1 Electronic appendix: Modelling of intensity distributions

The characterization of the GFP-LamA pixel intensity (density) distribution on a mesoscopic scale was carried out by assuming random lateral distributions of GFP-LamA. We assume that the lamin density variations are characterized by a single length scale, ξ. The area of the pixel can then be partitioned into $(l_{pix}/\xi)^2$ square cells each with area ξ^2. The total intensity for a pixel is the contributions from the squares which are are not devoid of GFP-LamA: $I = \rho(l_{pix}^2 - \xi^2 n)$ where n is the number of cells devoid of GFP-LamA and ρ is proportional to the density of GFP-LamA in the squares with flourescence contribution[1]. Within the simplified description the configurations of the regions are completely random and the probability distribution for n can be described by a simple binomial distribution:

$$p(n) = \binom{\left(\frac{l_{pix}}{\xi}\right)^2}{n} \phi^n \left(1-\phi\right)^{\left(\frac{l_{pix}}{\xi}\right)^2 - n} \tag{1}$$

where ϕ is the area fraction of GFP-LamA devoid regions. The mean and variance in the intensity are $\langle I \rangle = \rho l_{pix}^2 (1-\phi)$ and $\sigma(I) = \rho l_{pix}^2 \left(\frac{l_{pix}}{\xi}\right) \sqrt{\phi(1-\phi)}$. On this basis, we predict the density distributions of three models for the lateral organization of the lamina under lateral expansion.

1.1 Network lateral expansion model

For expansion of a regular lamina network by a factor $\lambda \sim \sqrt{A^i_{LamA}/A^o_{LamA}}$ where A^o_{LamA} is the initial GFP-LamA area, the density of GFP-LamA is reduced by a factor $A^o_{\text{LamA}}/A^i_{\text{LamA}}$. It follows that with area dilation, $\langle I \rangle$ is reduced by $\sim \frac{A^o_{\text{LamA}}}{A^i_{\text{LamA}}}$ while $\sigma(I)$ is reduced by $\sim (\frac{A^o_{\text{LamA}}}{A^i_{\text{LamA}}})^{1.5}$.

[1] Note that GFP-LamA is much smaller ($\sim$ 50nm) than both the optical resolution ($\sim$ 250nm) and l_{pix}, so the intensity of a pixel is the added contribution of fluorophores within a pixel.

1.2 Variable pore size model

Here the important length scale is the NPC diameter, ξ_p. For the unperturbed NE, A_p^o is the area initially occupied by NPCs and $\xi_p^o \sim 40-120$ nm varies under lateral stretching of NE. Here, NPCs are considered as regions devoid of GFP-LamA and the area of the surrounding lamina, A_{LamA}, is a constant. The area fraction occupied by NPCs changes during expansion and it follows that an expansion of NPC area gives rise to a small decrease in $\langle I \rangle$ while the relative width of the distribution remains constant: $\frac{\sigma(I)}{\langle I \rangle} = \frac{l_{pix}}{\xi_p^o}\sqrt{\frac{A_p^o}{A_{LamA}}}$.

1.3 Lamin vacancy model

For simplicity we assume that the characteristic length scale, ξ, for the vacancies or voids that appear upon expansion is the same as for the NPCs. The area of such vacancies/voids is denoted by A_{vac}. In this case $\langle I \rangle$ decreases like $\frac{A_{LamA}}{A_{LamA}+A_p^o+A_{vac}}$, and $\frac{\sigma(I)}{\langle I \rangle} = \frac{l_{pix}}{\xi_p^o}\sqrt{\frac{A_p^o+A_{vac}}{A_{LamA}}}$. Thus while the intensity monotonously declines, $\sigma(I)$ changes only modestly over a wide range of $\frac{A_p^o+A_{vac}}{A_{LamA}}$.