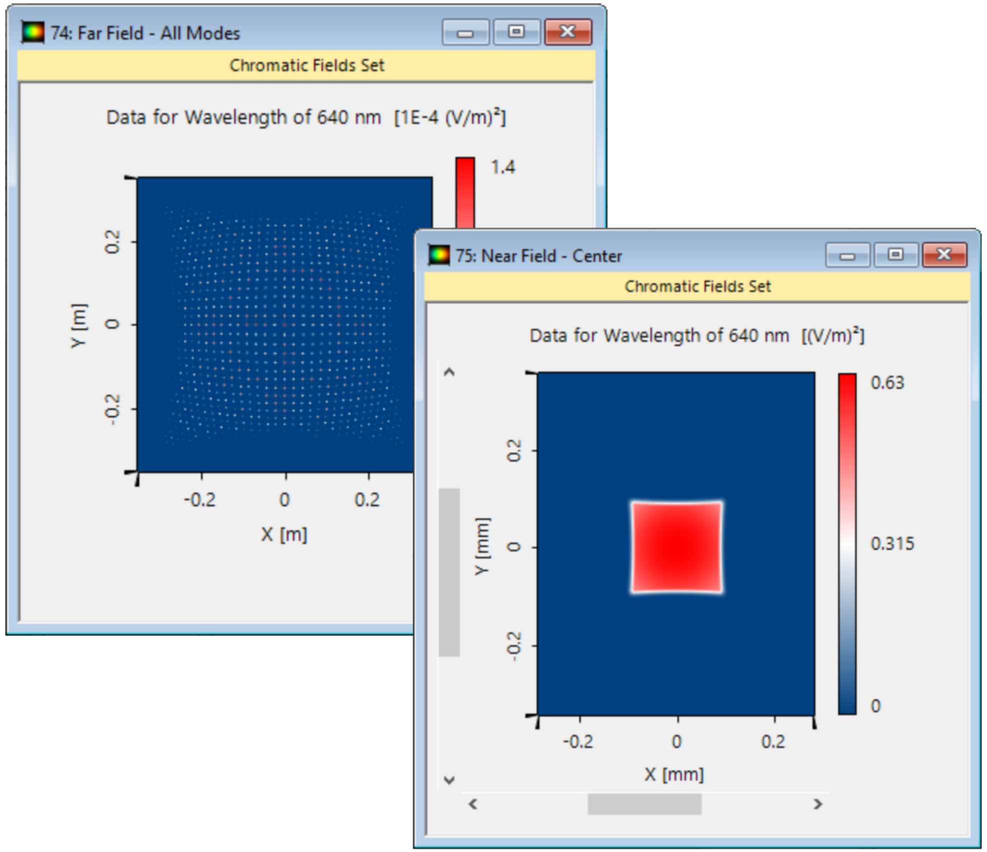
Investigation of Propagated Light Behind a Microlens Array

Abstract



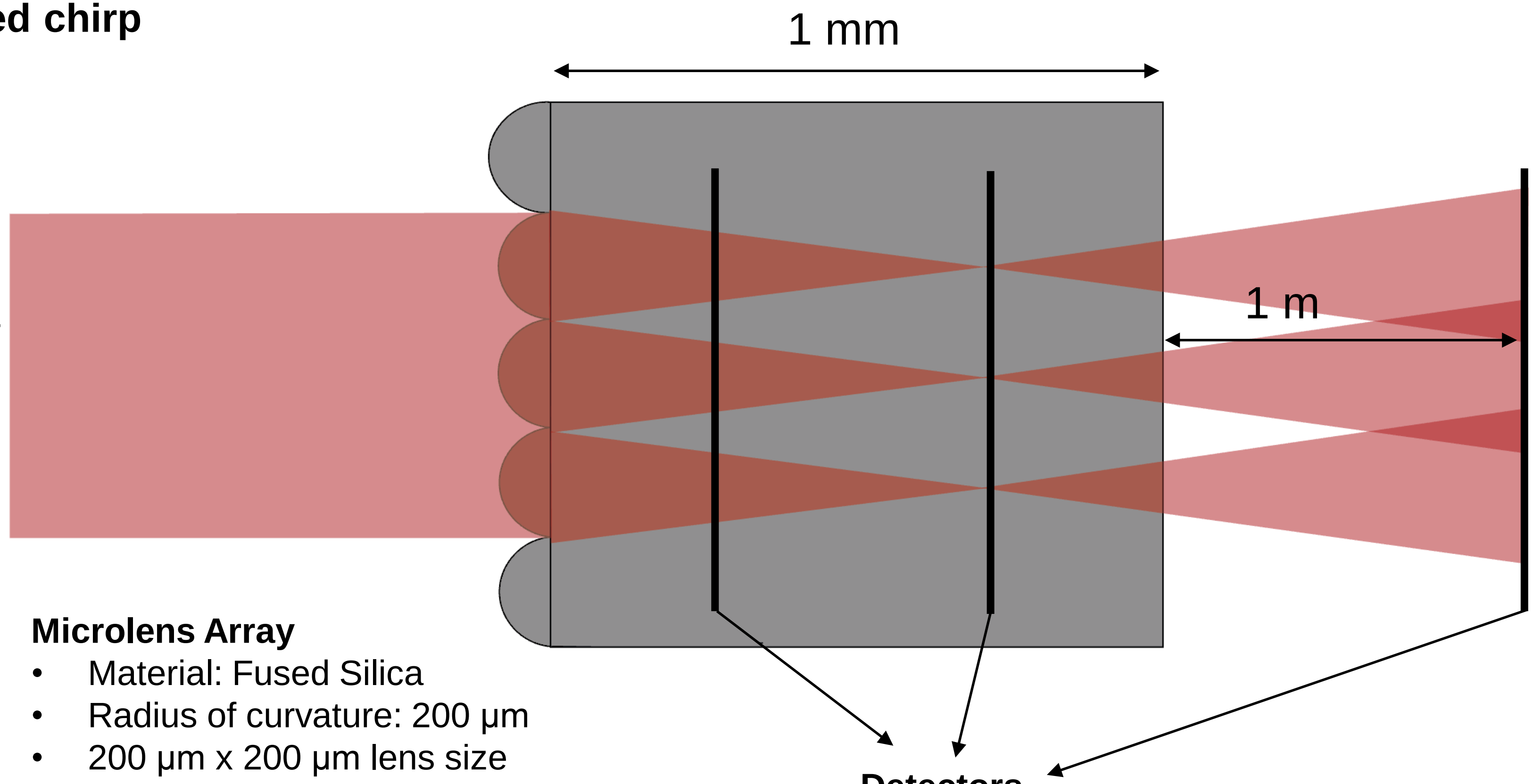
With the advent of modern technologies in the area of optical projection systems and laser material processing units, the request of more specialized optical components becomes more and more pressing. One type of component that is frequently used in these areas are microlens arrays. To fully understand the optical characteristics of such components, the simulation of the propagated light at various positions behind the microlens array is necessary. In this use case we investigate the field after the component in the near field, the focal zone, and the far field.

