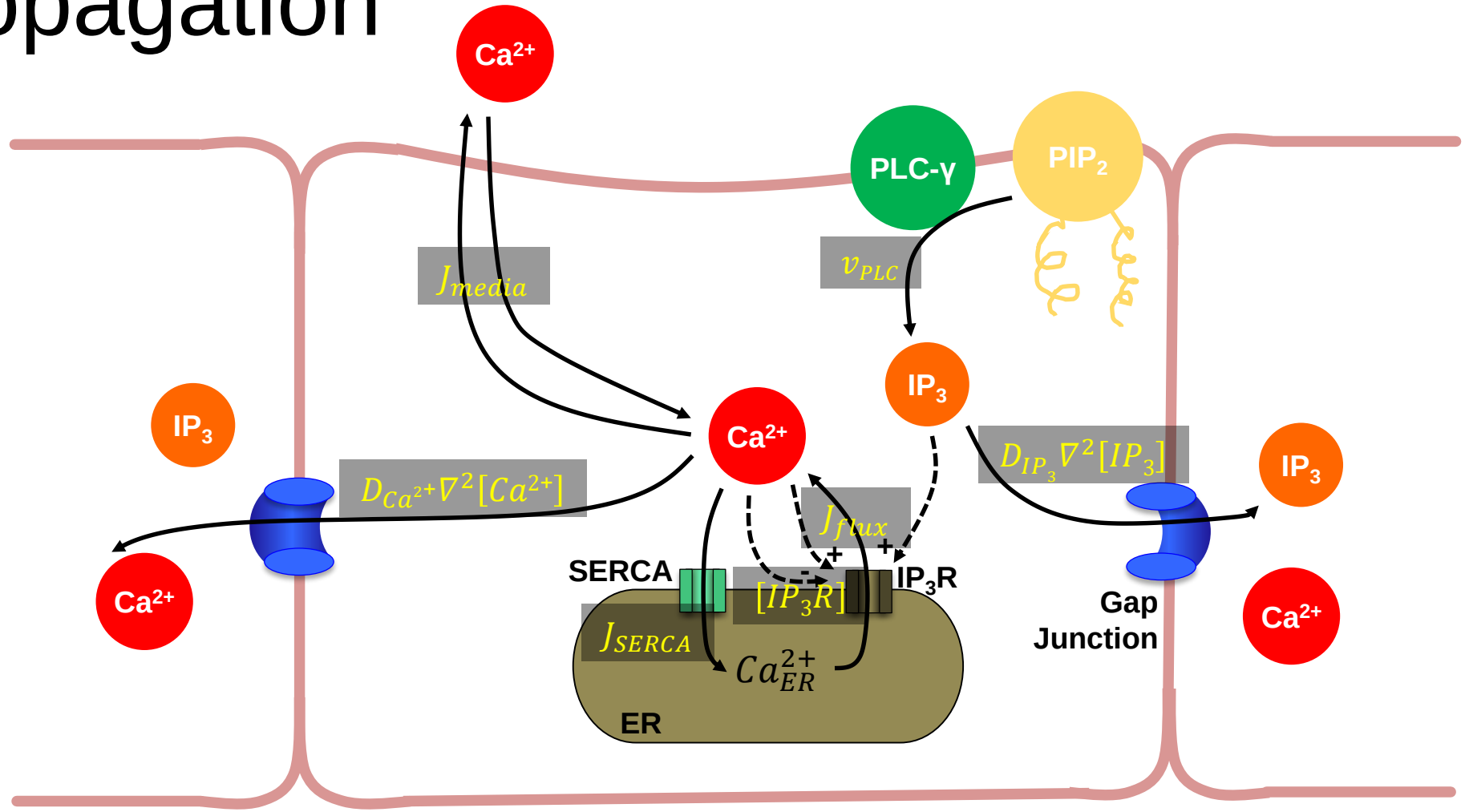
Molecular mechanism of calcium propagation



