

SimNeuron 2.2 – with new features

a brief overview, specifically addressing the new features of version 2.2:

The basic concept to offering virtual laboratories for **voltage-clamp** and **current-clamp** experiments in an easy to overlook lab design (see following pages) has been retained, including a **neuron editor** to check and/or to modify the **neuron parameters**.

New Features of SimNeuron 2.2:

1) Neurons of realistic size with random parameter values

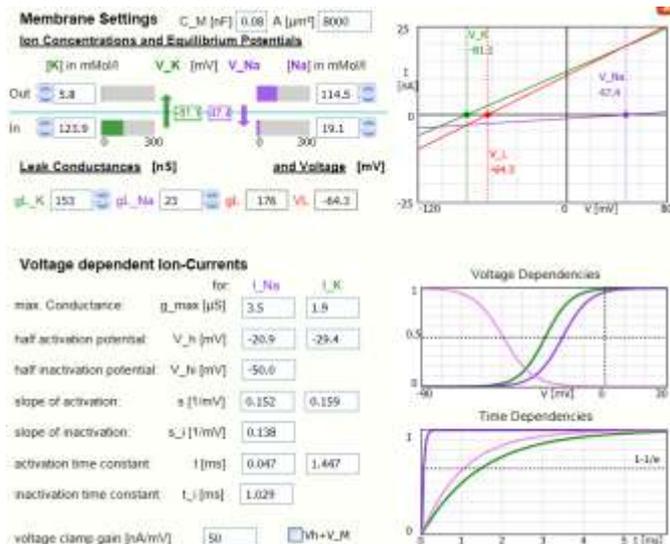
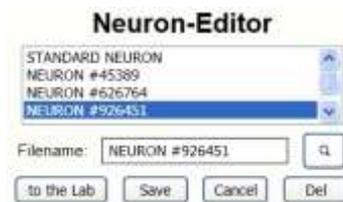
While the previous versions have been offering a Standard Neuron related to a standard membrane capacity of 1mF/cm^2 , SimNeuron 2.2 provides **neurons of realistic size**.

You still will find a Standard Neuron the parameters of which cannot be changed. However, the **size** of the neuron that appears after program start in your current- and voltage-clamp lab as well as its **parameter values** will be randomly chosen. Nevertheless, the neurons without current injection should be in a steady state, i.e. showing a stable membrane potential.

Using the Current- and Voltage-Clamp Lab the students can try to determine, as before, the threshold of action potential generation and the characteristics of the voltage-dependent currents (IV-curves, reversal potentials, maximum values, time constants, etc.) in the same way as before. Additionally, you will find different values of the leak conductance g_L and the membrane capacity C from which also the size of the membrane area A can be estimated (the corresponding values are listed in the neuron editor, see below).

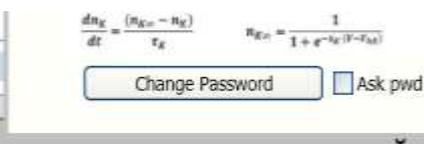
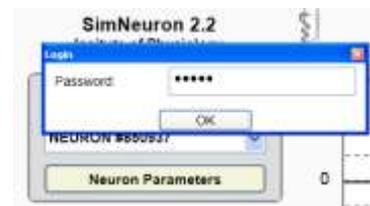
As before, you can change the membrane parameters to design and save your own neurons and now also can change the neuron's capacity and size.

Moreover, you can get a **new neuron** with random parameter settings with click on the schematized neuron in the current- and voltage clamp lab. These neurons will get a number of up to six digits for clear identification.



2) Password protected access to the Neuron Parameters

For students' practical courses, not implemented in the Demo versions, the access to the neuron parameters can be prohibited, only accessible with a correct password (see figure on the right). The password is preset to "admin" but can be changed in the neuron editor (**Change Password** button in the lower left corner of the Neuron Editor, see figure below).



