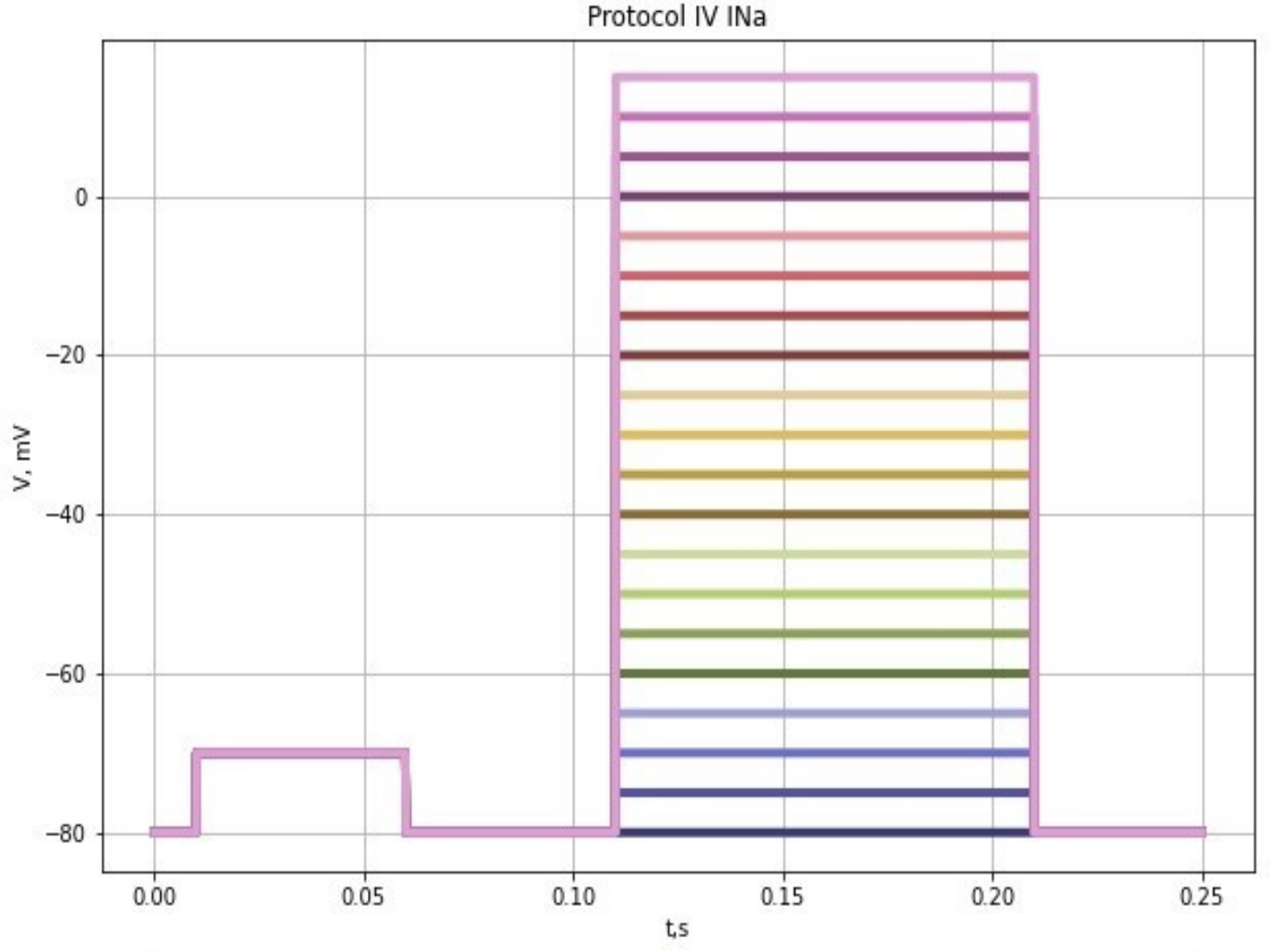
