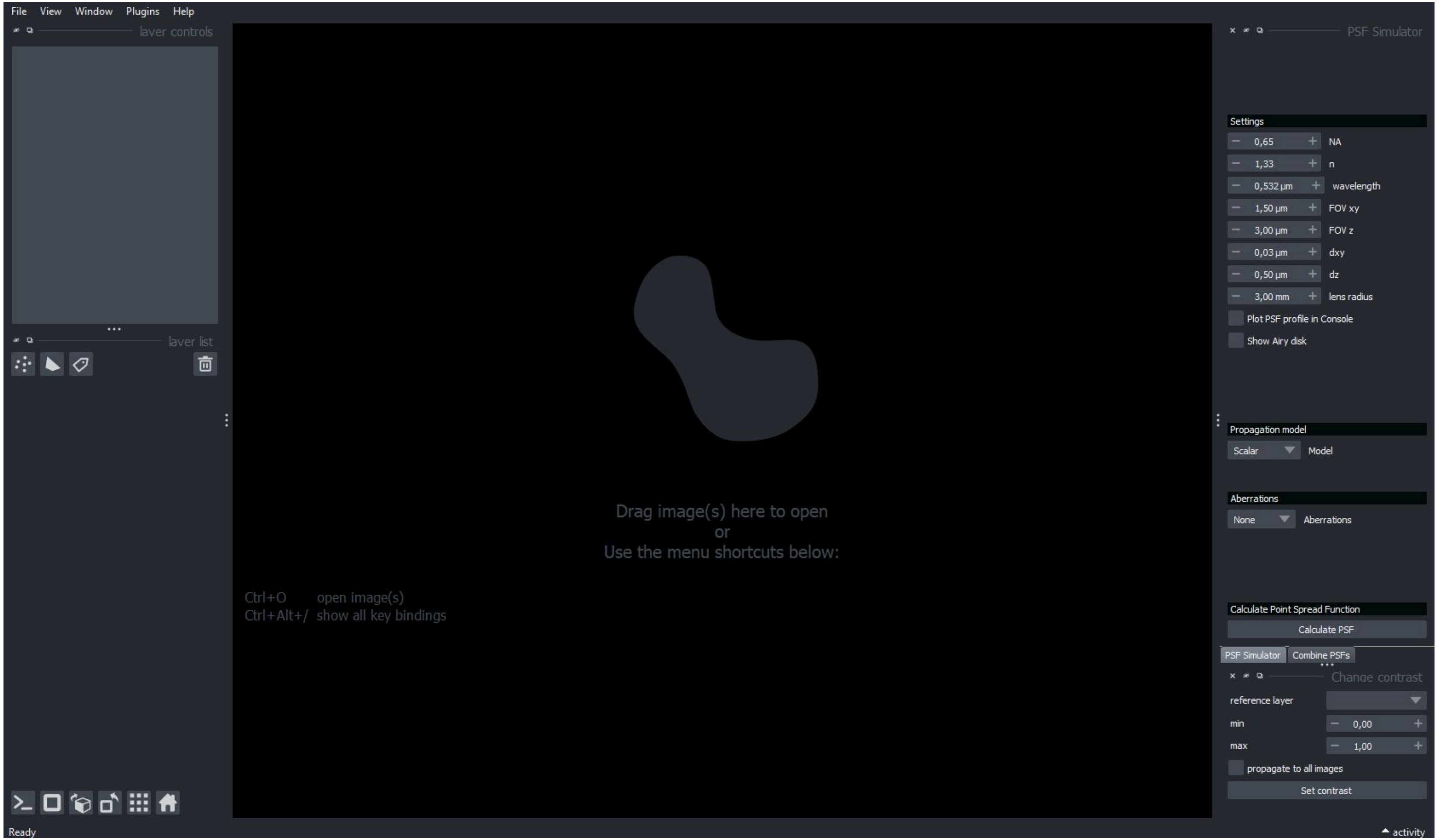
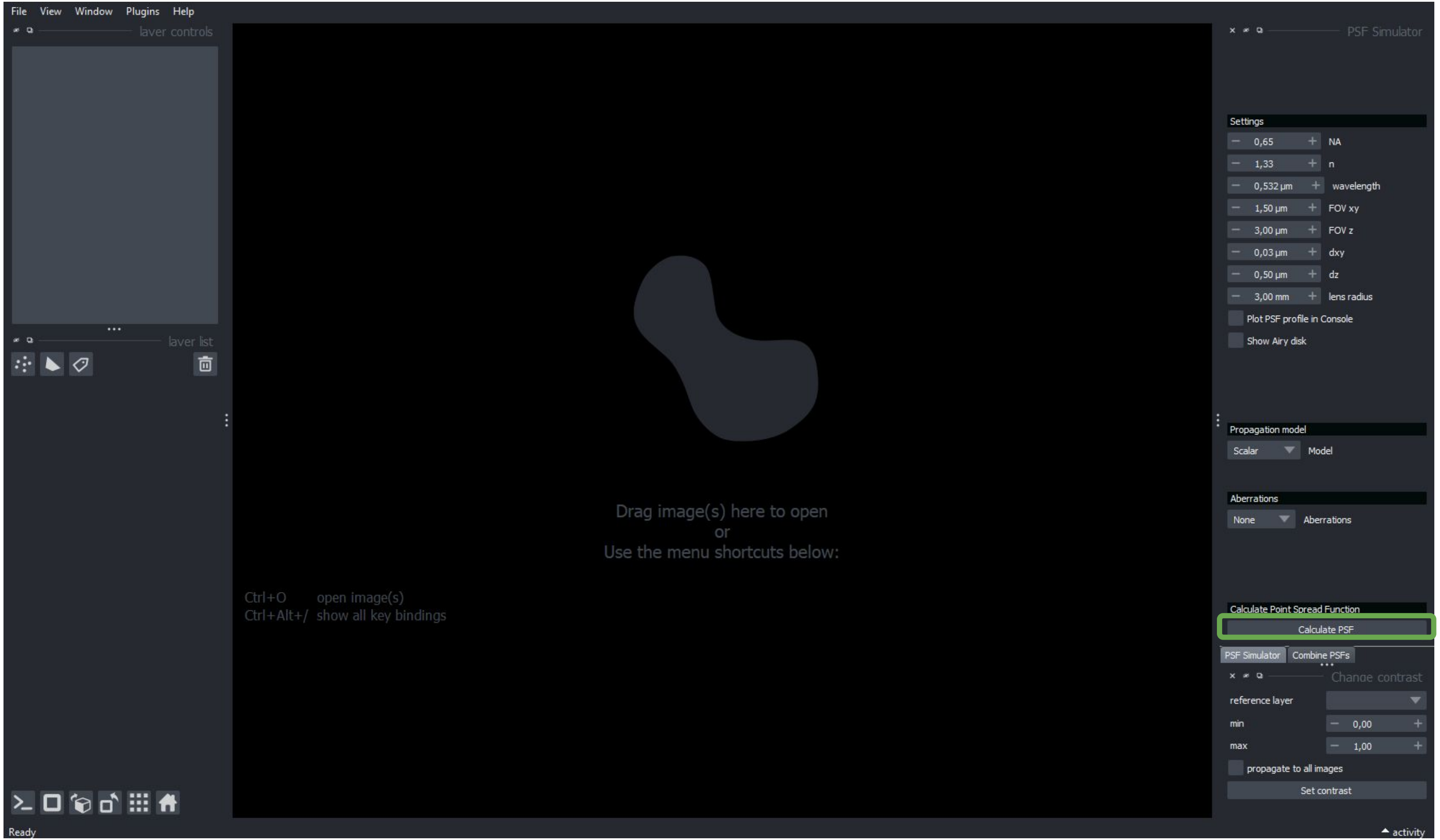
Napari PSF simulator (napari-psf-simulator)

