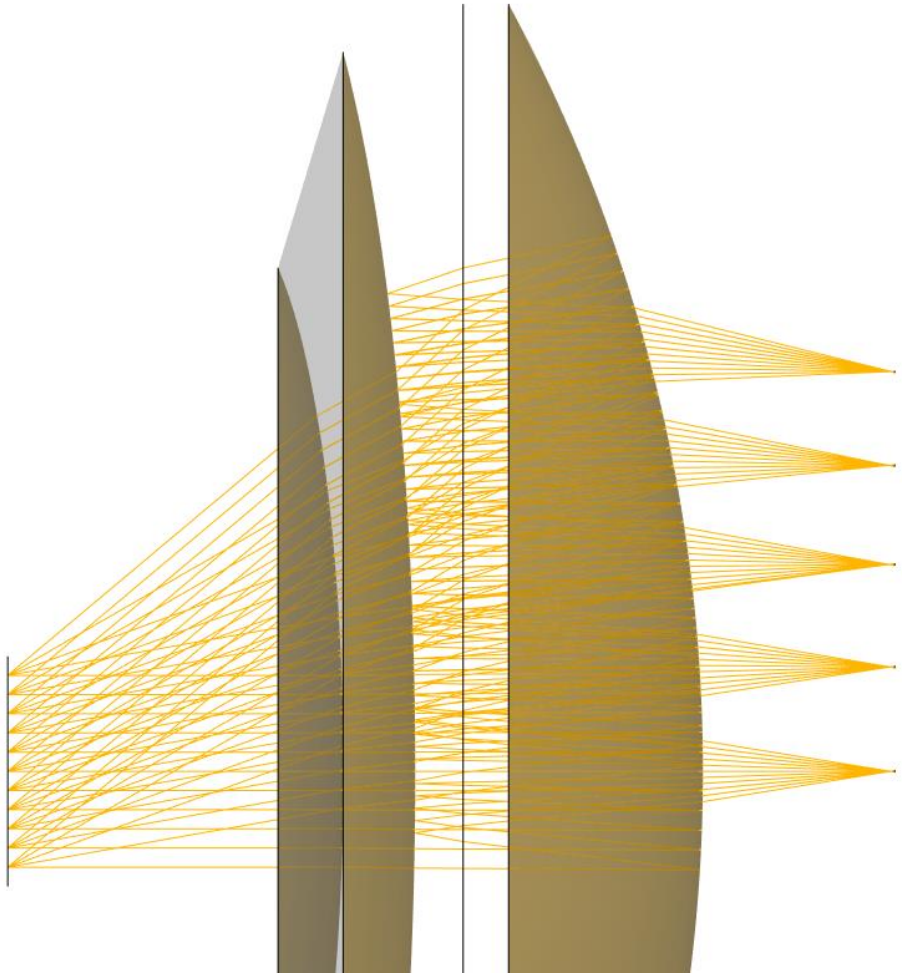
Catadioptric Imaging System Based on Pancake Lenses

Abstract

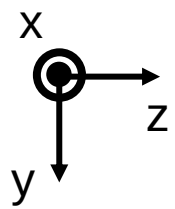


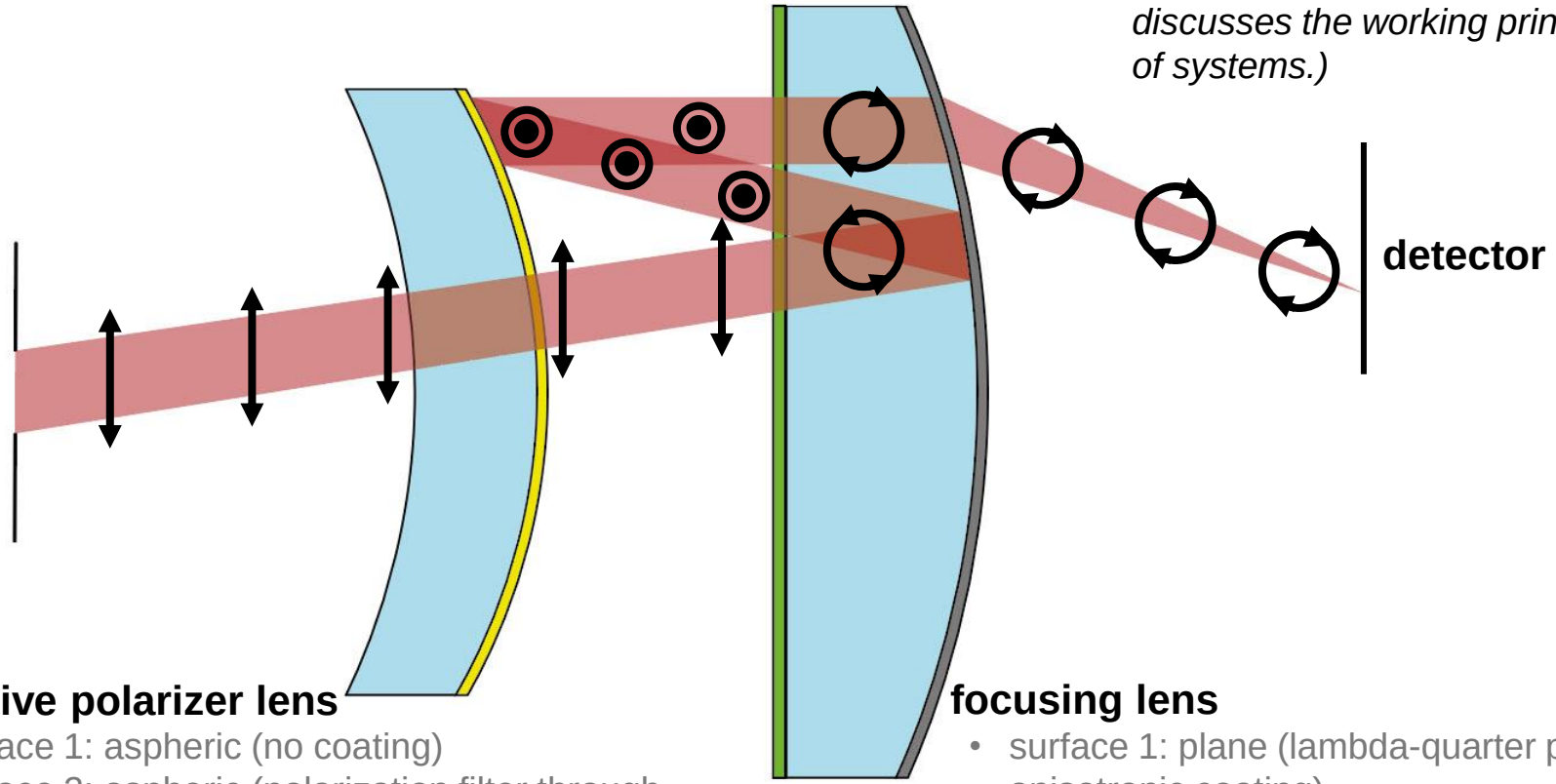
In order to reduce costs and weight, many modern application introduce smart ways to miniaturize their optical systems. One particular implementation of this principle is the folded imaging system, in which the property of a focusing lens is distributed between multiple components. By cleverly manipulating the polarizations status of the propagated light, this system allows for multiple internal reflection, mimicking the functionality of a much bigger lens. In this Use Case we show the working principle of such a system. For this purpose, we defined a set of Plane Wave with different incident angles, which then are propagated through the system to calculate the focal spots at the end.

