersensitivity to excitation

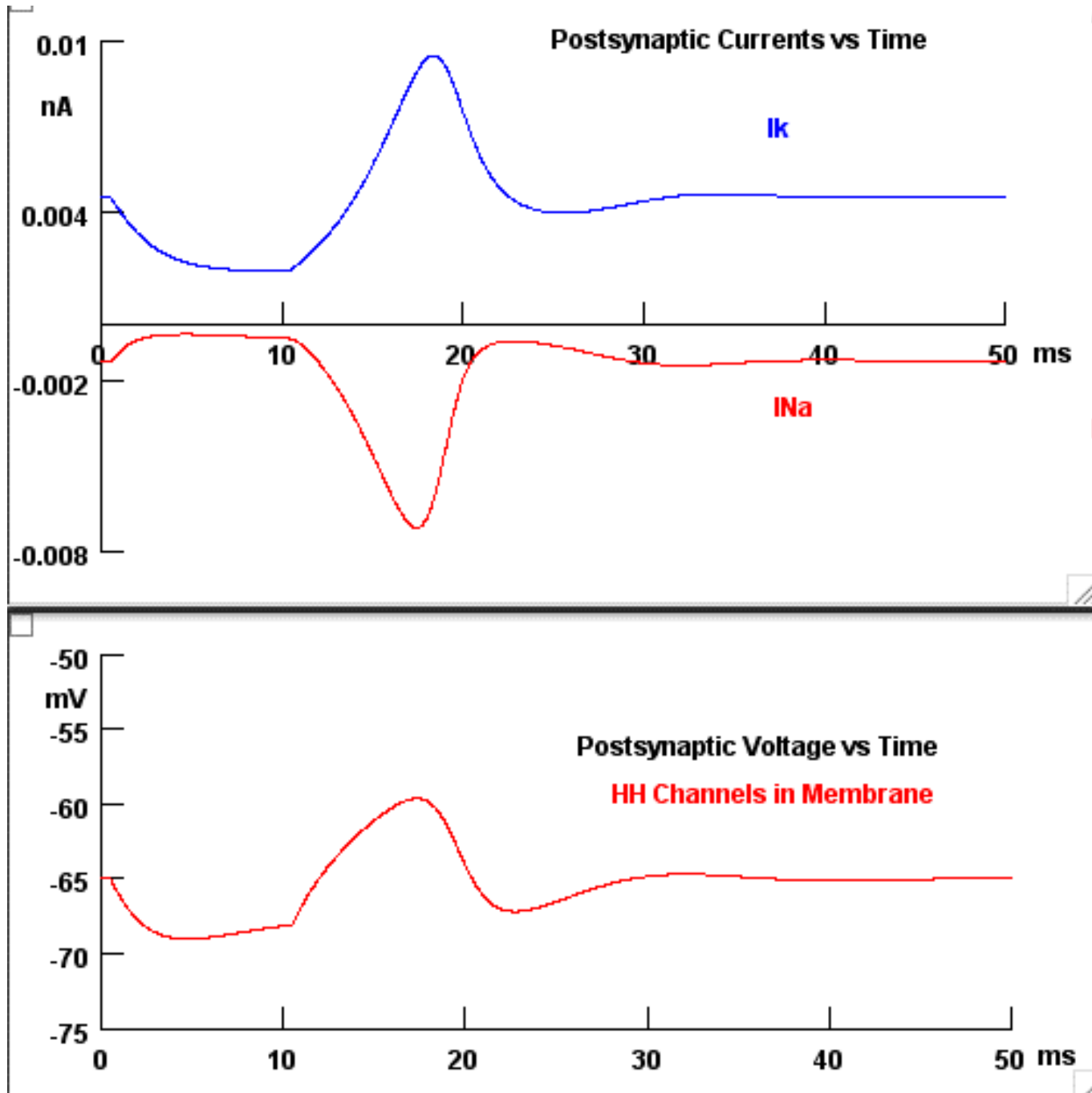


- Two electrodes are in this model, the first one to model inhibition and the second one is to test the excitability of the membrane
 - Delay of the 2nd pulse begins at 18ms and is increased by 4ms until it goes to 42ms
- PP Query: Will this complex behavior be observed at later intervals?**

PP Answer: No, the sensitivity is constant afterwards, due to the damping of the oscillation of the membrane voltage over time.



It is seen that the inconsistency is only seen initially but at later intervals the sensitivity is constant throughout



Any change in membrane potential causes transient changes in both the Na and K currents, as shown in the upper panel of the figure to the left. The differences there in time courses cause oscillations in the membrane voltage as they battle it out, shown in the lower panel; the oscillations finally damp out as the system settles back to the resting level.