PDE model (Version 1)

$$\frac{\partial[Ca^{2+}]}{\partial t} = \frac{(k_1 + k_2[IP_3R][Ca^{2+}]^2[IP_3]^2)([Ca^{2+}_{ER}] - [Ca^{2+}])}{(K^2_{Ca^{2+}} + [Ca^{2+}]^2)(K^2_{IP_3} + [IP_3]^2)} - \frac{v_{SERCA}[Ca^{2+}]^2}{k^2_{SERCA} + [Ca^{2+}]^2} + v_{leak}(k_{leak} - [Ca2+]) + D_{Ca^{2+}}\nabla^2[Ca^{2+}]$$

$$\frac{d[Ca^{2+}_{ER}]}{dt} = -\frac{V}{V_{ER}}\left(\frac{(k_1 + k_2[IP_3R][Ca^{2+}]^2[IP_3]^2)([Ca^{2+}_{ER}] - [Ca^{2+}])}{(K^2_{Ca^{2+}} + [Ca^{2+}]^2)(K^2_{IP_3} + [IP_3]^2)} - \frac{v_{SERCA}[Ca^{2+}]^2}{k^2_{SERCA} + [Ca^{2+}]^2}\right)$$

$$\frac{\partial[IP_3]}{\partial t} = \Gamma(1, \mu_{PLC}) - k_{deg}[IP_3] + D_{IP_3}\nabla^2[IP_3]$$

$$\frac{d[IP_3R]}{dt} = k_6\left(\frac{K_i^2}{K_i^2 + [Ca^{2+}]^2} - [IP_3R]\right)$$

PDE model (Version 2)

$$\frac{\partial[Ca^{2+}]}{\partial t} = J_{flux} - J_{SERCA} + J_{media} + D_{Ca^{2+}}\nabla^2[Ca^{2+}]$$

$$\frac{d[IP_3R]}{dt} = k_6\left(\frac{K_i^2}{K_i^2 + [Ca^{2+}]^2} - [IP_3R]\right)$$

$$\frac{d[Ca_{ER}^{2+}]}{dt} = -\frac{V}{V_{ER}}\left(J_{flux} - J_{SERCA}\right)$$

$$\frac{\partial[IP_3]}{\partial t} = v_{PLC} - k_{deg}[IP_3] + D_{IP_3}\nabla^2[IP_3]$$