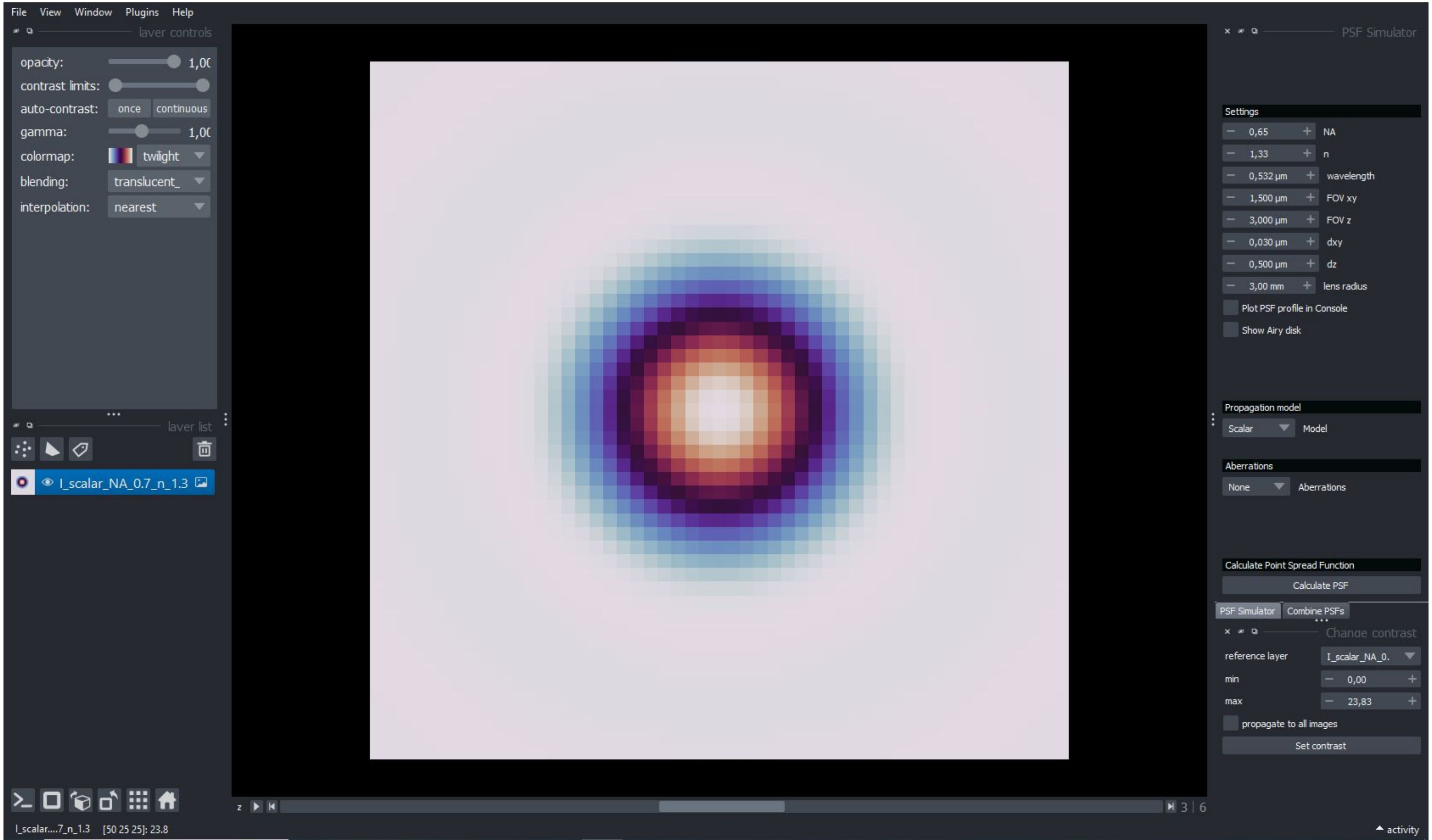
Scalar approximation



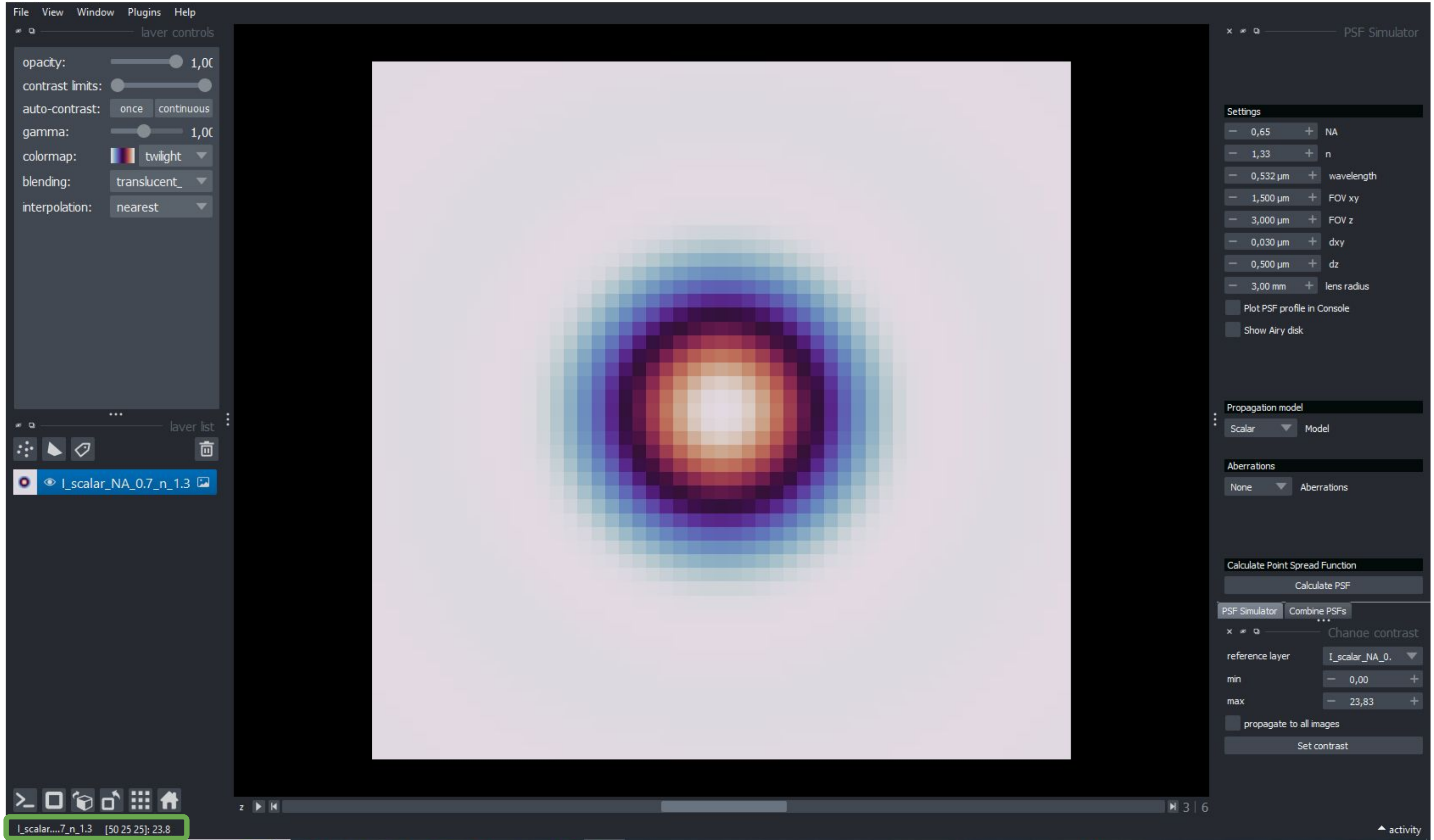
Scalar approximation



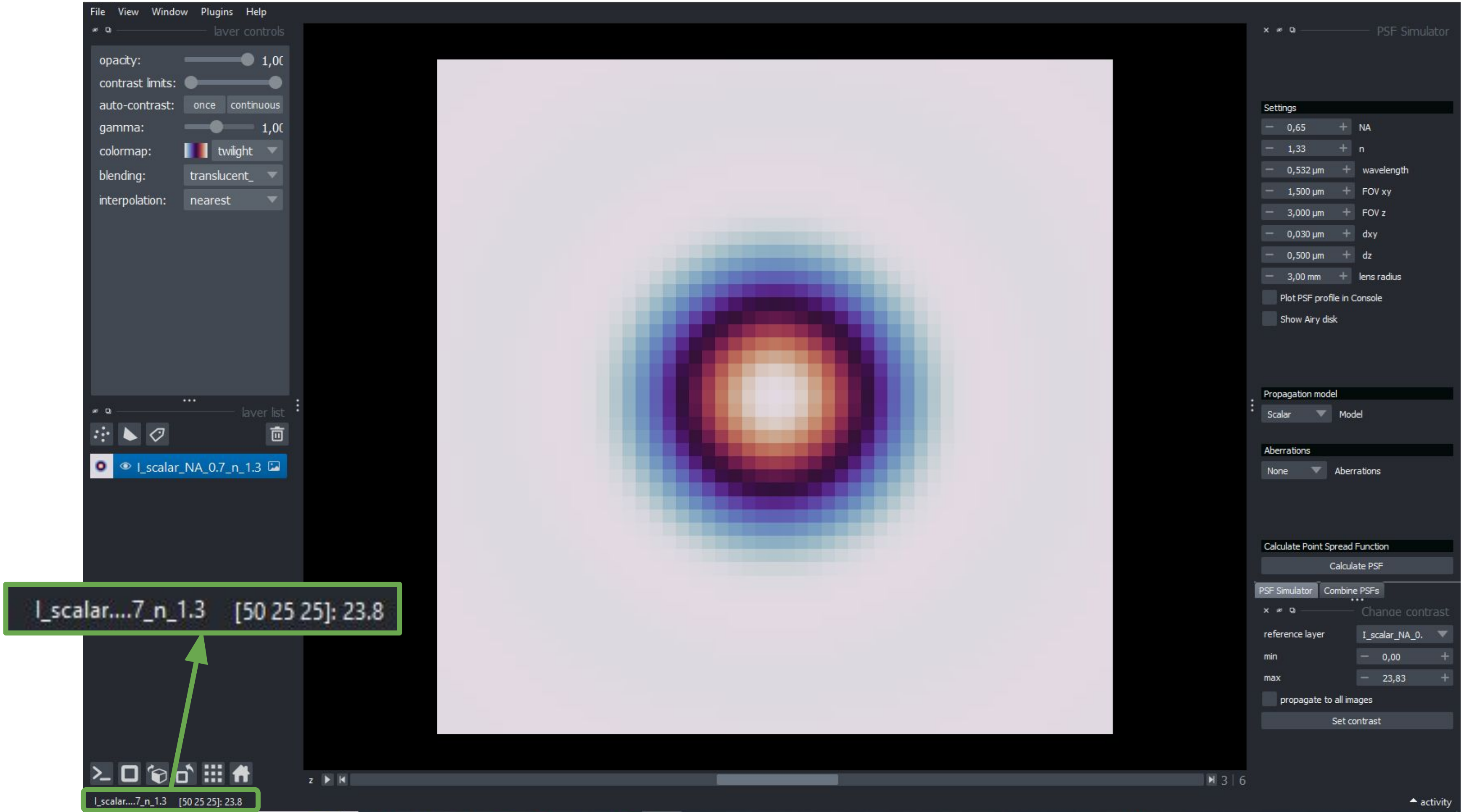
Scalar approximation



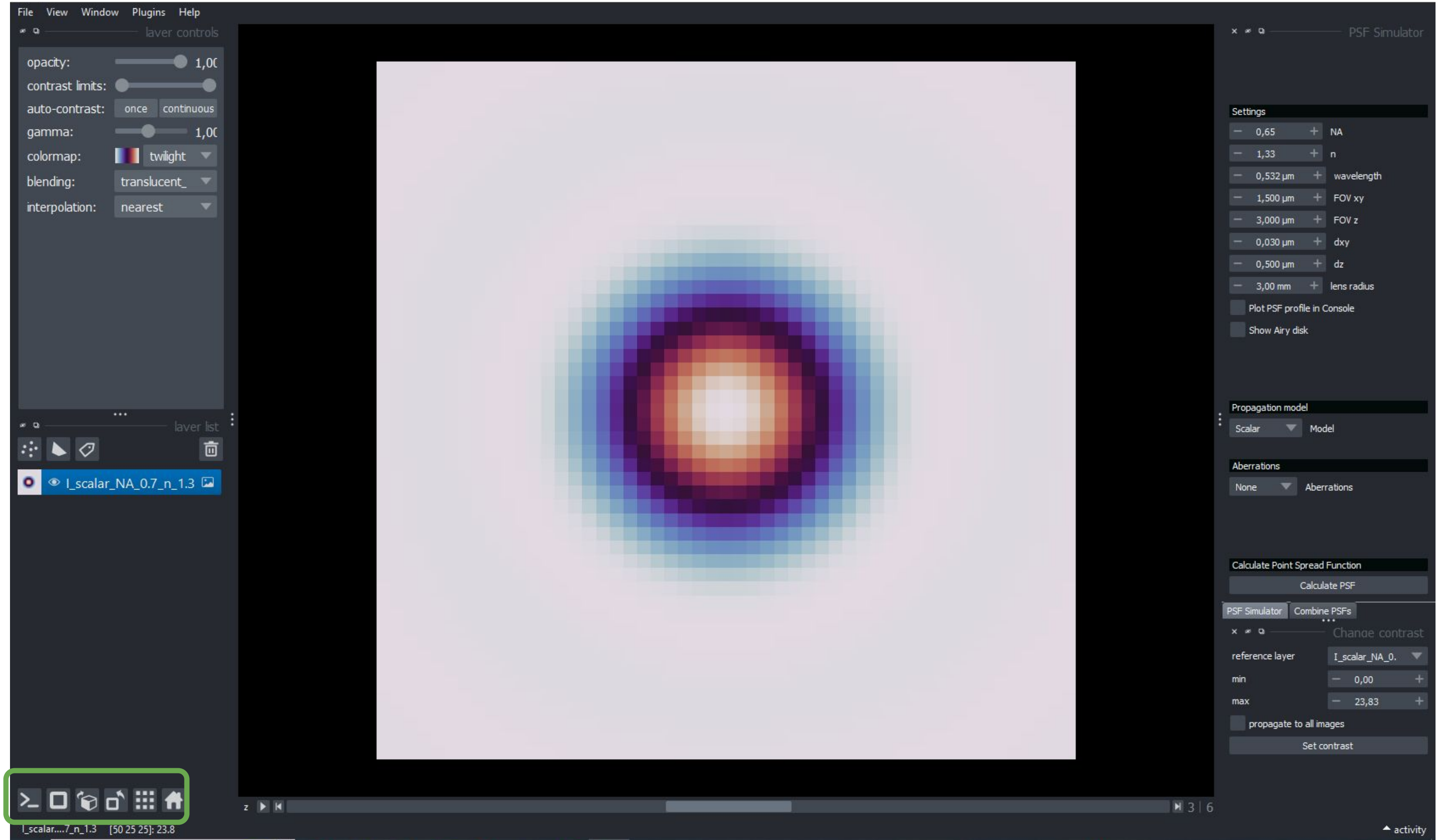
Scalar approximation



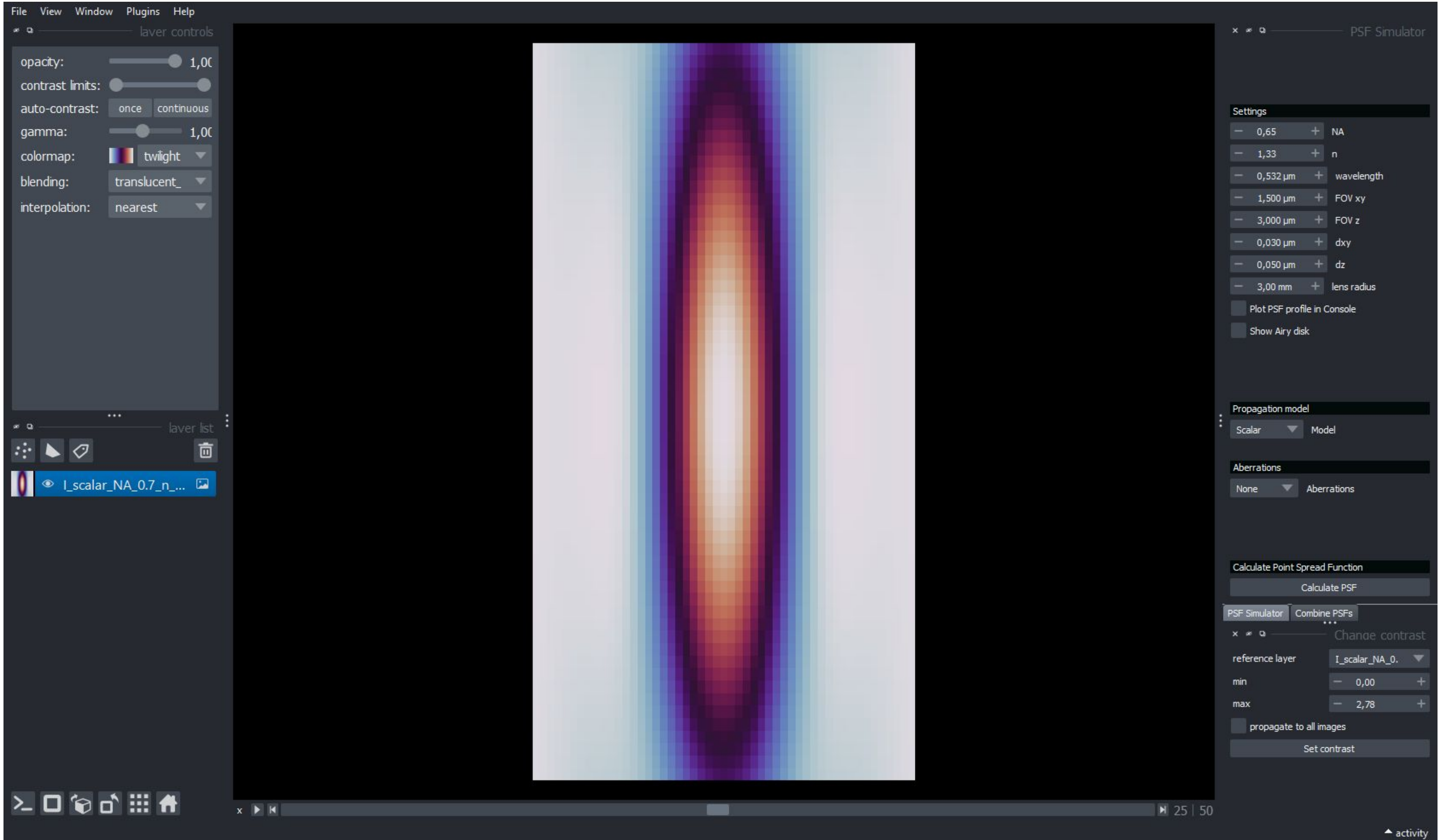
Scalar approximation



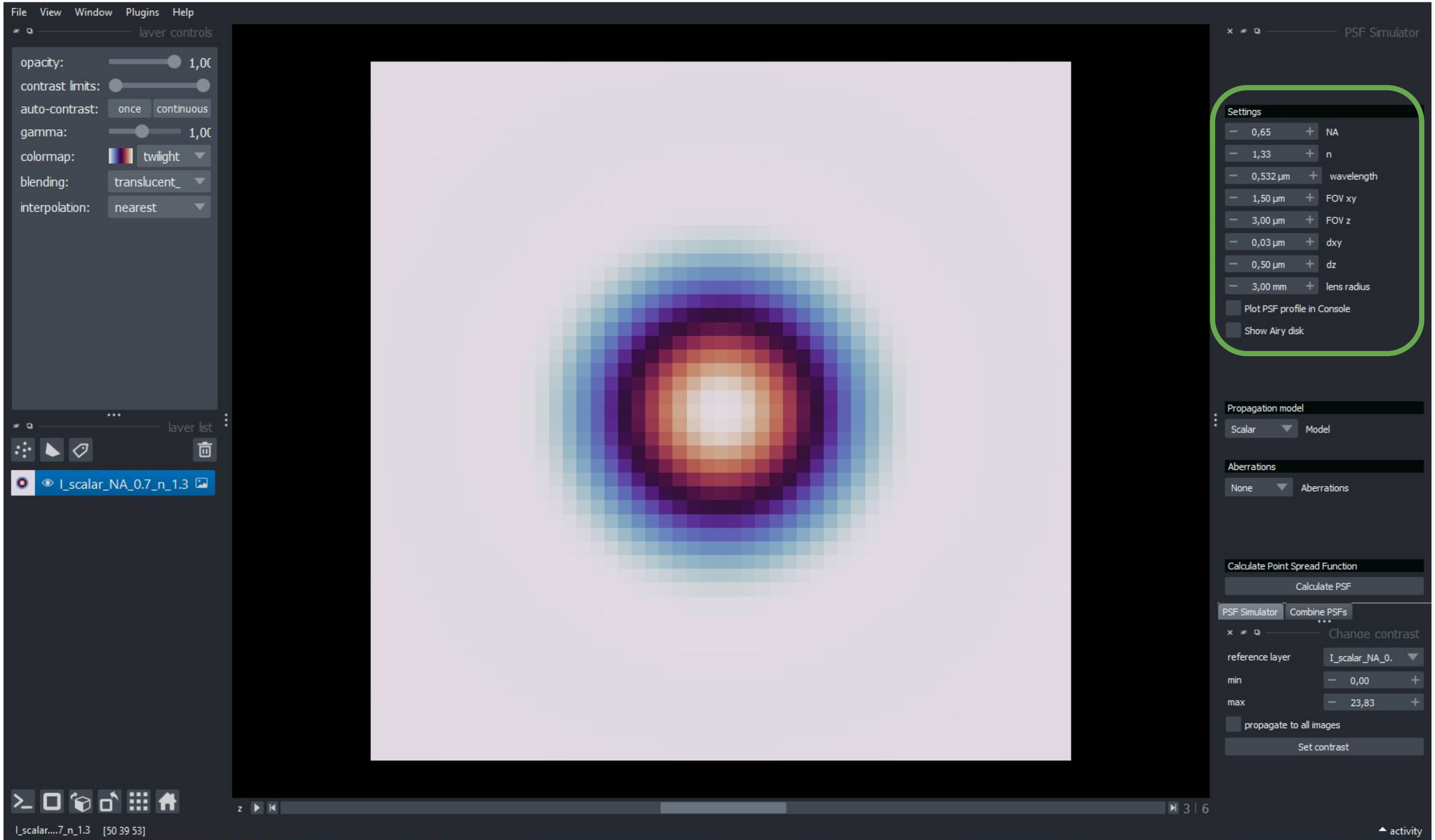
Scalar approximation



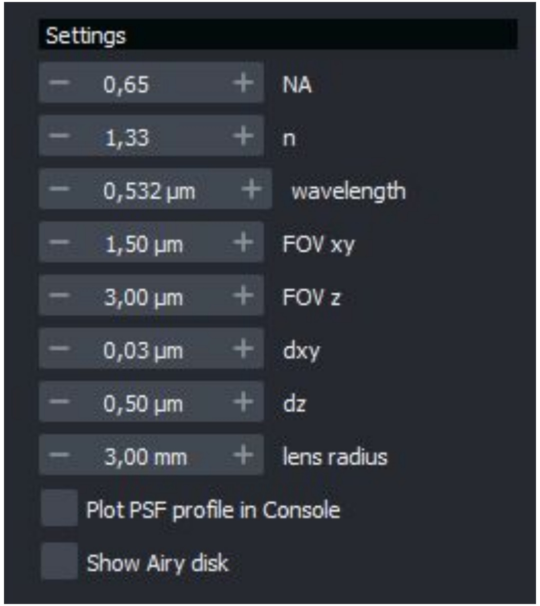
Scalar approximation



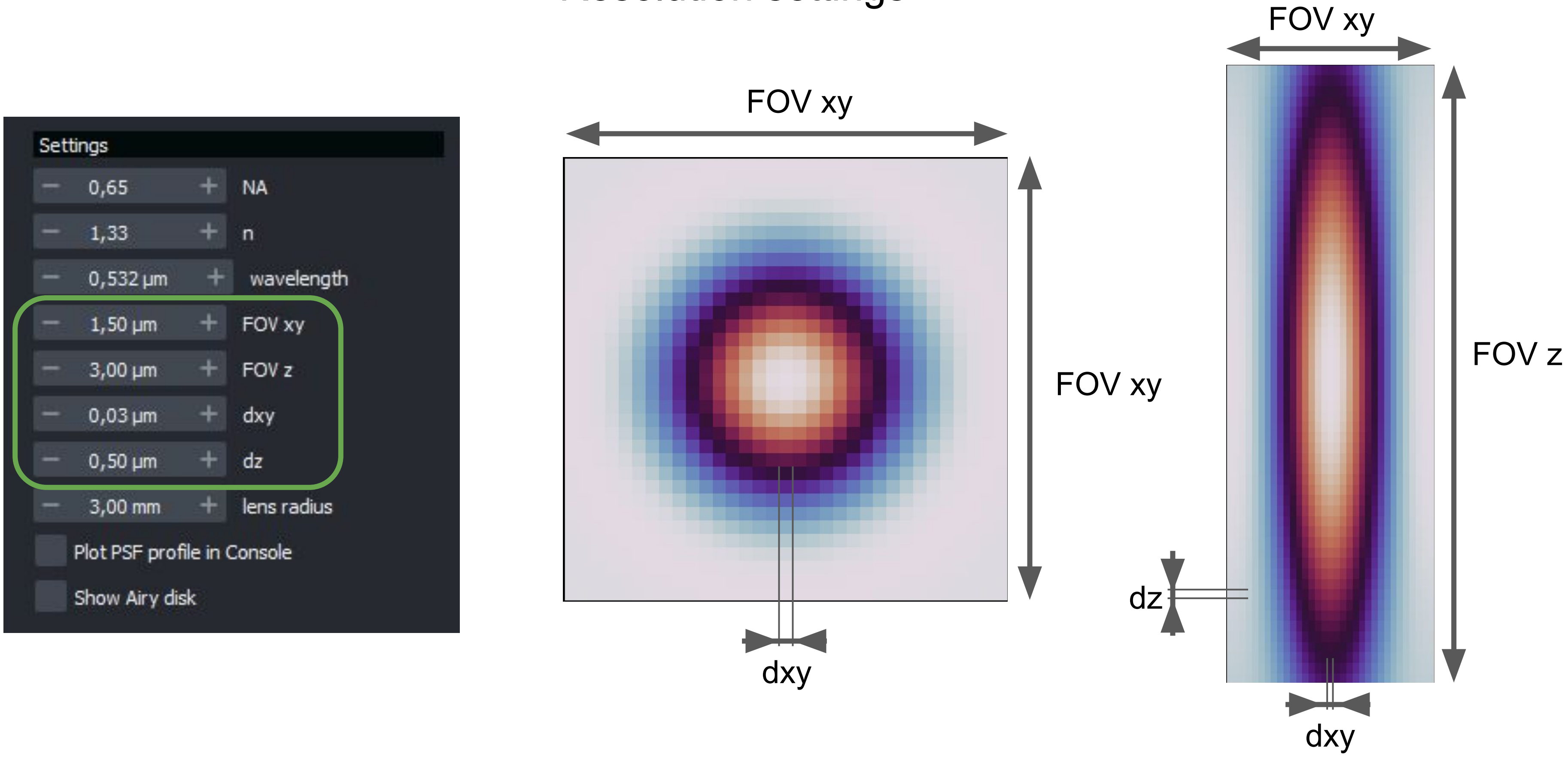
Base settings



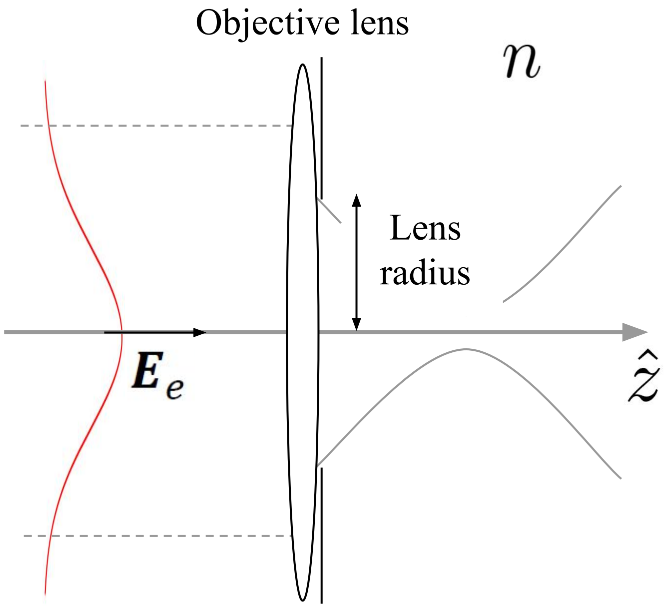
Base settings



Resolution settings

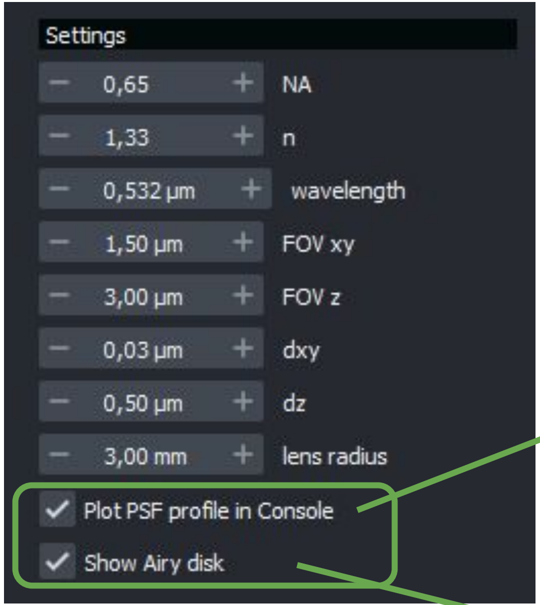


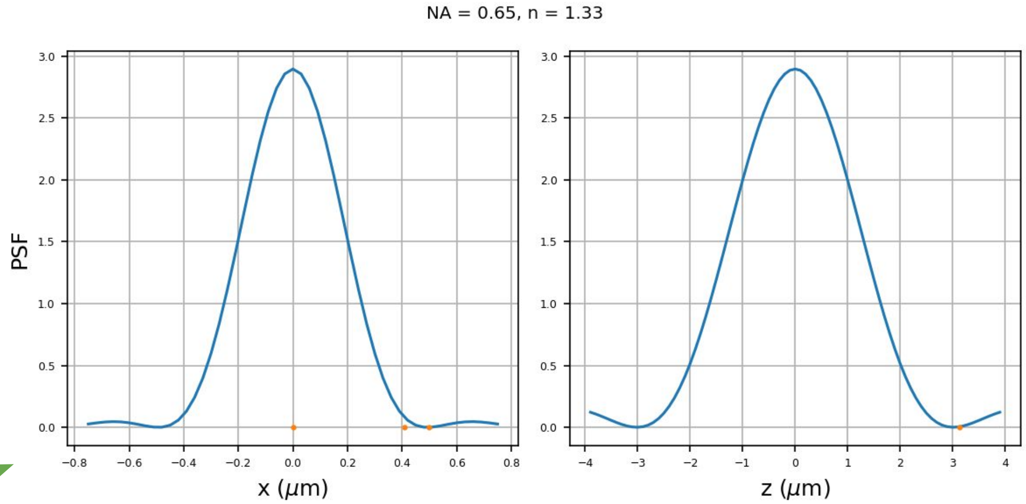
Optical system settings

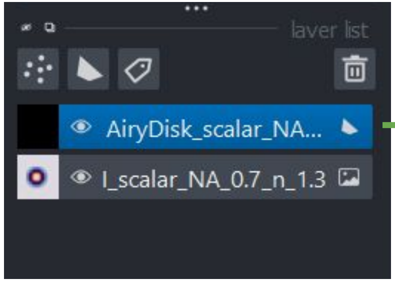


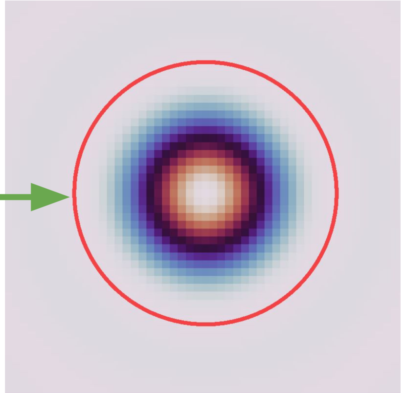
Show Airy disk and plot profile along X and Z

Show Airy disk and plot profile along X and Z

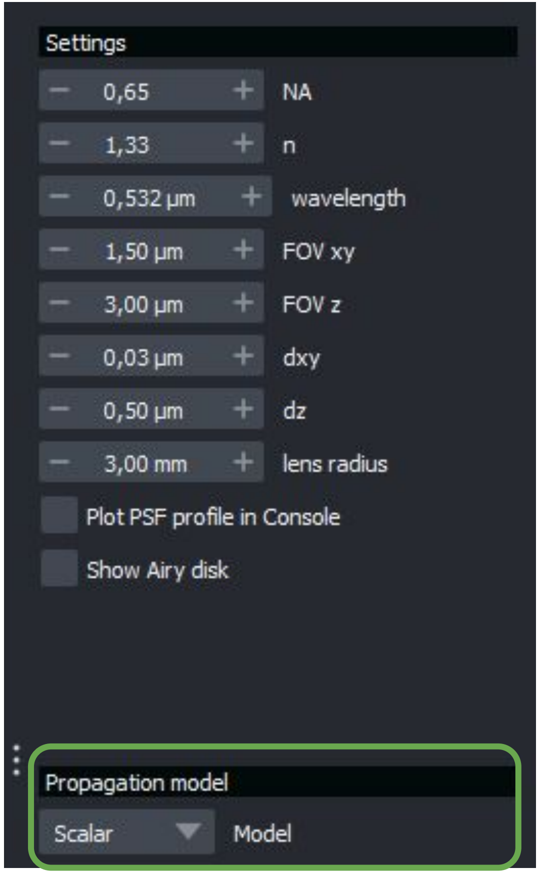








Vectorial simulation



Vectorial simulation: PyFocus

PyFocus – a Python package for vectorial calculations of focused optical fields under realistic conditions. Application to toroidal foci.