Scenario

(note: this use case does not include an optimization of the system, as it only discusses the working principle of such kind of systems.)

multiple FOVs*
- plane wave
- wavelength: 587.7 nm
- 0°- 40° incident angle
- linearly polarized in y-direction





reflective polarizer lens
- surface 1: aspheric (no coating)
- surface 2: aspheric (polarization filter through anisotropic coating)

focusing lens
- surface 1: plane (lambda-quarter plate through anisotropic coating)
- surface 2: conical (50/50 semi-transparent mirror)

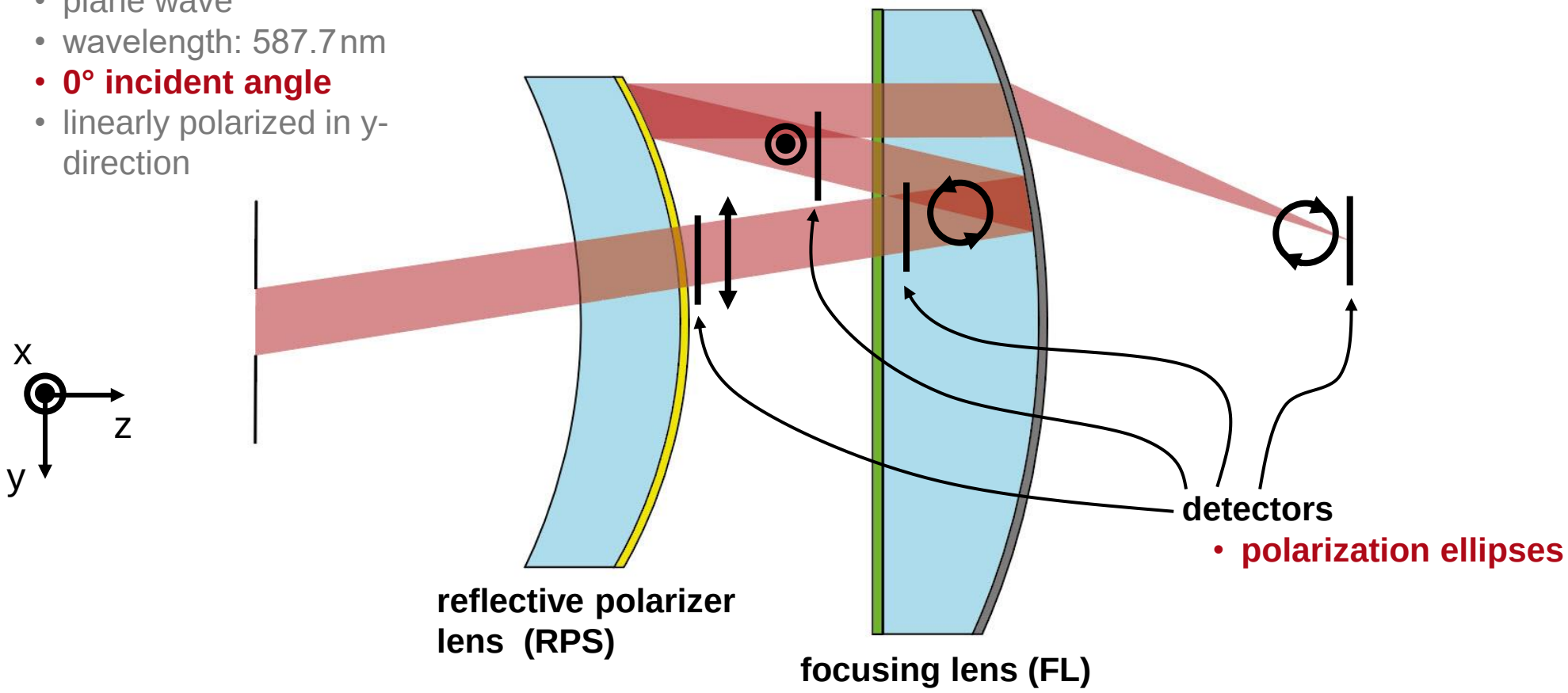
** for picture clarity only one FOV is depicted.*

system based on: Wong, Timothy, et. Al., "Folded Optics with Birefringent Reflective Polarizers", Proc. SPIE 10335

Modeling Task 1: Investigation of Polarization State in System

single FOV

- plane wave
- wavelength: 587.7 nm
- **0° incident angle**
- linearly polarized in y-direction