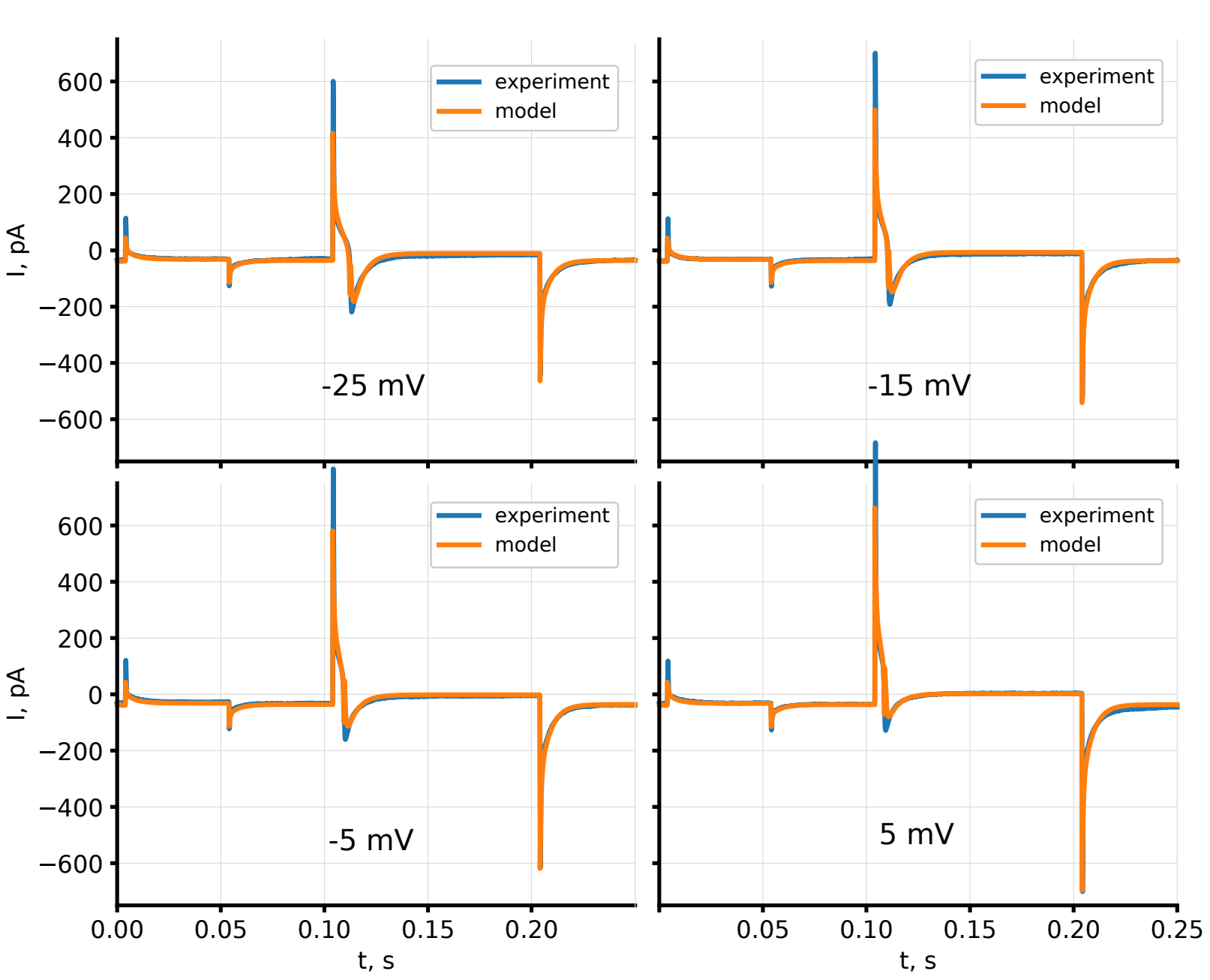
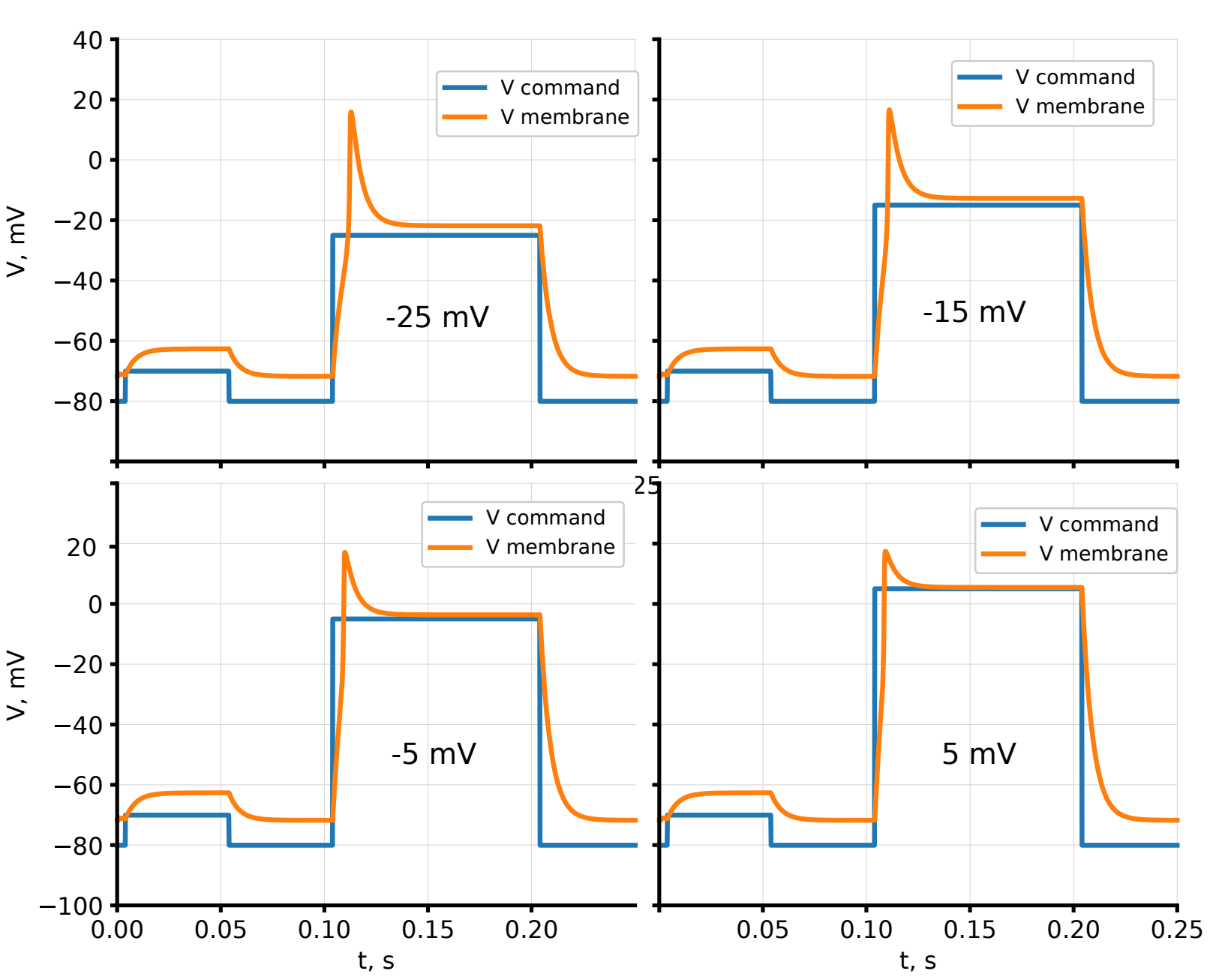