Fernando Caprile[1,2], Luciano A. Masullo[1,2*], Fernando D. Stefani[1,2*]

[1]Centro de Investigaciones en Bionanociencias (CIBION), Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Godoy Cruz 2390, C1425FQD, Ciudad Autónoma de Buenos Aires, Argentina

[2] Departamento de Física, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Güiraldes 2620, C1428EHA, Ciudad Autónoma de Buenos Aires, Argentina

Paper DOI: https://doi.org/10.48550/arXiv.2110.00160
Documentation: https://pyfocus.readthedocs.io/en/latest/

Vectorial simulation: PyFocus

The field near the focus can
be obtained by:

$$\boldsymbol{E}_f = \frac{-ikf\, e^{-ikf}}{2\pi} \int_0^{2\pi} \int_0^{\alpha} \boldsymbol{E}_0 e^{i\boldsymbol{k}\cdot\boldsymbol{r}} \sqrt{cos(\theta)}\, sin(\theta) d\theta d\phi'$$

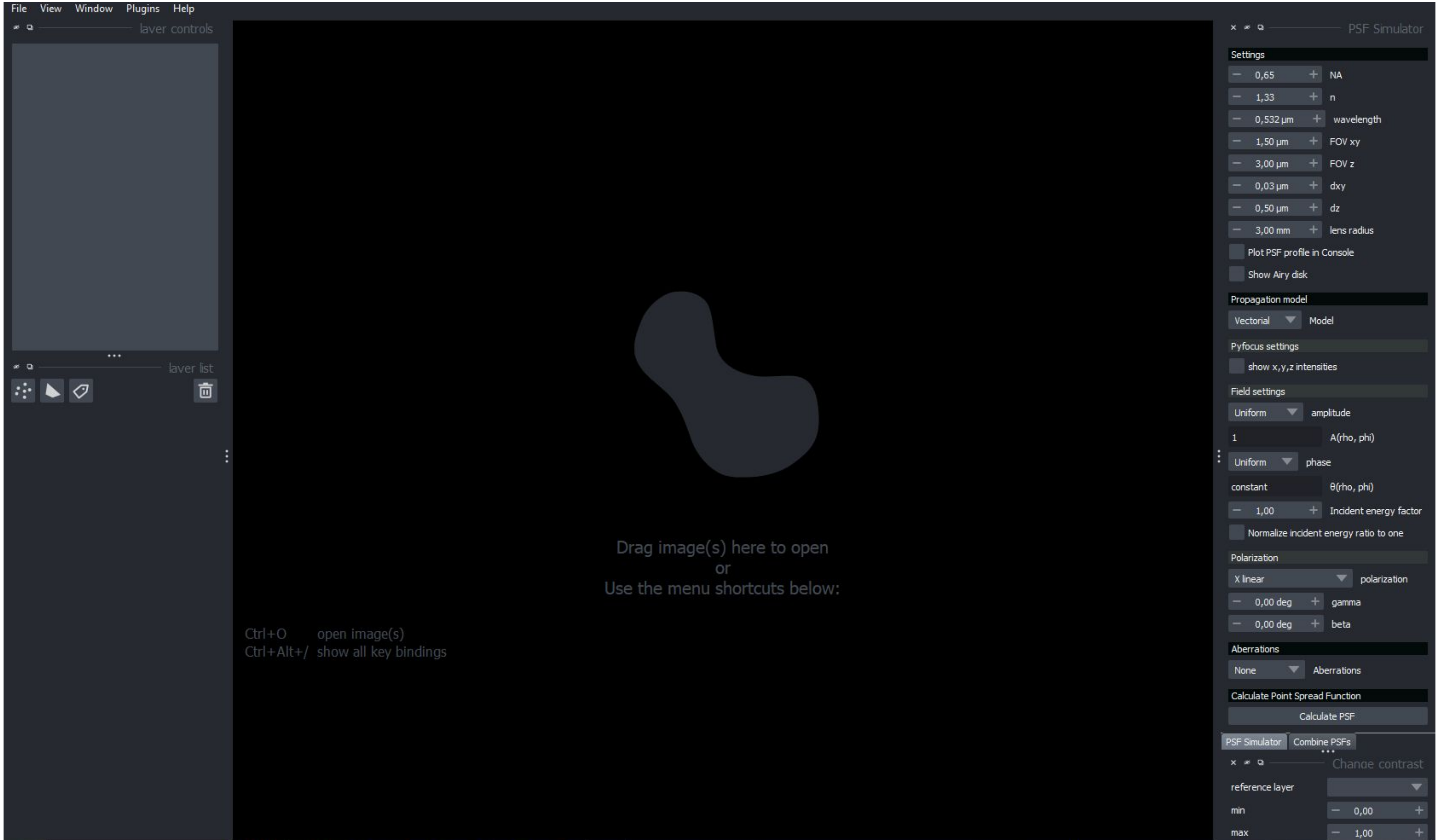
Vectorial simulation: PyFocus

The field near the focus can
be obtained by:

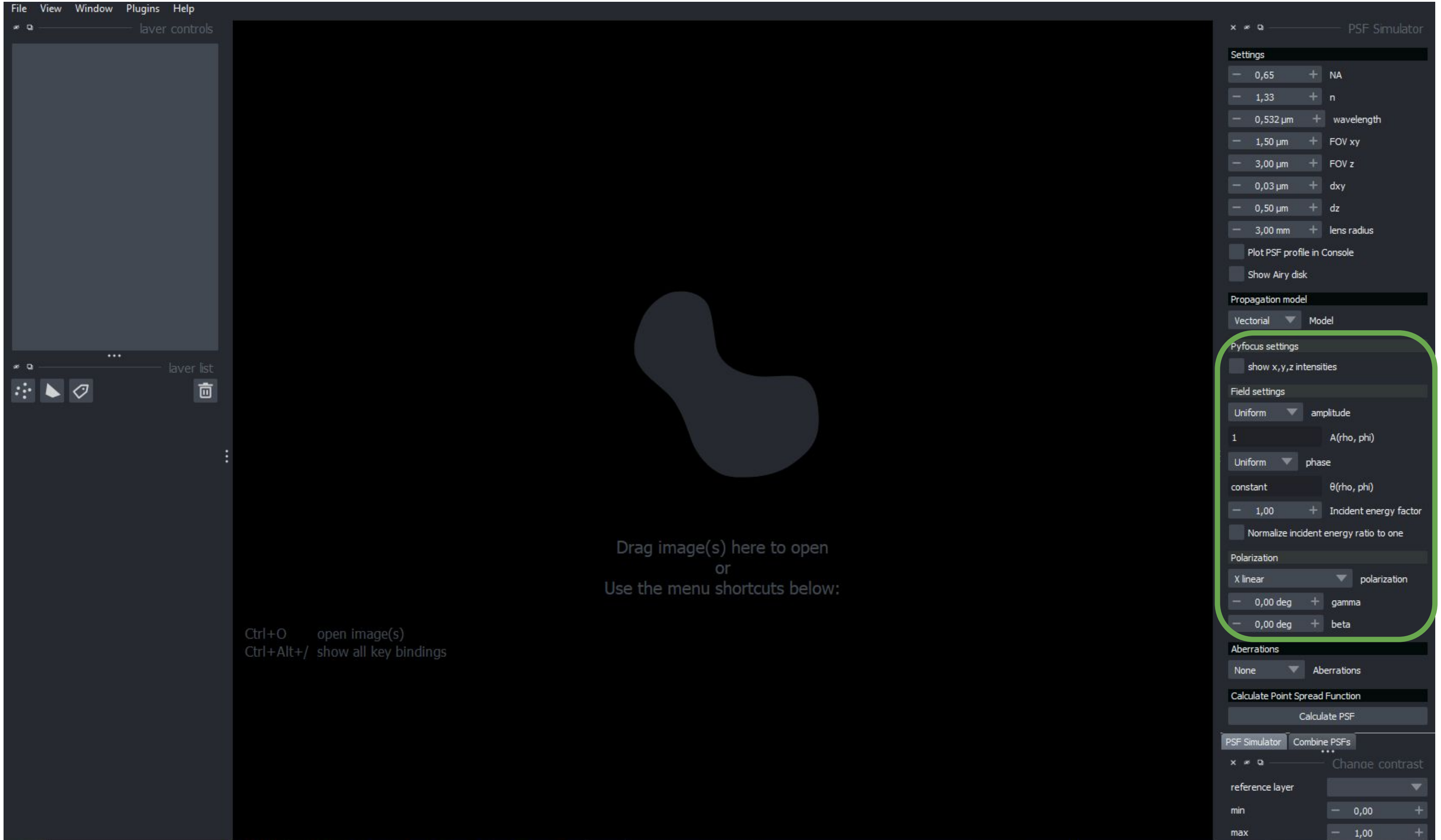
$$\boldsymbol{E}_f = \frac{-ikf\, e^{-ikf}}{2\pi} \int_0^{2\pi} \int_0^{\alpha} \boldsymbol{E}_0 e^{i\boldsymbol{k}\cdot\boldsymbol{r}} \sqrt{cos(\theta)}\, sin(\theta) d\theta d\phi'$$