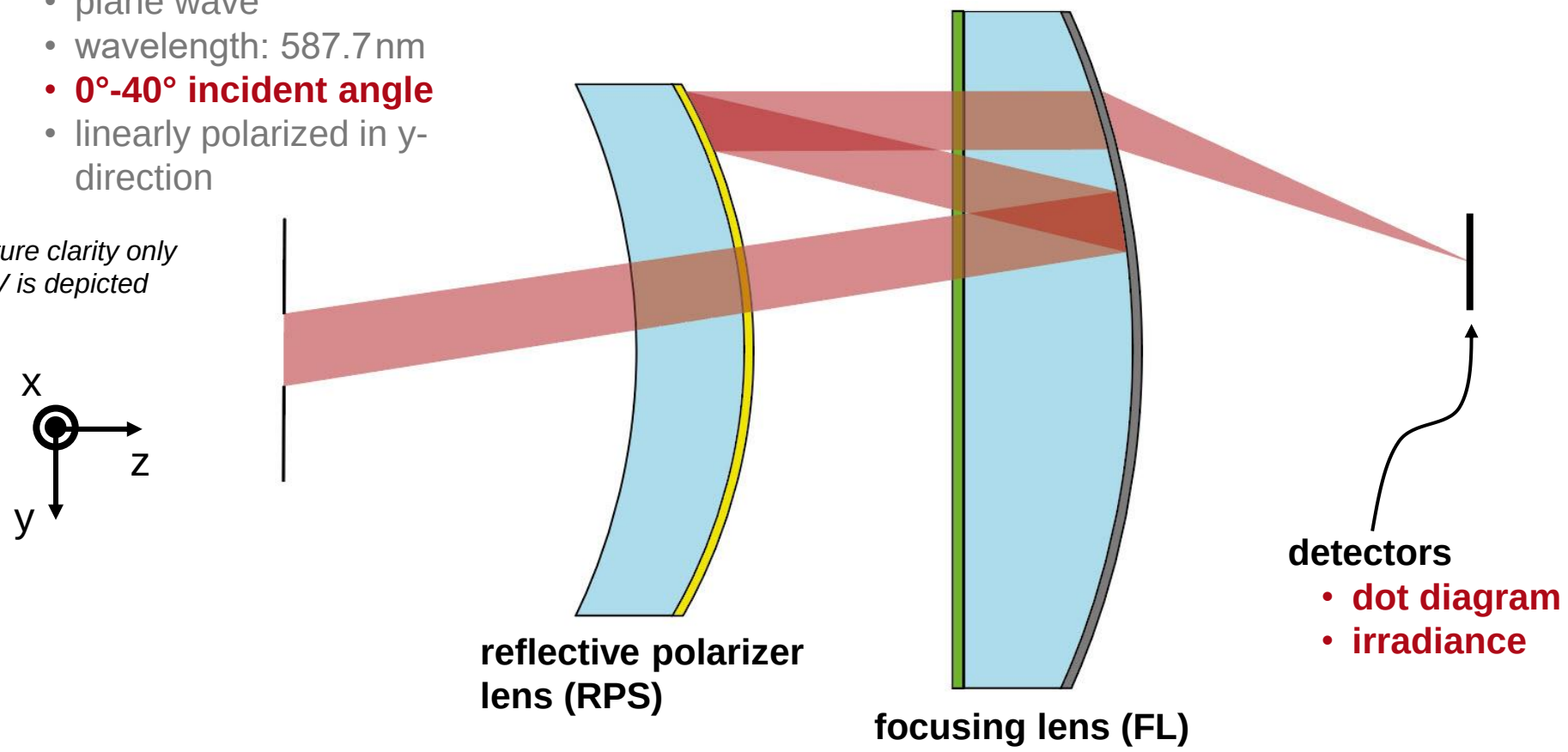


Modeling Task 2: PSF Investigation over Desired Field of View

multiple FOV

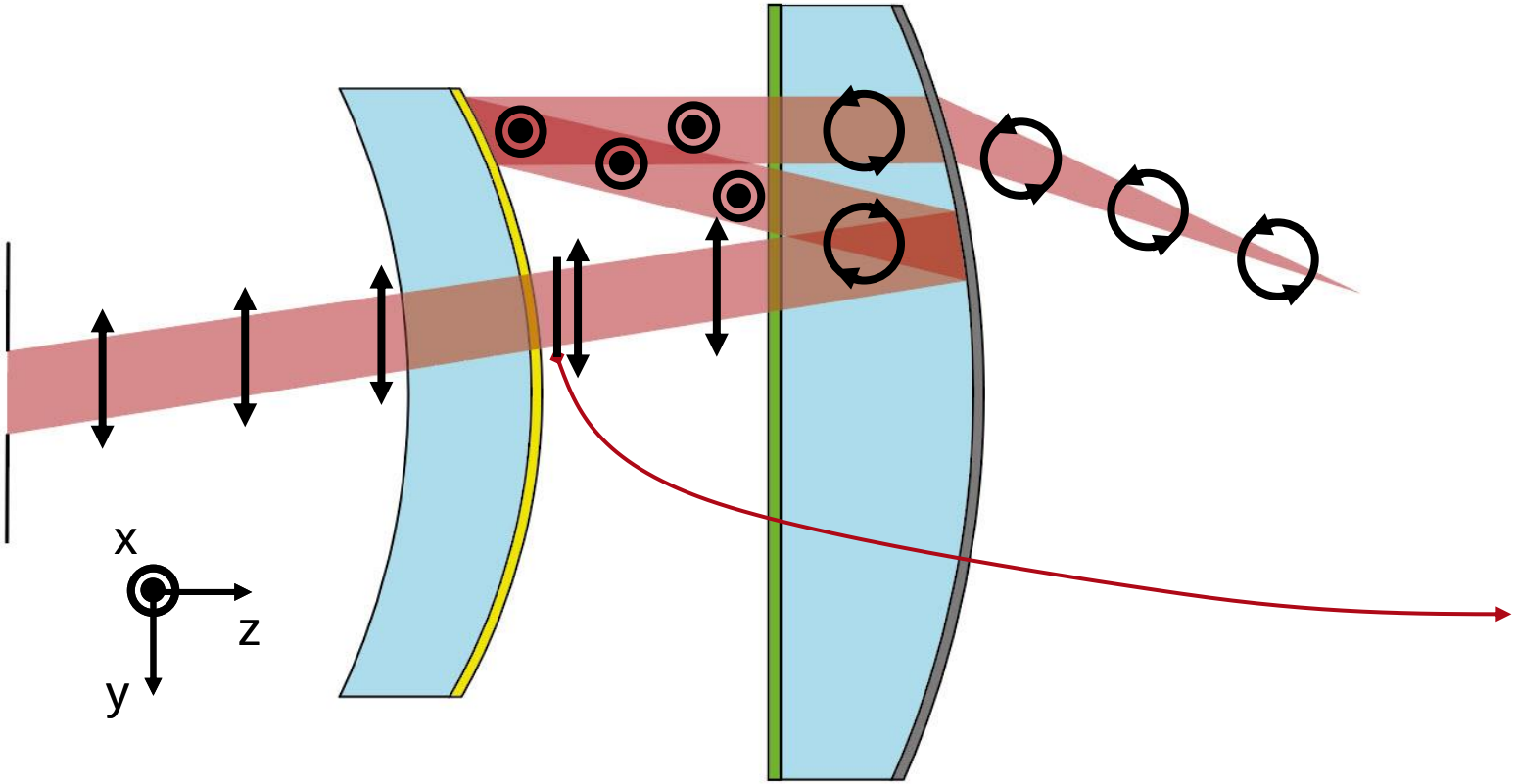
- plane wave
- wavelength: 587.7 nm
- **0°-40° incident angle**
- linearly polarized in y-direction

