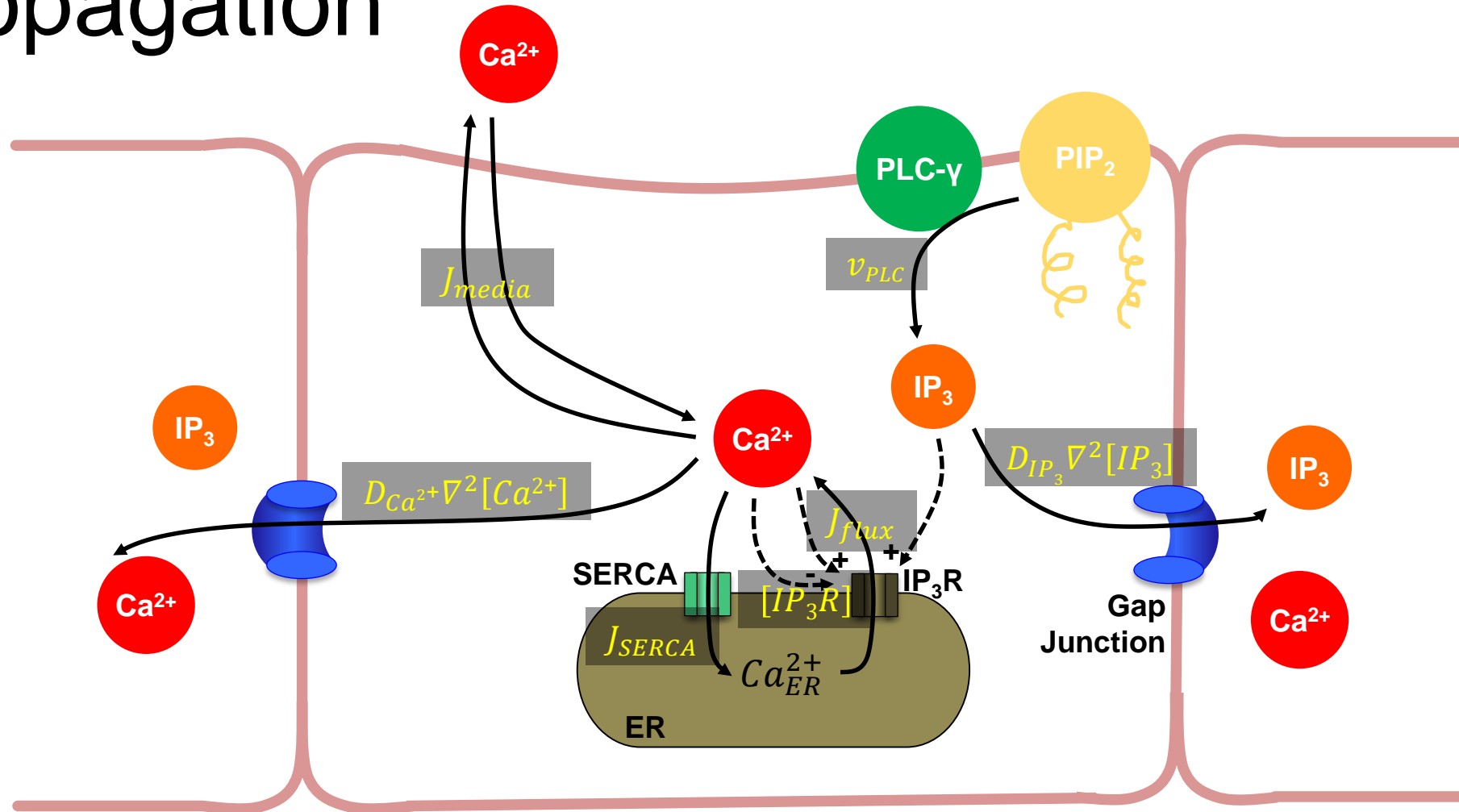


# Molecular mechanism of calcium propagation



# PDE model (Version 1)

$$\frac{\partial [Ca^{2+}]}{\partial t} = \frac{(k_1 + k_2 [IP_3 R] [Ca^{2+}]^2 [IP_3]^2) ([Ca_{ER}^{2+}] - [Ca^{2+}])}{(K_{Ca^{2+}}^2 + [Ca^{2+}]^2) (K_{IP_3}^2 + [IP_3]^2)} - \frac{v_{SERCA} [Ca^{2+}]^2}{k_{SERCA}^2 + [Ca^{2+}]^2} + v_{leak} (k_{leak} - [Ca^{2+}]) + D_{Ca^{2+}} \nabla^2 [Ca^{2+}]$$

$$\frac{d[Ca_{ER}^{2+}]}{dt} = -\frac{V}{V_{ER}} \left( \frac{(k_1 + k_2 [IP_3 R] [Ca^{2+}]^2 [IP_3]^2) ([Ca_{ER}^{2+}] - [Ca^{2+}])}{(K_{Ca^{2+}}^2 + [Ca^{2+}]^2) (K_{IP_3}^2 + [IP_3]^2)} - \frac{v_{SERCA} [Ca^{2+}]^2}{k_{SERCA}^2 + [Ca^{2+}]^2} \right)$$