For most fields, 2D
numerical integration

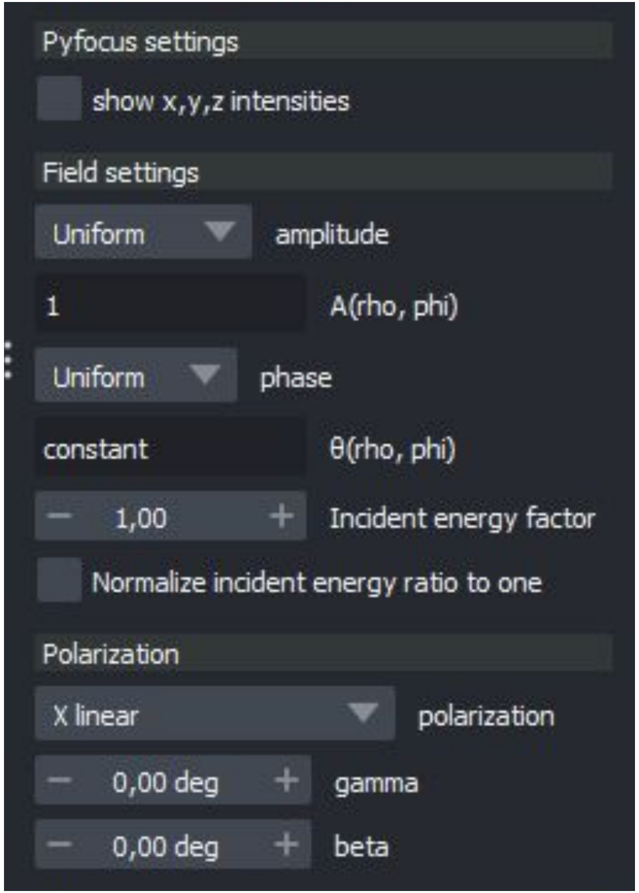
Vectorial simulation: PyFocus settings



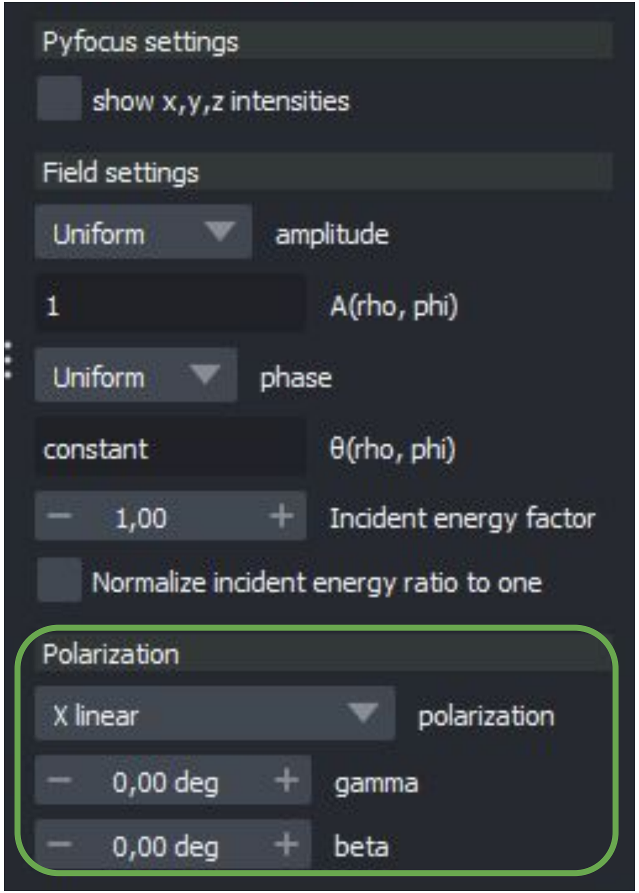
Vectorial simulation: PyFocus settings



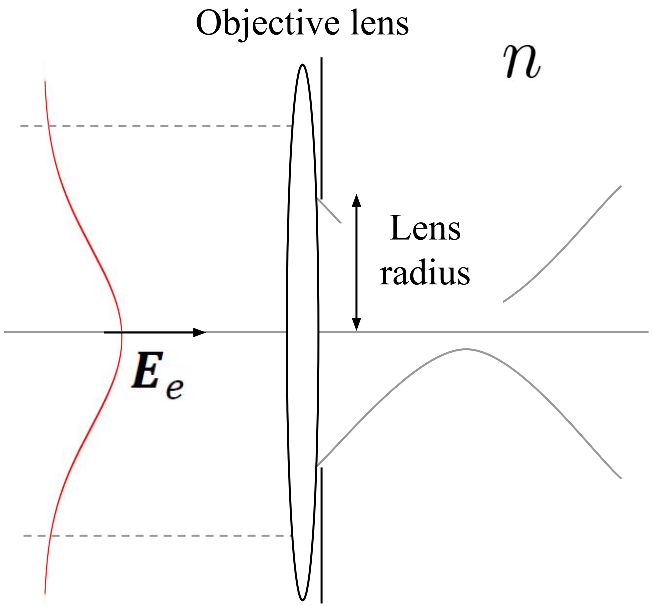
Vectorial simulation: Field settings



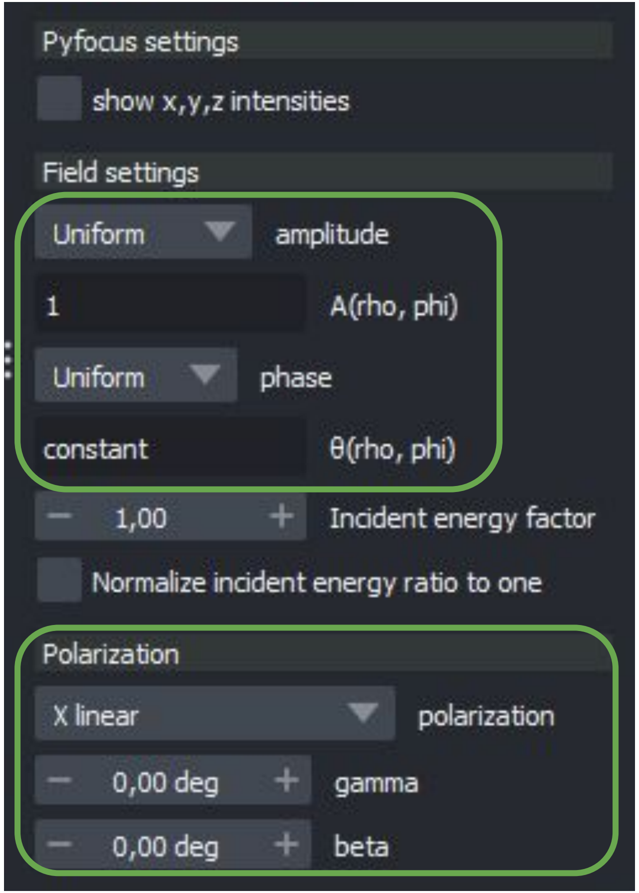
Vectorial simulation: Field settings



$$\boldsymbol{E}_e = E_e\left(\cos(\gamma)\hat{\boldsymbol{x}} + \sin(\gamma)e^{i\beta}\,\hat{\boldsymbol{y}}\right)$$



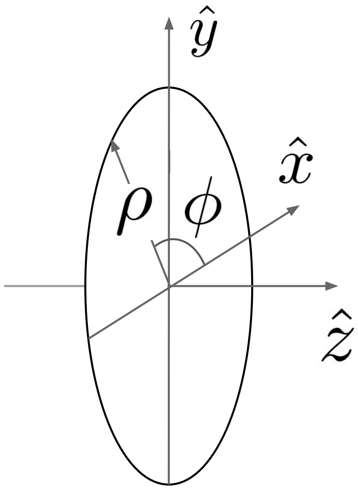
Vectorial simulation: Field settings



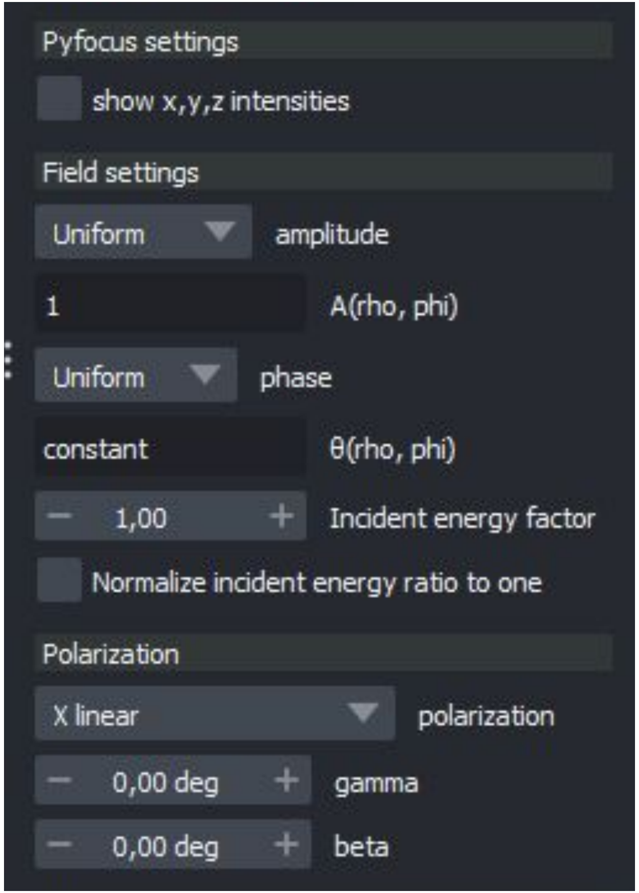
$$\boldsymbol{E}_e = E_e\left(\cos(\gamma)\hat{\boldsymbol{x}} + \sin(\gamma)e^{i\beta}\,\hat{\boldsymbol{y}}\right)$$

$$E_e = A(\rho, \phi)e^{i\theta(\rho,\phi)}$$

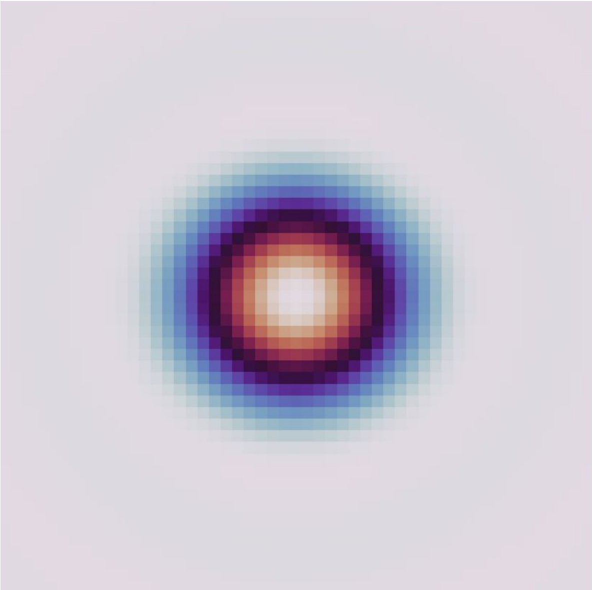
Objective lens



Vectorial simulation: Default simulation

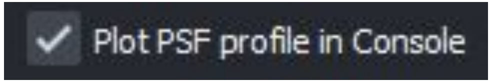


Uniform incident field with X linear polarization

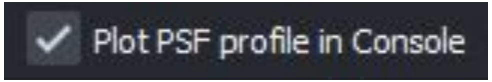


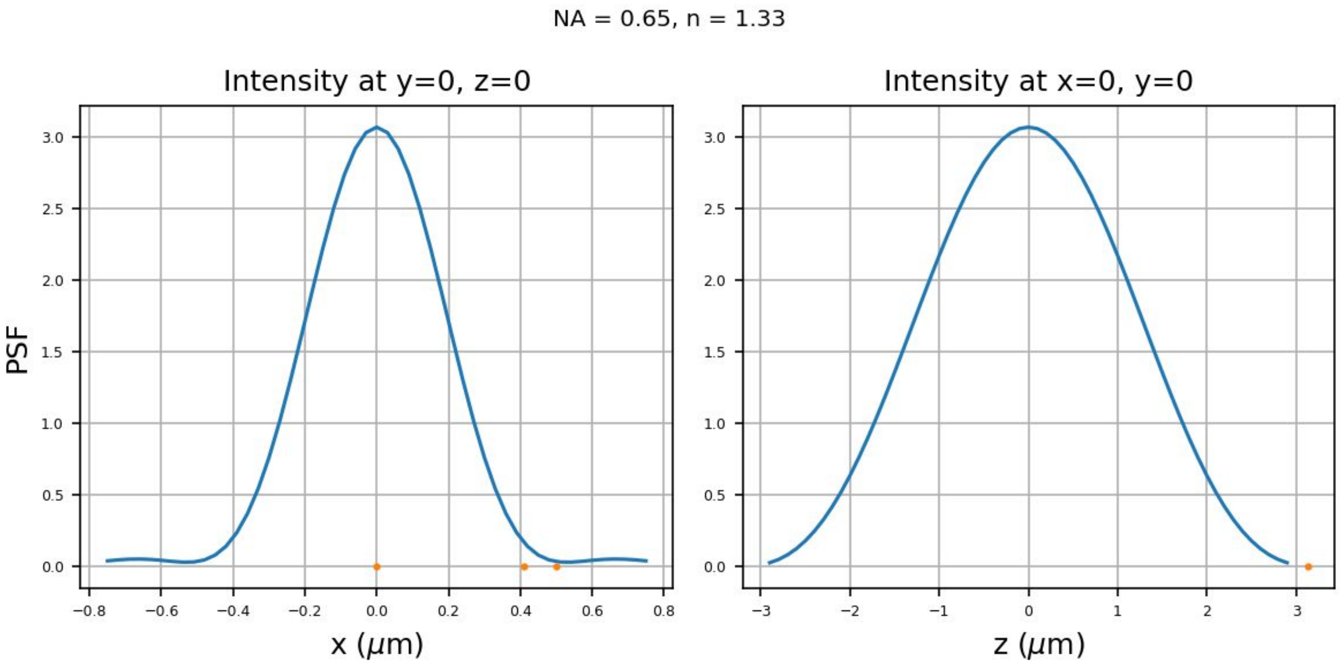
Simulation time: 34 sec

Vectorial simulation: Intensity of the X, Y and Z components

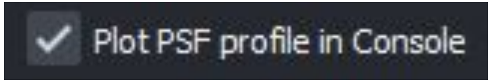


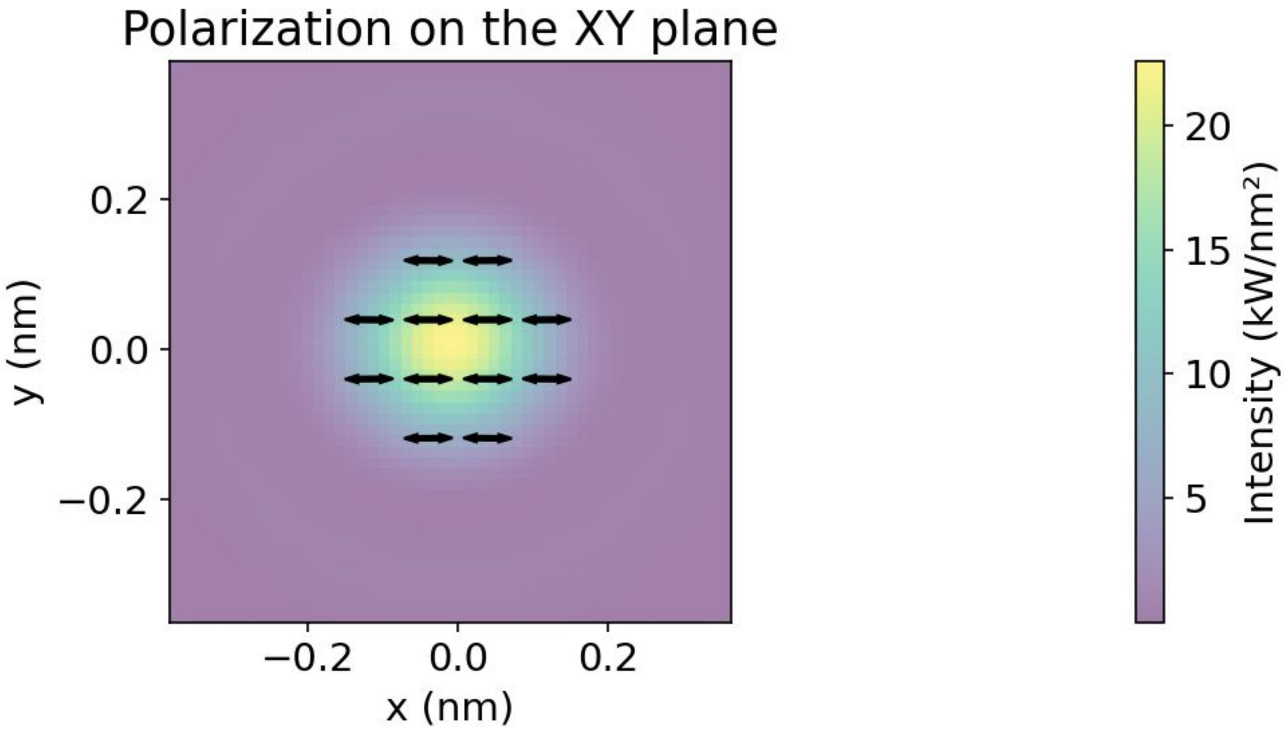
Vectorial simulation: Intensity of the X, Y and Z components