Scenario

Scenario 1: System Configuration

a) ideal system with removed chirp

Plane Wave
- 532 nm wavelength
- 5 mm x 5 mm diameter (rectangular)

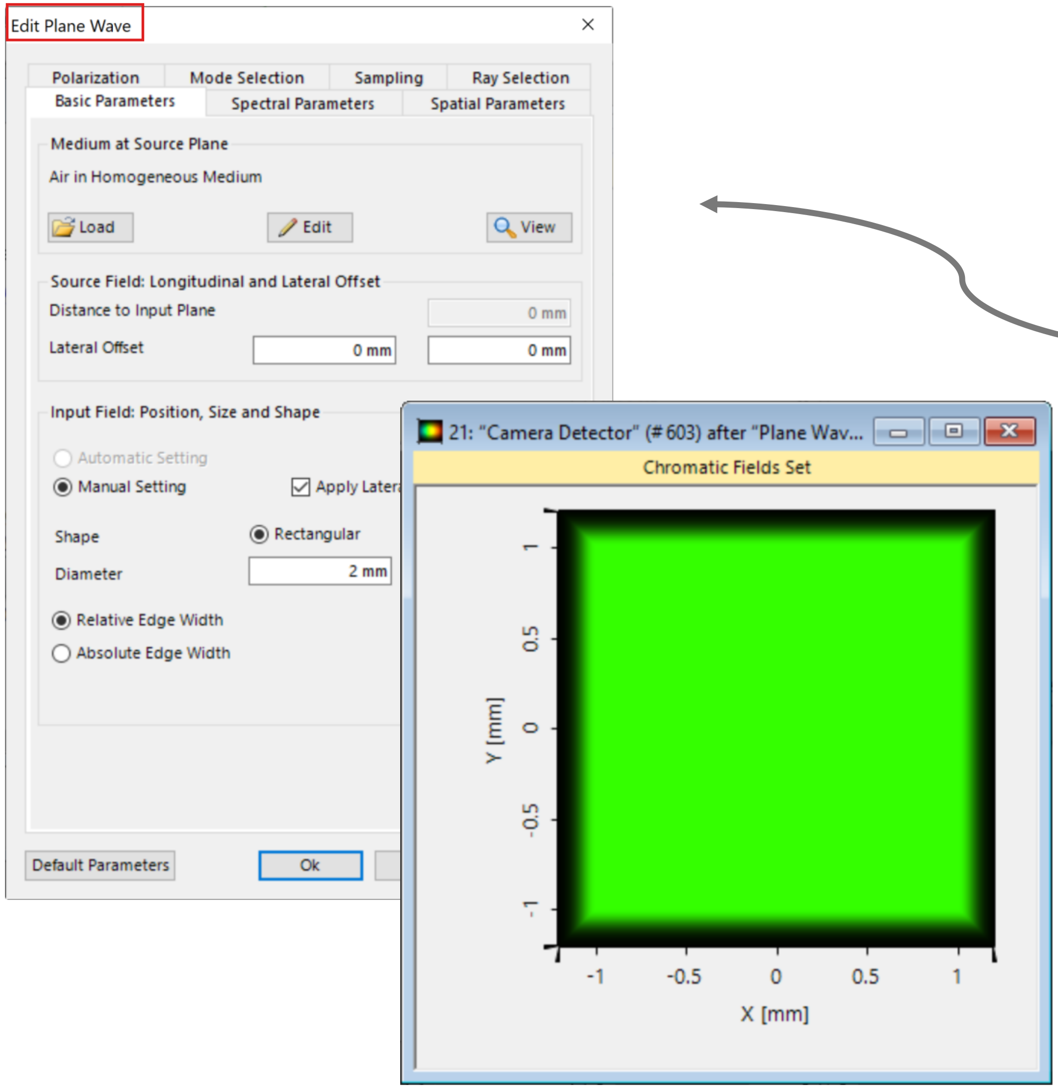


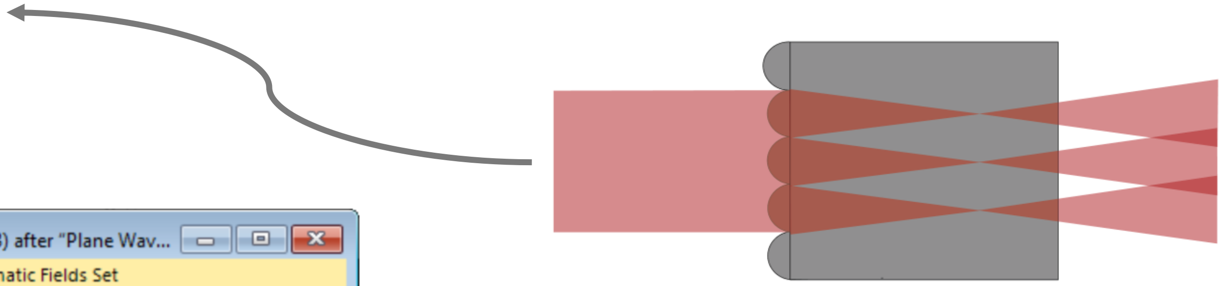
Microlens Array
- Material: Fused Silica
- Radius of curvature: 200 µm
- 200 µm x 200 µm lens size (rectangular)
- 5 x 5 microlenses

