National Nanotechnology Coordinated Infrastructure

NIMS

Modeling Complex Random Memristor Networks

- model networks
- understand behavior
- use for computation

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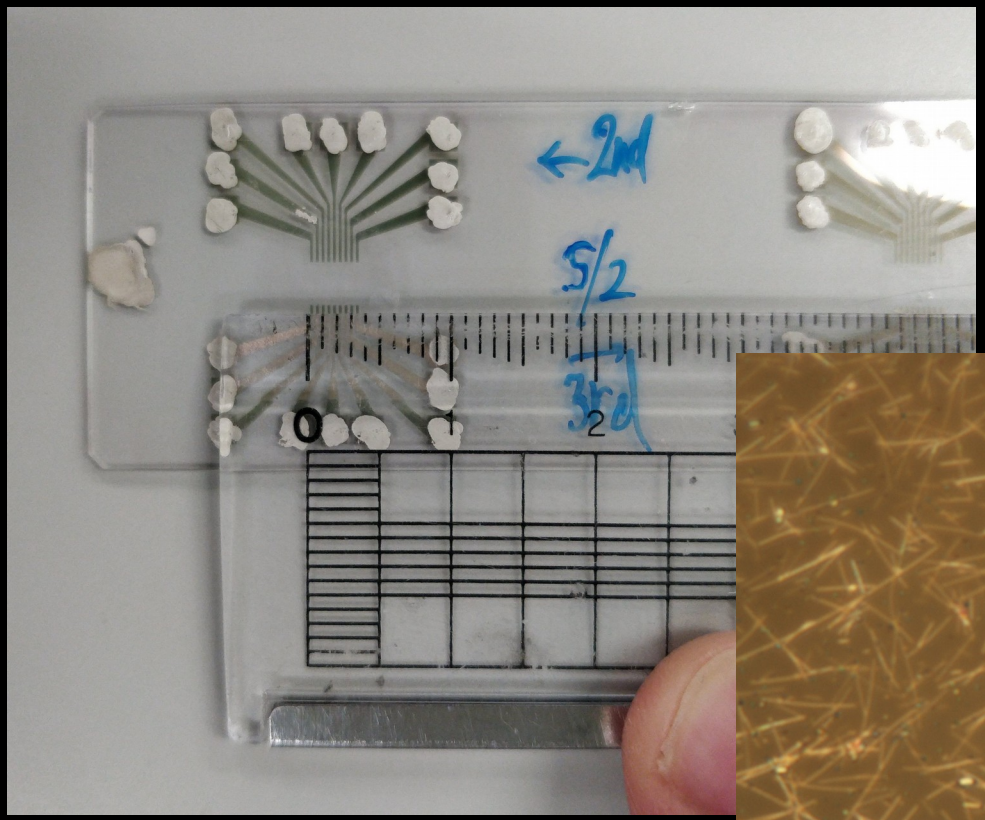
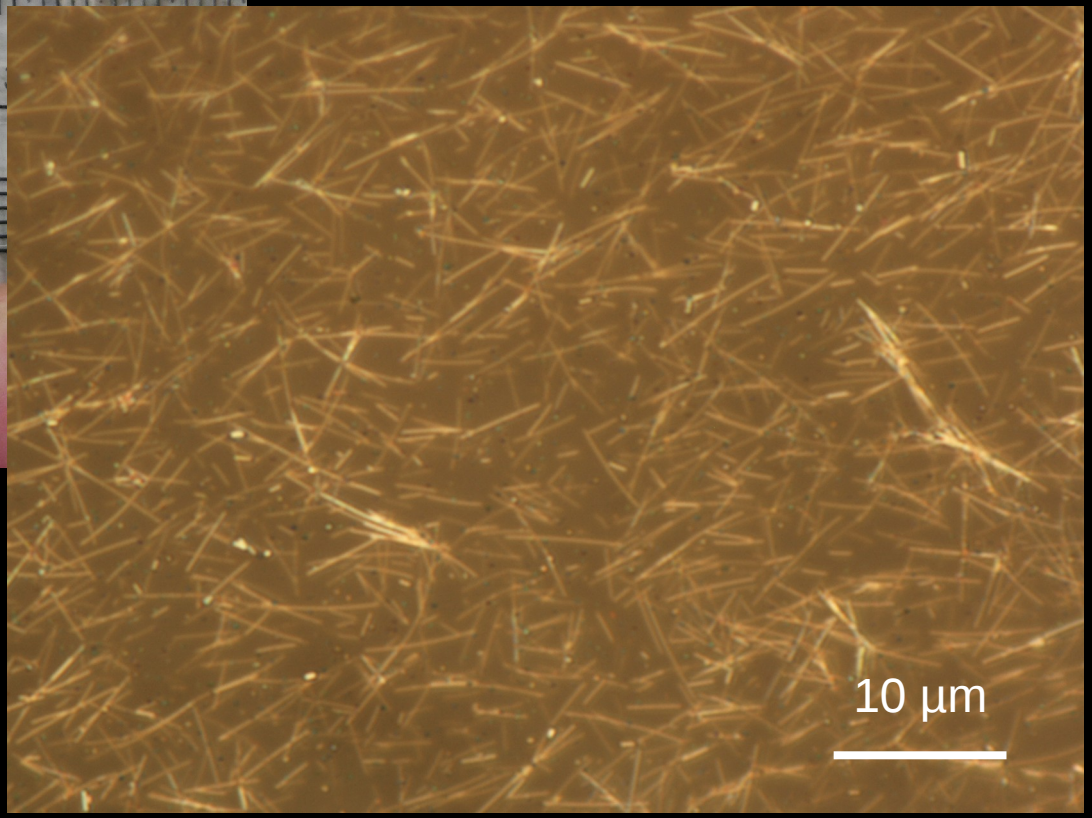
Nano Functionality Integration Group at NIMS

