A detailed model of the PN : the role of the SK channel

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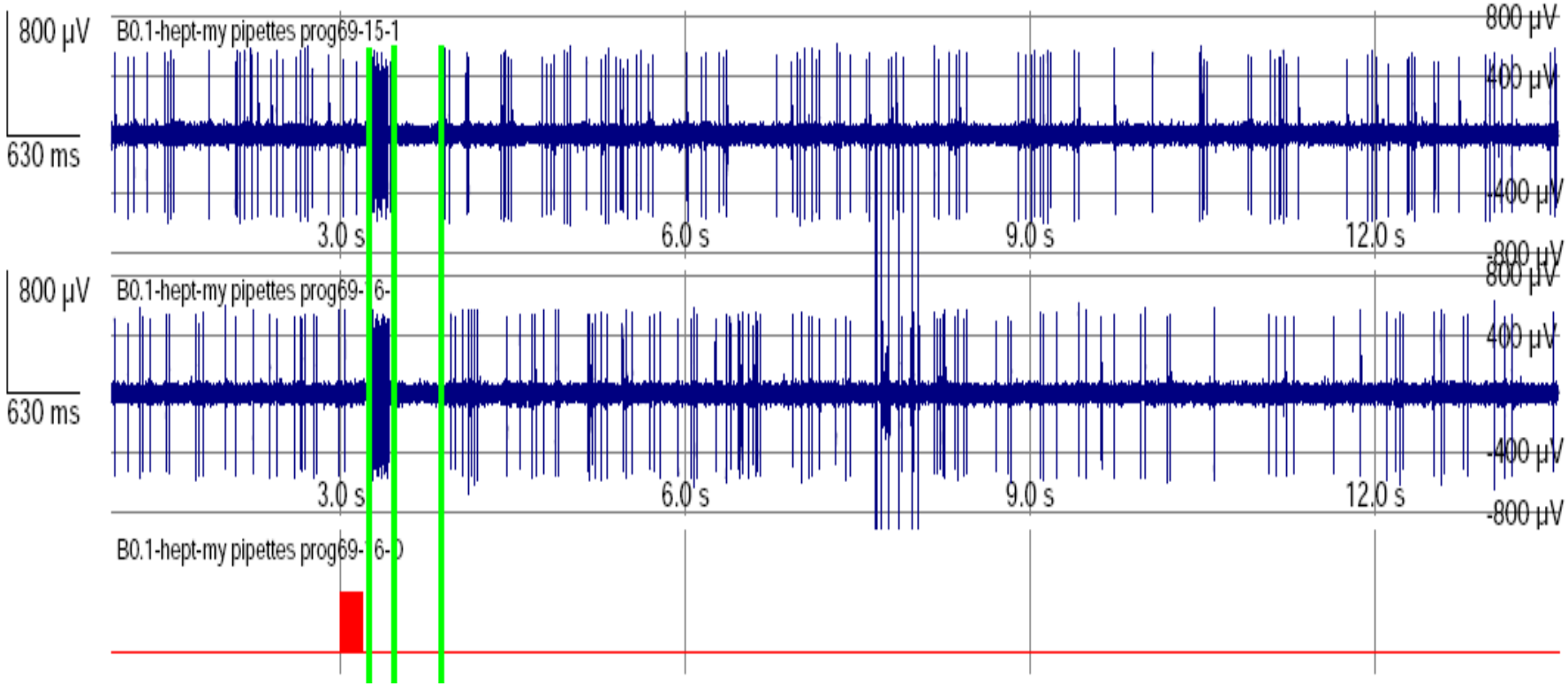
Plan