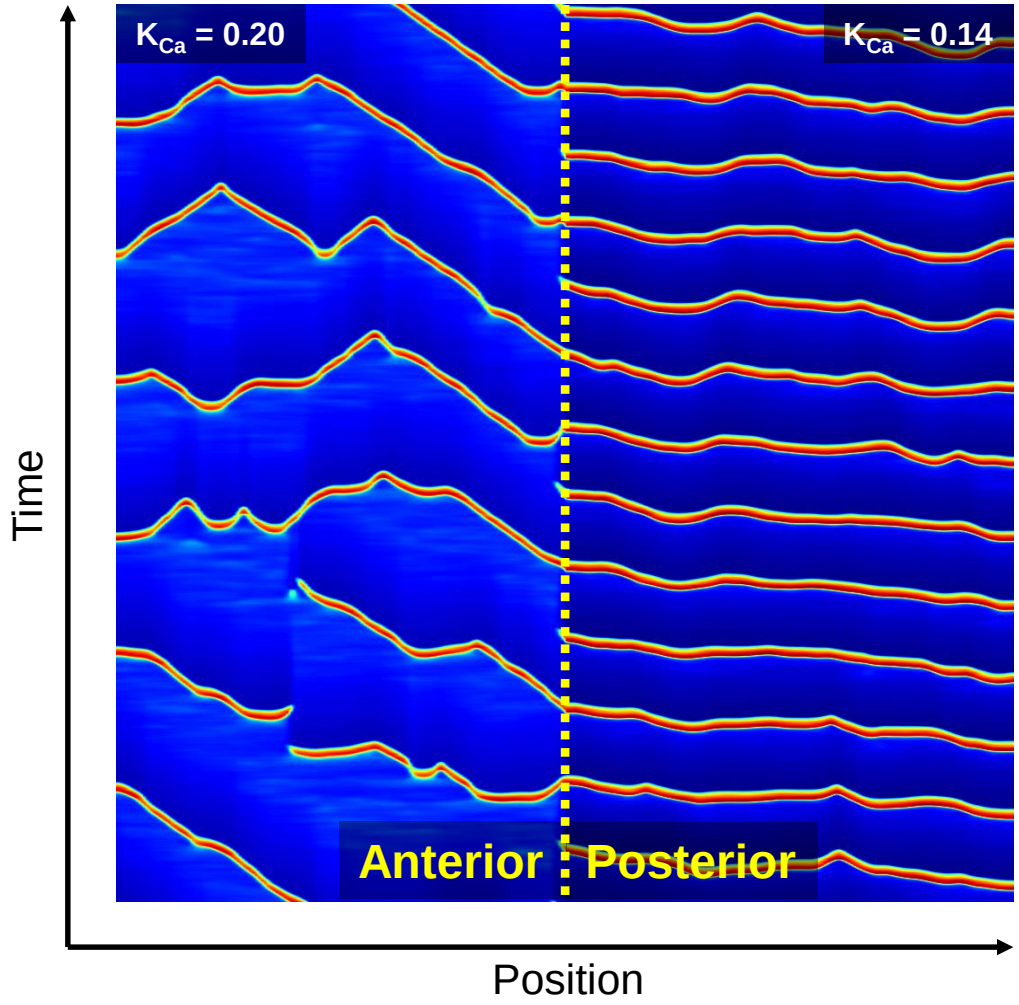
$$J_{flux} = \frac{(k_1 + k_2[IP_3R][Ca^{2+}]^2[IP_3]^2)([Ca_{ER}^{2+}] - [Ca^{2+}])}{(K_{Ca^{2+}}^2 + [Ca^{2+}]^2)(K_{IP_3}^2 + [IP_3]^2)}$$

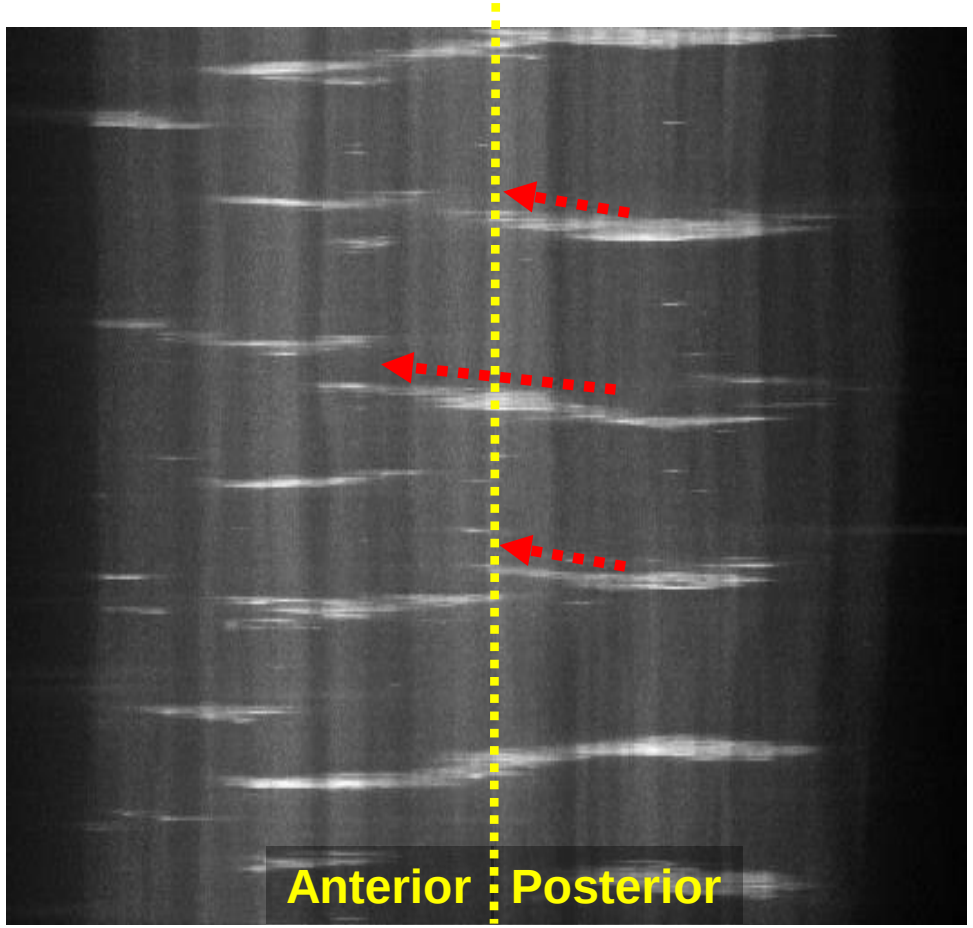
$$J_{SERCA} = \frac{v_{SERCA}[Ca^{2+}]^2}{k_{SERCA}^2 + [Ca^{2+}]^2}$$