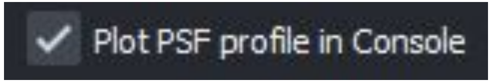


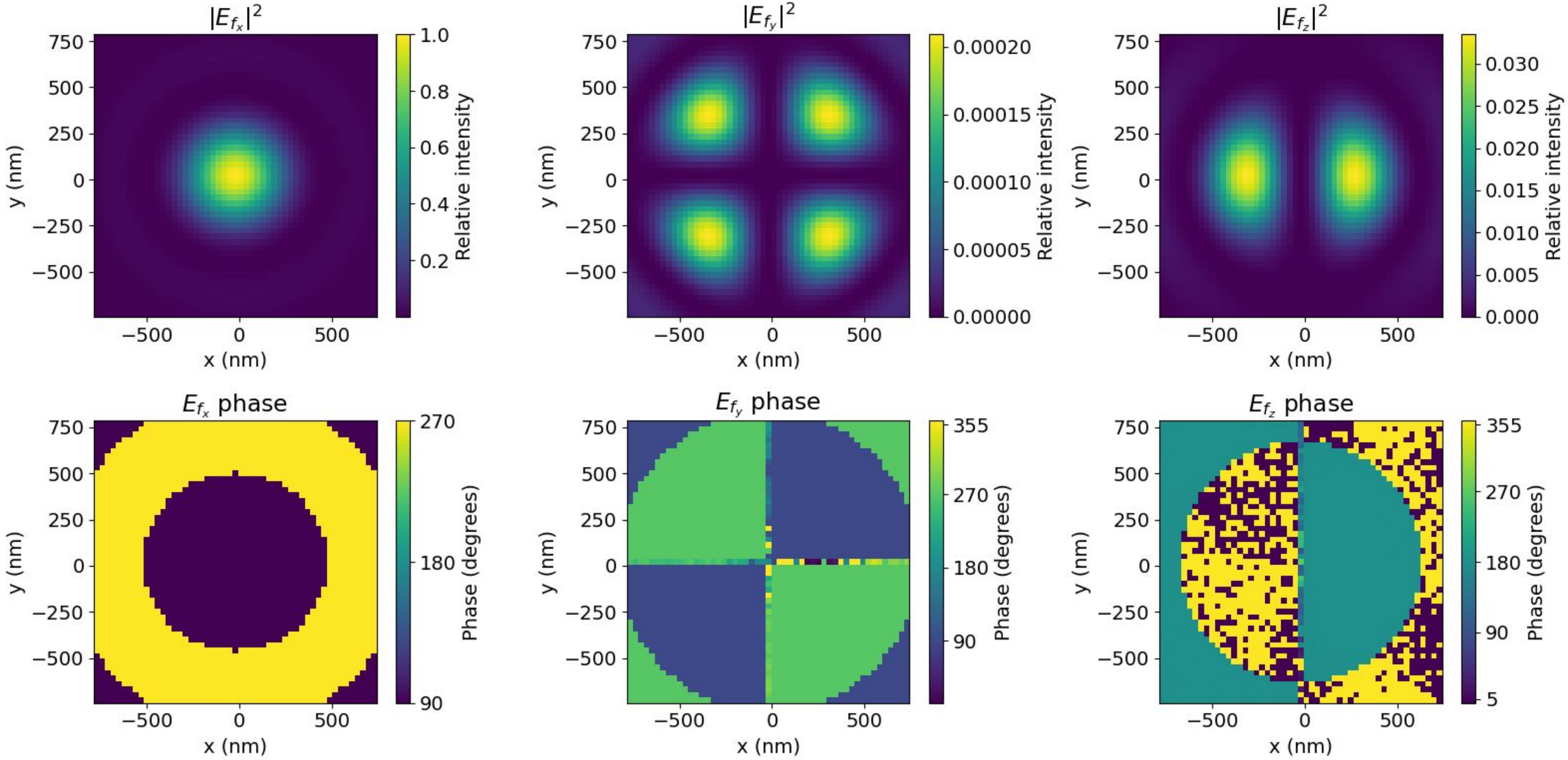
Vectorial simulation: Intensity of the X, Y and Z components



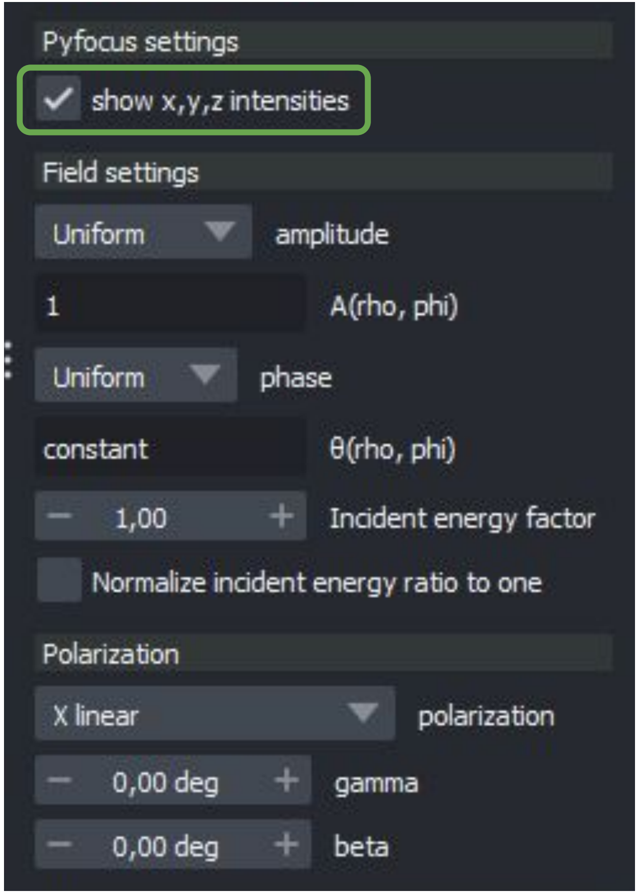


Vectorial simulation: Intensity of the X, Y and Z components

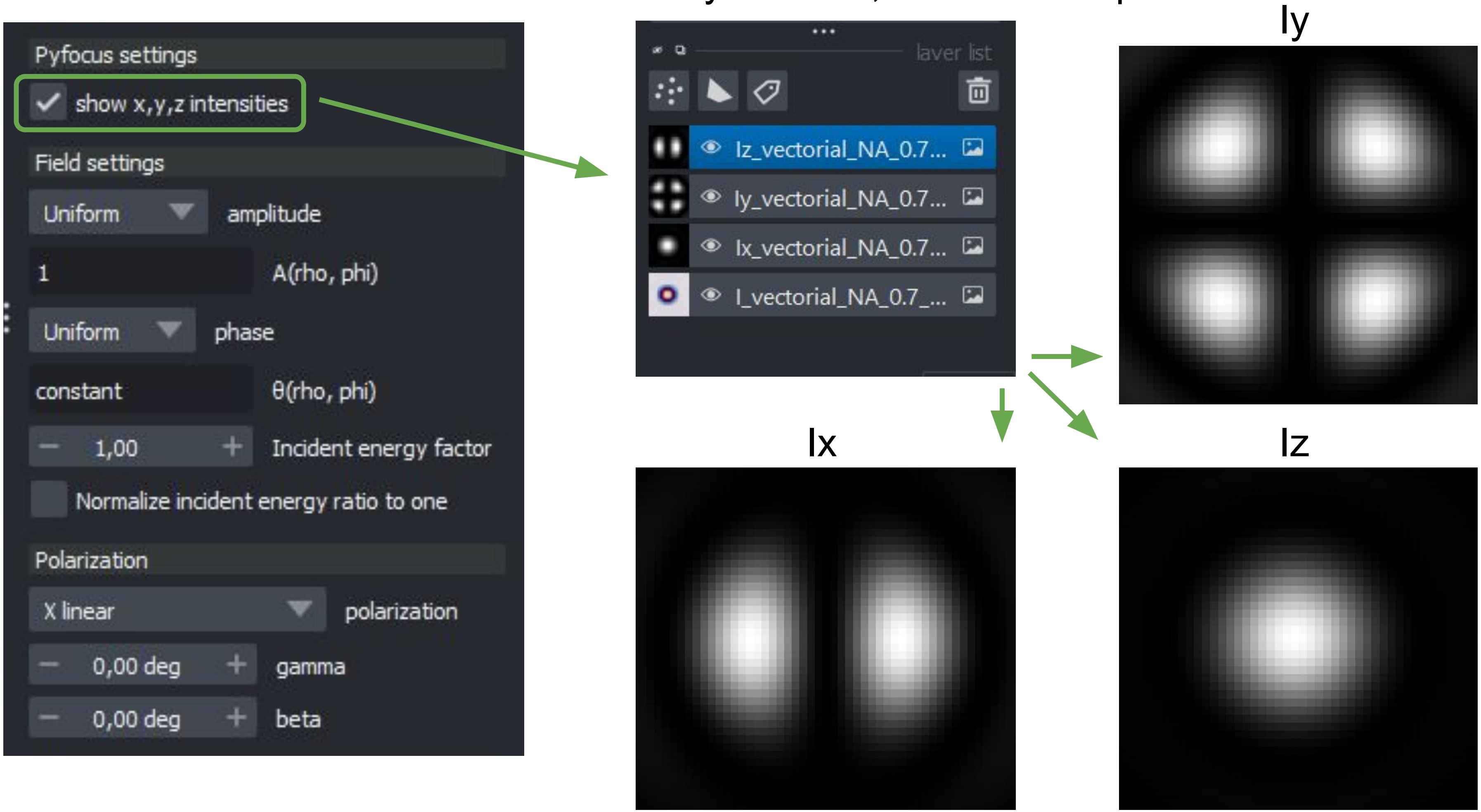




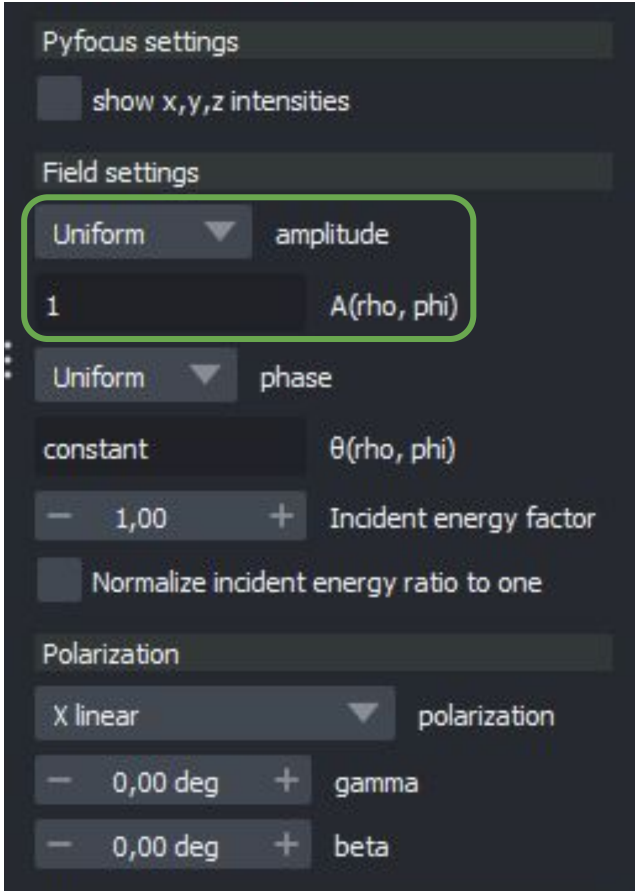
Vectorial simulation: Intensity of the X, Y and Z components



Vectorial simulation: Intensity of the X, Y and Z components

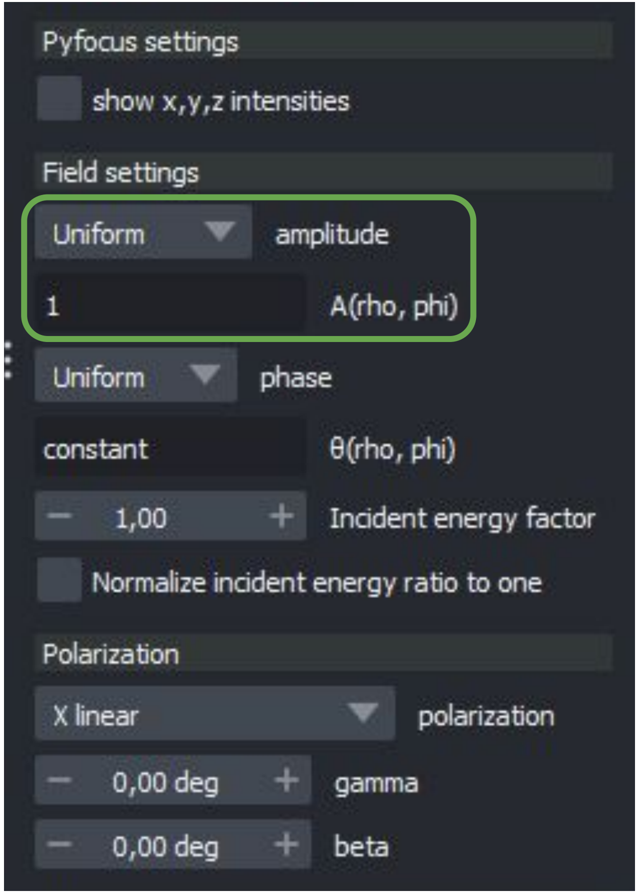


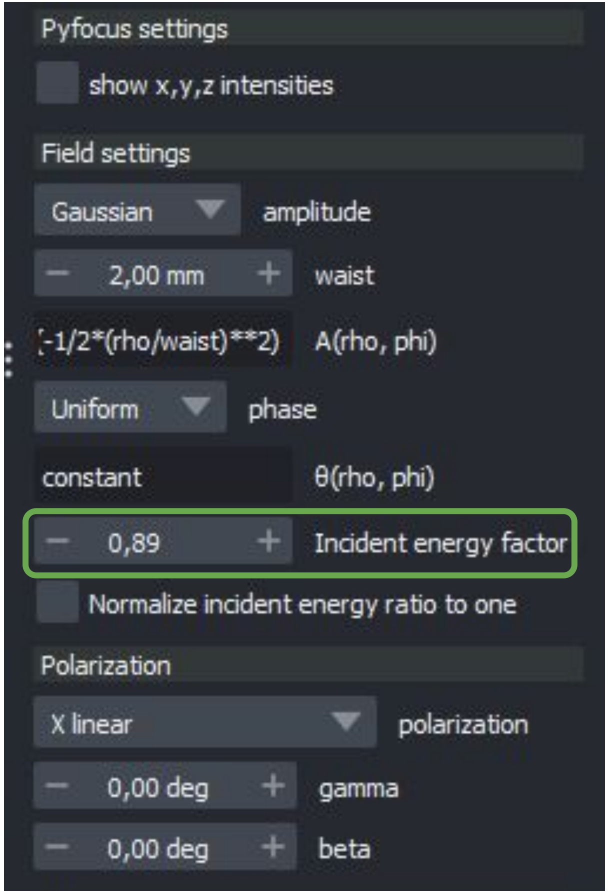
Vectorial simulation: Amplitude setting



Vectorial simulation: Gaussian amplitude

Vectorial simulation: Gaussian amplitude

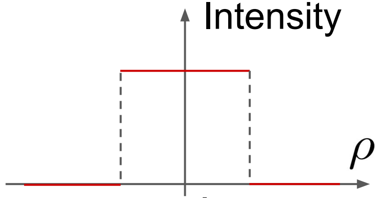




$$\frac{\text{Energy of custom field}}{\text{Energy of uniform field}}$$

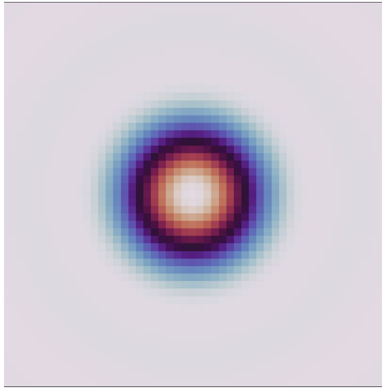
Vectorial simulation: Gaussian amplitude

Uniform



Aperture radius → 3mm

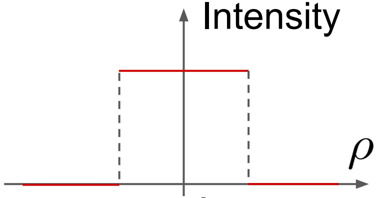
Incident energy factor: 1



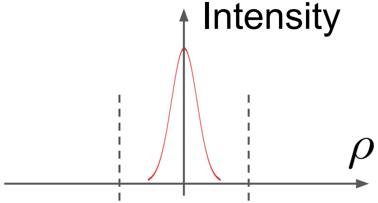
Intensity at the center:
22.6 kW/nm^2

Vectorial simulation: Gaussian amplitude

Uniform

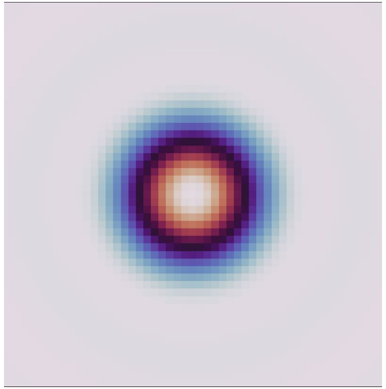


Waist: 1mm



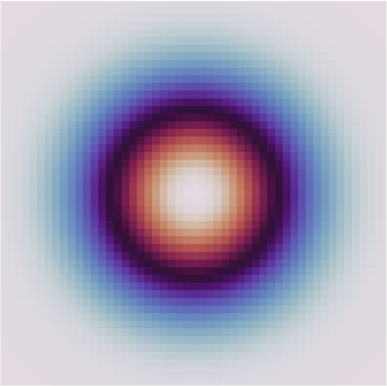
Aperture radius → 3mm

Incident energy factor: 1



Intensity at the center: 22.6 kW/nm^2

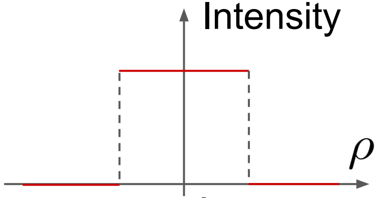
Incident energy factor: 1



Intensity at the center: 9.01 kW/nm^2

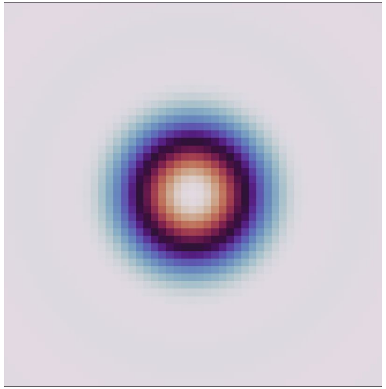
Vectorial simulation: Gaussian amplitude