Physical Network

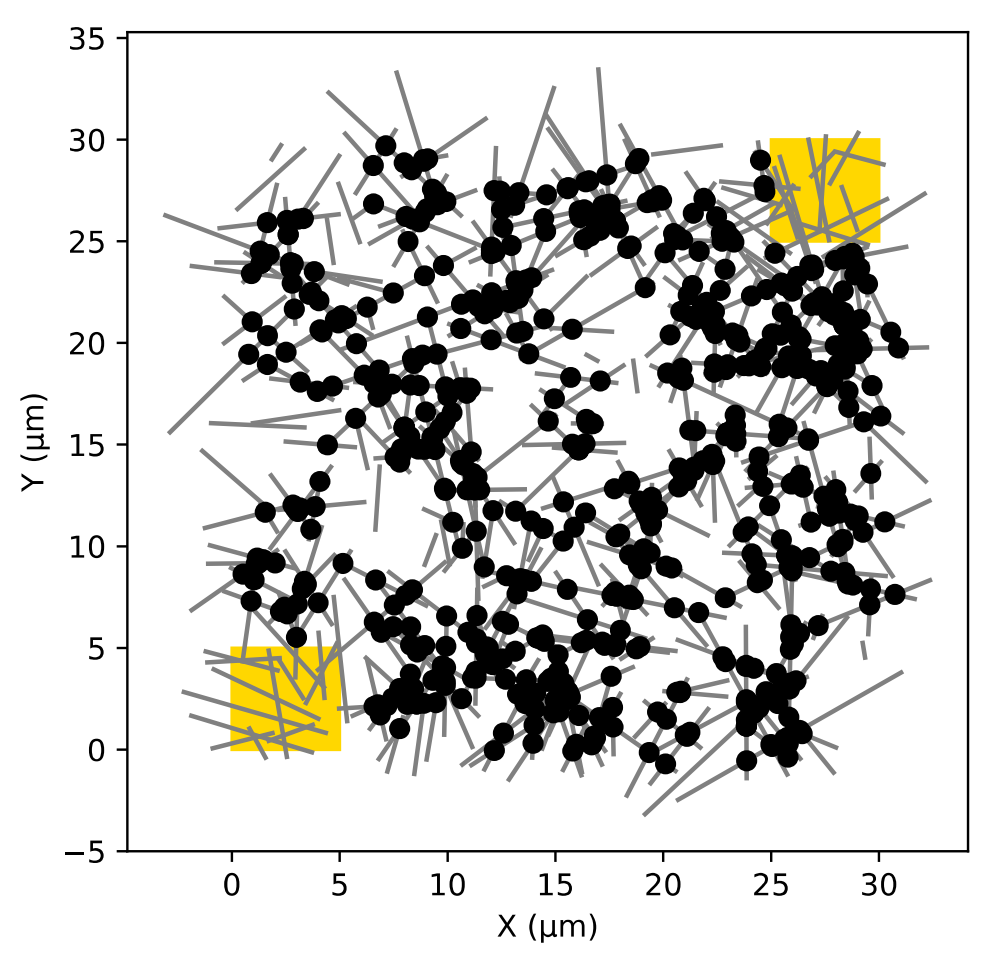


network electrodes

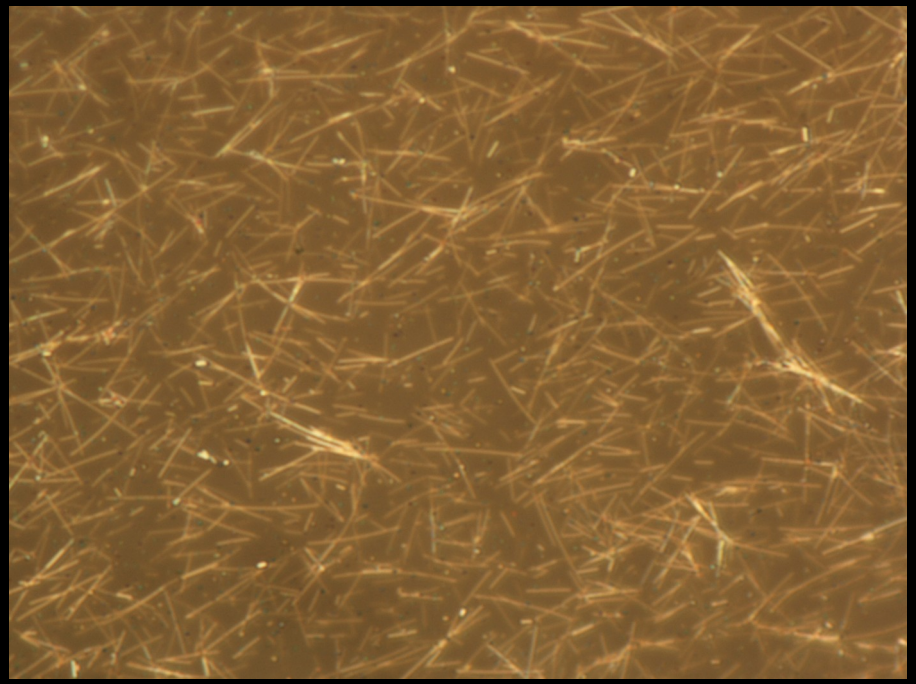
PVP@Ag nanowires



Network Model



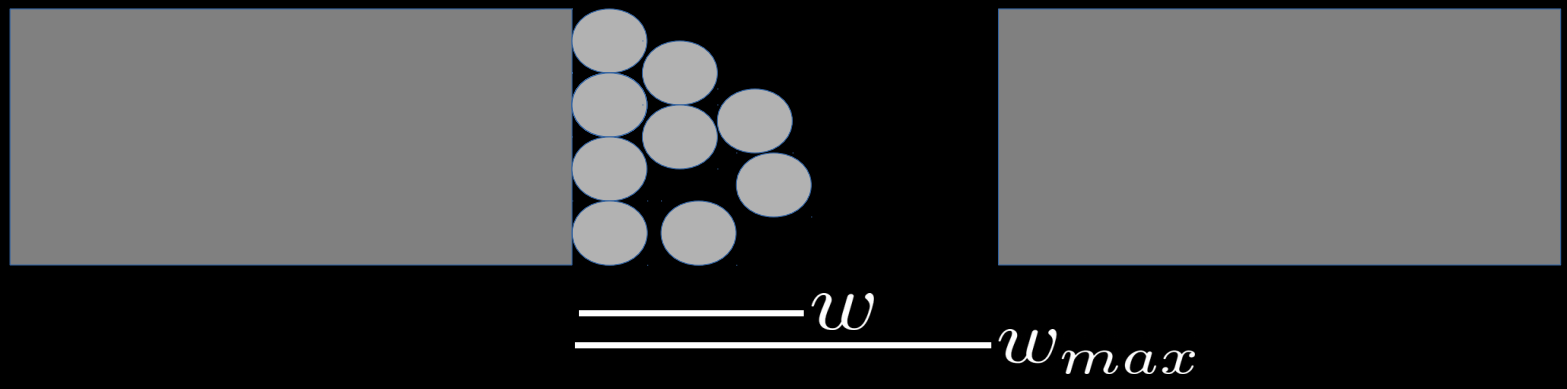
representative computer model