Detectors
- Electromagnetic field at various distances behind microlens array

Building the System in VirtualLab Fusion

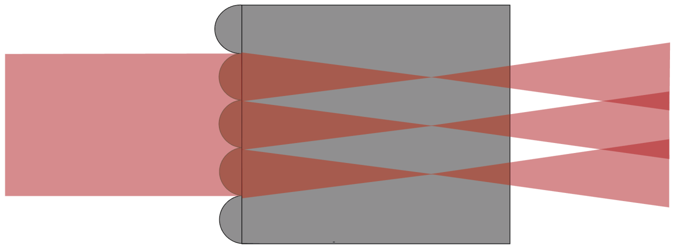
System Building Blocks – Source



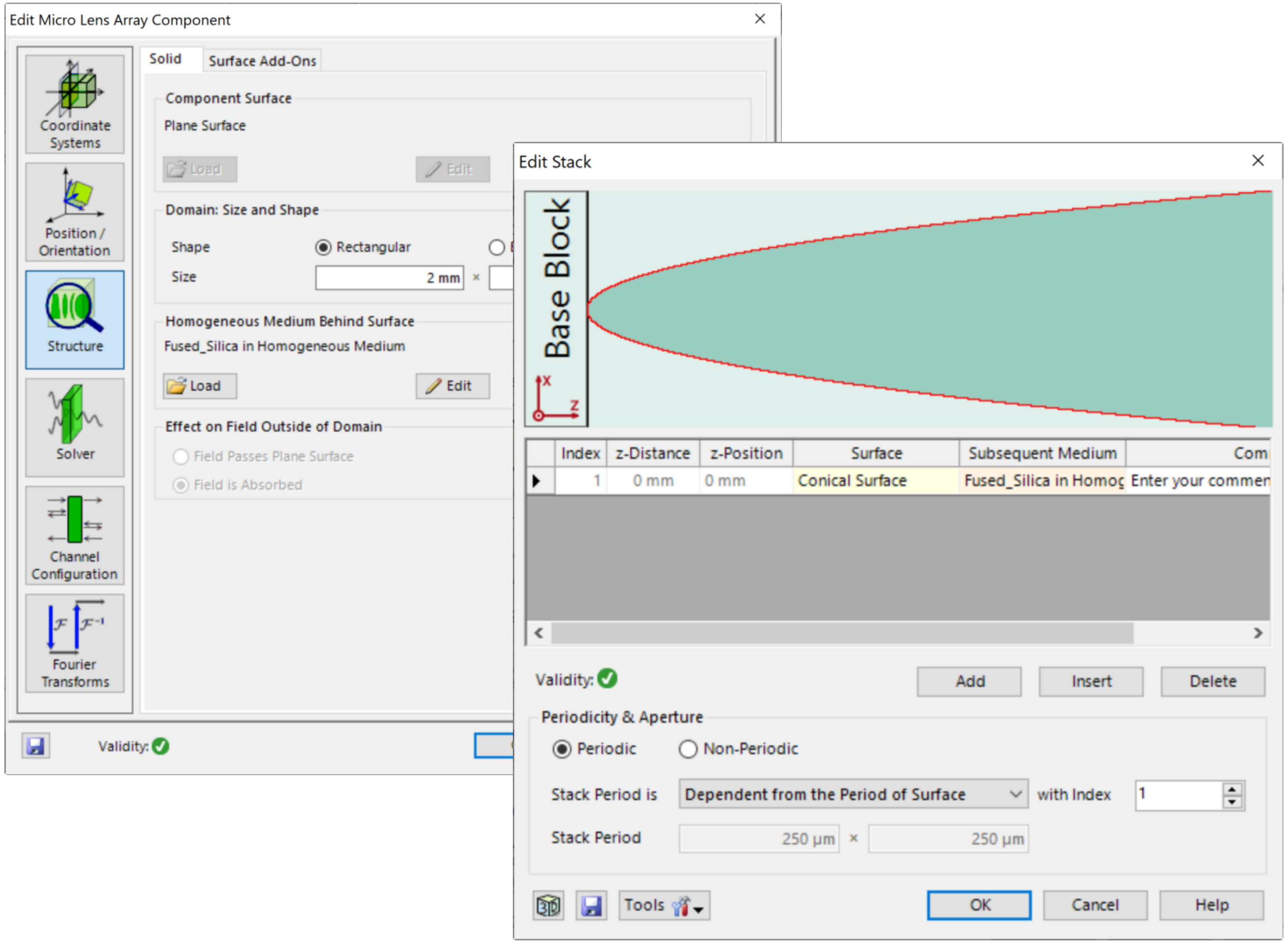


A Plane Wave source generates a truncated plane wave.
It is possible to use elliptical or rectangular apertures for this truncation.

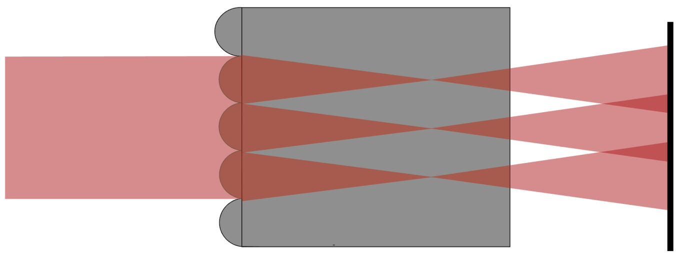
System Building Blocks – Components



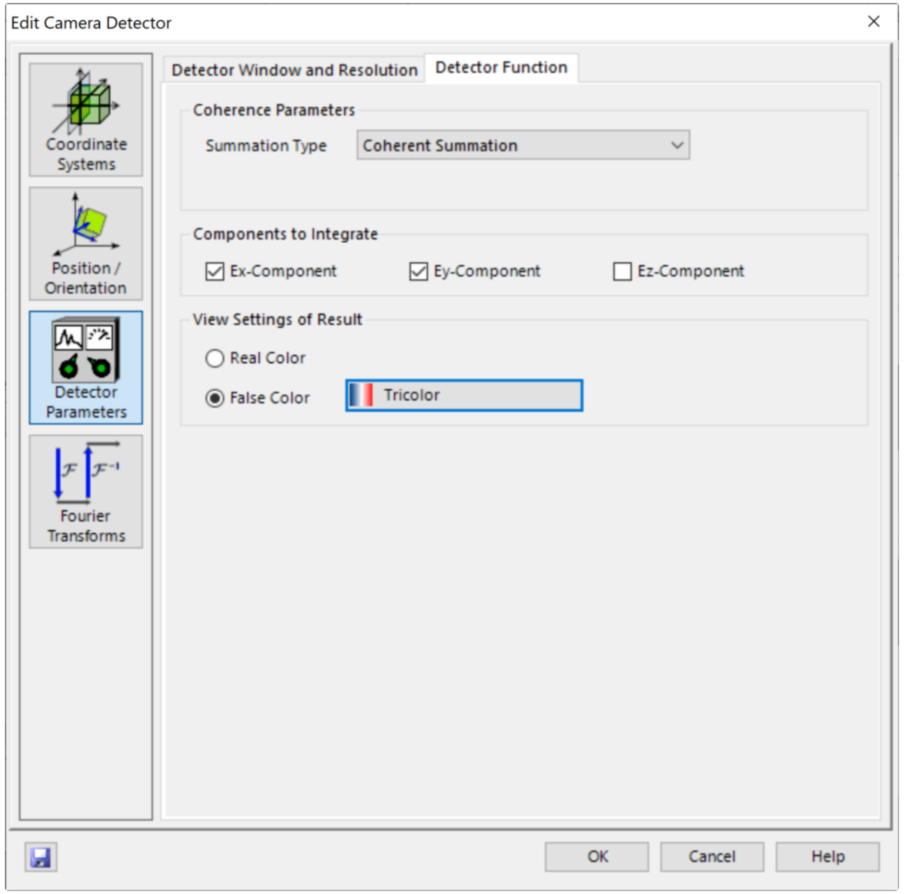
The *Microlens Array* component allows for an easy definition of an arbitrarily shaped microlens array. The material and size are defined in the component itself, while the shape is attached in stack form onto the component surface.