** for picture clarity only one FOV is depicted*

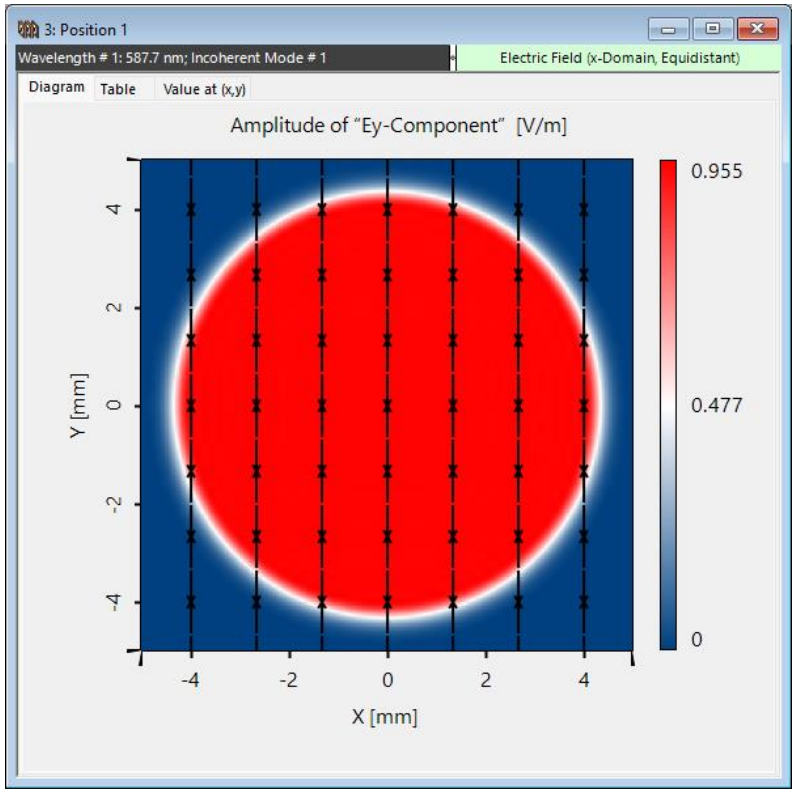


Simulation Results – Polarization State

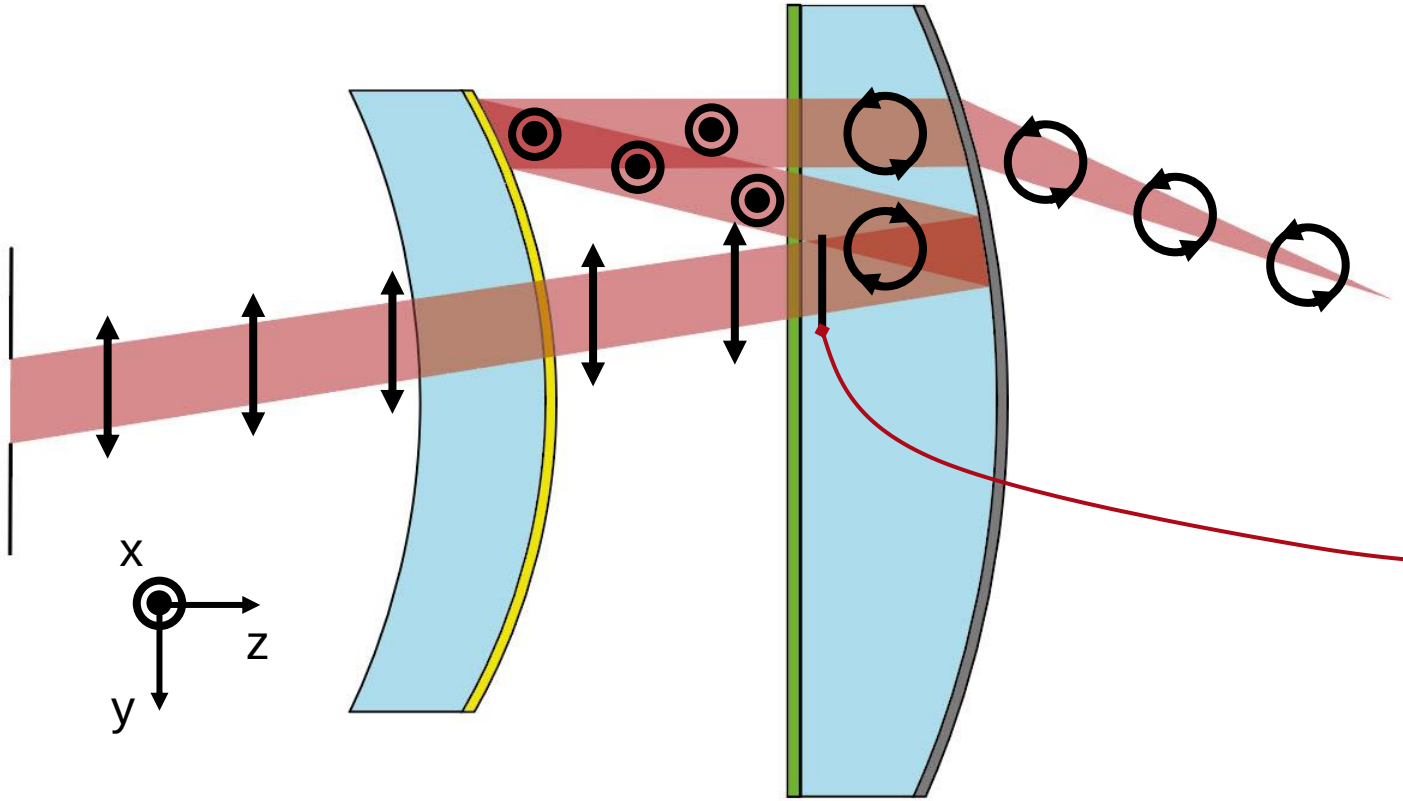
Polarization State through the System



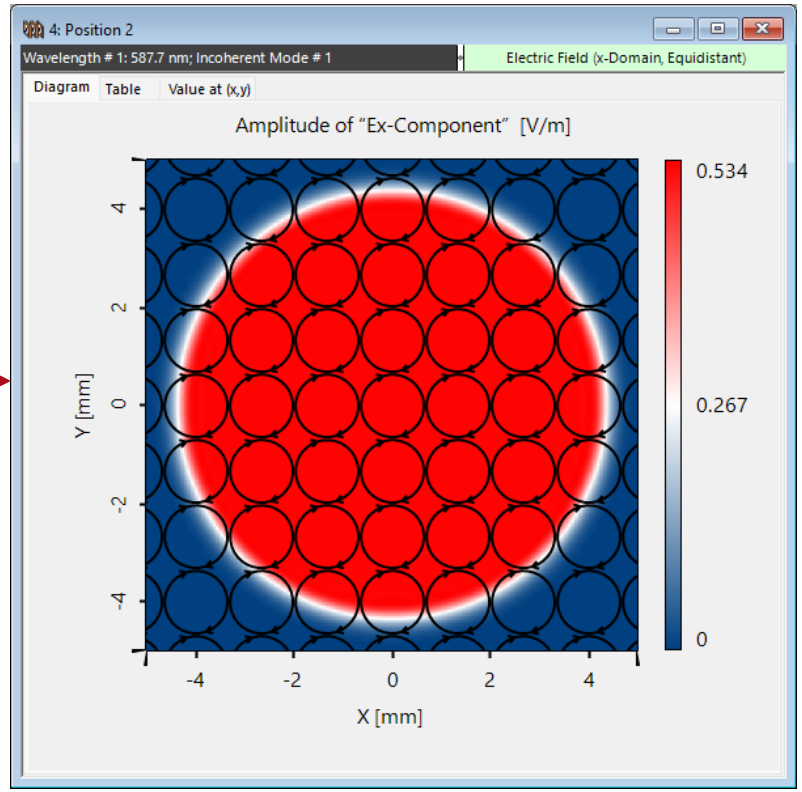
The y-polarized light mostly transmits through the anisotropic coating of the first lens.