PVP@Ag nanowires

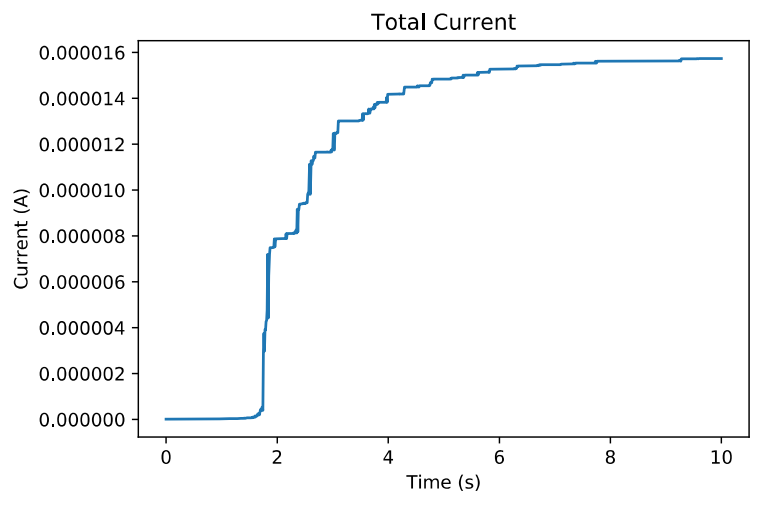
Junction Memristor Model

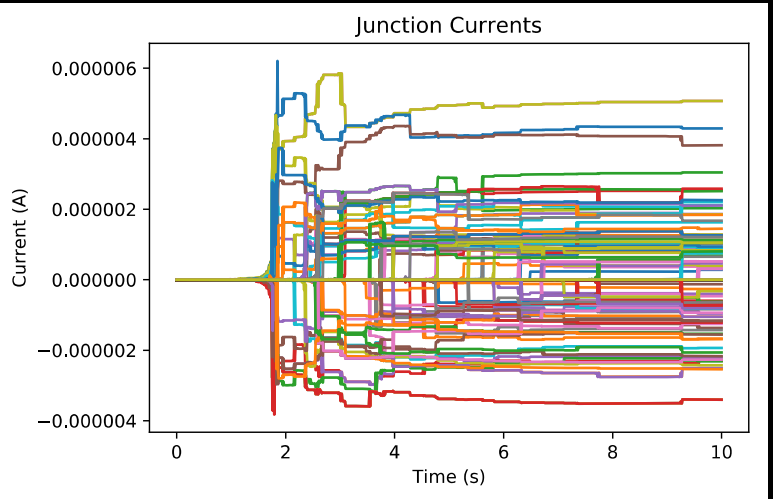
$$V = \left[\frac{w}{w_{max}} \cdot R_{on} + \left(1 - \frac{w}{w_{max}} \right) \cdot R_{off} \right] \cdot I$$