1. Biological results
2. Model
3. Results
4. Conclusion

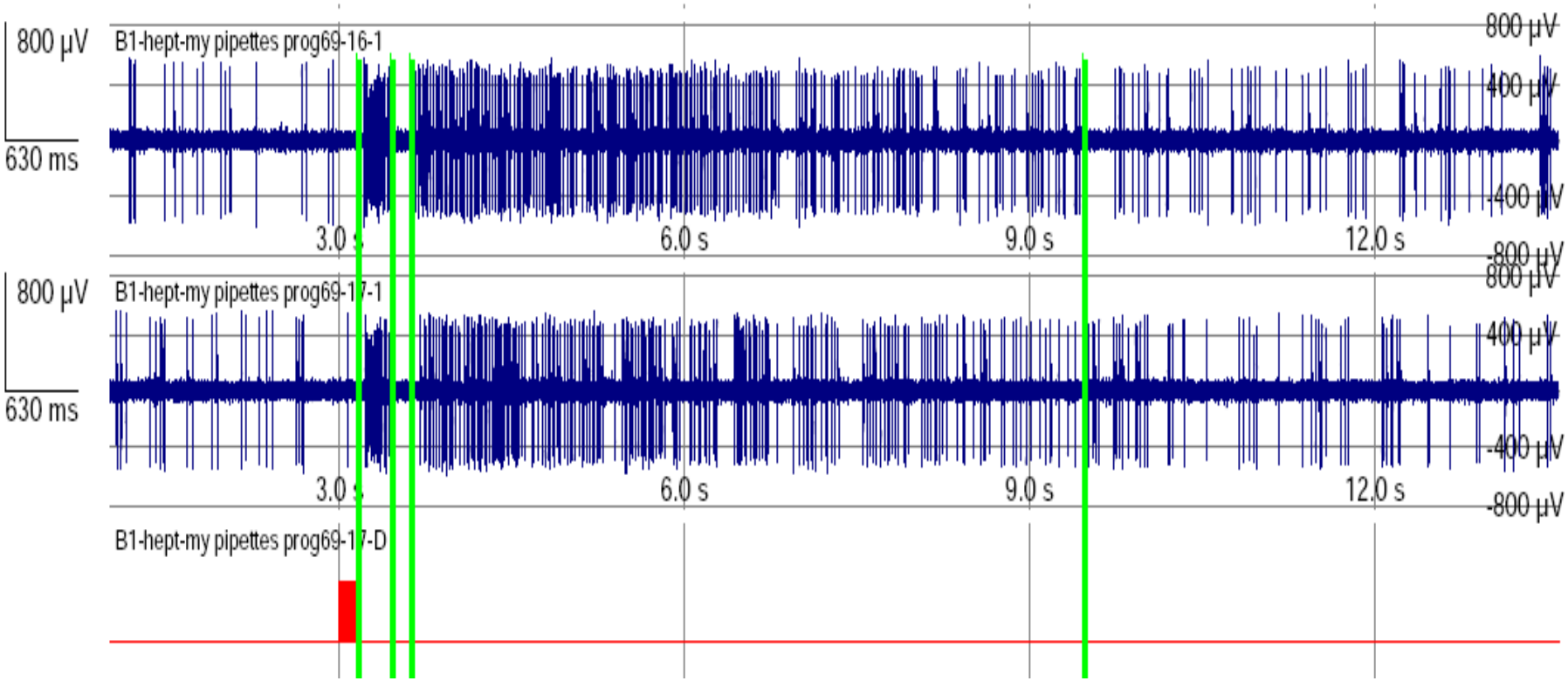
Biphasic PNs response

- At low concentration $\Longrightarrow$ Biphasic response



Triphasic PNs response

- At high concentration $\Longrightarrow$ Triphasic response



Common properties of biphasic and triphasic response

First

The after-hyperpolarizing potential (AHP) observed after the burst.

Second

The PNs respond after a delay.

Third

The burst duration is equal to the stimulus duration.

Fourth

The PNs respond whith a high frequency burst (120Hz∼160Hz).

How to reproduce these observations?

- The AHP ???

  ↻ Applying Bicuculline (a $GABA_A$ (g-aminobutyric acid) receptor antagonist) block the AHP.
  ⇒ ***Most of the litterature :*** AHP is caused by the architecture of the network.