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

$$\frac{d[IP_3 R]}{dt} = k_6 \left( \frac{K_i^2}{K_i^2 + [Ca^{2+}]^2} - [IP_3 R] \right)$$

# PDE model (Version 2)

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

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

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

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

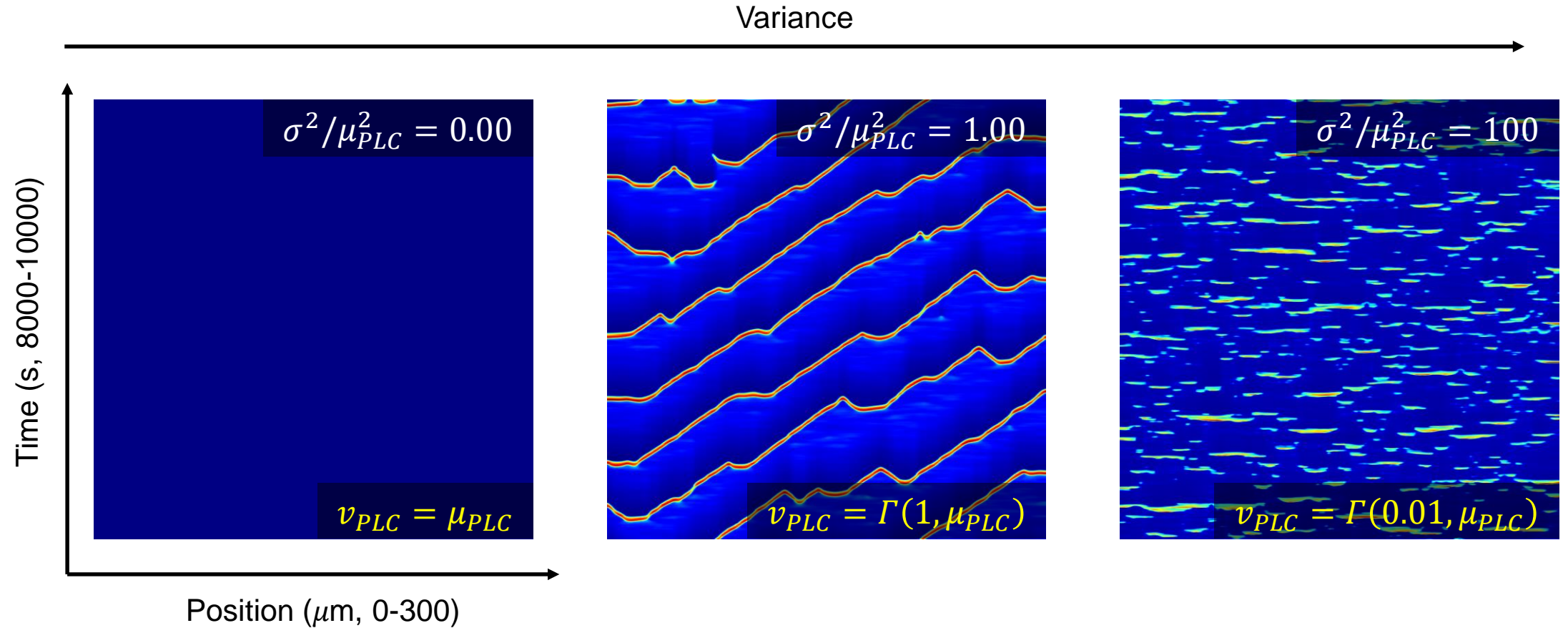
$$J_{flux} = \frac{(k_1 + k_2[IP_3R][Ca^{2+}]^2[IP_3]^2)([Ca_{ER}^{2+}] - [Ca^{2+}])}{(K_{Ca^{2+}}^2 + [Ca^{2+}]^2)(K_{IP_3}^2 + [IP_3]^2)}$$

