# 4 – Current addition

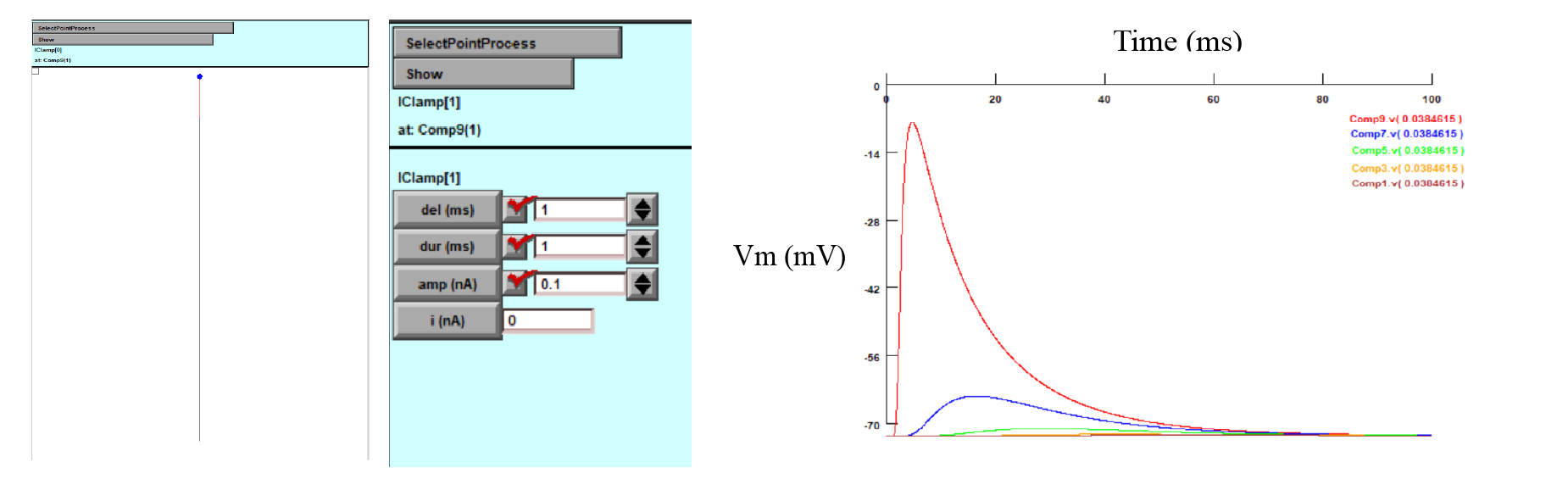
## 4.1. Comparison between the electrodiffusion based model with NEURON software

We next compared our electrodiffusion based multicompartmental model with a similar model constructed as a series of equivalent circuits in NEURON to ensure that our model had comparable time and length constants that could be worked out analytically.

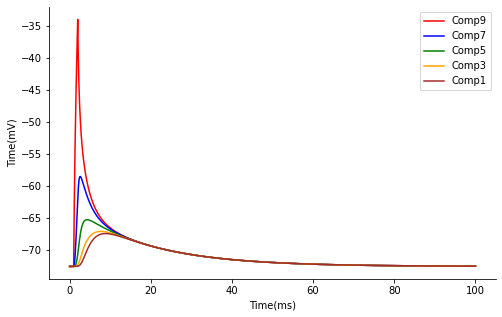
A 9 compartment multicompartment model was employed with lengths of 20µm and a diameter of 1µm. The capacitance was set at 2µF/cm2  while the total leak conductances were set at 0.0001 S/cm2.

We then pulsed 0.1nA of current with a 1ms duration onto compartment 9(Comp9) to calculate the time and length constants (Fig4a). This depolarized Comp9 to -7.82mV and by 100ms had returned to a resting voltage of -72.48mV. A time constant (Τ) of 12.9ms was calculated based on the rate of voltage attenuation in Comp9. The length constant (λ) was in the range of 15-20µm.

We then pulsed current of 10nA with 1ms duration onto the Comp9 in the multicompartment model with electrodiffusion.



Shape

Description automatically generatedA picture containing chart

Description automatically generated

Multicomp model

ED ON – ED default (1e-7)

10nA current

Tau = 2ms

Lambda = 37.73um

NEURON

0.1nA current

Tau = 12.9ms

Lambda = 17.5um

Multicomp model

ED ON – ED constants scaled down by 10 (1e-8)

10nA current

Tau = 5.7ms

Lambda = 20.73um

Shape

Description automatically generated

Multicomp model

ED OFF

0.1nA current

Tau = 17.85ms

Lambda = 20.4 um

Figure 4a. **Cable properties in NEURON versus the multicompartment biophysical model with and without electrodiffusion.** (1) 0.1nA current propagation in a 9-compartment model in Neuron with the current placed at compartment 9. A 10nA current was pulsed into compartment 9 of the biophysical model with (2) electrodiffusion turned off, (3) default electrodiffusion, (4) electrodiffusion ionic diffusion constants scaled down by 10X.

## 4.2 Current in scenarios of varying z in all compartments

z = -0.45

z = -0.85

z = -1.25

Shape

Description automatically generatedShape

Description automatically generated

A picture containing background pattern

Description automatically generatedBackground pattern

Description automatically generated with medium confidence

Tau = 5.7ms

Lambda = 20.73um

Tau = 8.87ms

Lambda = 77.51um

Figure 4b. **Cable properties in the multicompartment biophysical model with varied impermeant anion valency.** 100ms simulations of 10nA current pulsed for 1ms into Comp9 of a multicompartment model with impermeant anion valency in all compartments of -1.25, -0.85 (default), and -0.45.*Top row:* Voltage change to Compartment 9,7,5,3 and 1 during the simulation**.** *Middle row:* Heat maps of membrane potentials in each compartment at 4ms intervals during the first 50ms. *Bottom row:* Time constants (Tau) and length constants (Lambda) for each simulation.

## 4.3 Current when z is changed just in comp 8

Figure 4c. **Cable properties in the multicompartment biophysical model with varied impermeant anion valency in a nearby compartment.**