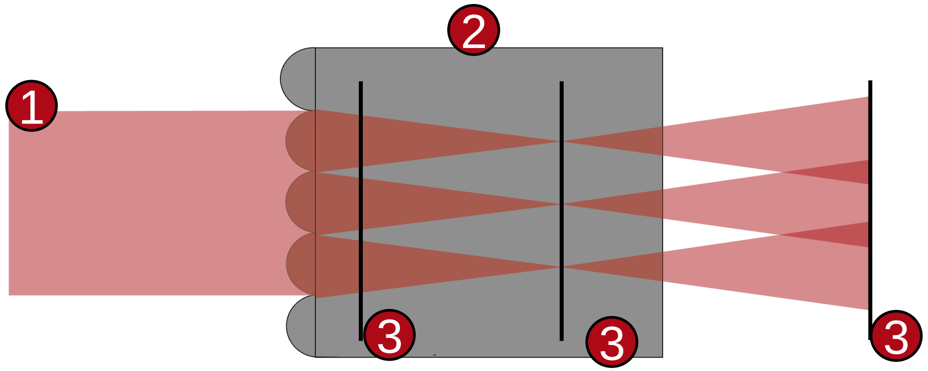
System Building Blocks – Detectors



The *Camera Detector* calculates the energy density of the electromagnetic field at the plane where it is located. The user can decide which field components will be used for the calculation of the result and whether the display should be in *Real Color* or *False Color*



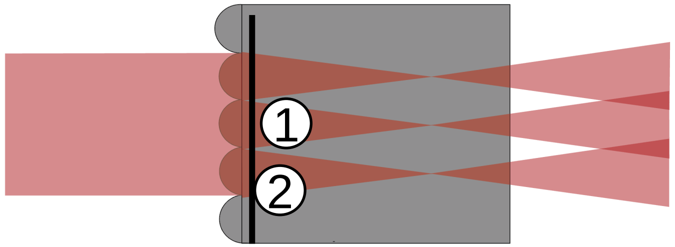
Summary – Components...

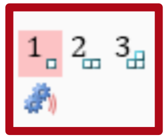


… of Optical System	… in VirtualLab Fusion	Model/Solver
1. Source	Plane Wave Source	Truncated Ideal Plane Wave
2. Micro lens Array	Micro lens Array Component	Local Plane Interface Approximation
3. Detector	Camera Detector	Energy density over all components