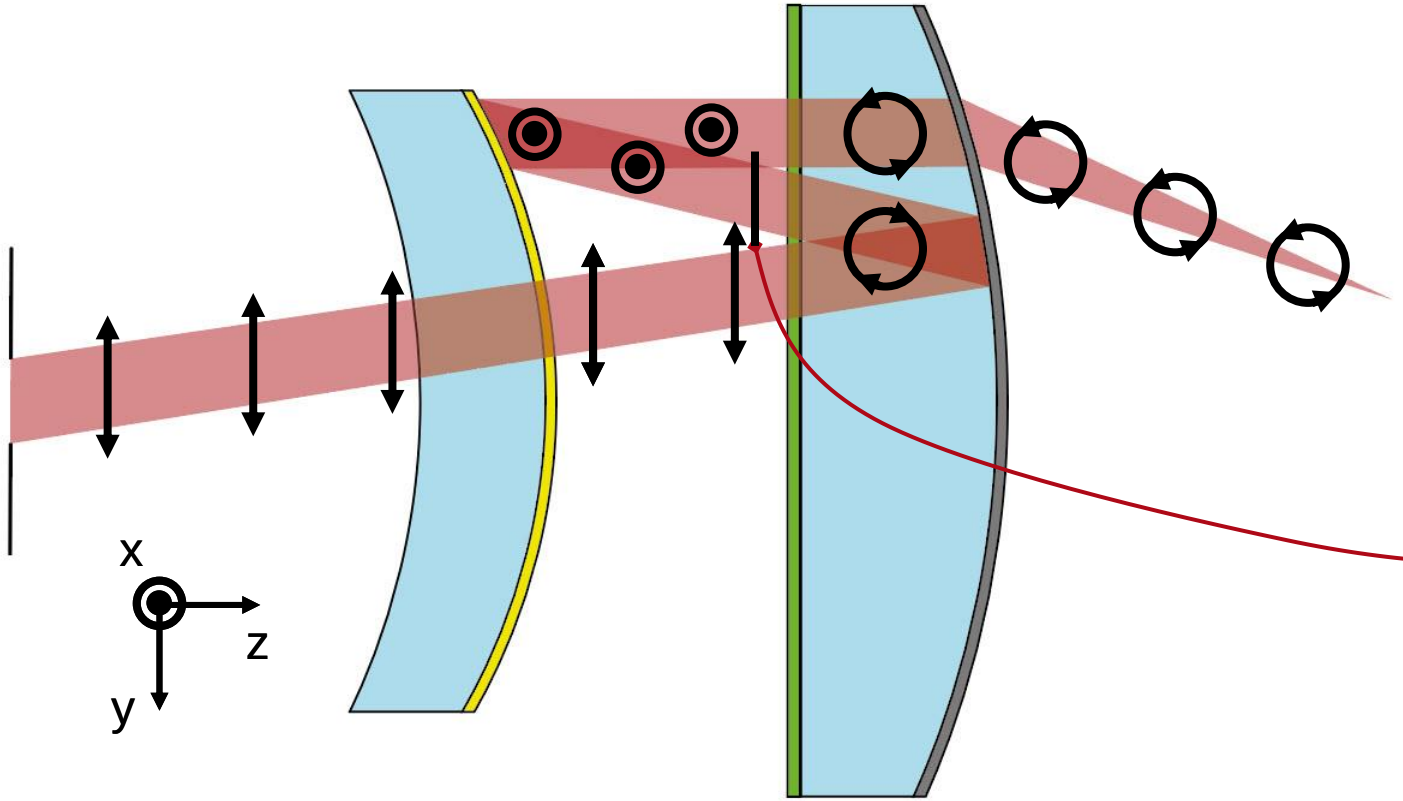
Polarization State through the System



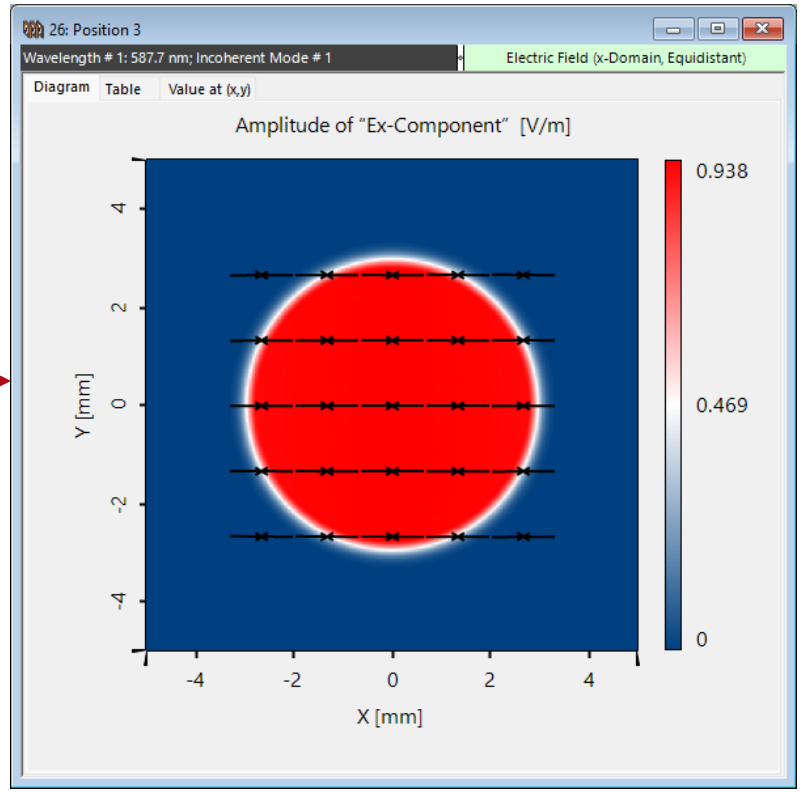
Propagating through the quarter-wave plate, changes its polarization state to clockwise circular.