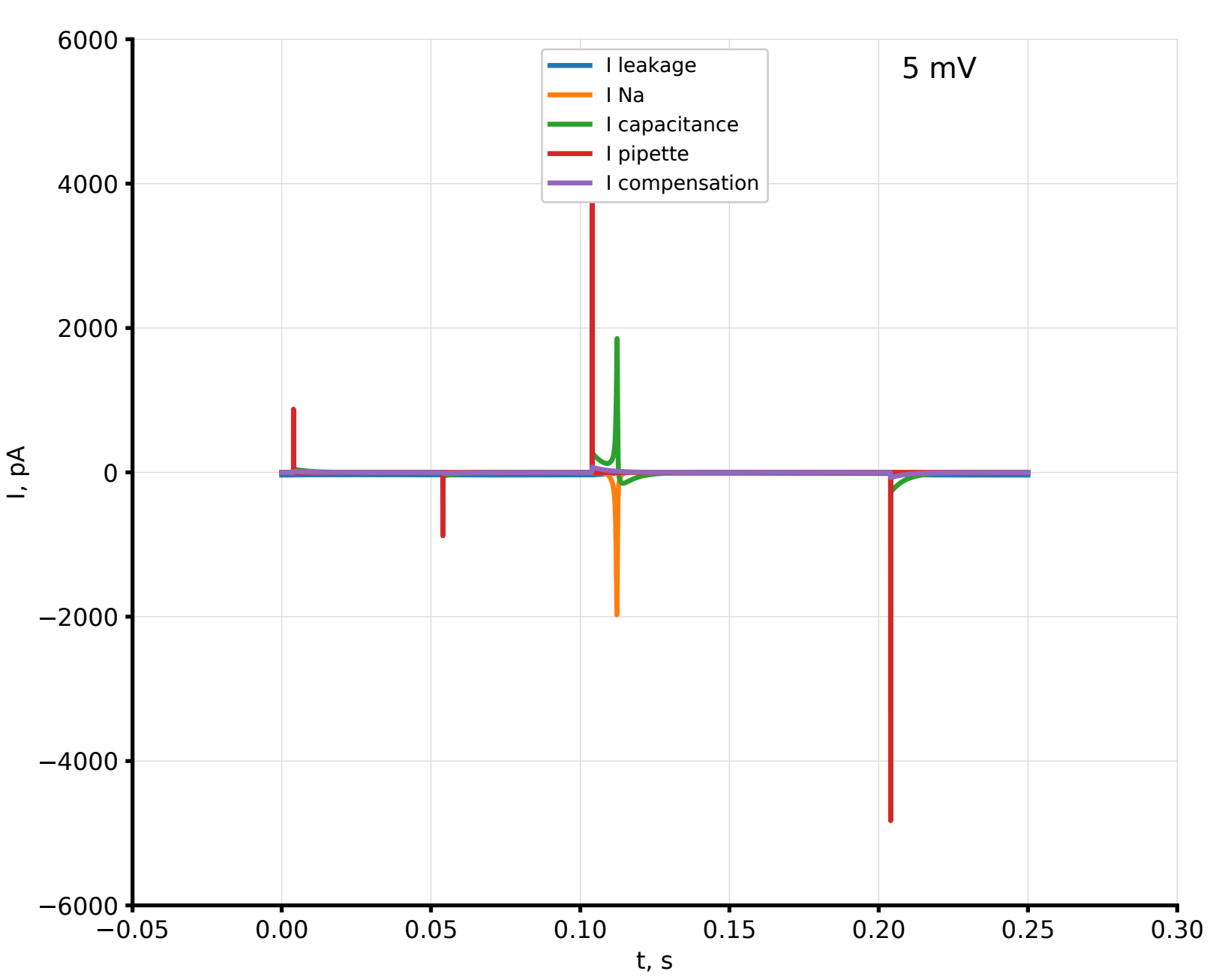