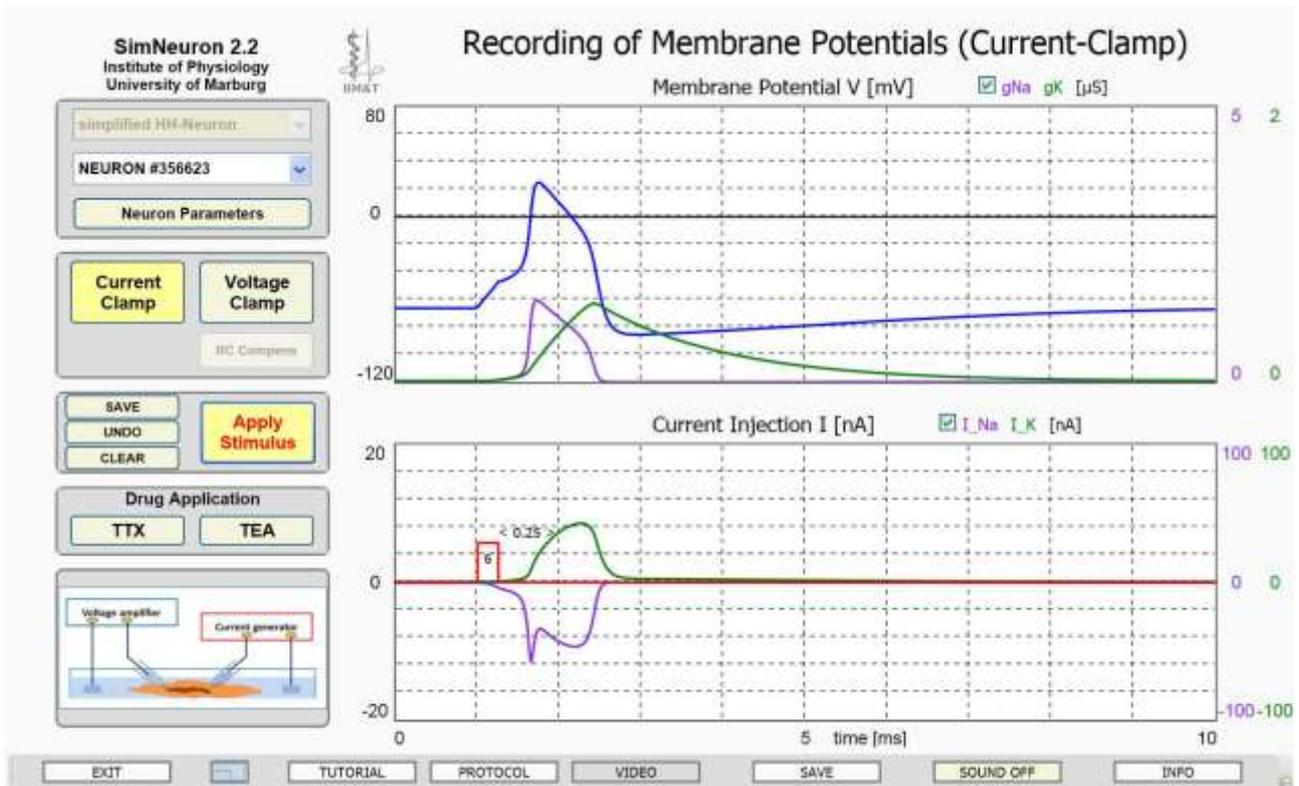
In the password protected mode (when the **Ask psw** checkbox is activated), also the ionic conductances and separated Na^+ - and K^+ -currents will not be displayed. The idea is not to provide the students too much data in advance but to let them determine the diverse neuron parameters by their own recordings in the voltage and current clamp

labs. Switching on the password protected neuron editor will allow the supervisor to directly countercheck the students' results.

The Current-Clamp Lab – an overview:

examine the effects of current injection on the neurons' membrane-potentials (e.g. threshold of action-potential generation, local potentials with subthreshold currents, purely passive potential changes) and check the effects of blockade of the voltage dependent Na^+ - and K^+ - currents.

(for more specific suggestions see the Tutorial, unfortunately still from the previous cLabs_neuron tools)



The figure below shows a **current pulse** of 0.25ms duration and 8nA amplitude (red curve in the lower diagram) inducing an **action potential** (blue curve in the upper diagram).

In this case, also the **voltage-dependent Na^+ -and K^+ -conductances and Na^+ -and K^+ -currents** are displayed in the upper and lower diagram, respectively. For this purpose, the corresponding check boxes need to be activated. **Please note: in the licensed versions for teaching this possibility can be switched off, password protected, e.g. for students' practical courses.**

For current injection just click on the “**Apply Stimulus**” button.

Current **amplitude** as well as the position of **stimulus onset and offset** (to determine the stimulus duration) can be adjusted clicking with the mouse on the corresponding lines of the stimulus curve.

Pressing the **SAVE** button will keep all your recordings on the screen.

The **UNDO** button erases the last recording while the **CLEAR** button erases all.

“**Drug Application**” allows to block the voltage-dependent Na^+ - (**TTX**) and/or K^+ - (**TEA**) current

Scaling of the diagrams can be changed with click on the maximum numbers at the scale bars.