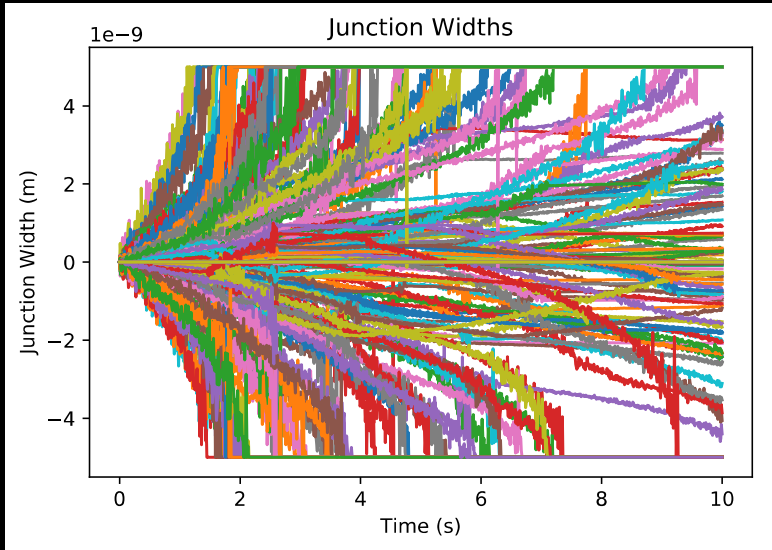


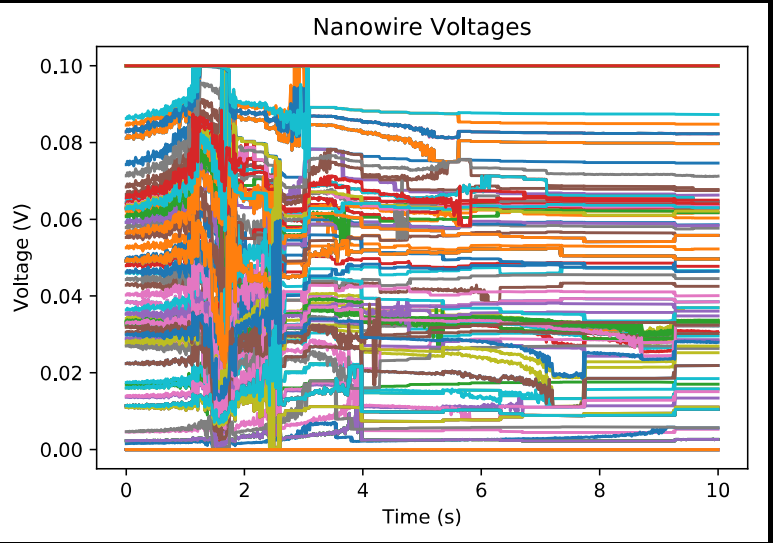
$$\frac{dw}{dt} = \mu_v \cdot \frac{R_{on}}{w_{max}} \cdot |I| - \frac{w}{\tau}$$