Uniform



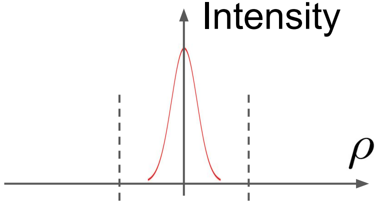
Aperture radius → 3mm

Incident energy factor: 1

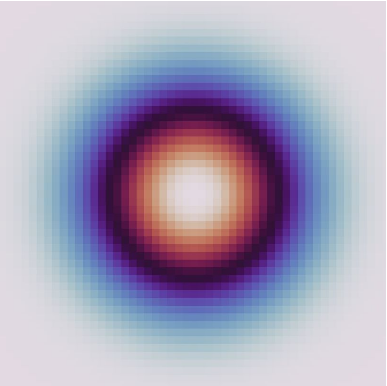


Intensity at the center:
22.6 kW/nm^2

Waist: 1mm

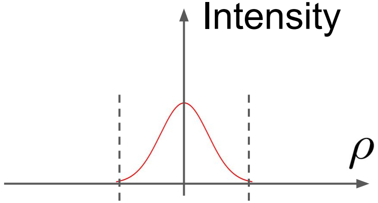


Incident energy factor: 1

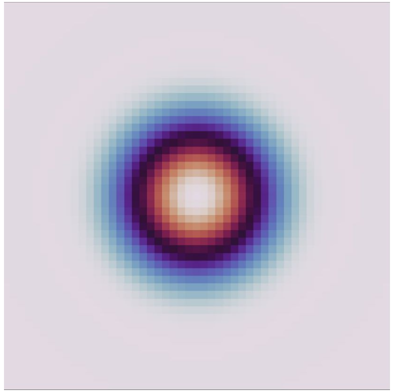


Intensity at the center:
9.01 kW/nm^2

Waist: 2mm



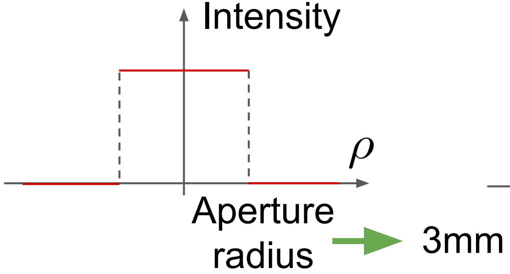
Incident energy factor: 0.89



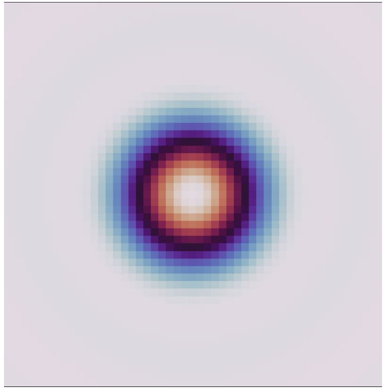
Intensity at the center:
16.8 kW/nm^2

Vectorial simulation: Gaussian amplitude

Uniform

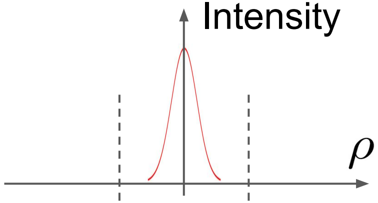


Incident energy factor: 1

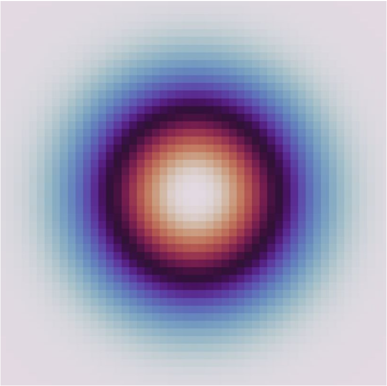


Intensity at the center: 22.6 kW/nm^2

Waist: 1mm

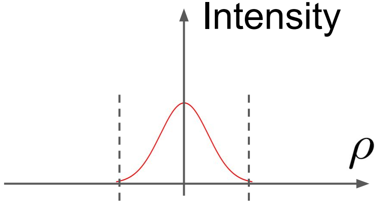


Incident energy factor: 1

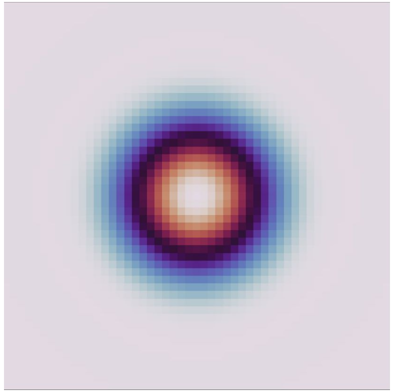


Intensity at the center: 9.01 kW/nm^2

Waist: 2mm

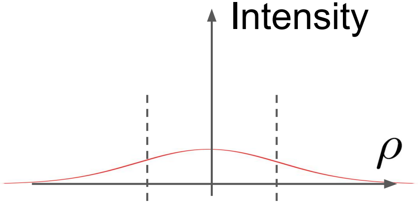


Incident energy factor: 0.89

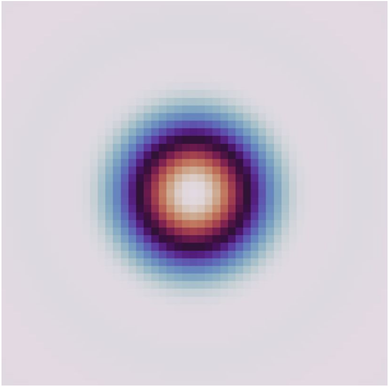


Intensity at the center: 16.8 kW/nm^2

Waist: 10mm

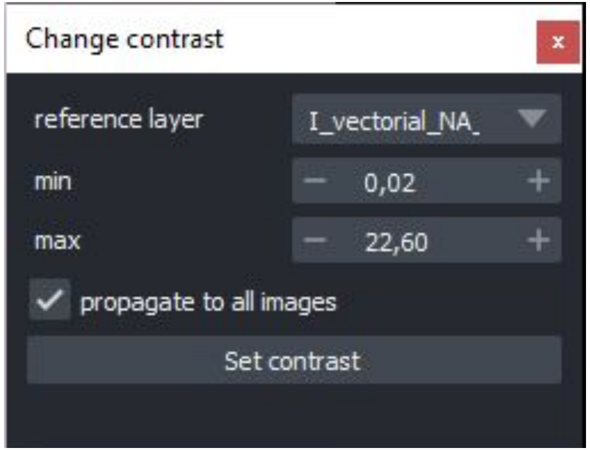


Incident energy factor: 0.09

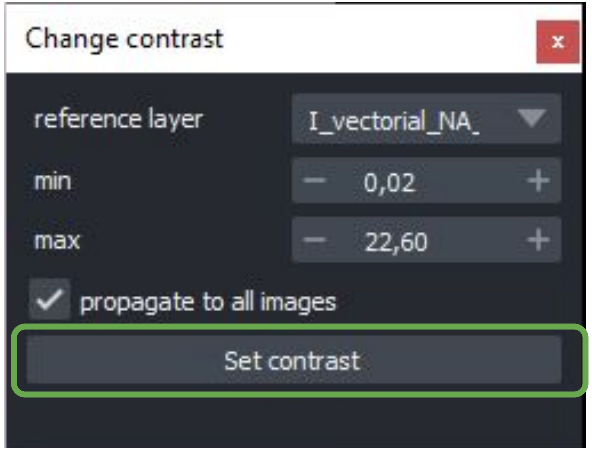


Intensity at the center: 1.92 kW/nm^2

Vectorial simulation: Intensity contrast

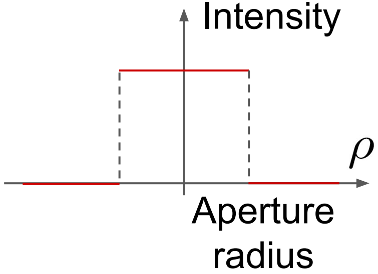


Vectorial simulation: Intensity contrast

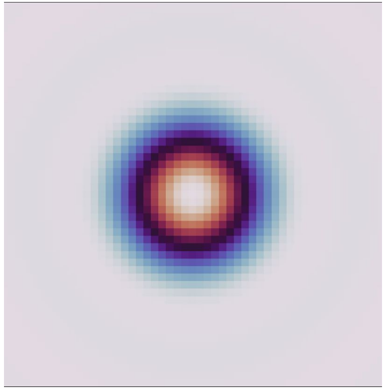


Vectorial simulation: Intensity contrast

Uniform

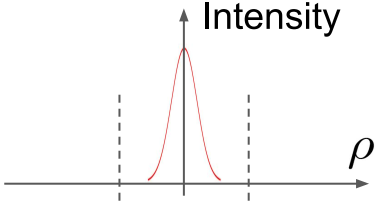


Incident energy factor: 1

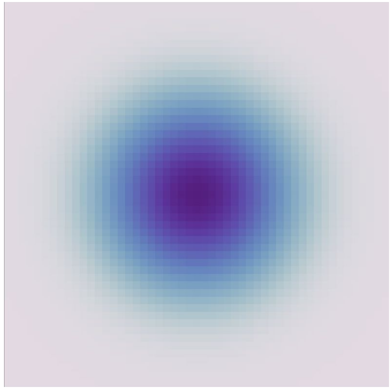


Intensity at the center: 22.6 kW/nm^2

Waist: 1mm

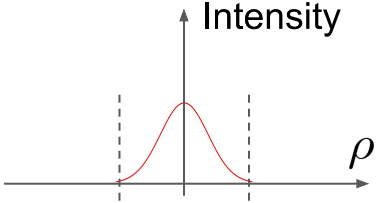


Incident energy factor: 1

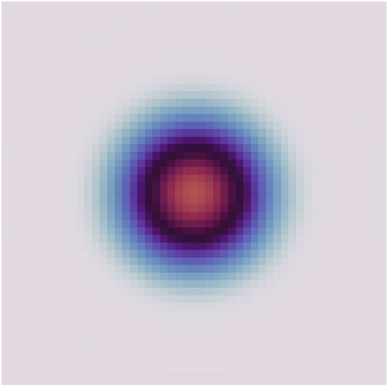


Intensity at the center: 9.01 kW/nm^2

Waist: 2mm

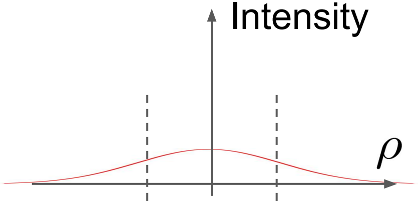


Incident energy factor: 0.89

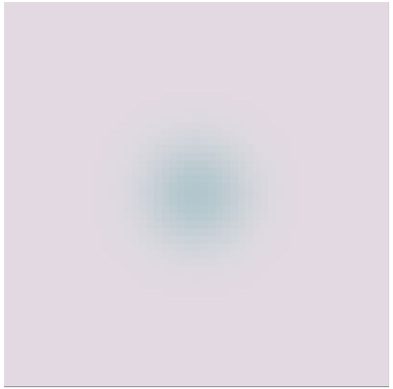


Intensity at the center: 16.8 kW/nm^2

Waist: 10mm

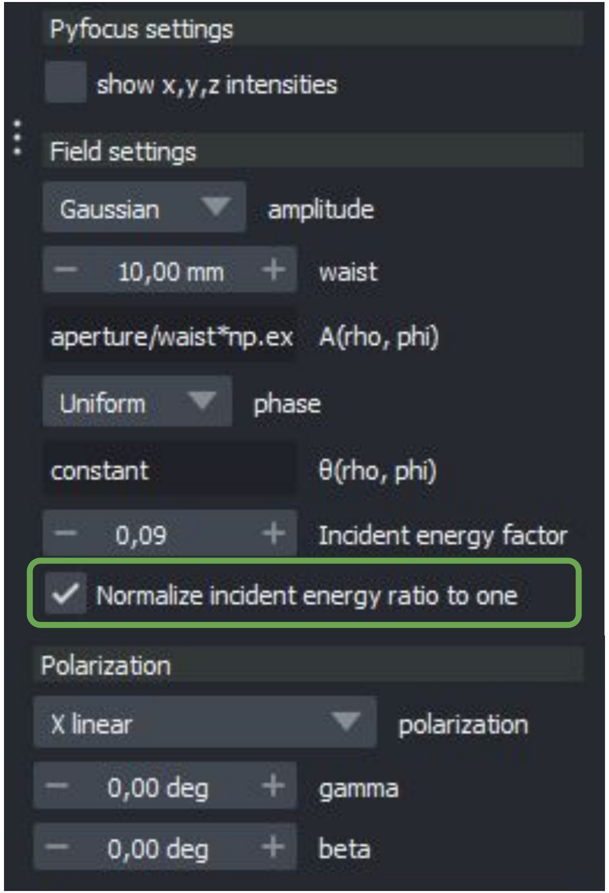


Incident energy factor: 0.09

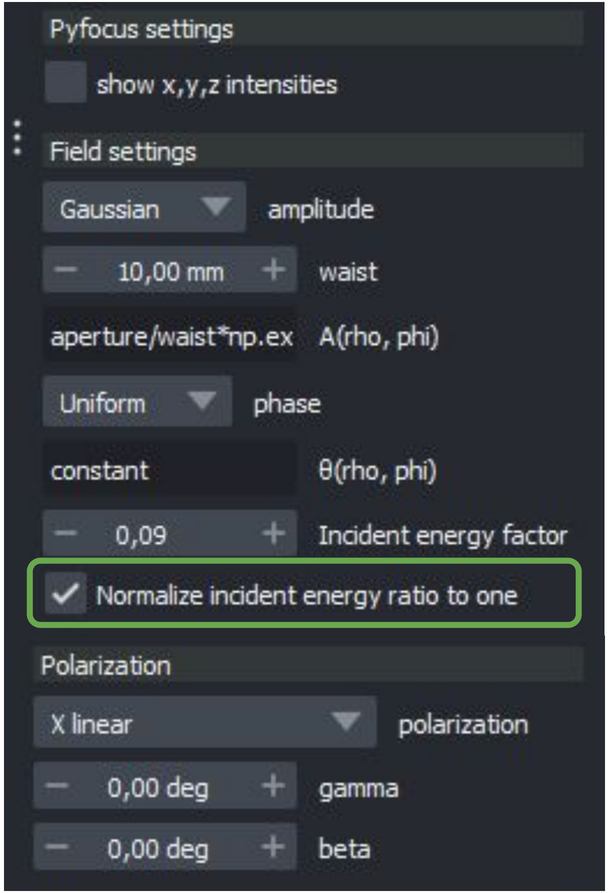


Intensity at the center: 1.92 kW/nm^2

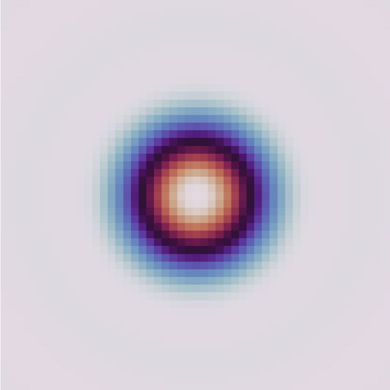
Vectorial simulation: Incident energy ratio