Protocol IV INa
0
−20
−40
−60
−80
V, mV
0.00
0.05
0.10
0.15
0.20
0.25
t,s
-80, mV
-75, mV
-70, mV
-65, mV
-60, mV
-55, mV
-50, mV
-45, mV
-40, mV
-35, mV
-30, mV
-25, mV
-20, mV
-15, mV
-10, mV
-5, mV
0, mV
5, mV
10, mV
15, mV


experiment
model
-25 mV
-15 mV
-5 mV
5 mV
I, pA
600
400
200
0
−200
−400
−600
0.00
0.05
0.10
0.15
0.20
0.25
t, s


V command
V membrane
-25 mV
-15 mV
-5 mV
5 mV
V, mV
t, s
40
20
0
−20
−40
−60
−80
−100
0.00
0.05
0.10
0.15
0.20
0.25


I leakage
I Na
I capacitance
I pipette
I compensation
5 mV
6000
4000
2000
0
−2000
−4000
−6000
I, pA
−0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30
t, s

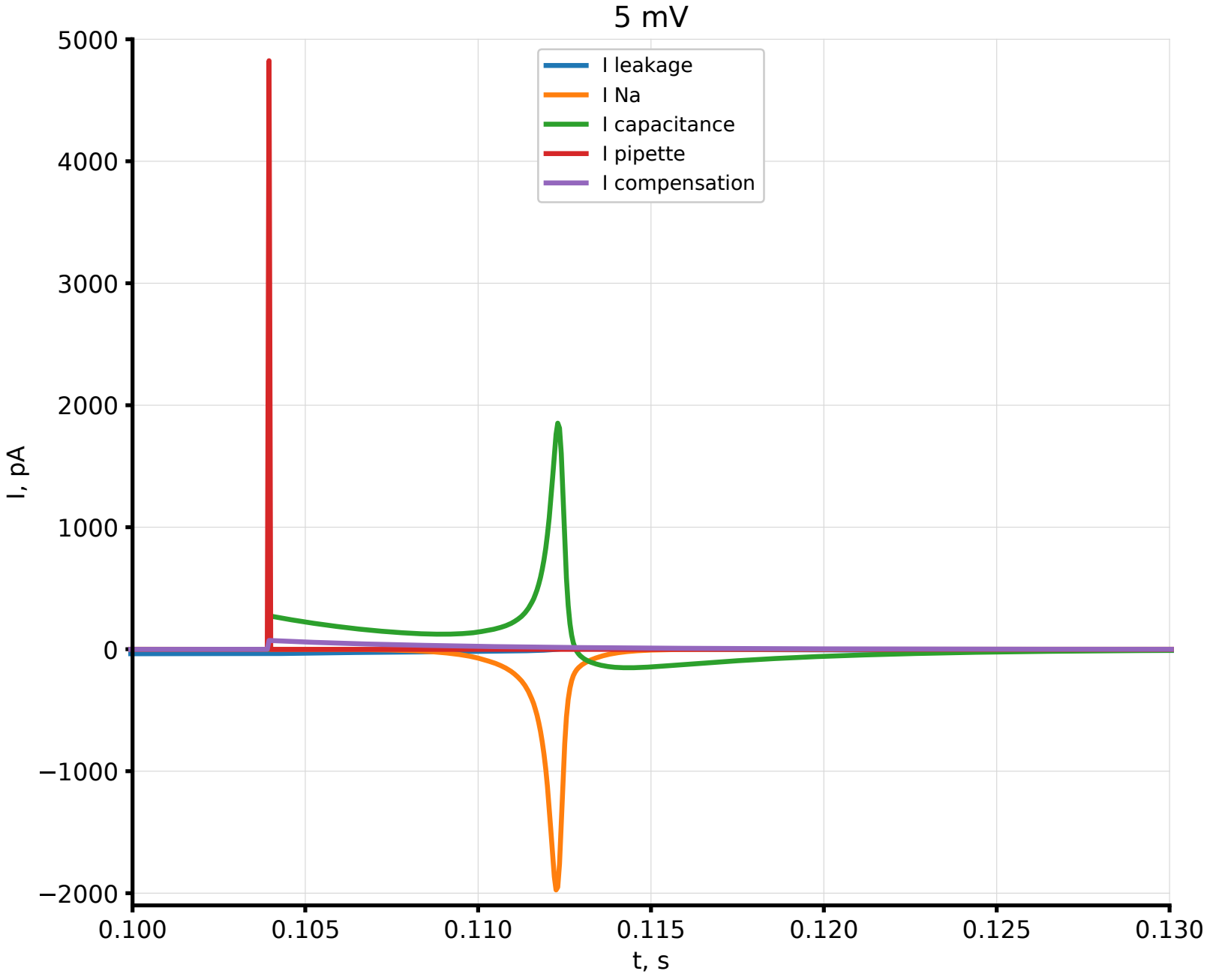
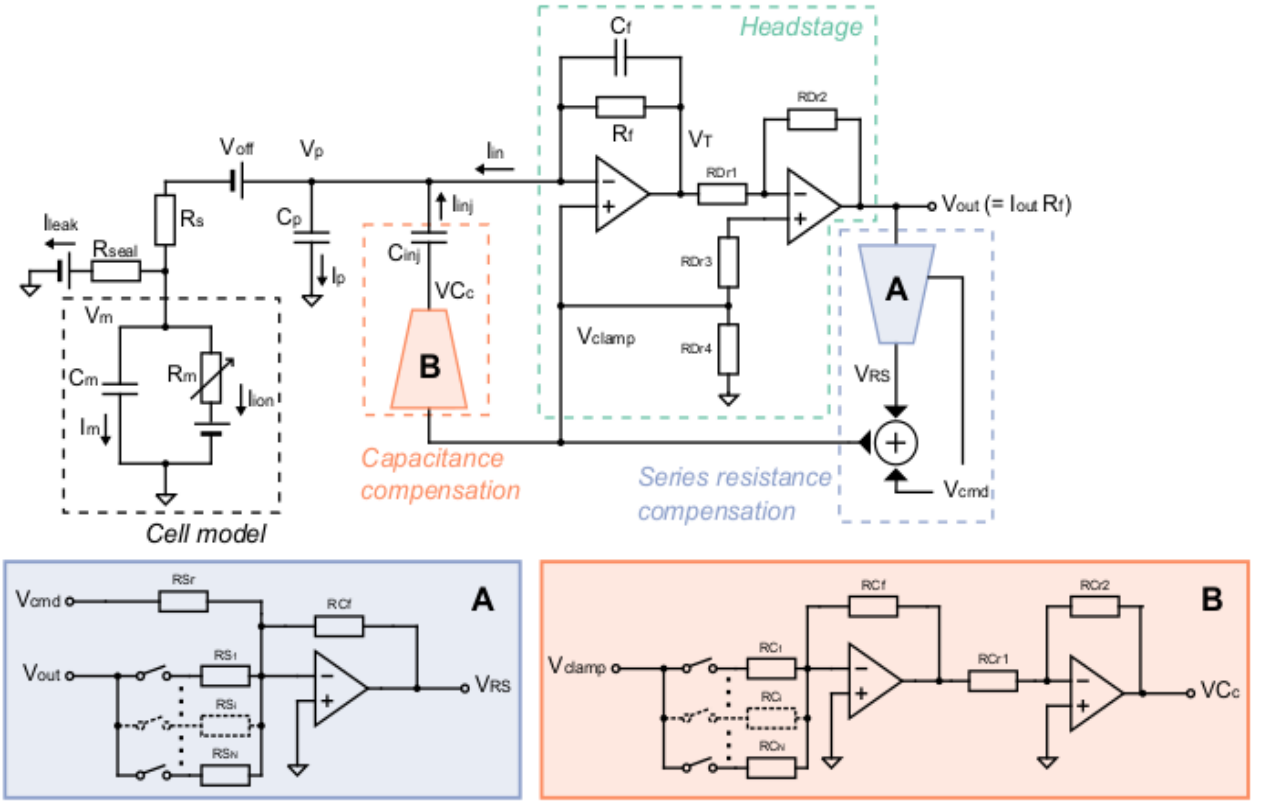