  ↻ **BUT** Bicuculline also blocks small-conductance calcium-activated potassium channel!
  ⇒ ***Our proposal :*** AHP is caused by intrinsic properties of the neuron.

Electrical currents involved in our model

- **Basic model (HH)**

  I_{Na} : fast sodium current.
  I_K : potassium current.
  I_L : leak current

- **Current responsible of AHP**

  I_{SK} : small-conductance calcium-activated potassium current.
  I_{Ca} : calcium current.

- **Current responsible of delay**

  I_A : transient 'A'-type current.

The PN model

$$C_m \frac{dV}{dt} = I_{stim} - I_{Na} - I_K - I_L - I_{SK} - I_{Ca} - I_A \tag{1}$$

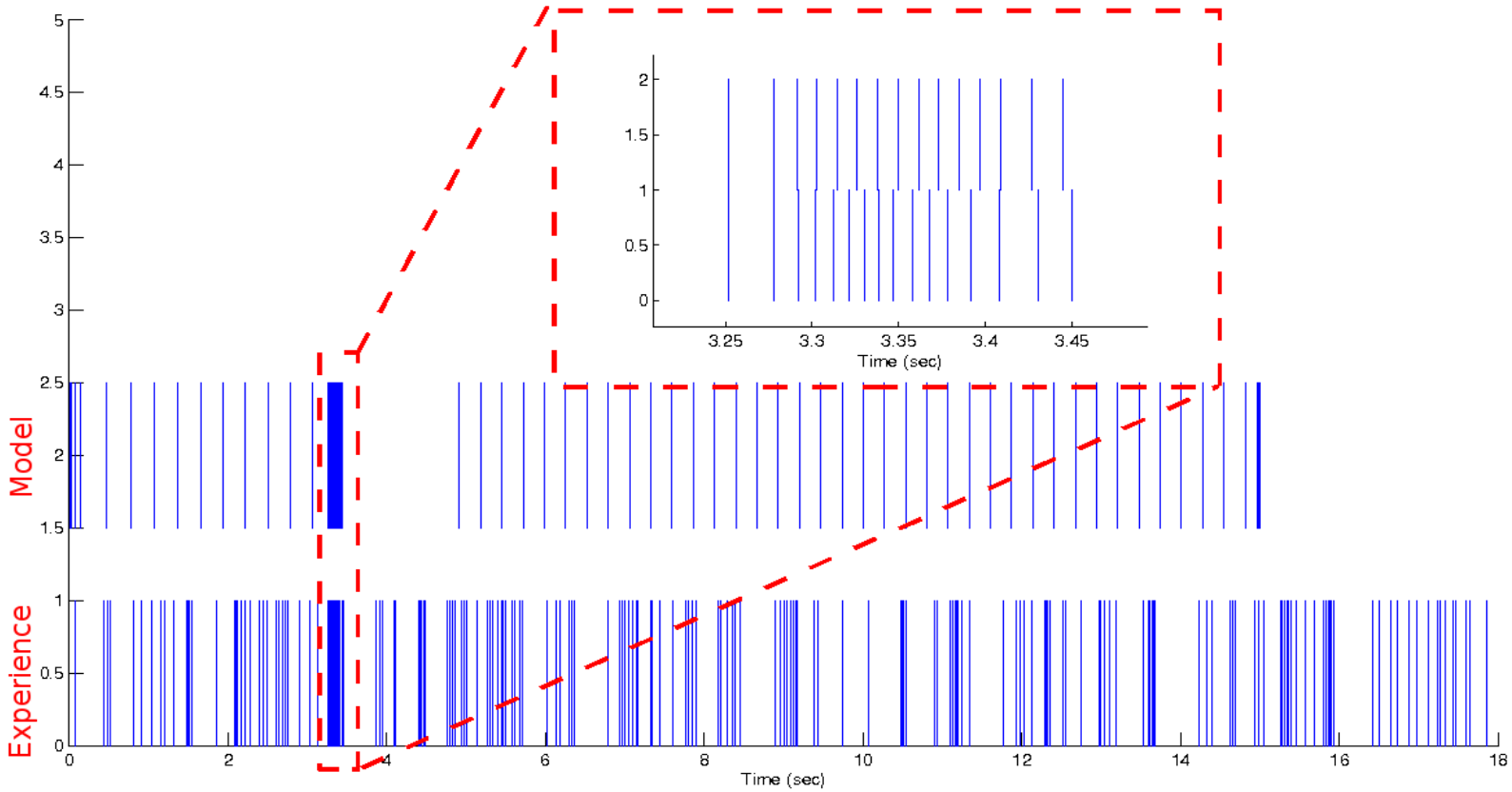
All the voltage- and calcium-dependent currents have the standard activation/inactivation form :