Network Time Response



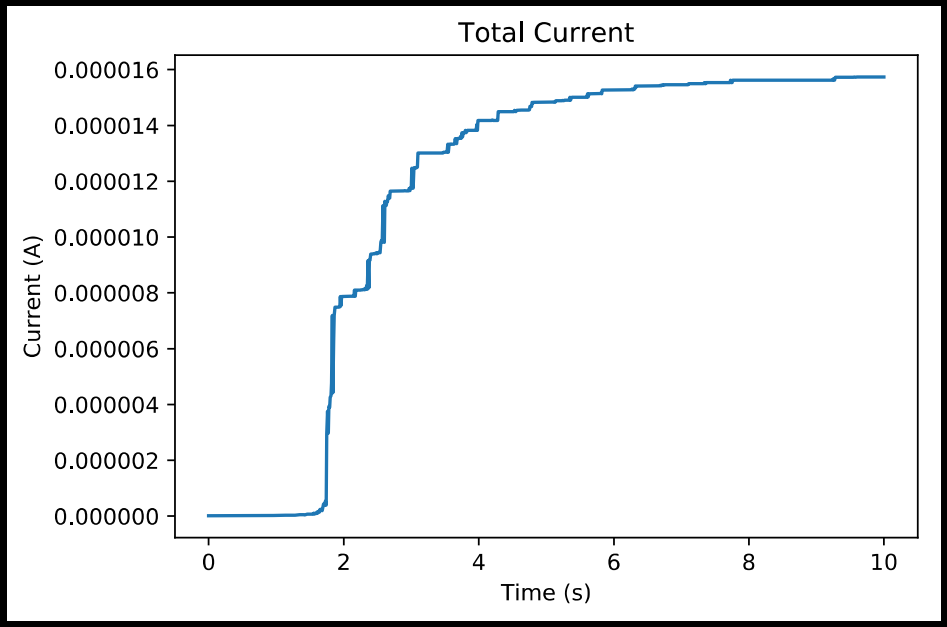




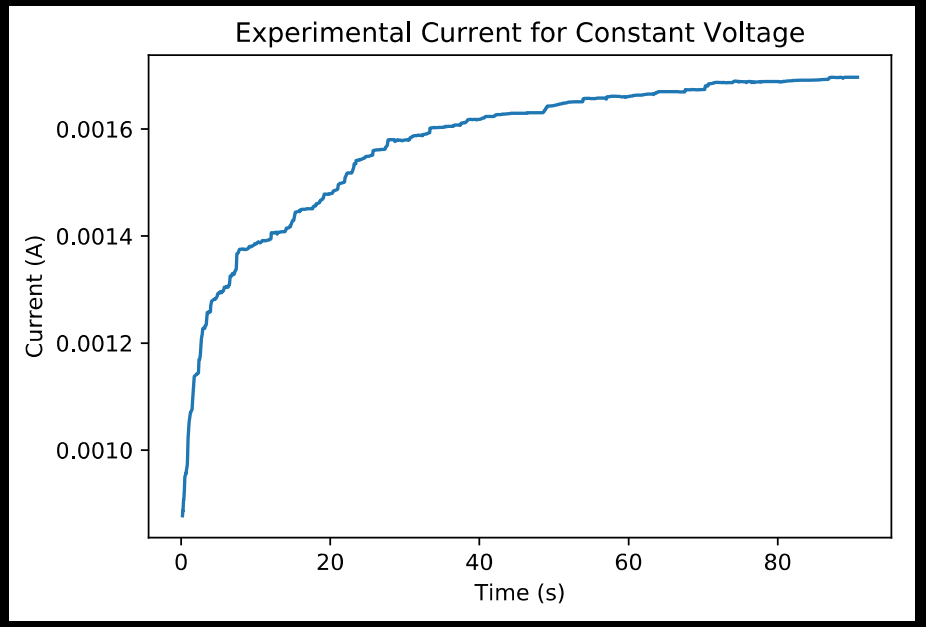


Experimental Confirmation

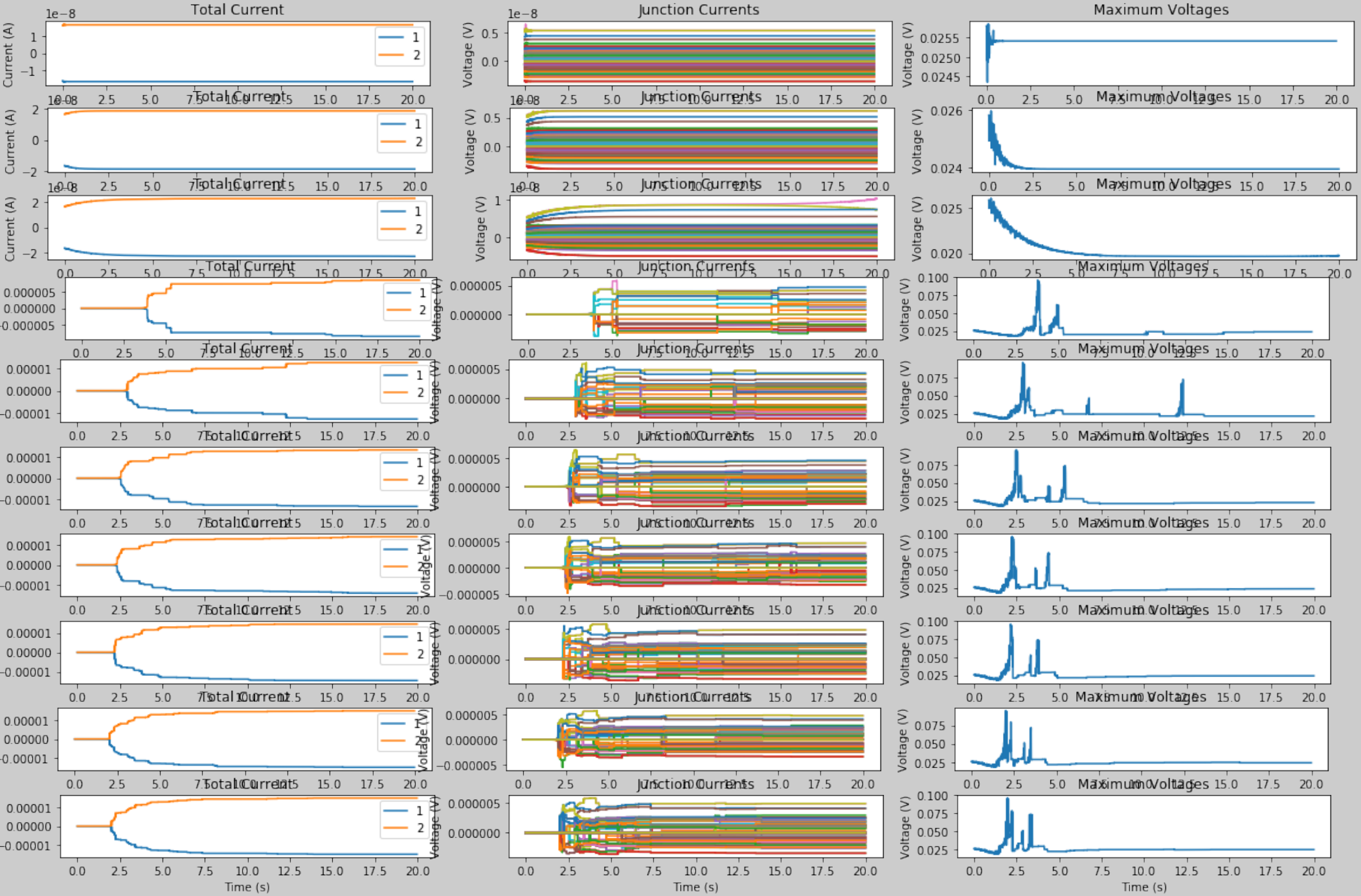
current from zero width