5 mV
I leakage
I Na
I capacitance
I pipette
I compensation
5000
4000
3000
2000
1000
0
−1000
−2000
I, pA
0.100
0.105
0.110
0.115
0.120
0.125
0.130
t, s

Схема patch-clamp



Lei Chon Lok, Clerx Michael, Whittaker Dominic G., Gavaghan David J., de Boer Teun P. and Mirams Gary R.
2020Accounting for variability in ion current recordings using a mathematical model of artefacts in voltage-clamp experimentsPhil. Trans. R. Soc. A.3782019034820190348
http://doi.org/10.1098/rsta.2019.0348

Параметры и расчет воротных переменных

$$\alpha_m = a_{0_m} * exp^{\frac{v_m}{s_m}}$$
$$\beta_m = b_{0_m} * exp^{\frac{v_m}{-\delta_m}}$$

$$\alpha_h = a_{0_h} * exp^{\frac{v_m}{s_h}}$$
$$\beta_h = b_{0_h} * exp^{\frac{v_m}{-\delta_h}}$$

$$\alpha_j = a_{0_j} * exp^{\frac{v_m}{s_j}}$$
$$\beta_j = b_{0_j} * exp^{\frac{v_m}{-\delta_j}}$$

$$\tau_m = \frac{1}{\beta_m + \alpha_m}$$
$$\tau_h = \frac{1}{\beta_h + \alpha_h}$$
$$\tau_j = \tau_{j_{const}} + \frac{1}{\beta_j + \alpha_j}$$

$$\frac{\partial m}{\partial t} = \frac{m_{inf} - m}{\tau_m}$$
$$\frac{\partial h}{\partial t} = \frac{h_{inf} - h}{\tau_h}$$

$$m_{inf} = \frac{1}{1 + exp^{\frac{-V_{half_m} - V_m}{k_m}}}$$
$$h_{inf} = j_{inf} = \frac{1}{1 + exp^{\frac{-V_{half_h} - V_m}{k_h}}}$$

Расчет потенциалов и ионных токов

$$\alpha = 0.75$$

$$\tau_{srp} = r_m * c_m * (1 - \alpha)$$

$$\beta = \frac{1}{1 - alpha} - 1$$

$$\frac{\partial V_{comp}}{\partial t} = \frac{V_c - V_{comp}}{\tau_{srp}}$$

$$V_{cp} = V_c + (V_c - V_{comp}) * \beta$$

$$\frac{\partial V_p}{\partial t} = \frac{V_{cp} - V_p}{C_p * R_p}$$

$$\frac{\partial V_m}{\partial t} = \frac{V_p + V_{off} - V_m}{C_m * R_s} - \frac{I_{ion} + I_{leak}}{C_m}$$