$$I_\varepsilon(t) = g_\varepsilon m^\alpha(t) h^\beta(t)(V - V_{rev}) \tag{2}$$

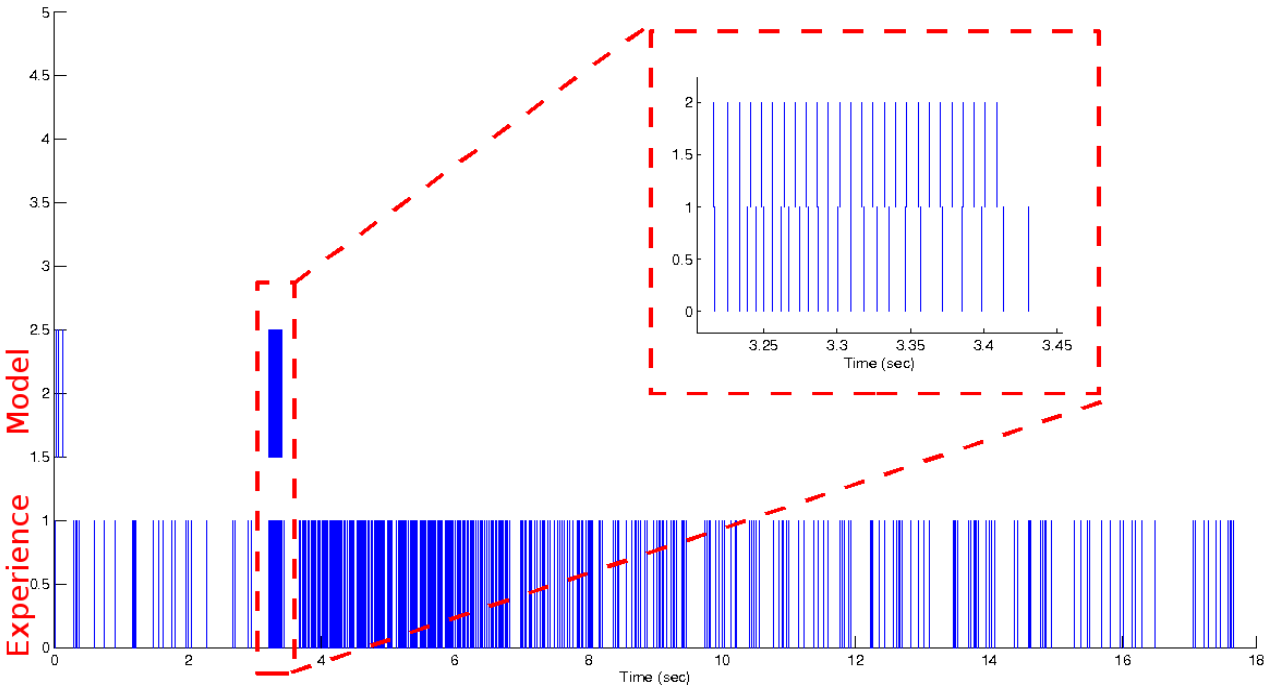
More specifically :