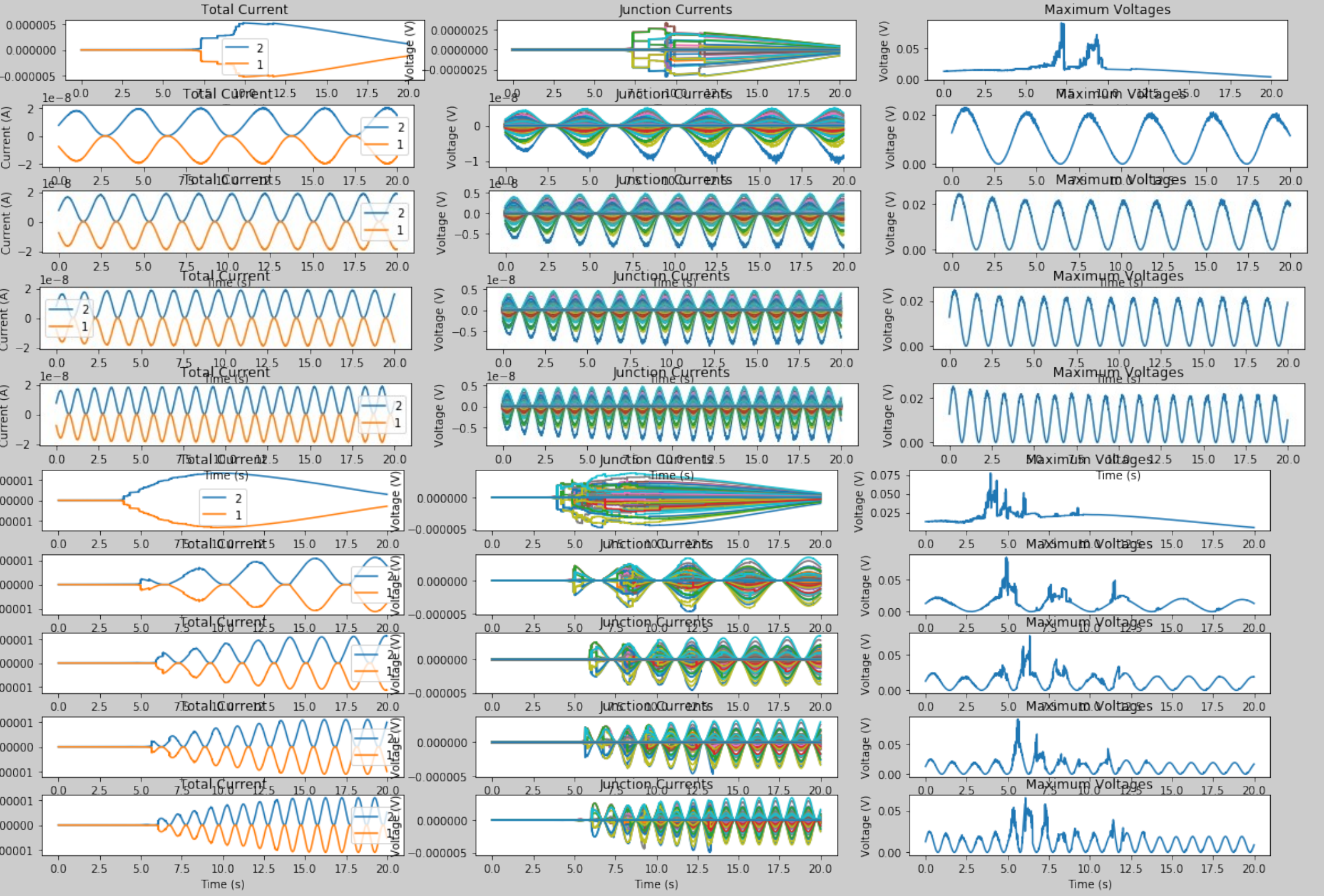


simulation



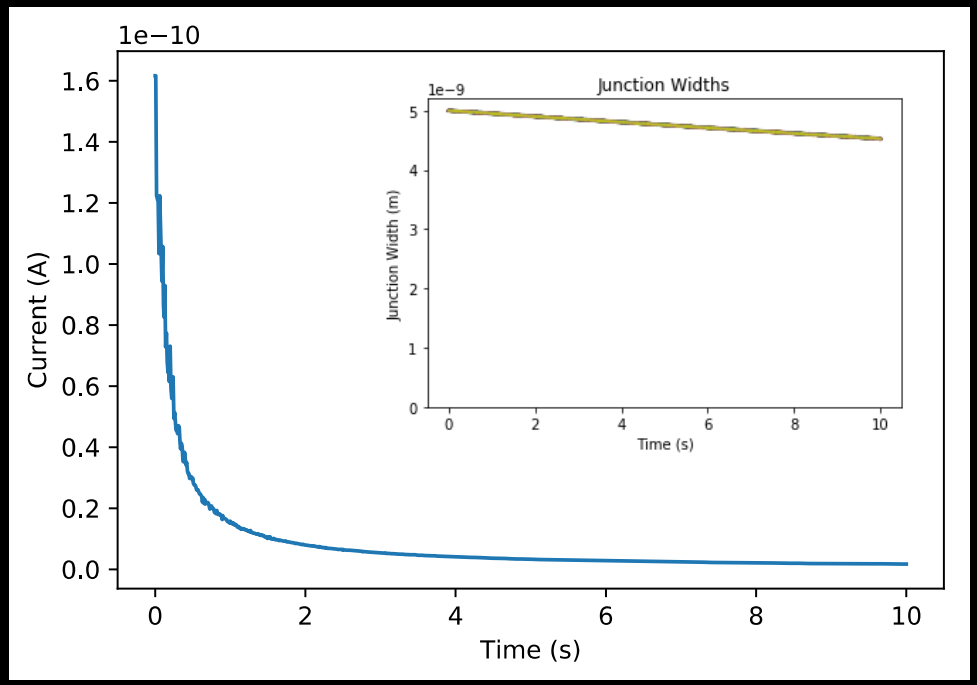
experiment


Total Current
Junction Currents
Maximum Voltages
Current (A)
Voltage (V)
Time (s)
1
2

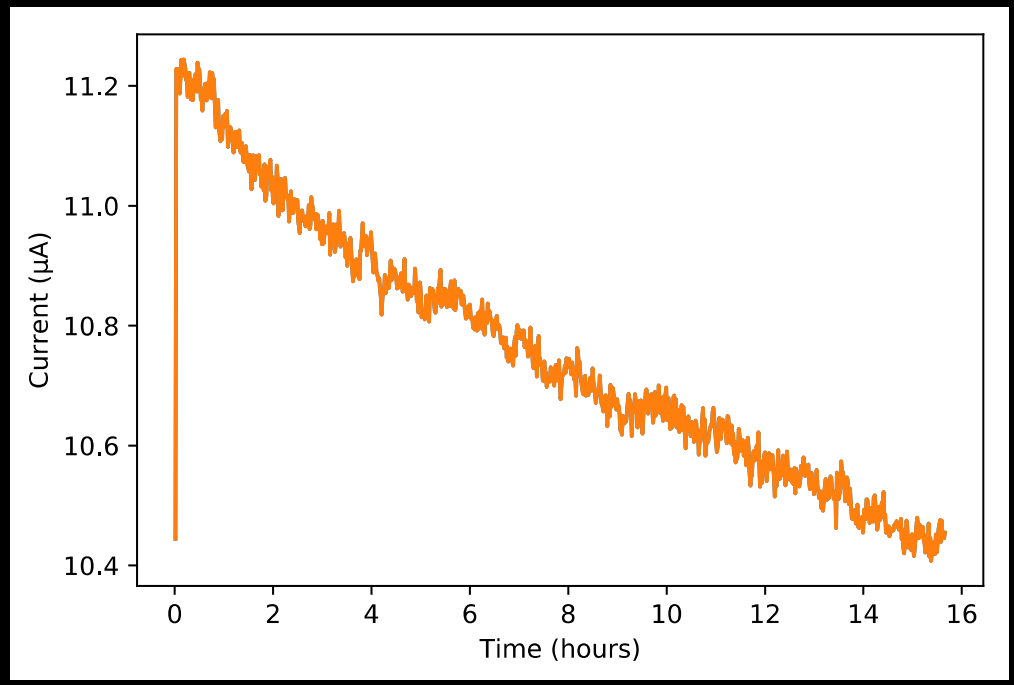