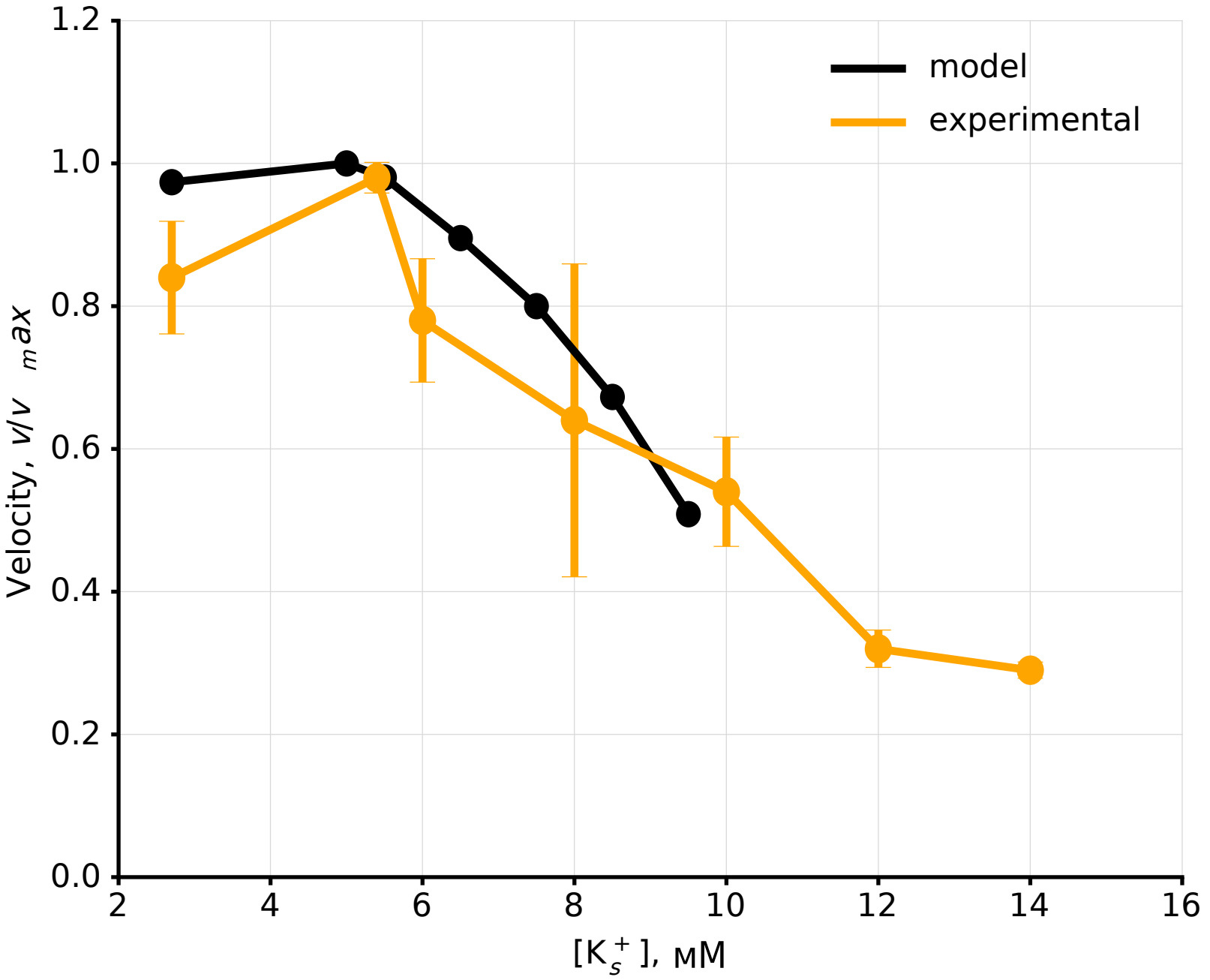
$$I_m = C_m * \frac{\partial V_m}{\partial t}$$