$$J_{media} = v_{leak}(k_{leak} - [Ca2+])$$

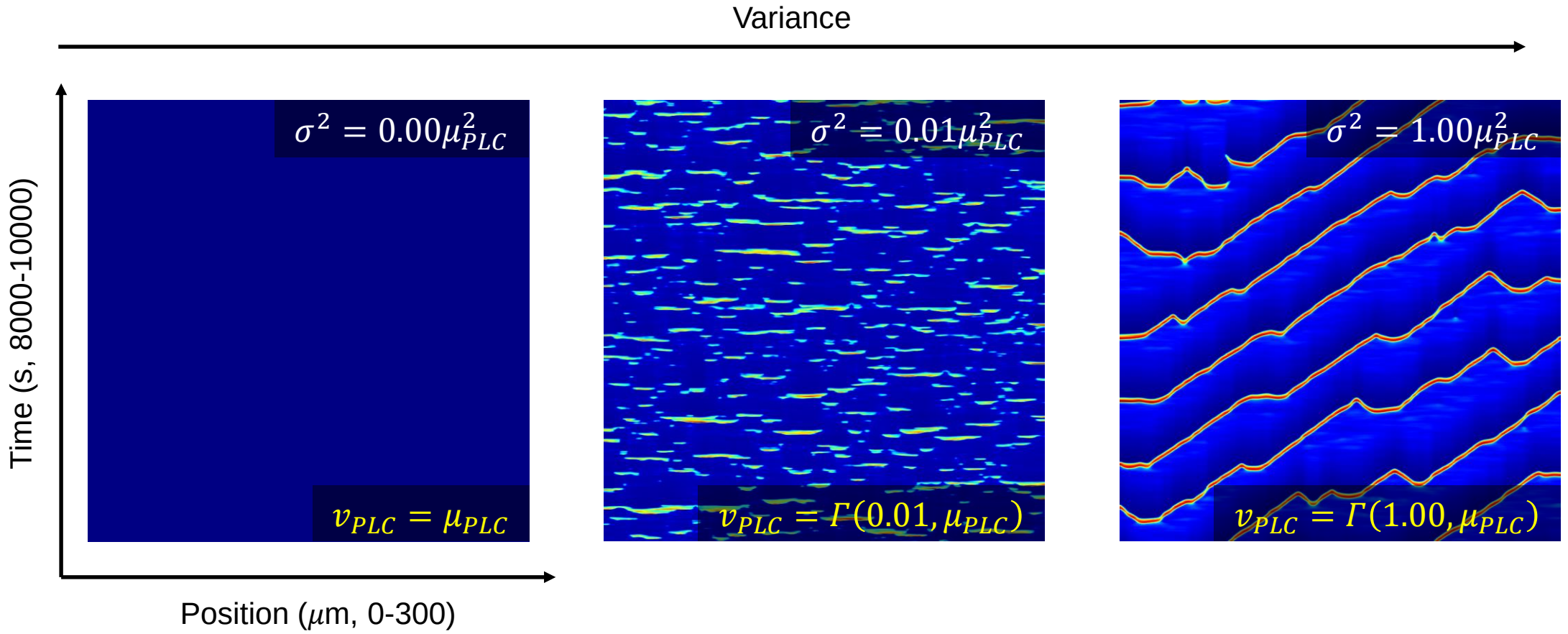
$$v_{PLC} = \Gamma(1, \mu_{PLC})$$

Boundary penetrance may be explained by differential cell properties in compartments





Signal variance may explain pulse to wave transition



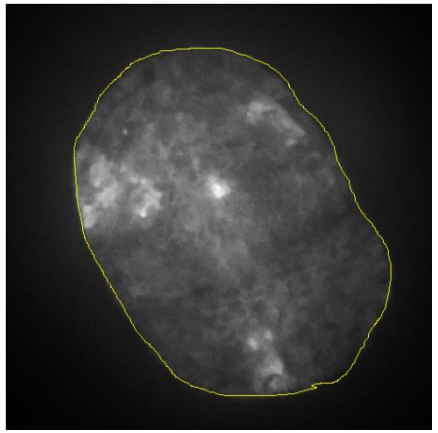
t = 8000s to 10000s

Parameter	Category	Amplitude	Steady state concentration	Frequency	Speed
k_1	J_{flux}	X	X	-	X
k_2		X	X	-	X
$K_{Ca^{2+}}$		X	X	X	-
K_{IP_3}		X	X	X	-
v_{SERCA}	J_{SERCA}	X	X	-	X
k_{SERCA}		X	X	-	X
v_{leak}	J_{media}	X	X	-	X
k_{leak}		-	-	X	X
V/V_{ER}	$[Ca^{2+}_{ER}]$	-	-	-	-
k_6	$[IP_3R]$	-	-	-	-
K_i		X	X	-	-
k_{deg}	$[IP_3]$	X	X	X	X
μ_{PLC}		-	-	-	X
D_{IP_3}	Diffusion	-	-	X	X
$D_{Ca^{2+}}$		-	-	-	-

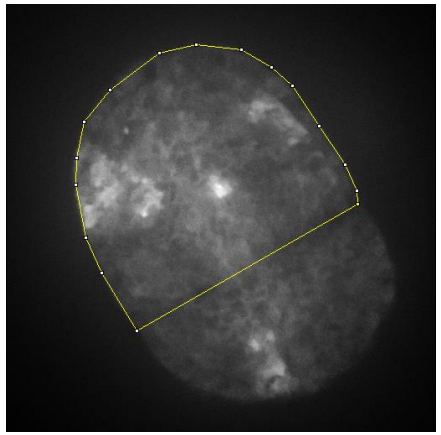
OTHER SLIDES:

Domain specificity of Ca^{2+} transients

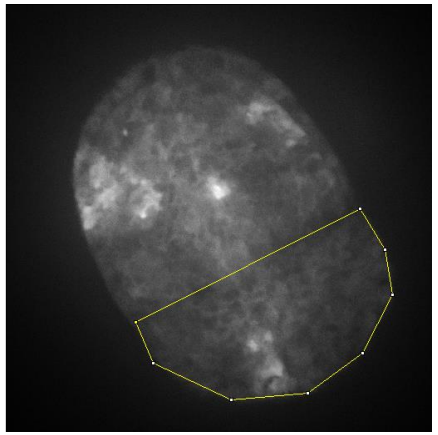
Whole disc

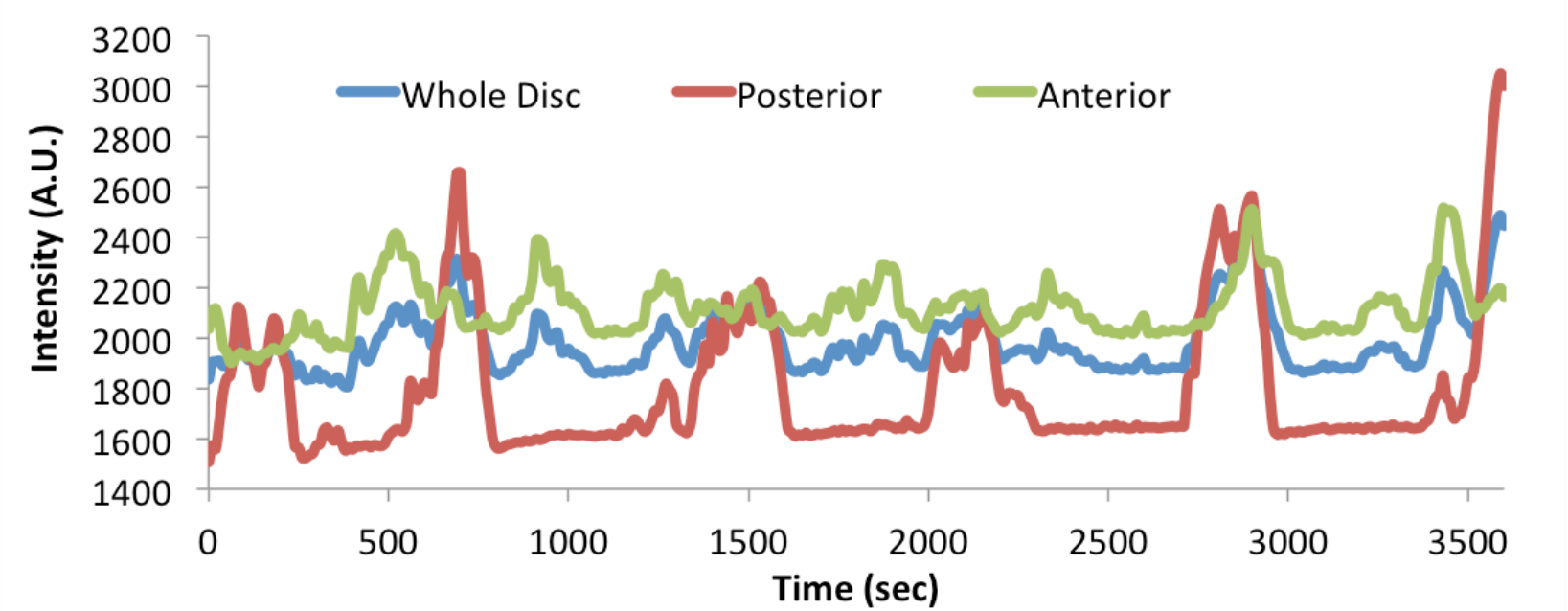