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

$$J_{media} = v_{leak}(k_{leak} - [Ca^{2+}])$$

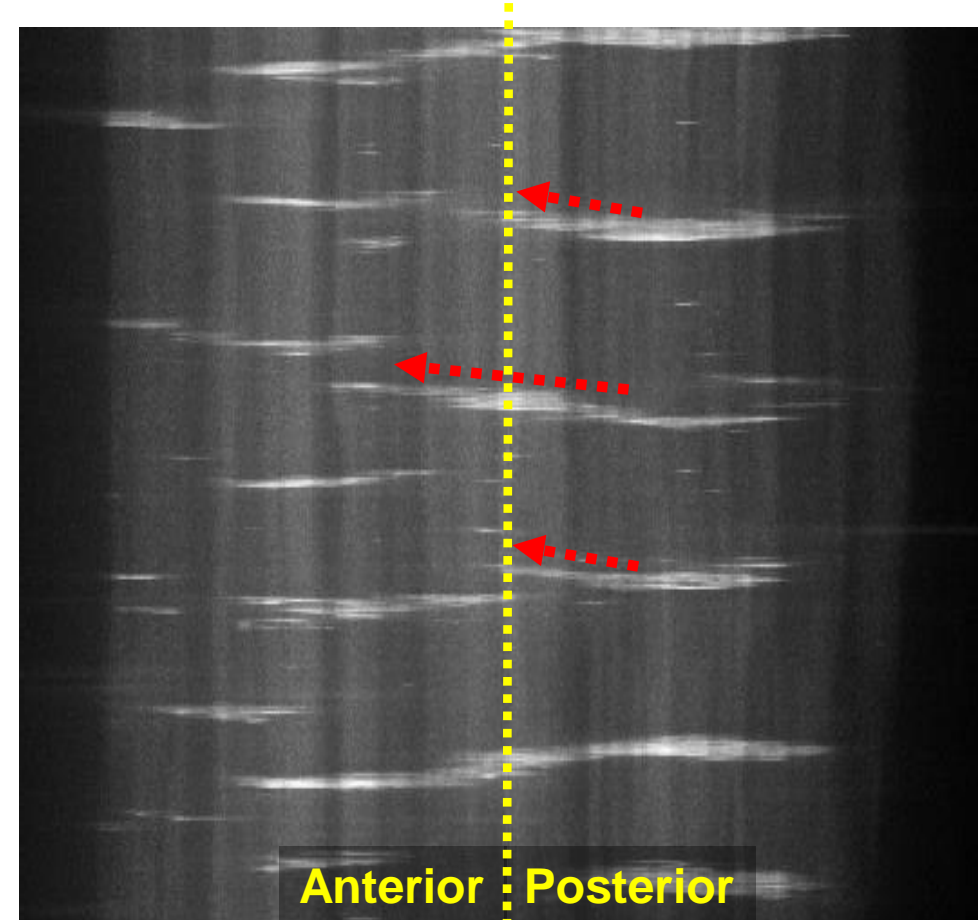
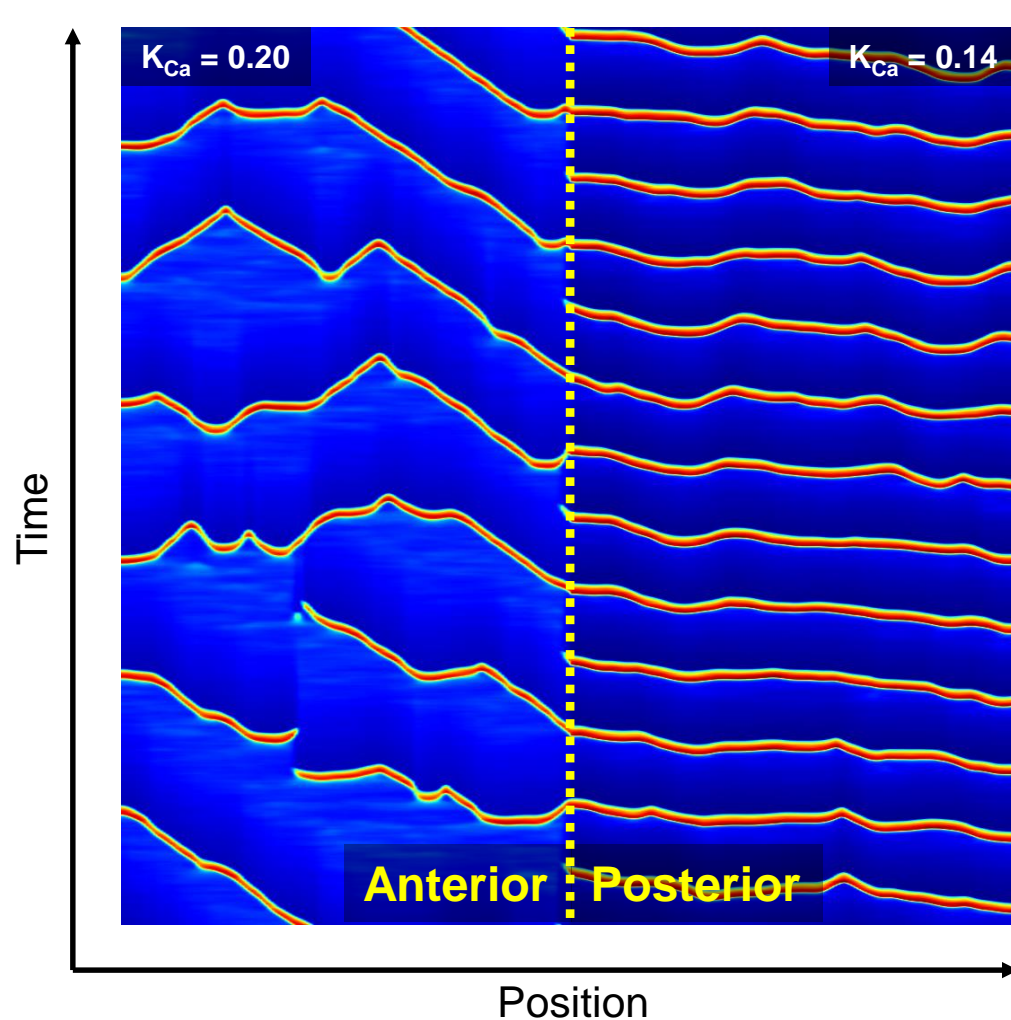
$$v_{PLC} = \Gamma(1, \mu_{PLC})$$