$$I_{SK} = g_{SK} * m_{SK} Inf^2(Csk) * (V - Vk); \tag{3}$$

Biphasic response



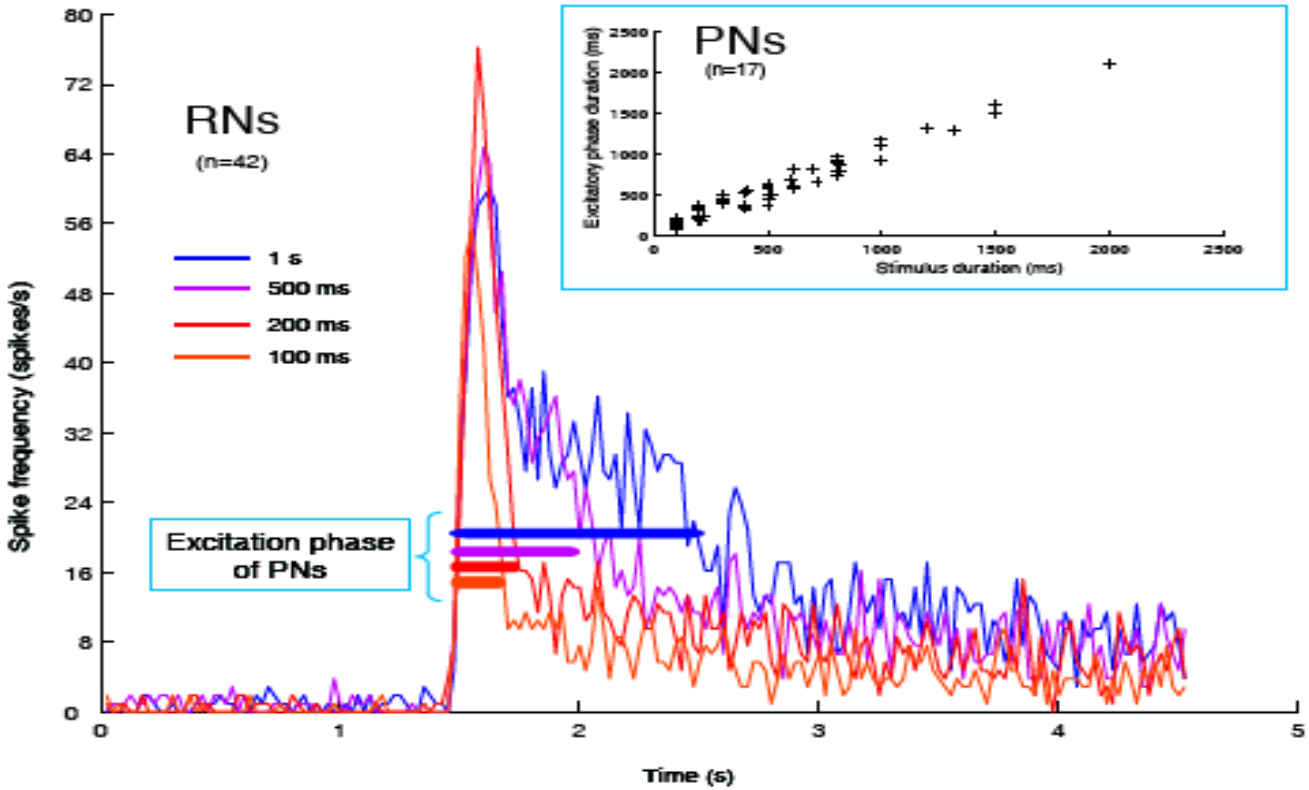
When we increase the stimulus concentration