Total Current
Junction Currents
Maximum Voltages
Current (A)
Voltage (V)
Time (s)
2
1

Network Decay

width decay, measured by current



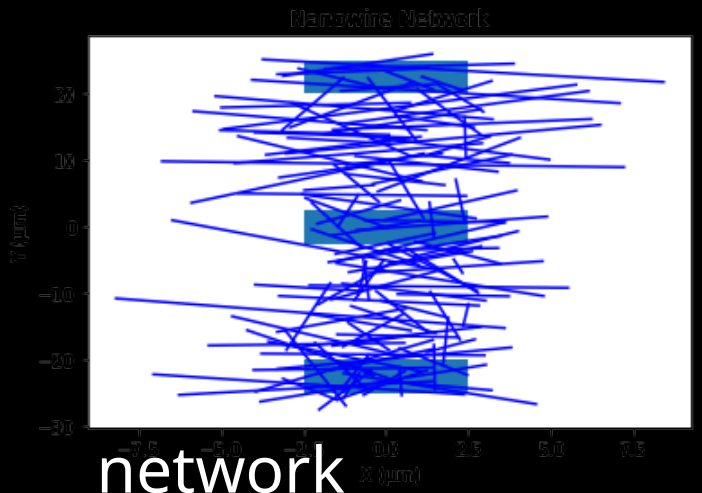
simulation (100s time constant)