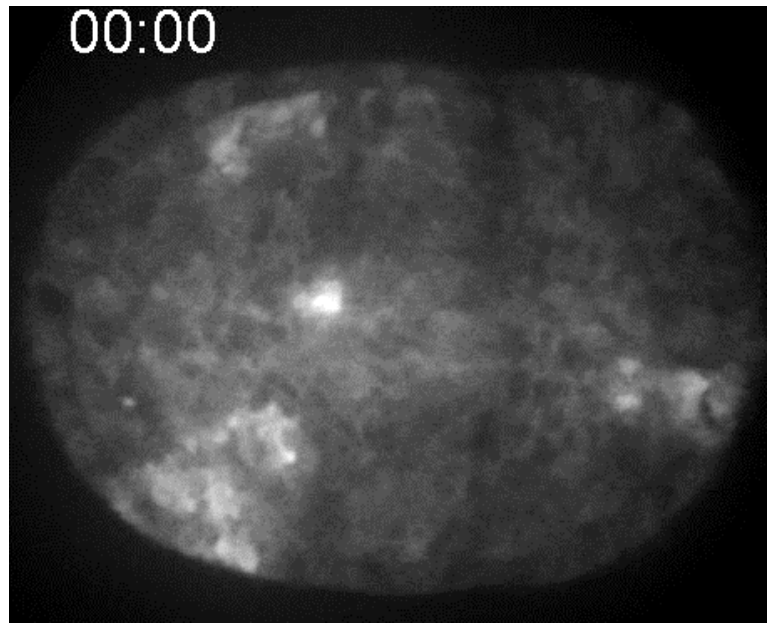
Anterior



Posterior



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