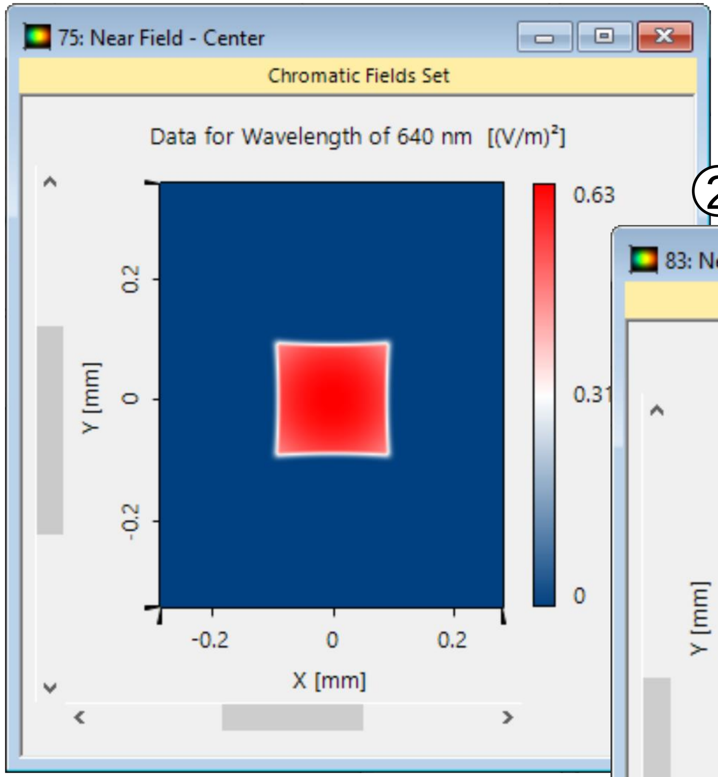
Simulation Results

Field Tracing Results – Near Field

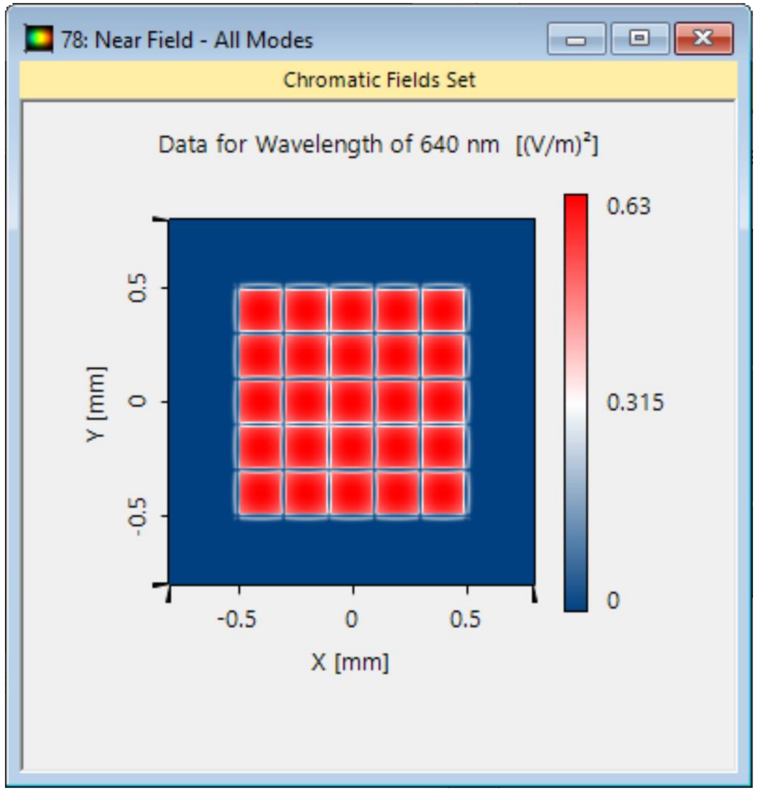


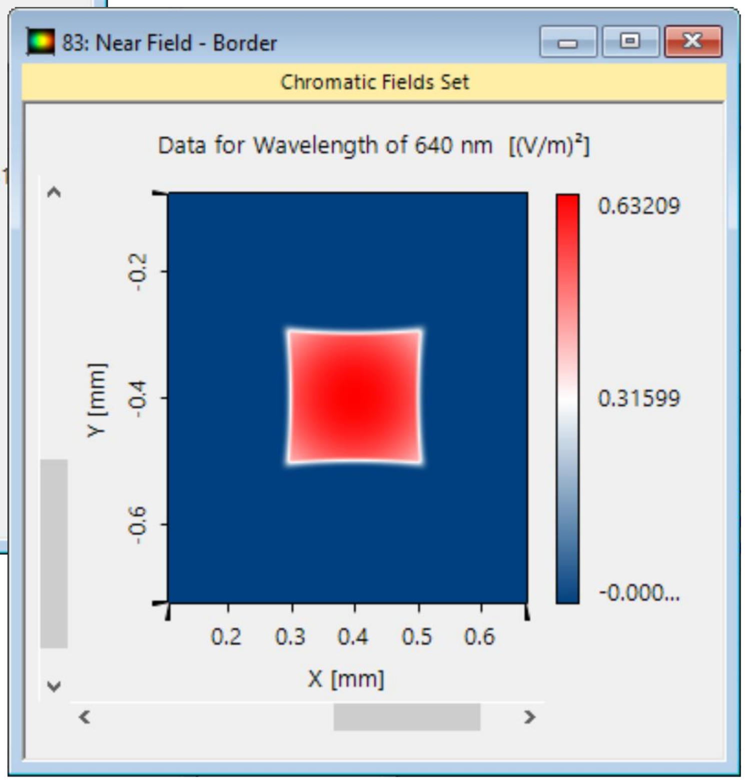


① Only central mode



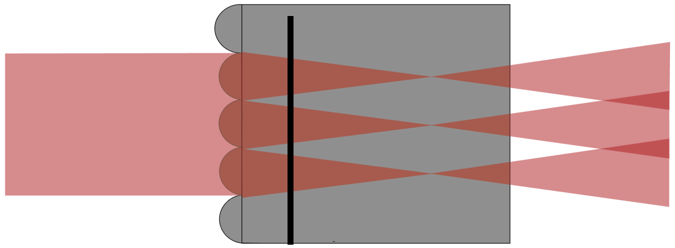
② Only corner mode

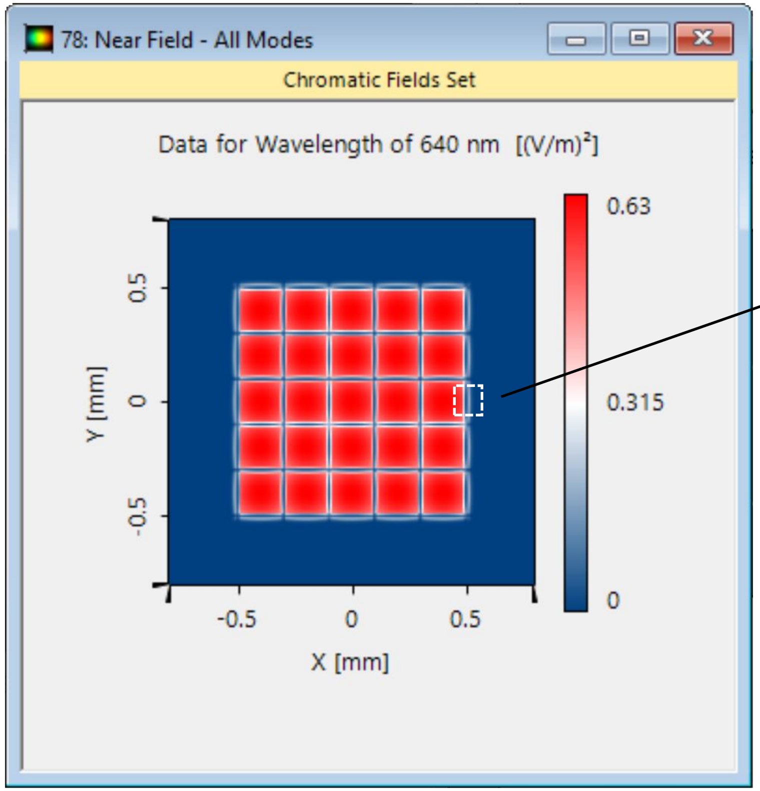


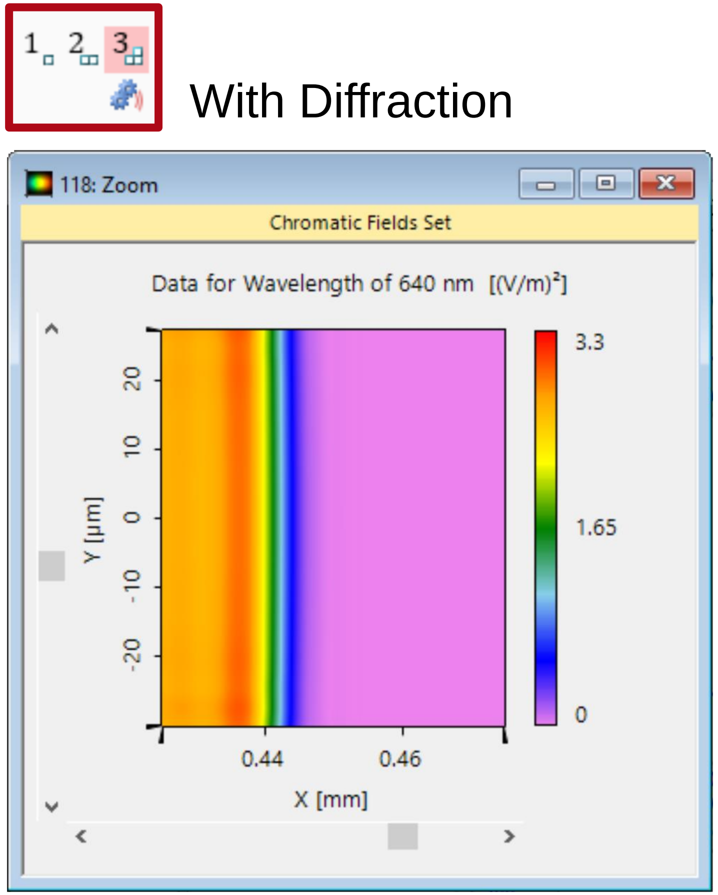


As we use a focusing microlens array, the modes in the nearfield do not overlap

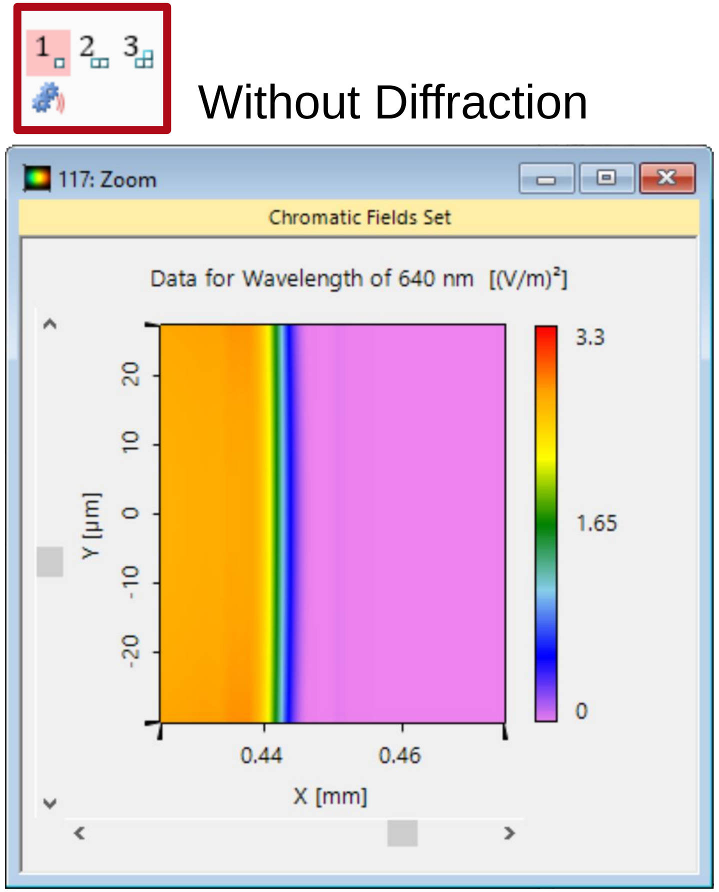
Field Tracing Results – Near Field