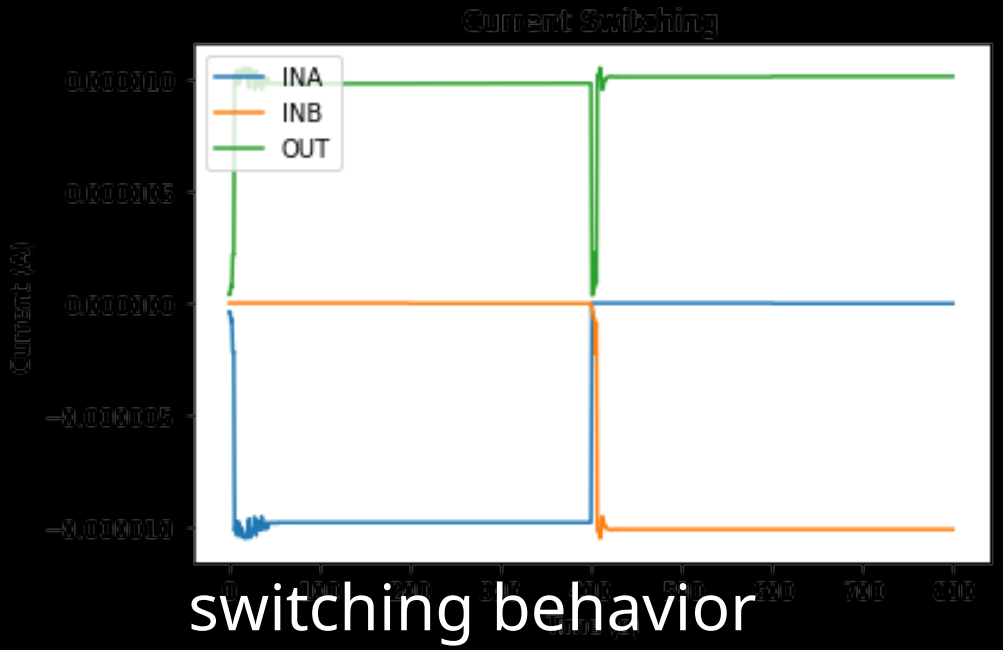
experiment

time constant ~ 1 week

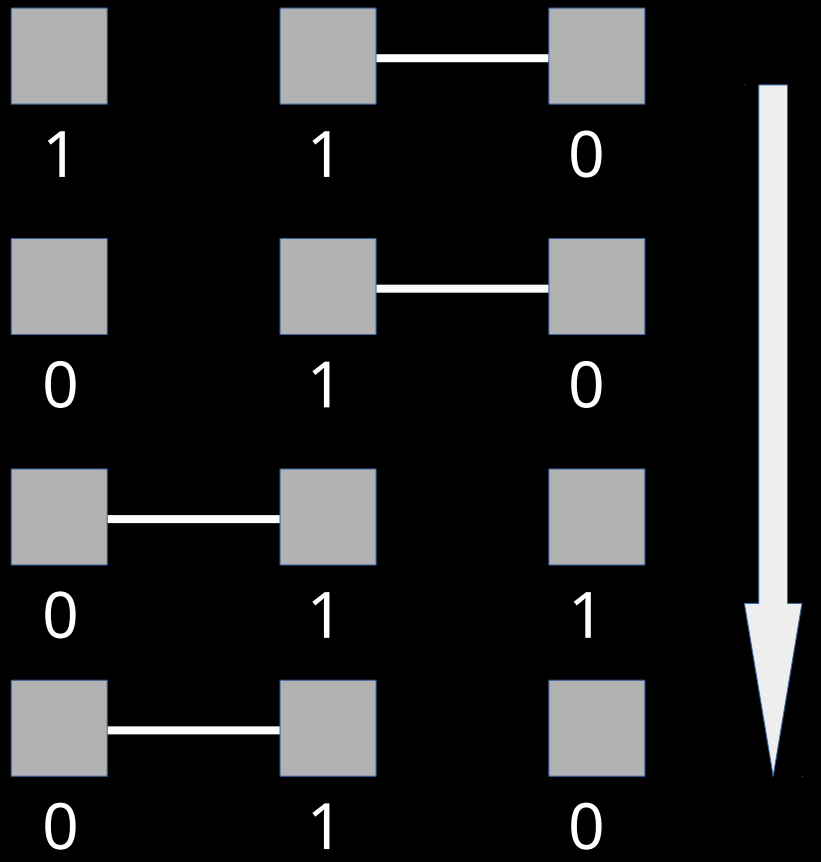
Finite State Machine



network



switching behavior



Conclusions

- behavior reaches a steady state
- low time constant - more complexity
- as-is, not very useful

- ephemeral memory
- finite state machine