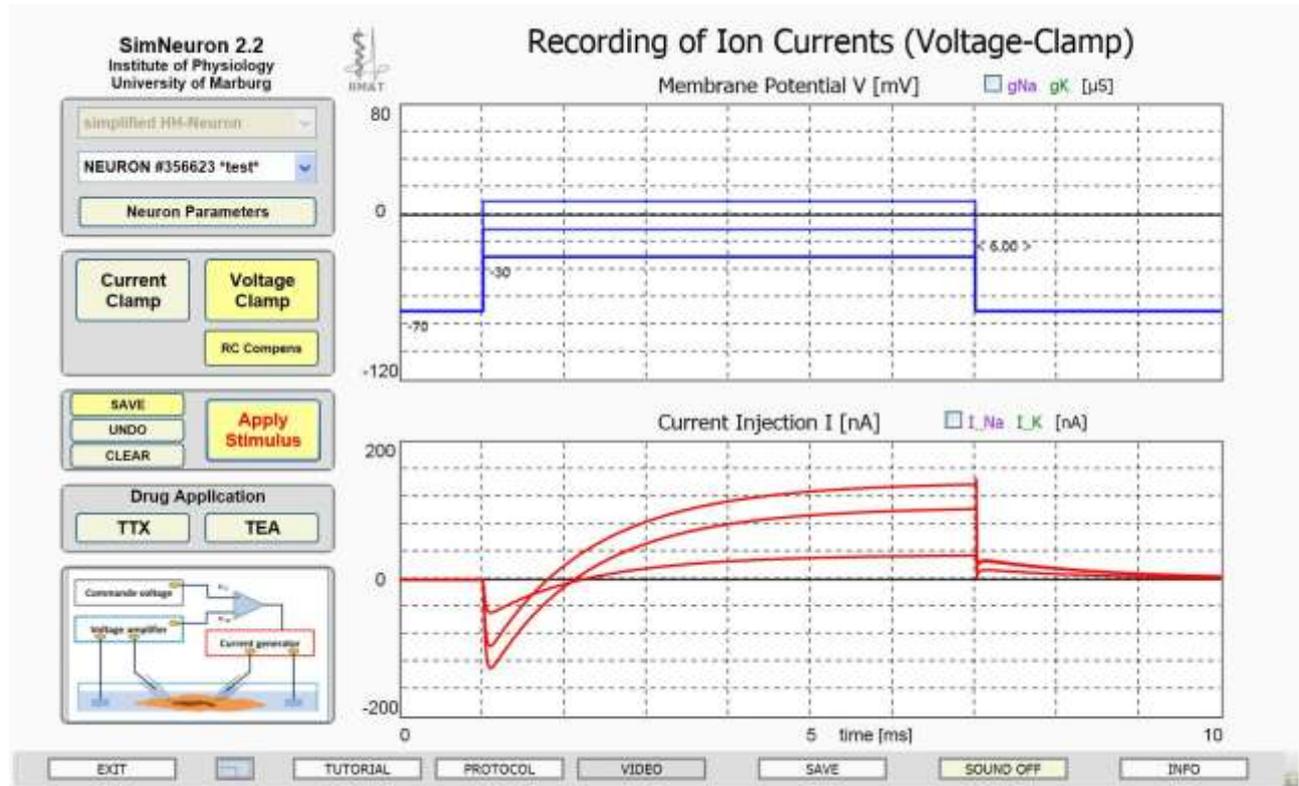
With click on the neuron in the schematic drawing of the recording circuit another neuron, again with random parameter settings, will be provided. Each neuron can be identified by a number of up to six digits.

In the Current Clamp Lab, the Current Clamp button is highlighted.

To go to the Voltage Clamp Lab click on the Voltage Clamp button.

The Voltage-Clamp Lab – an overview:

Recordings of voltage-dependent ion currents during step-like potential changes from a holding potential to a command potential. The membrane potential is kept constant at the desired value via a feedback loop with current injection opposite to the voltage-activated currents (according to the schematic drawing of the circuit). This circuit, in combination with appropriate ion channel blockers, allows to record specific ion currents at different voltages, to plot the corresponding IV-curves and to determine, for example, the maximum currents, the reversal potentials and also the time constants of current activation and inactivation. For a more detailed description of typical voltage-clamp experiments see the SimNeuron “Tutorial”, unfortunately still from the previous cLabs-Neuron tools.



The figure shows the **time course of voltage-dependent ion currents** (red curves in the lower diagram) in response to three voltage steps from resting potential at -70mV to three different command potentials (blue curves in the upper diagram). RC compensation is activated so that the charging and discharging currents at the beginning and the end of the voltage step are not displayed. In this example, only the time course of the voltage dependent currents for action potential generation, beginning with the Na^+ inward current (downward deflection) followed by an outward K^+ current (upward deflection), is displayed.

With activation of the **I_{Na} / I_K check boxes**, separate curves of Na^+ and K^+ currents will be displayed in addition to the compound current curves. With activation of the **g_{Na} / g_K check boxes** also the underlying changes of the Na^+ and K^+ conductances will be shown).

Drug application (TTX or TEA) also allows recording of Na^+ and K^+ currents separately.

The **holding potential** and the **command potential**, as well as the onset and offset of the **potential step** can be adjusted clicking with the mouse on the corresponding lines in the upper diagrams. To start the recording just click on the “**Apply Stimulus**” button.

The **SAVE** button, here activated, the **UNDO** button, and the **CLEAR** button have the same, intuitively to understand functions as in the Current Clamp lab.

Also, **scaling of the diagrams** can be changed with click on the maximum numbers at the scale bars.