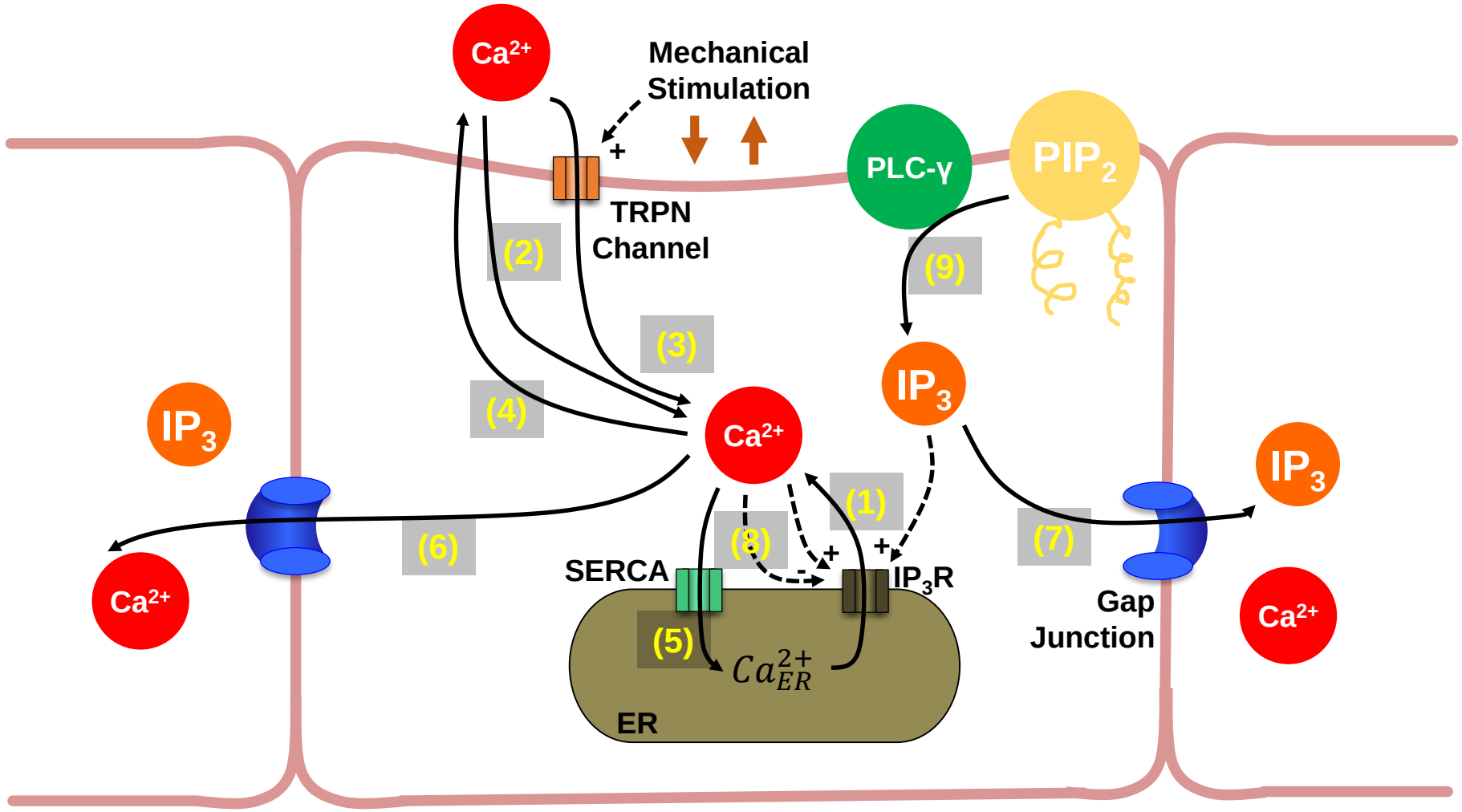
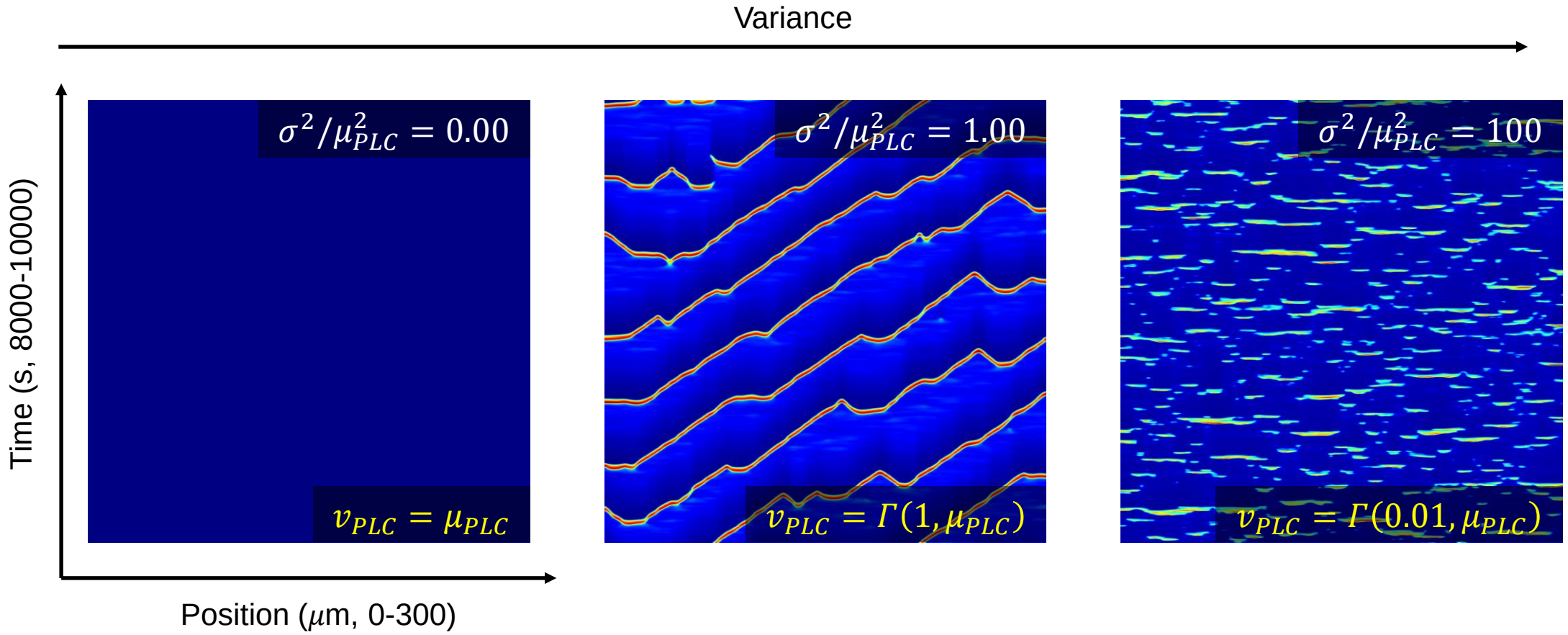


THIS SLIDE IS WRONG



t = 8000s to 10000s