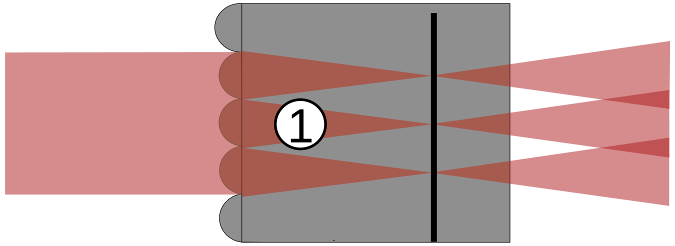
With Diffraction

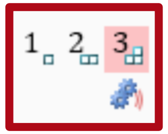


Without Diffraction

Diffraction effects can be calculated everywhere in the system

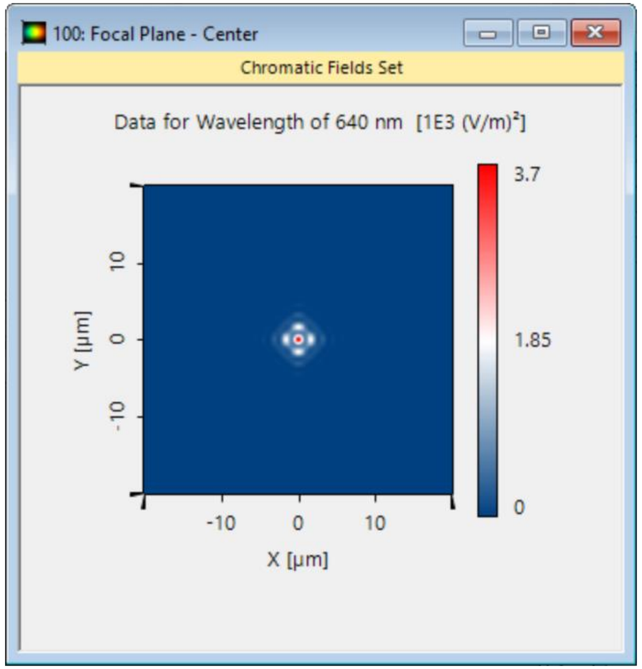
Field Tracing Results – Focal Plane

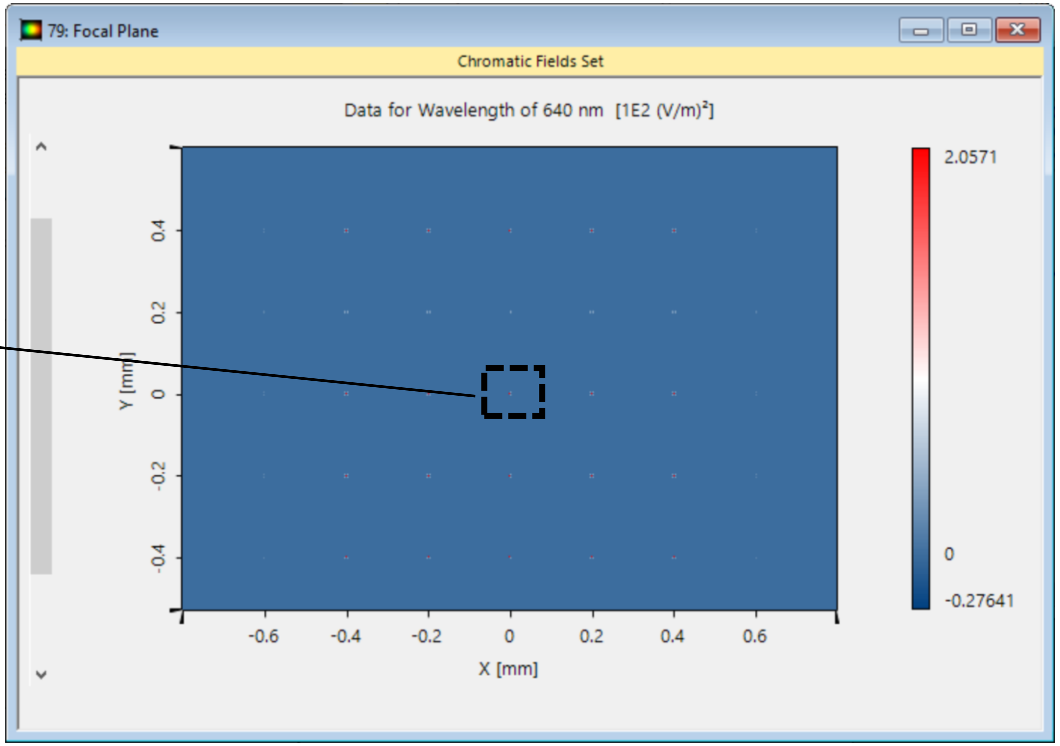




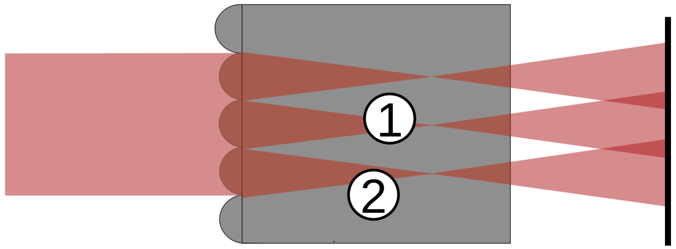
Per microlens, a focal spot is generated at the focal plane. As the individual modes are still disjunct each spot corresponds exclusively to a specific mode of the microlens array.