Vectorial simulation: Incident energy ratio

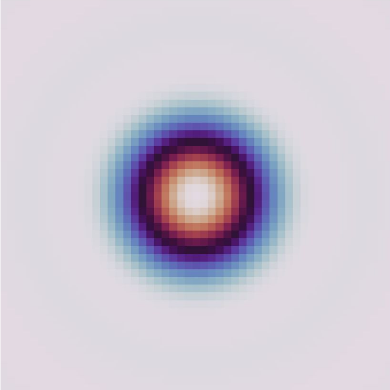


Gaussian amplitude with 10mm waist normalized



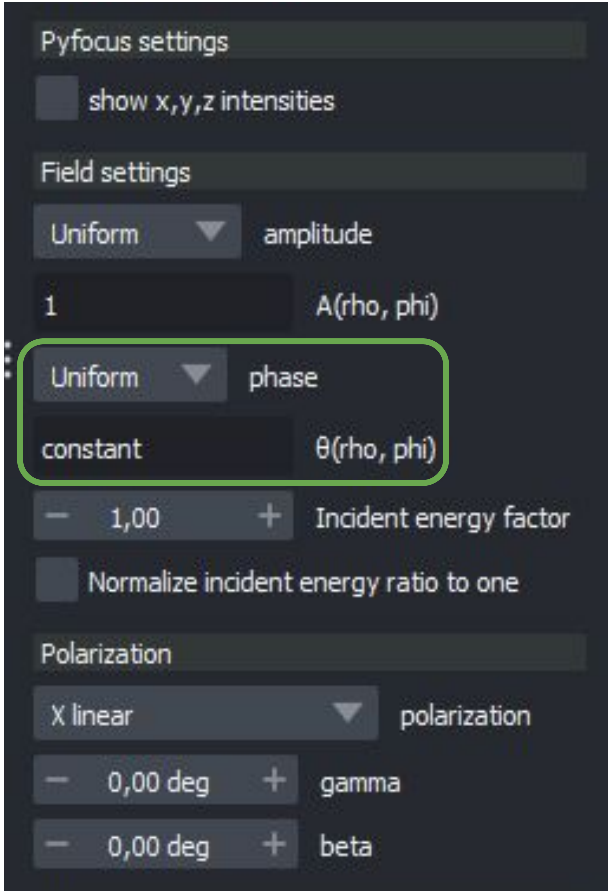
Intensity at the center: 22.5 kW/nm^2

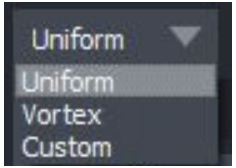
Uniform amplitude



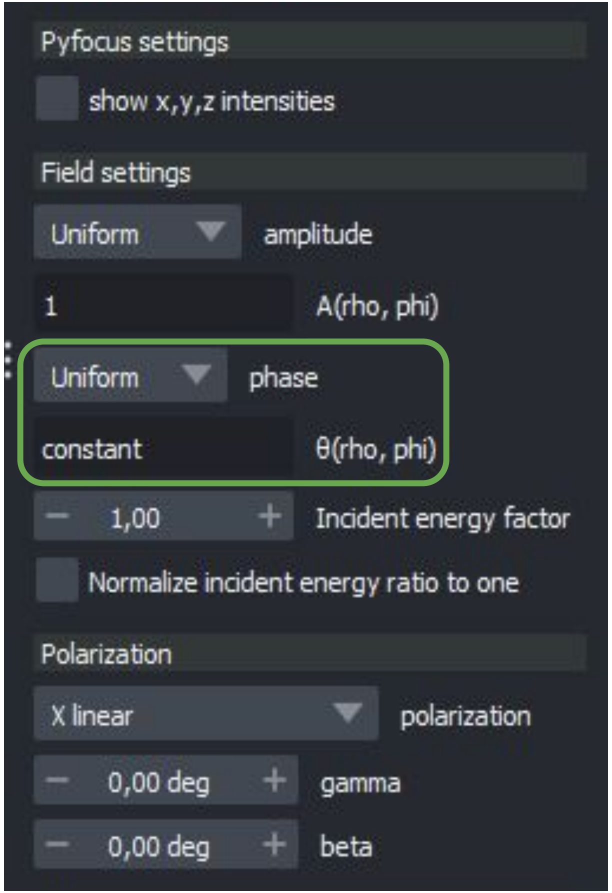
Intensity at the center: 22.6 kW/nm^2

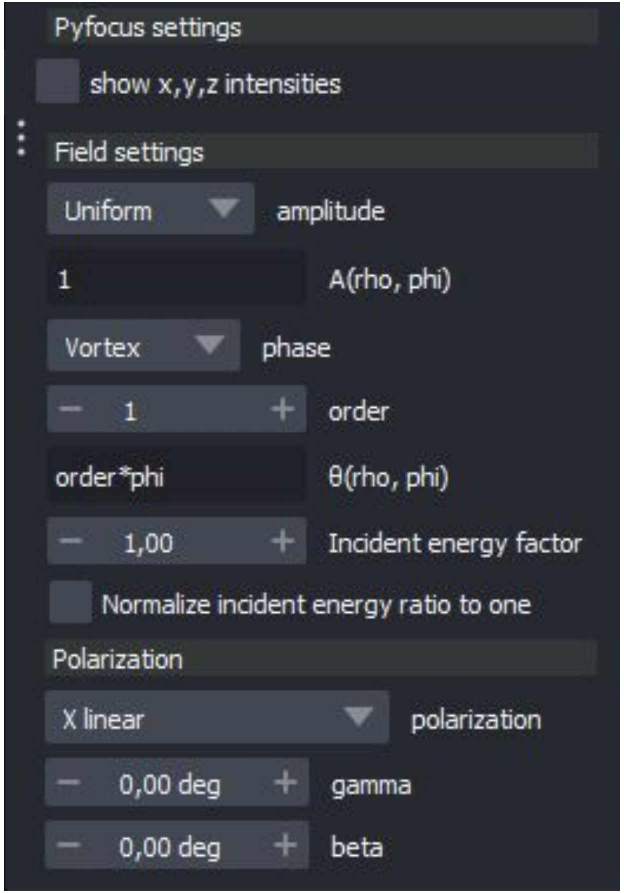
Vectorial simulation: Phase settings



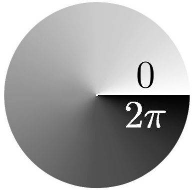


Vectorial simulation: Vortex phase

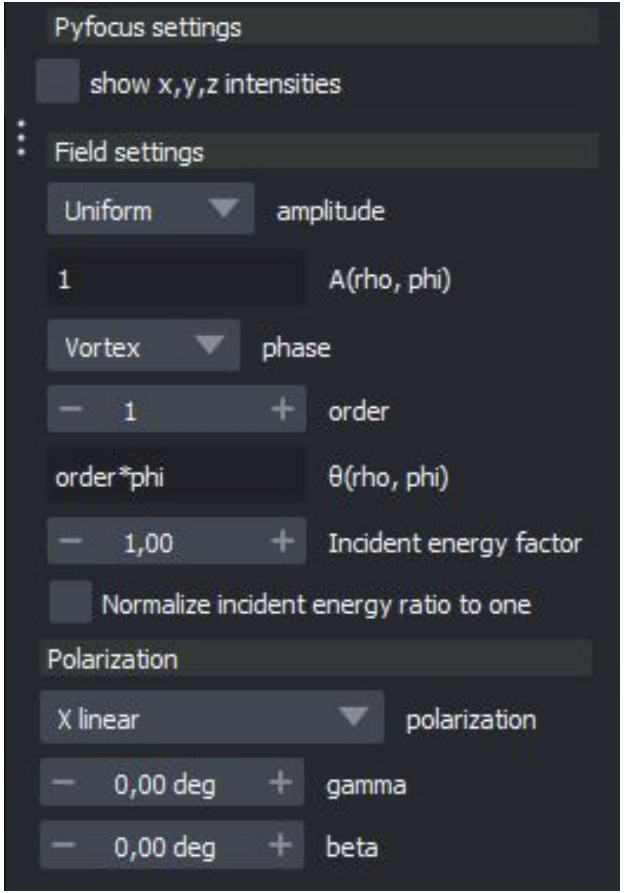




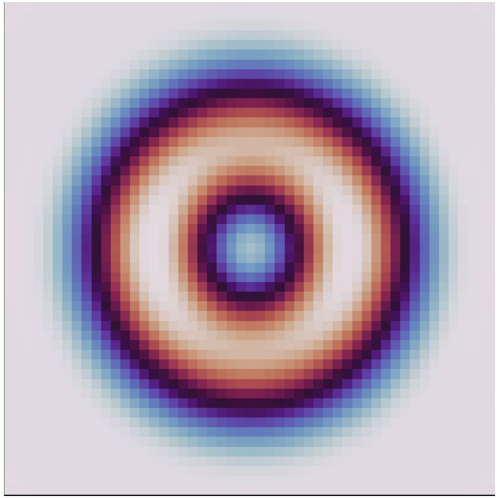
Order = 1



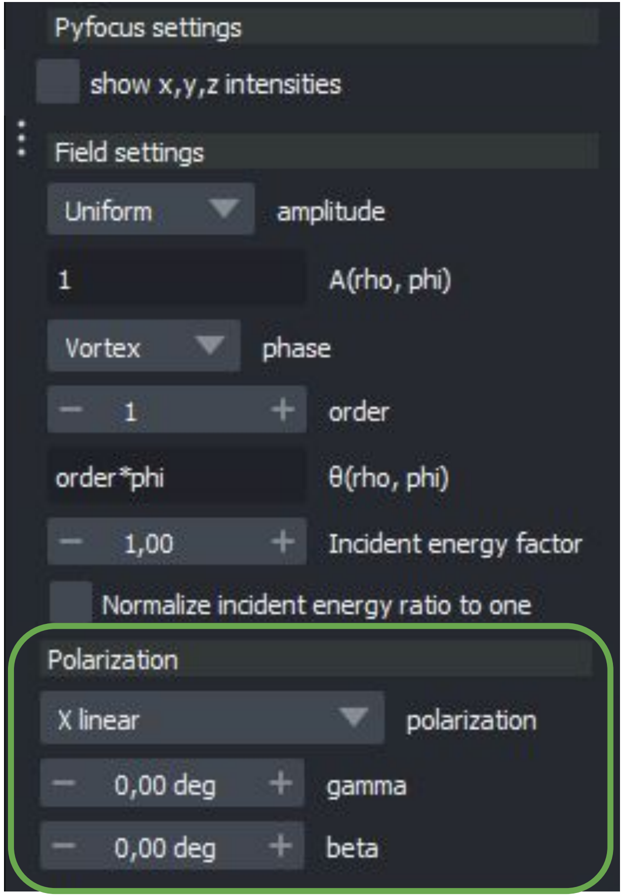
Vectorial simulation: Vortex phase



Vortex phase with X linear polarization



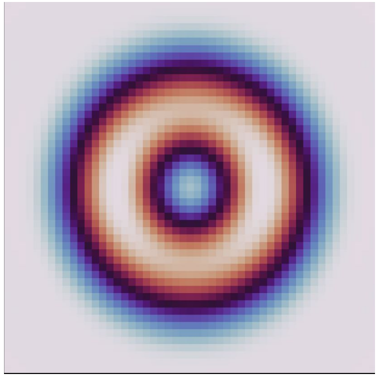
Vectorial simulation: Polarization setting



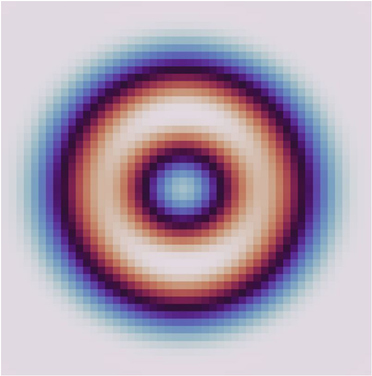
Vectorial simulation: Vortex phase for various polarizations

With
NA = 0.65
n = 1.3
FOVxy = 1.5μm

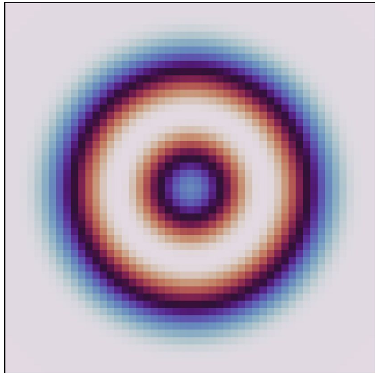
Y Linear



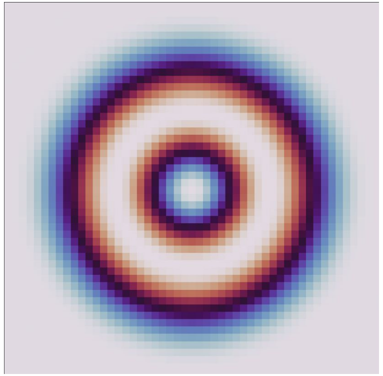
X Linear



Left Circular



Right Circular

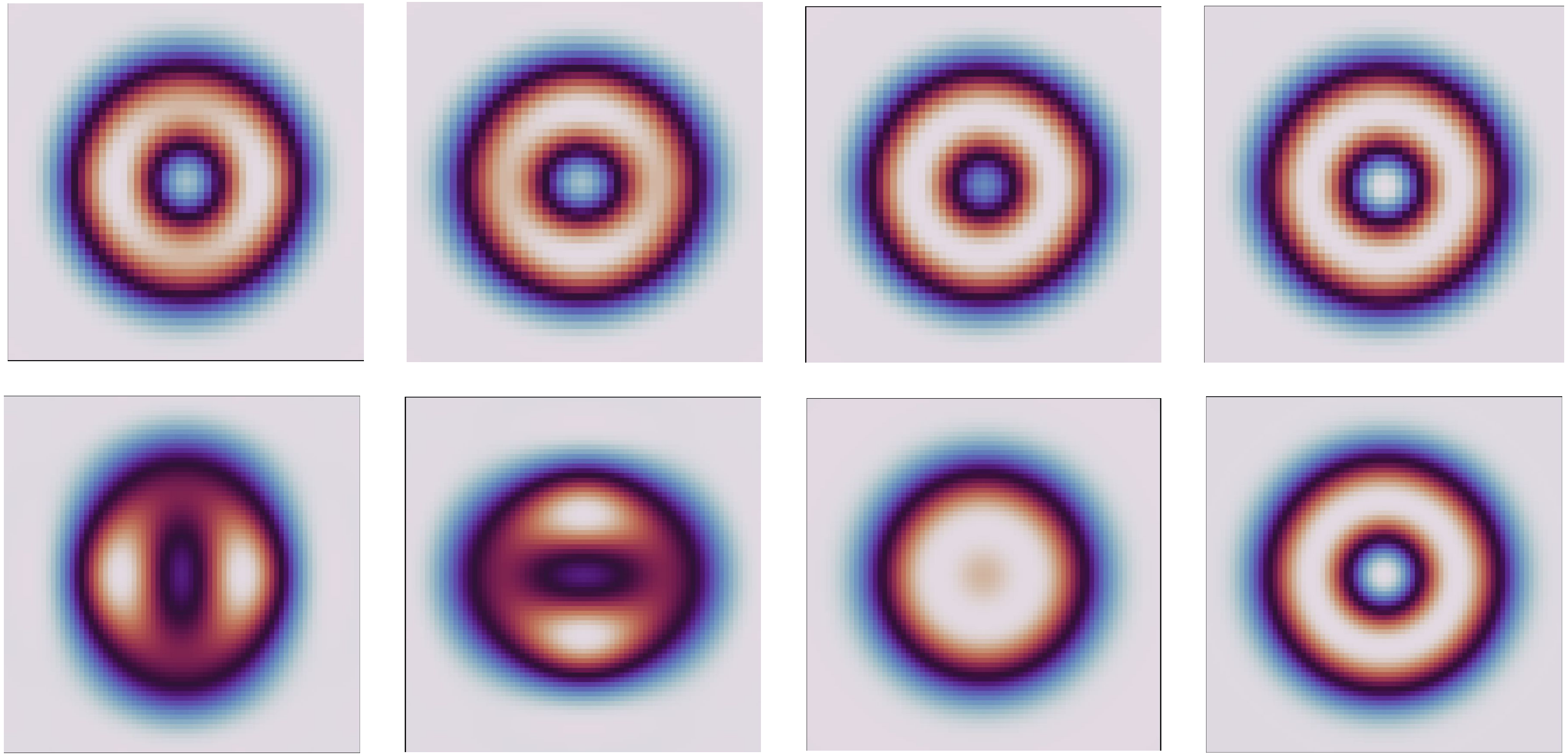


Vectorial simulation: Vortex phase for various polarizations

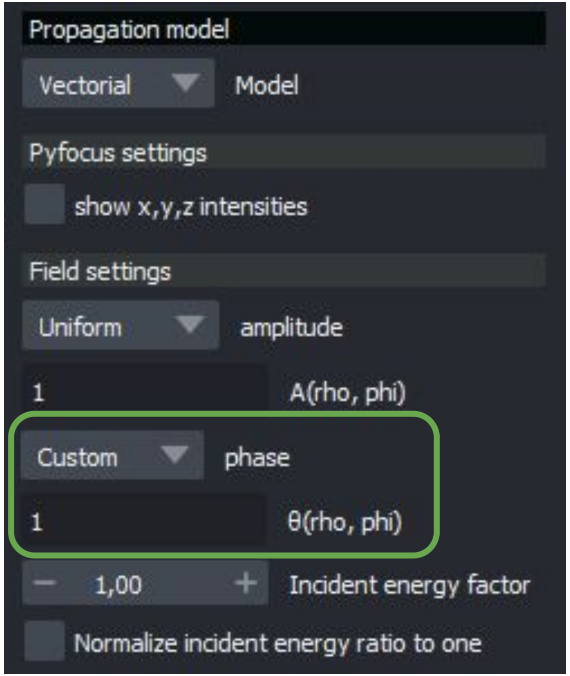
Y Linear | X Linear | Left Circular | Right Circular

With
NA = 0.65
n = 1.3
FOVxy = 1.5µm

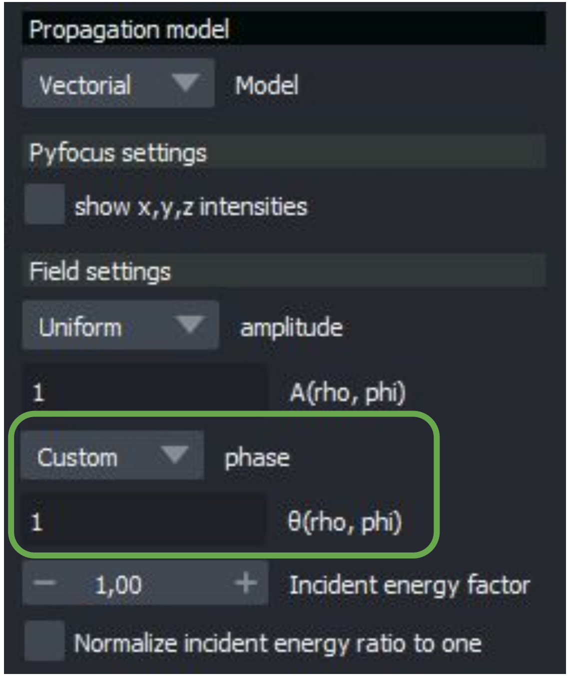
With
NA = 1.4
n =1.5
FOVxy = 0.75µm



Vectorial simulation:
Custom phase (amplitude)