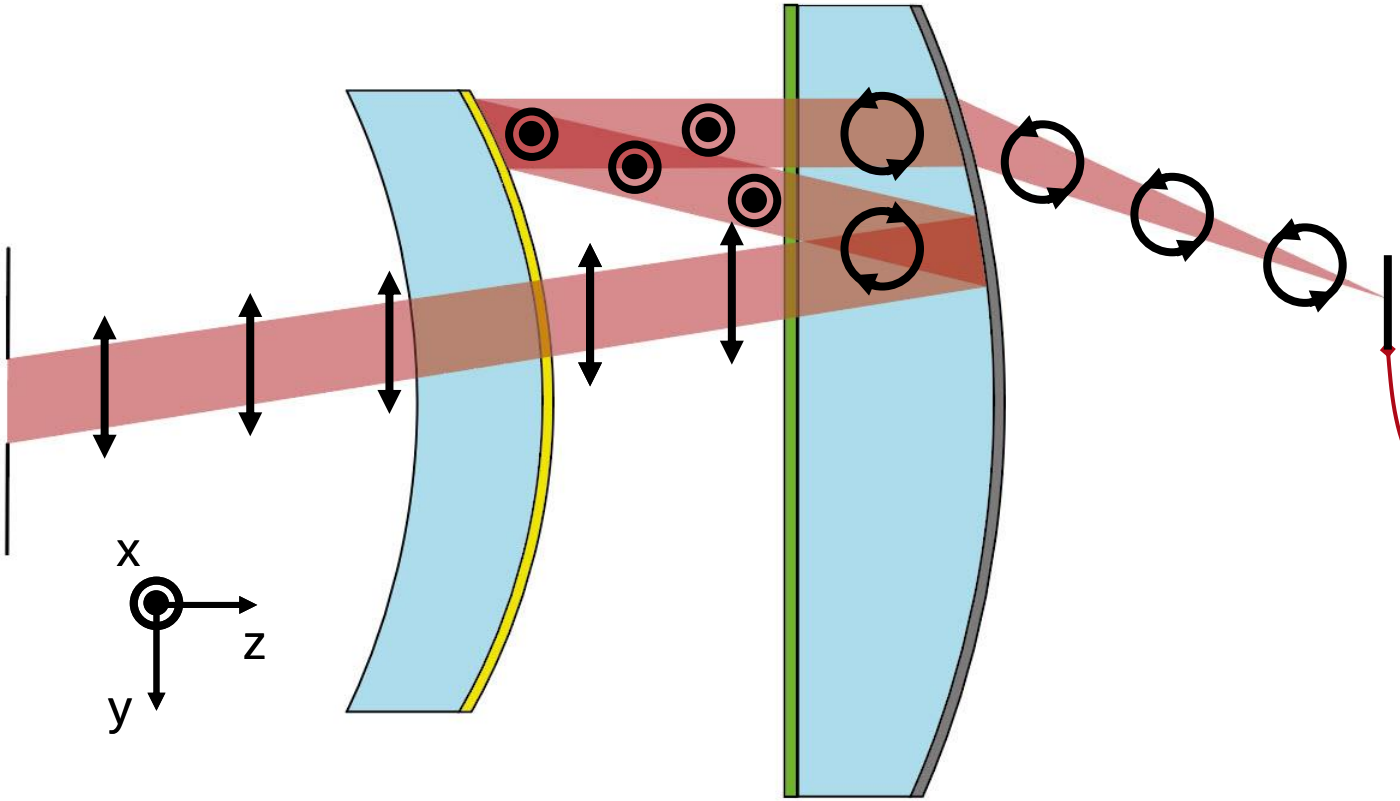
Polarization State through the System



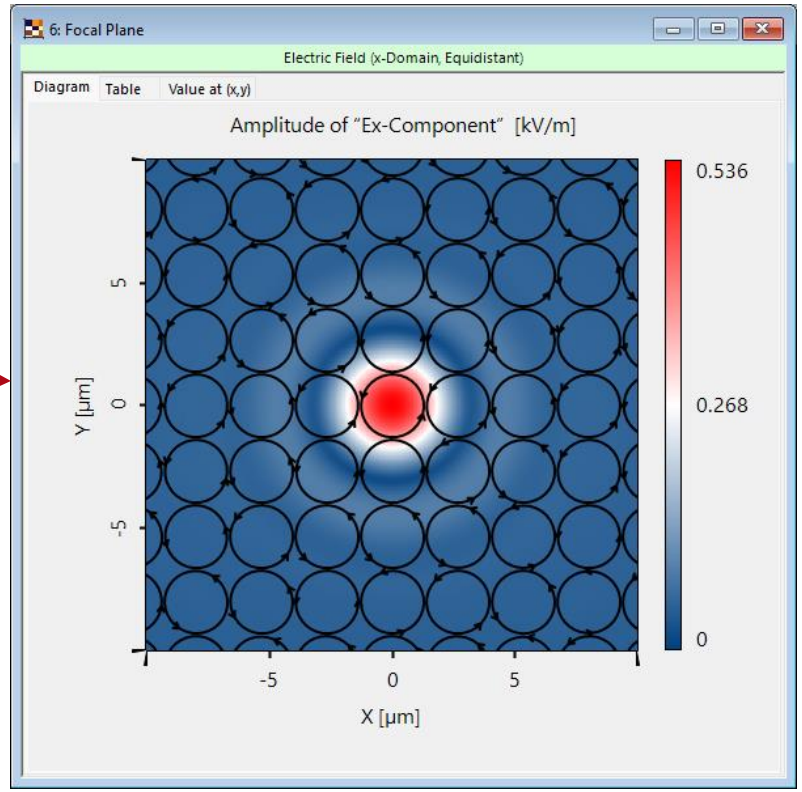
Another propagation through the quarter-wave plate will change the polarization to linear in x. Hence, it will now mostly reflect on the anisotropic coating of the first lens.



Polarization State through the System

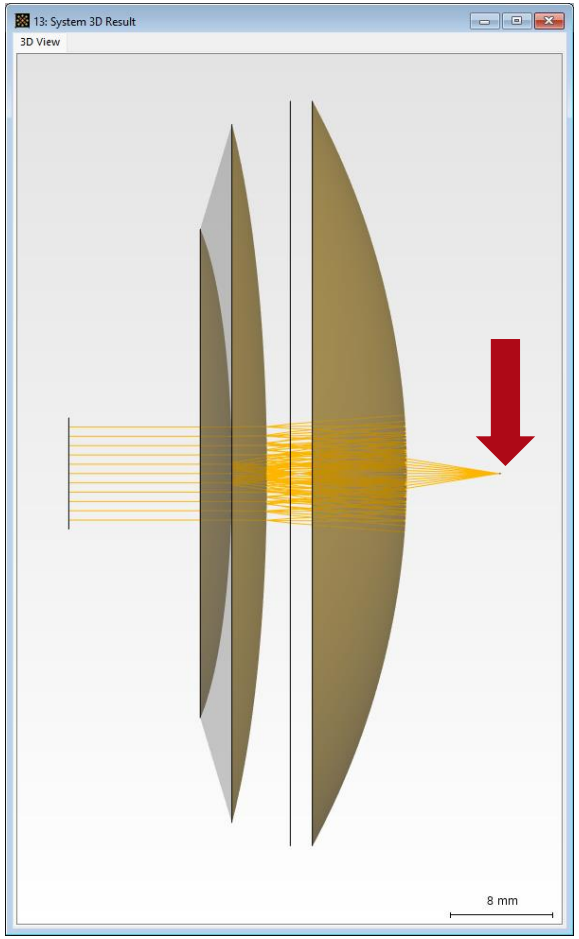


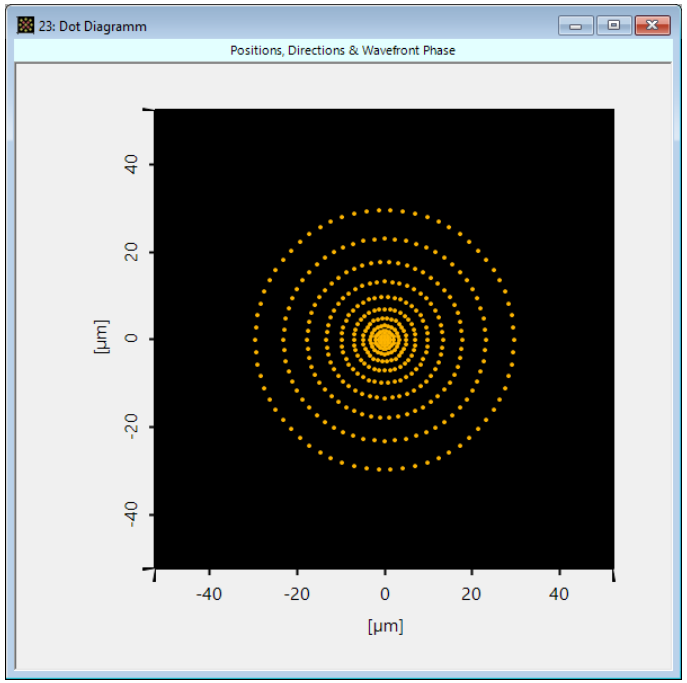
After a final passing through the quarter-wave plate, the light is focused with a counter-clockwise circular polarization state.



Simulation Results – PSF Investigation over Desired Field of View

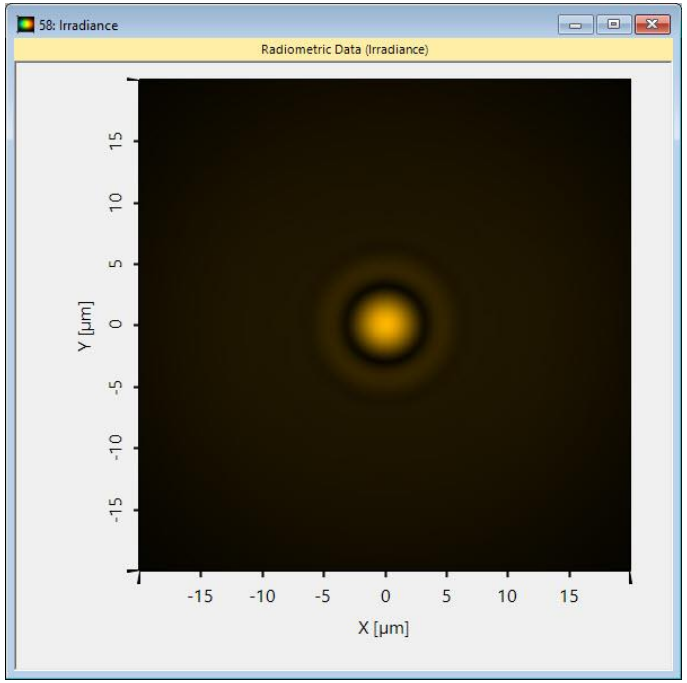
Dot Diagram & Irradiance of the 0° - Mode