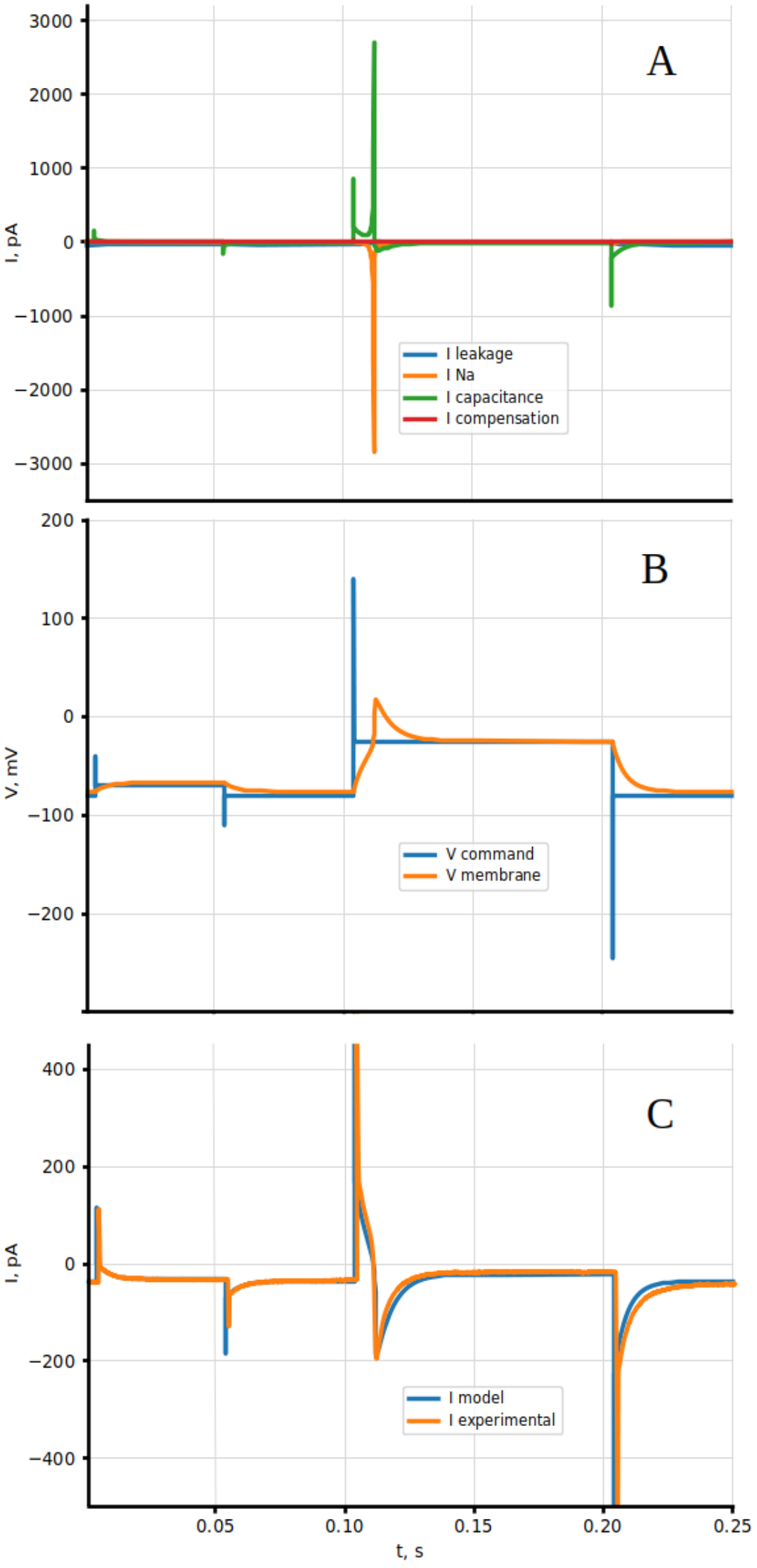
$$I_p = C_p * \frac{\partial V_p}{\partial t}$$

$$I_p = x_{c_{comp}} * C_m * \frac{\partial V_{comp}}{\partial t}$$

$$I_{leak} = g_{leak} * V_m$$

$$I_{ion} = g_{ion} * m^3 * h * j * (V_m - V_{rev})$$


model
experimental
Velocity, v/v max
[K+s], мМ
0.0
0.2
0.4
0.6
0.8
1.0
1.2
2
4
6
8
10
12
14
16


A
I, pA
3000
2000
1000
0
−1000
−2000
−3000
I leakage
I Na
I capacitance
I compensation
B
V, mV
200
100
0
−100
−200
V command
V membrane
C
I, pA
400
200
0
−200
−400
I model
I experimental
0.05
0.10
0.15
0.20
0.25
t, s