# Signal variance may explain pulse to wave transition



t = 8000s to 10000s

Boundary penetrance may be explained by differential cell properties in compartments

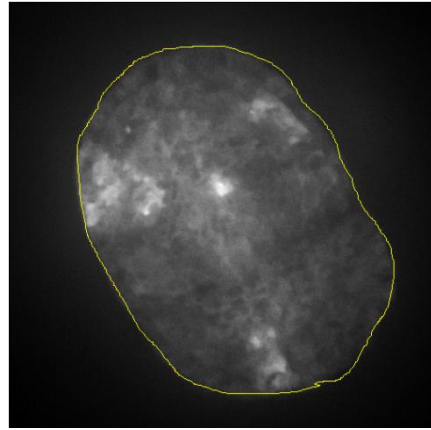


Parameter	Category	Amplitude	Steady state concentration	Frequency	Speed
$k_1$	$J_{flux}$	X	X	-	X
$k_2$		X	X	-	X
$K_{Ca^{2+}}$		X	X	X	-
$K_{IP_3}$		X	X	X	-
$v_{SERCA}$	$J_{SERCA}$	X	X	-	X
$k_{SERCA}$		X	X	-	X
$v_{leak}$	$J_{media}$	X	X	-	X
$k_{leak}$		-	-	X	X
$V/V_{ER}$	$[Ca_{ER}^{2+}]$	-	-	-	-
$k_6$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

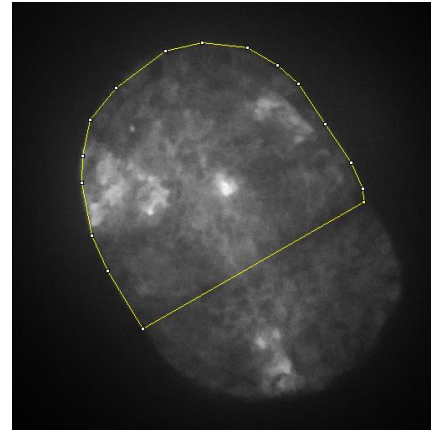
OTHER SLIDES:

# Domain specificity of $\text{Ca}^{2+}$ transients

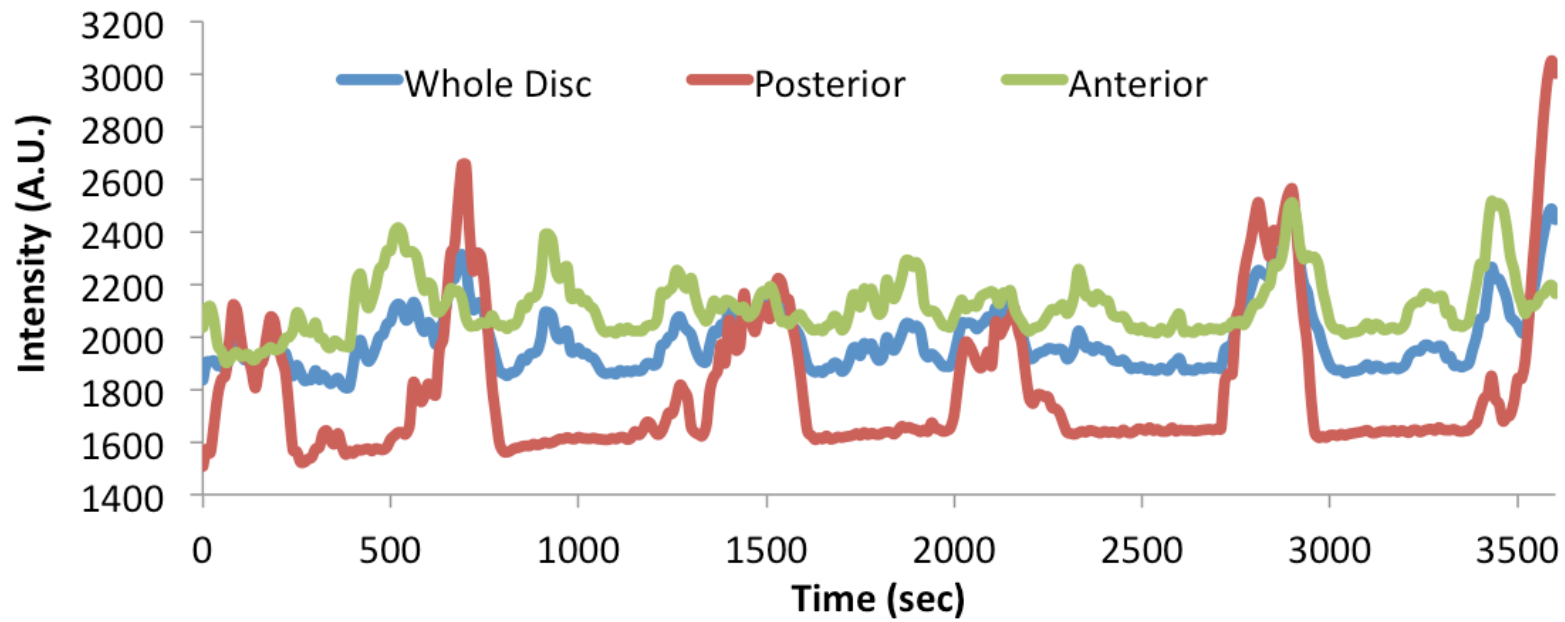
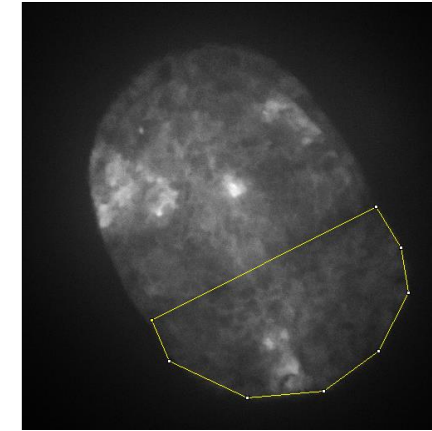
Whole disc



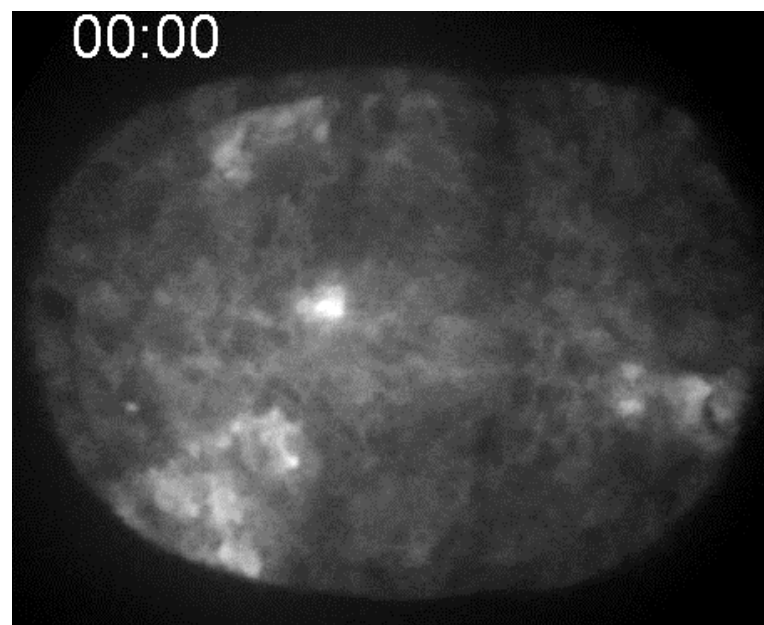
Anterior



Posterior







# Molecular mechanism of calcium propagation