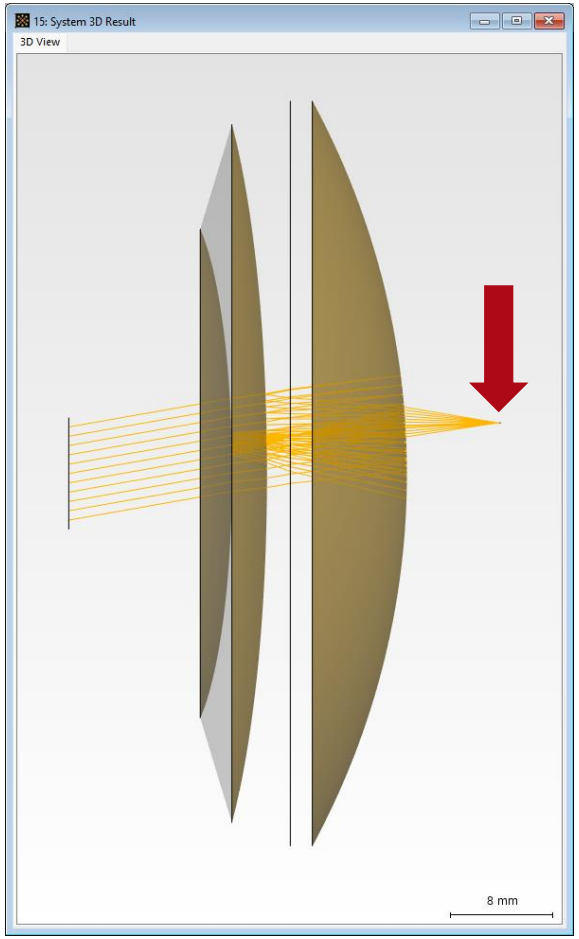


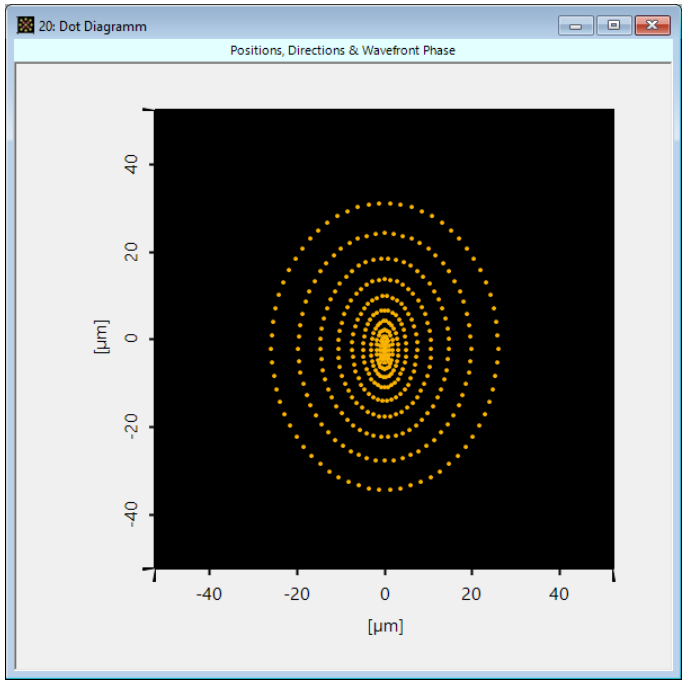
dot diagram

irradiance

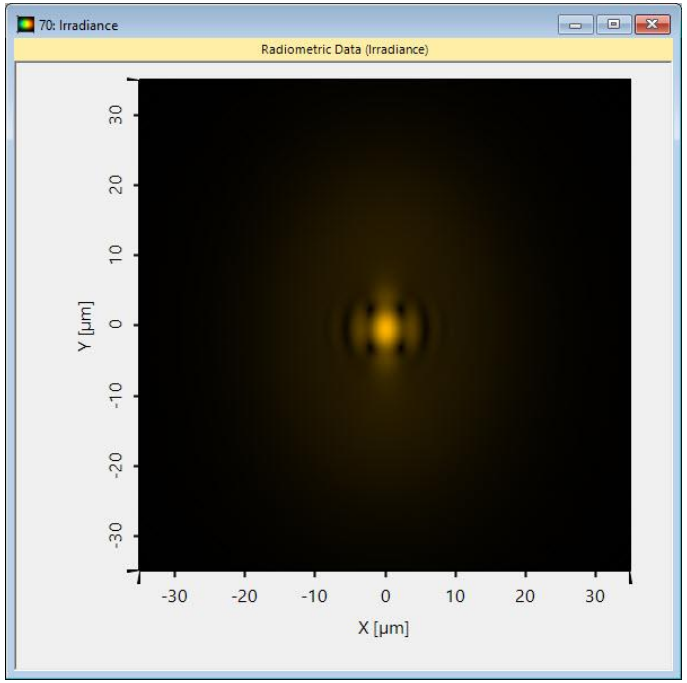


Dot Diagram & Irradiance of the 10° - Mode





dot diagram



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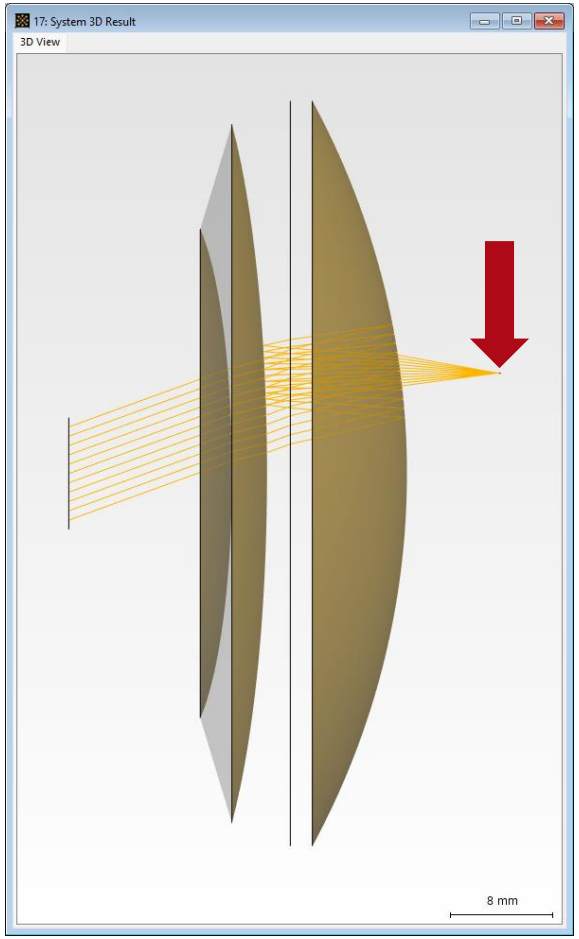
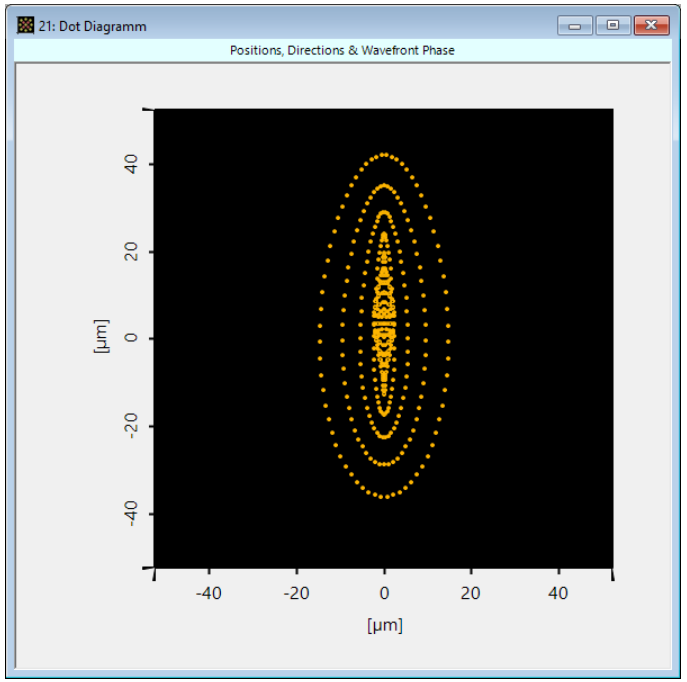
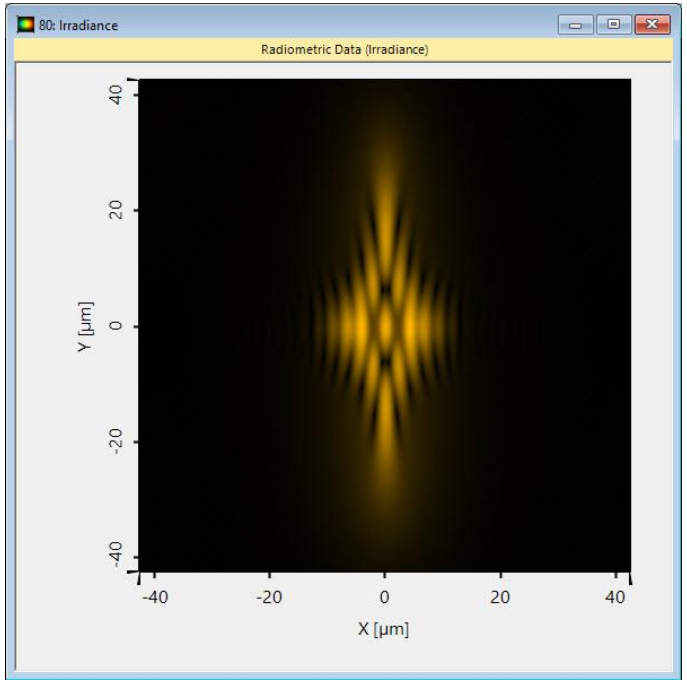
Dot Diagram & Irradiance of the 20° - Mode