↻ No triphasic response ↬ We have to change the shape of the input

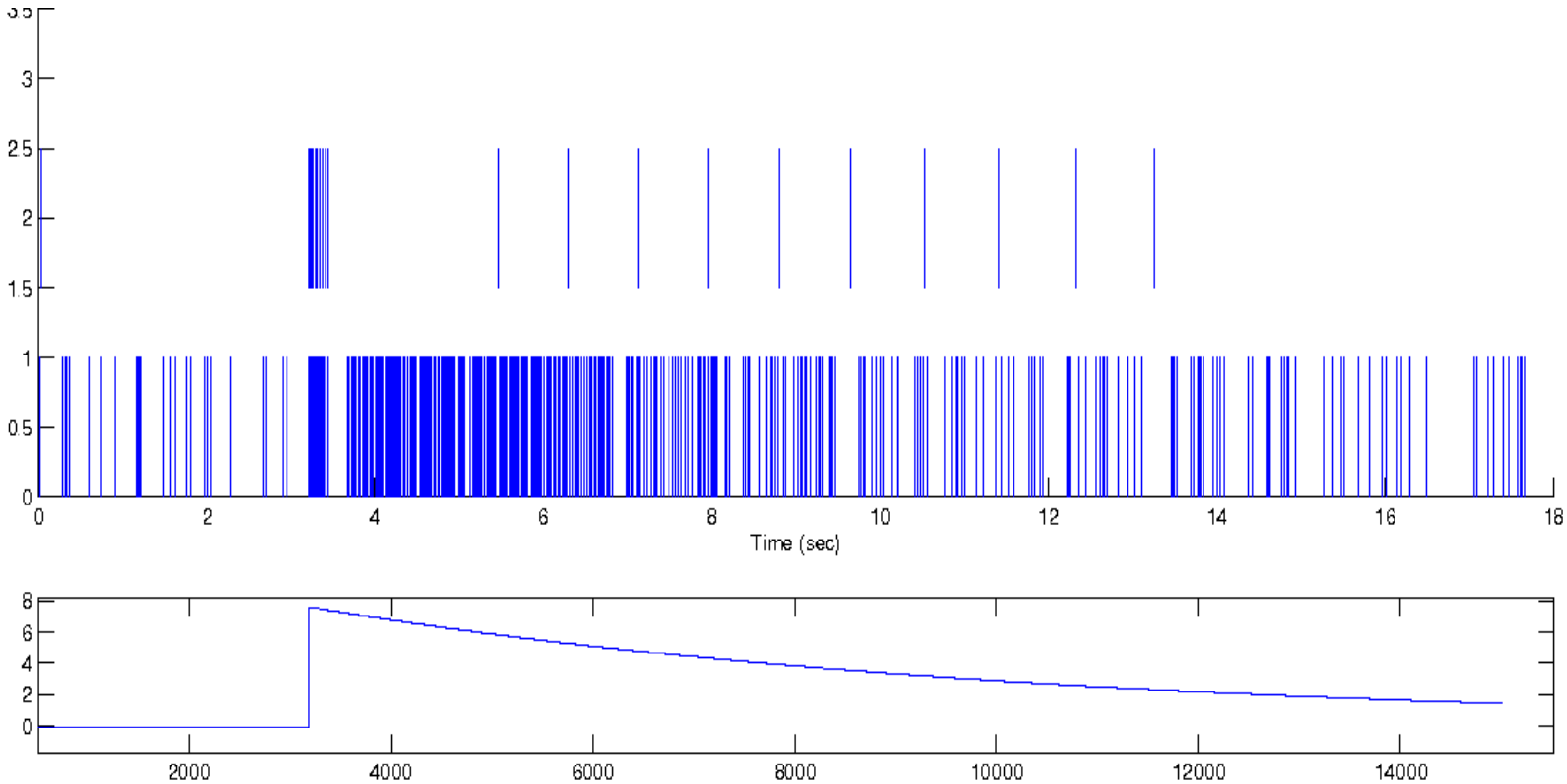
⇒ The response of the PN depends on the intrinsic properties BUT also depends on the input!!!