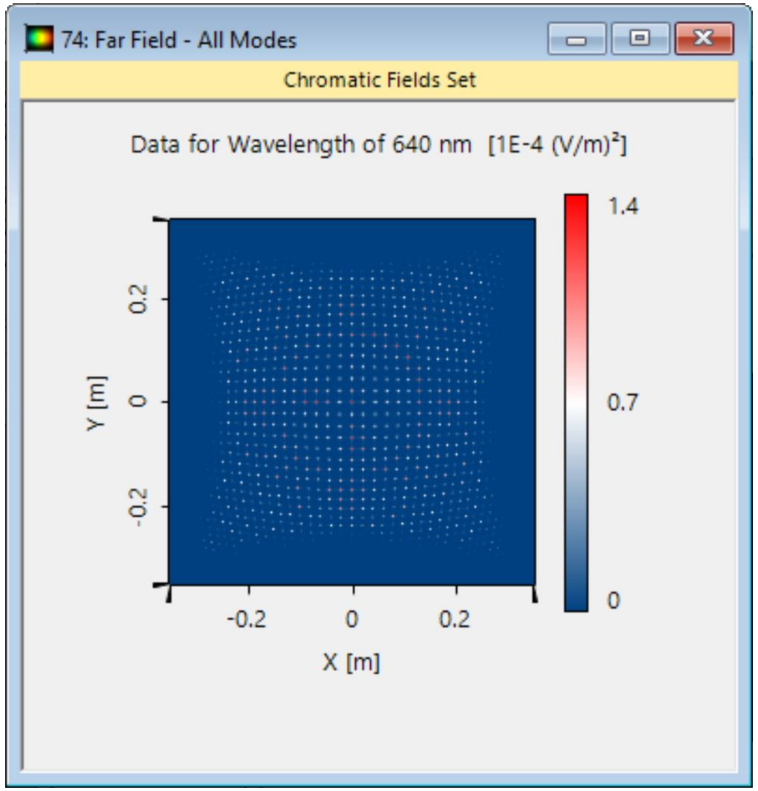
① Only central mode

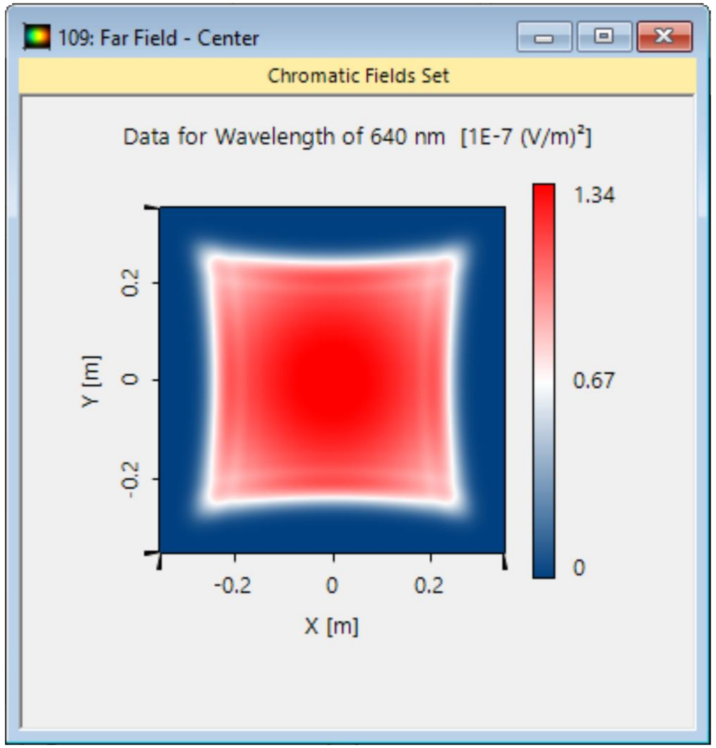




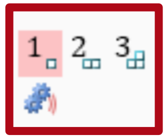
Field Tracing Results – Far Field



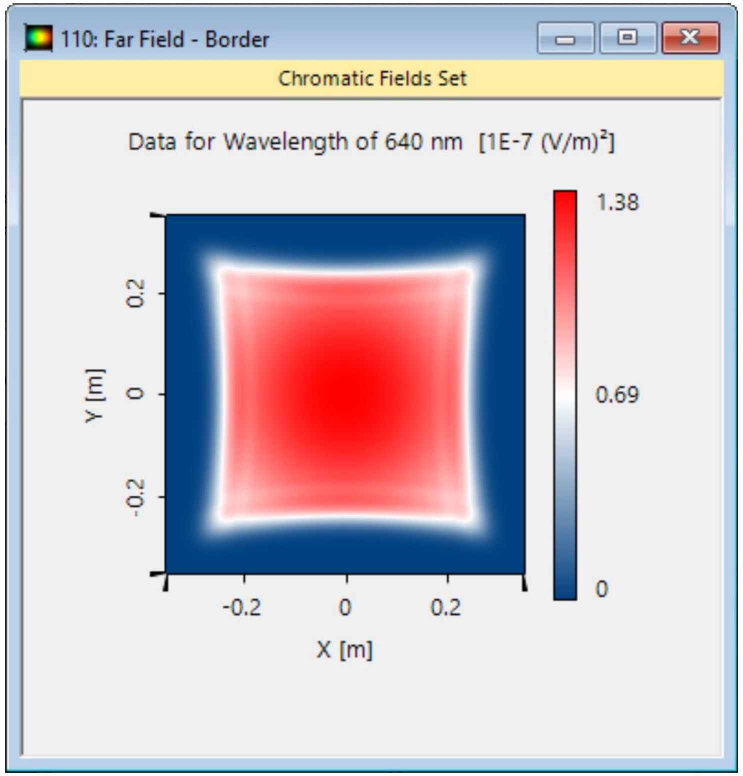




① Only central mode

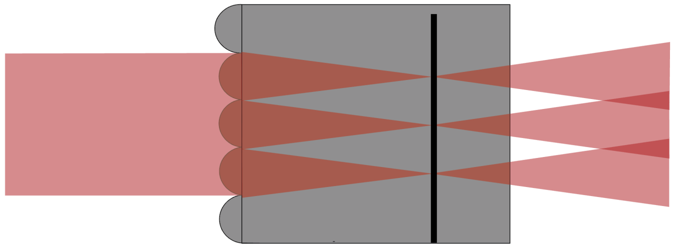


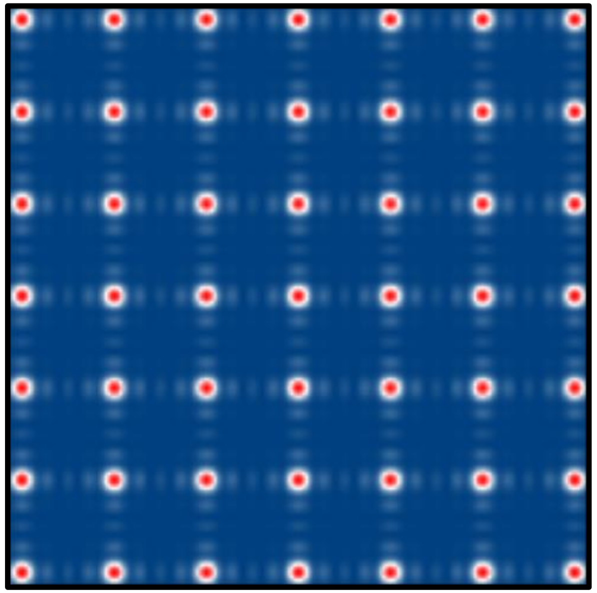
② Only corner mode

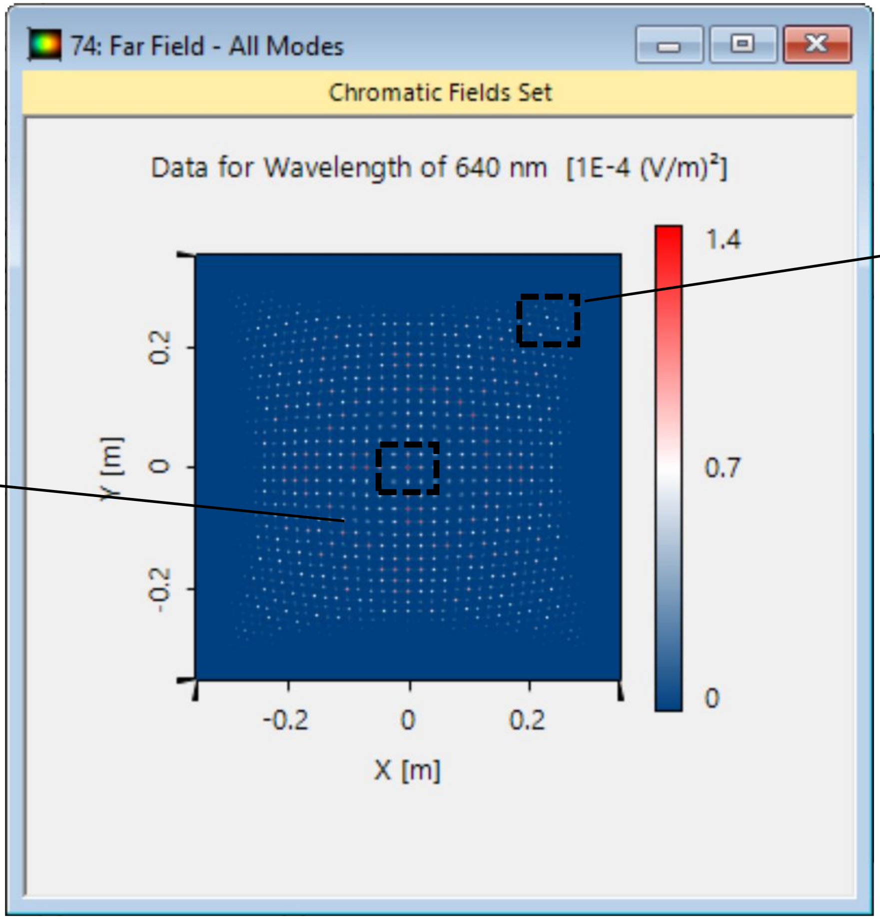