dot diagram



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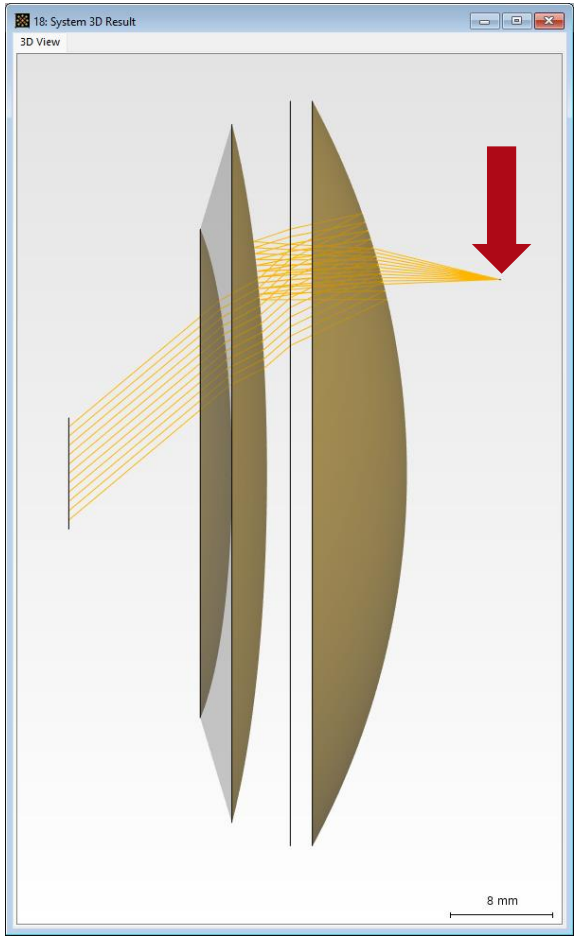
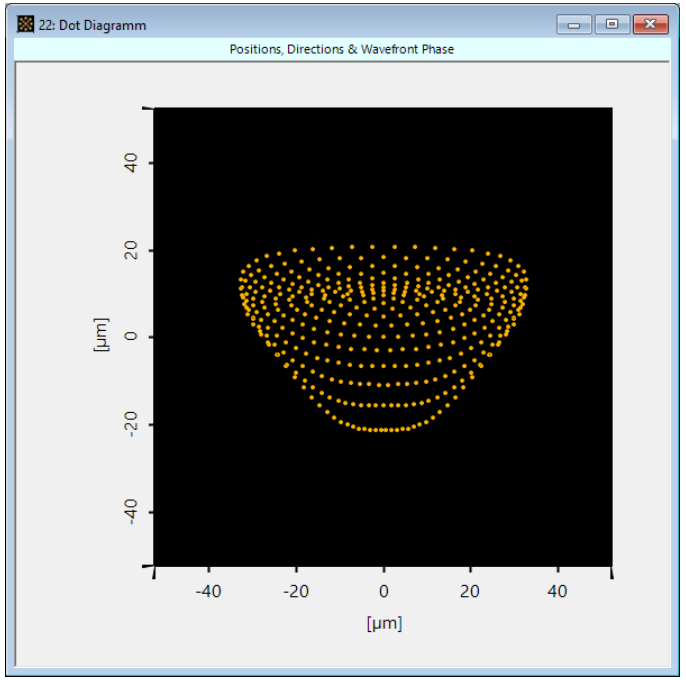
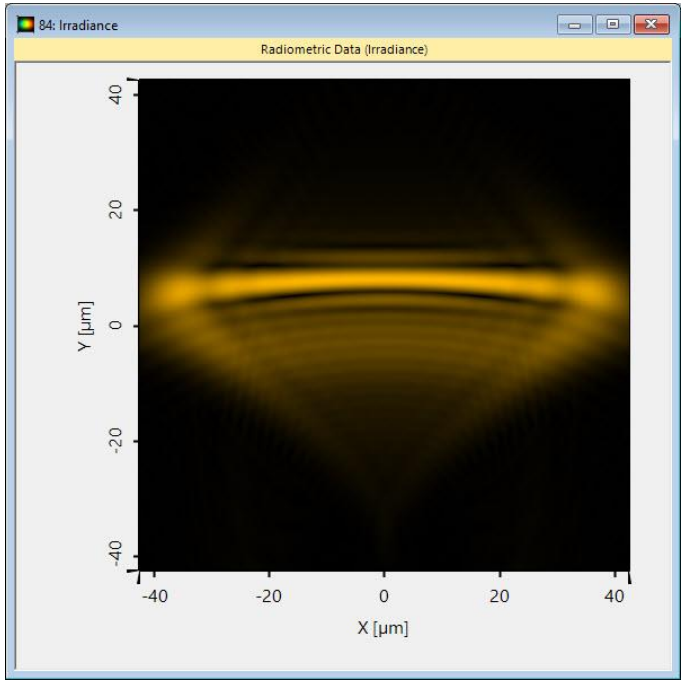
Dot Diagram & Irradiance of the 40° - Mode





dot diagram



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Document Information

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