ORNs reponses (from D. Jarriault and *al.*)



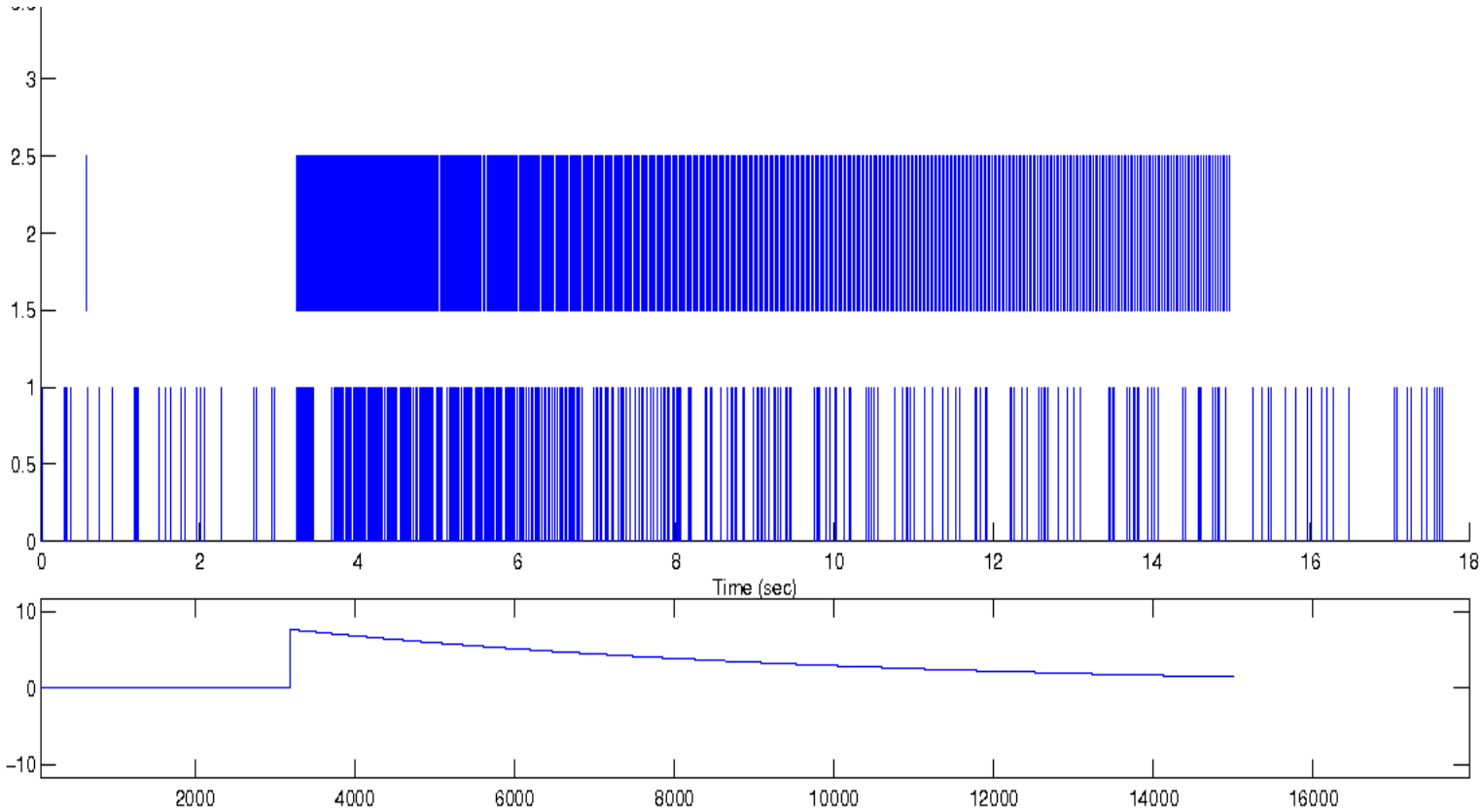
↬ Decreasing exponential with variable τ.

Triphasic response



$\Rightarrow$ We have to define a better input function.

Response without the I_{sk} current



Conclusion

↬ We developped a detailed model of PNs.

↬ We can obtain the two response profiles (biphasic and triphasic) observed biologically.

BUT

↬ We have to improve the input function to better fit biological responses.

perspectives

↬Study if the delay is an intrinsic properties or not.

↬Study the effect of stimulus duration on response duration (burst) and on AHP duration.

Thank you for your attention