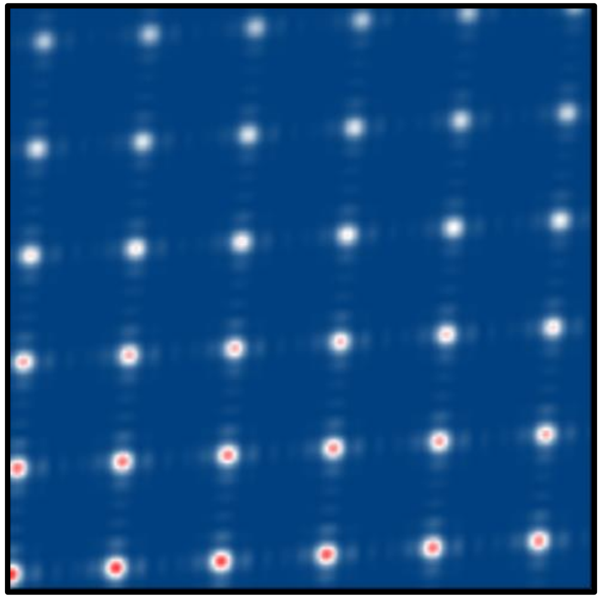
In the far field all the modes overlap and therefore generate this kind of dot structure. Each spot does no longer correspond to a specific mode alone.

Field Tracing Results – Far Field









Also in the far field spots that are close to the borders and corner become elongated.

Document Information

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