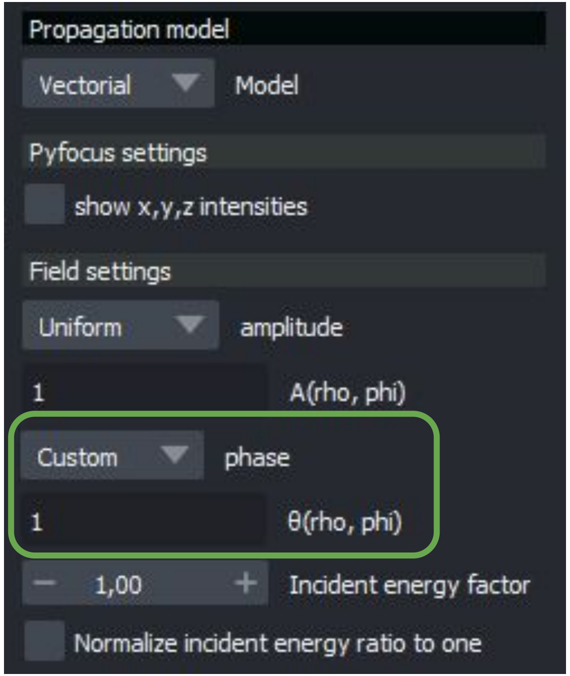


Vectorial simulation:
Custom phase (amplitude)



$$\frac{\text{rho}}{\text{lens radius}}$$

Vectorial simulation:
Custom phase (amplitude)

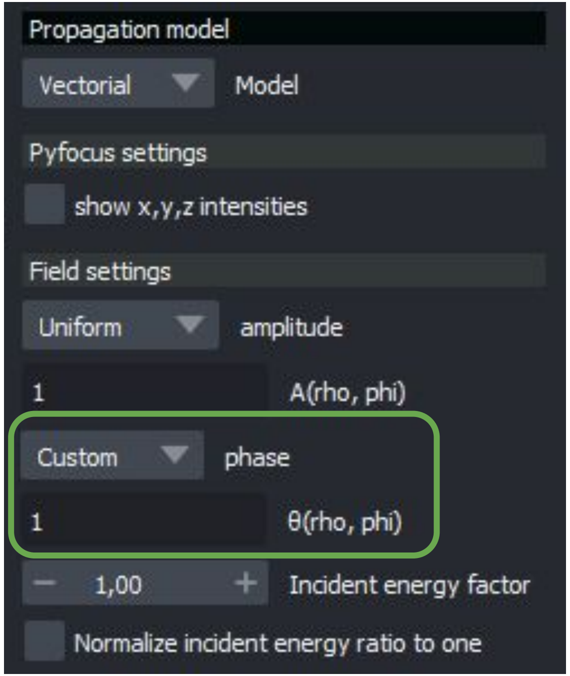


$$\frac{\text{rho}}{\text{lens radius}}$$

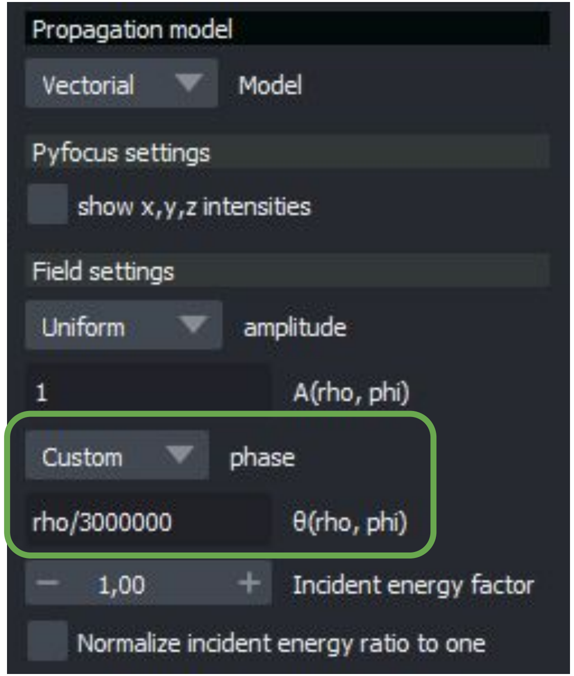
Units must be in nm

3mm = 3000000nm

Vectorial simulation:
Custom phase (amplitude)



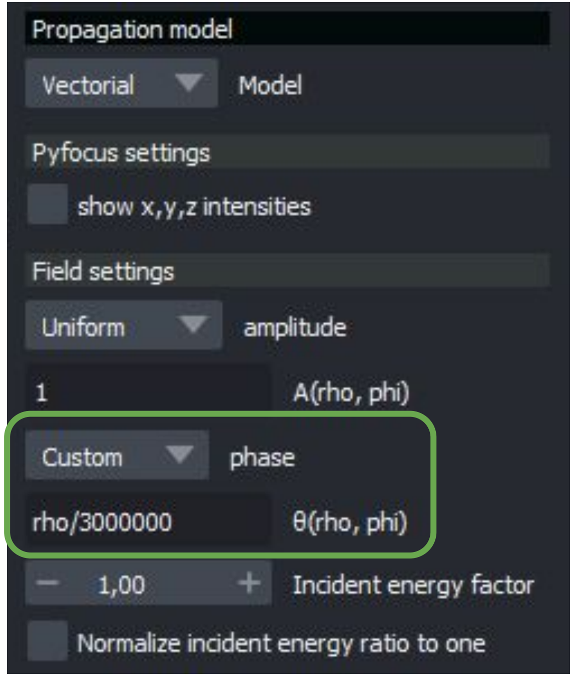
$$\frac{\text{rho}}{\text{lens radius}}$$

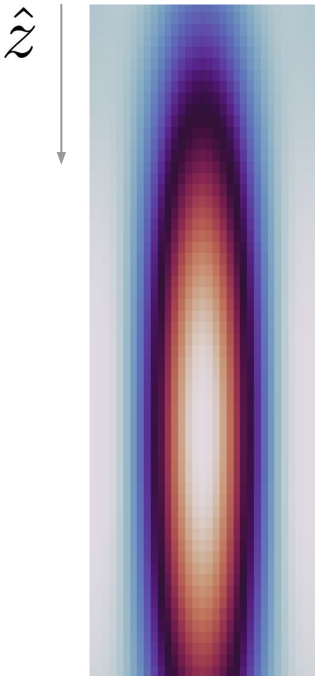


Units must be in nm

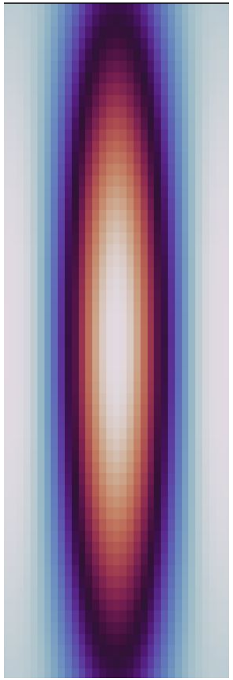
3mm = 3000000nm

Vectorial simulation:
Custom phase (amplitude)



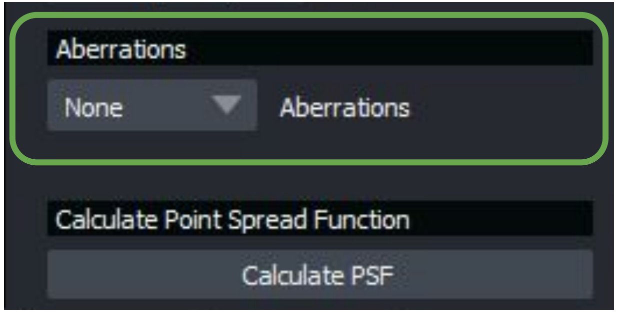


custom phase

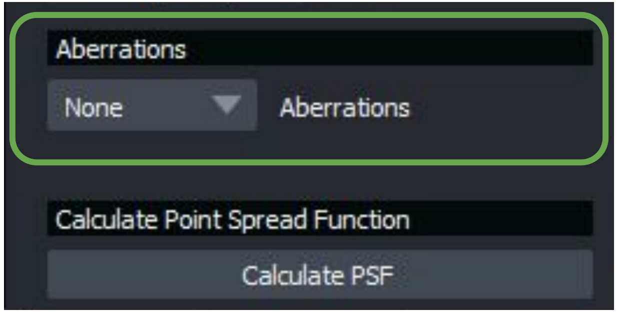


uniform field

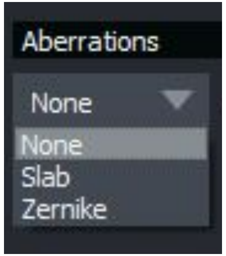
Aberrations



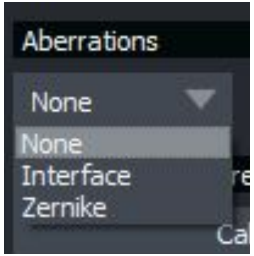
Aberrations



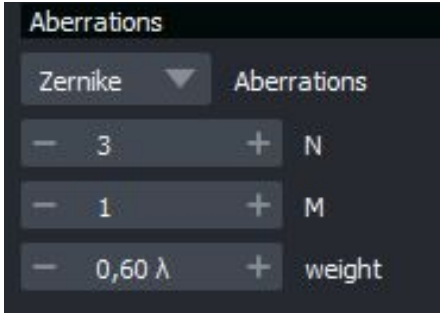
Scalar mode



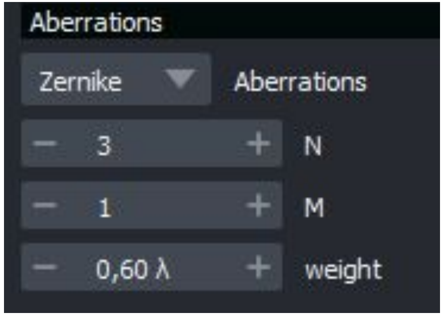
Vectorial mode



Aberrations: Zernike
Uniform field



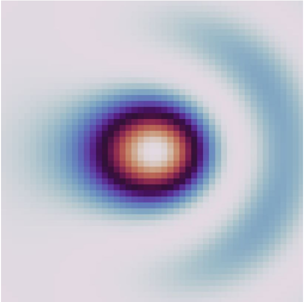
Aberrations: Zernike
Uniform field

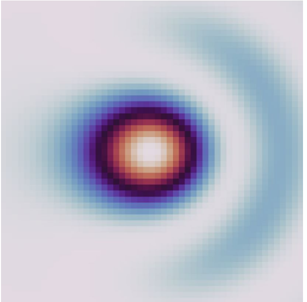


Scalar mode

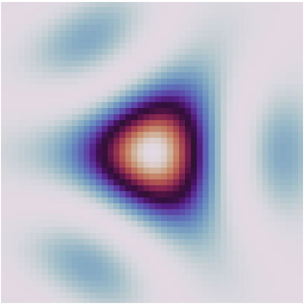
Vectorial mode

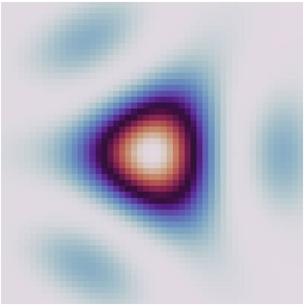
N = 3, M = 1,
weight = 0.6



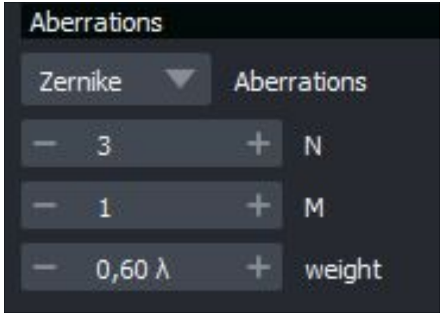


N = 3, M = 3,
weight = 0.6

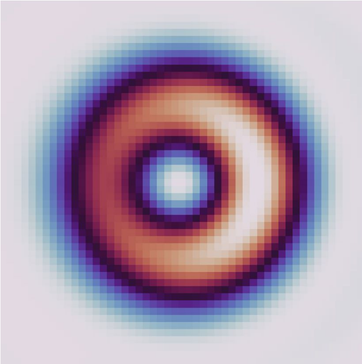




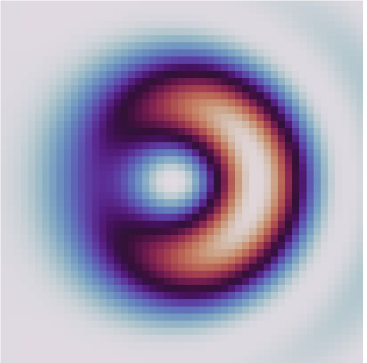
Aberrations: Zernike
Vortex phase with right handed circular polarization



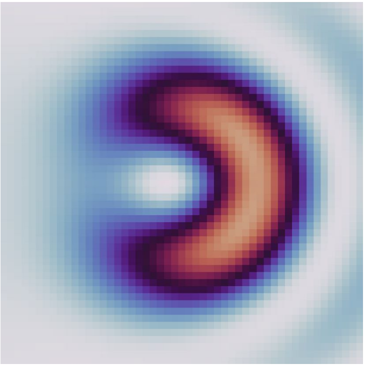
N = 3, M = 1,
weight = 0.15



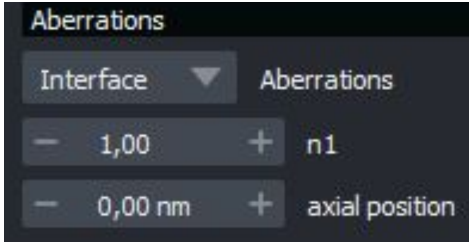
N = 3, M = 1,
weight = 0.4

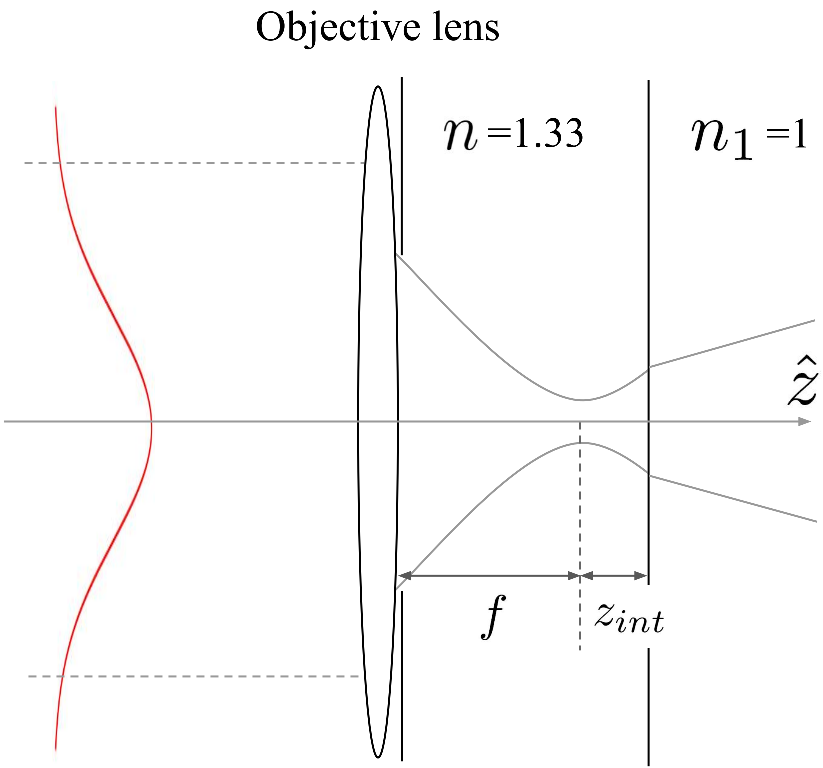


N = 3, M = 1,
weight = 0.6

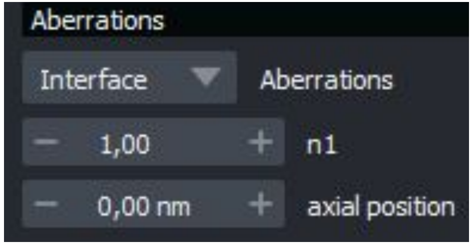


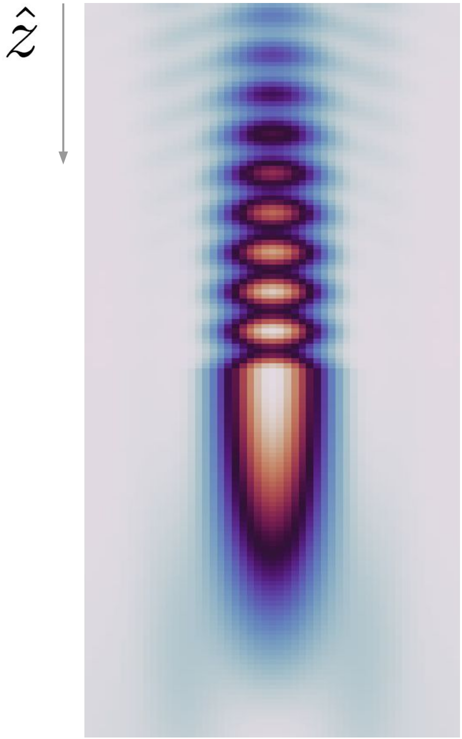
Aberrations: Vectorial simulation
Interface





Aberrations: Vectorial simulation
Interface, uniform field





Now, lets see it in action!