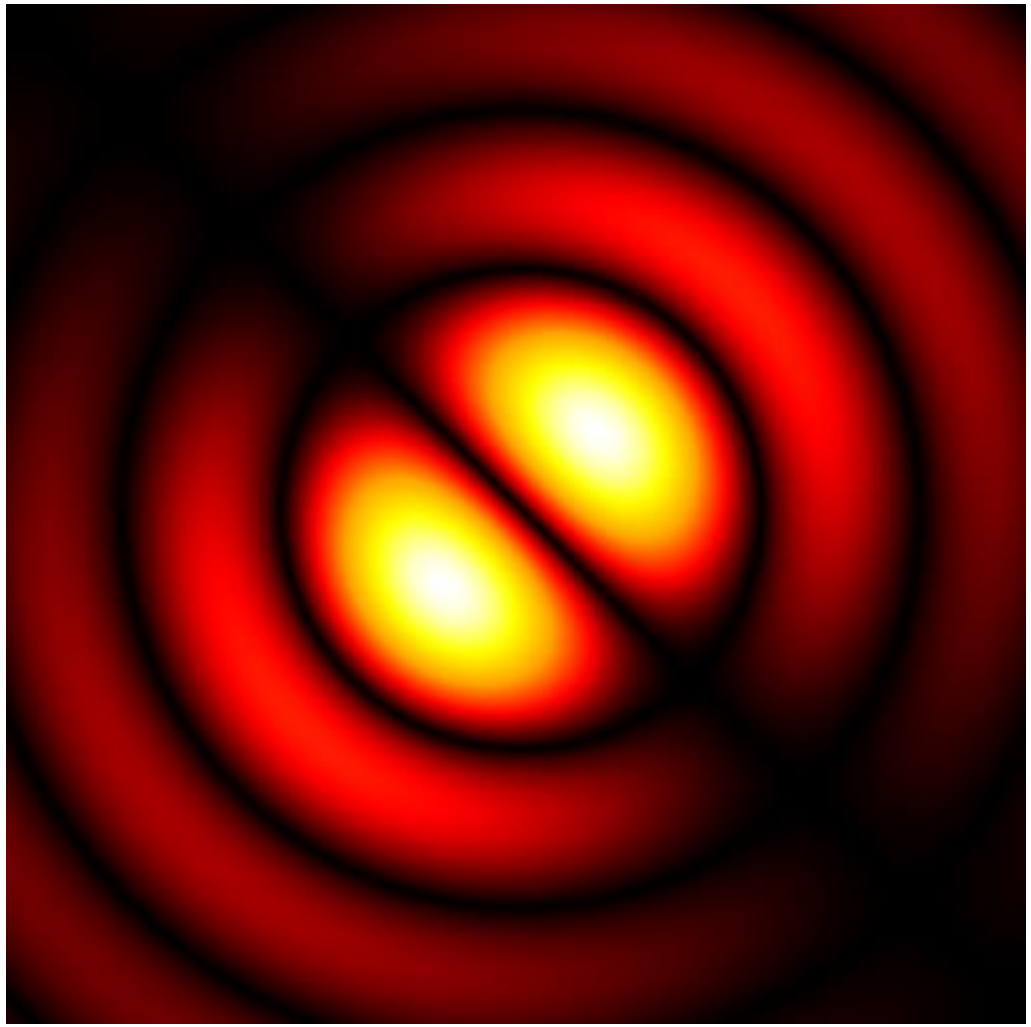
Investigation of Idealized Vectorial Focusing Situation Using Debye-Wolf Integral

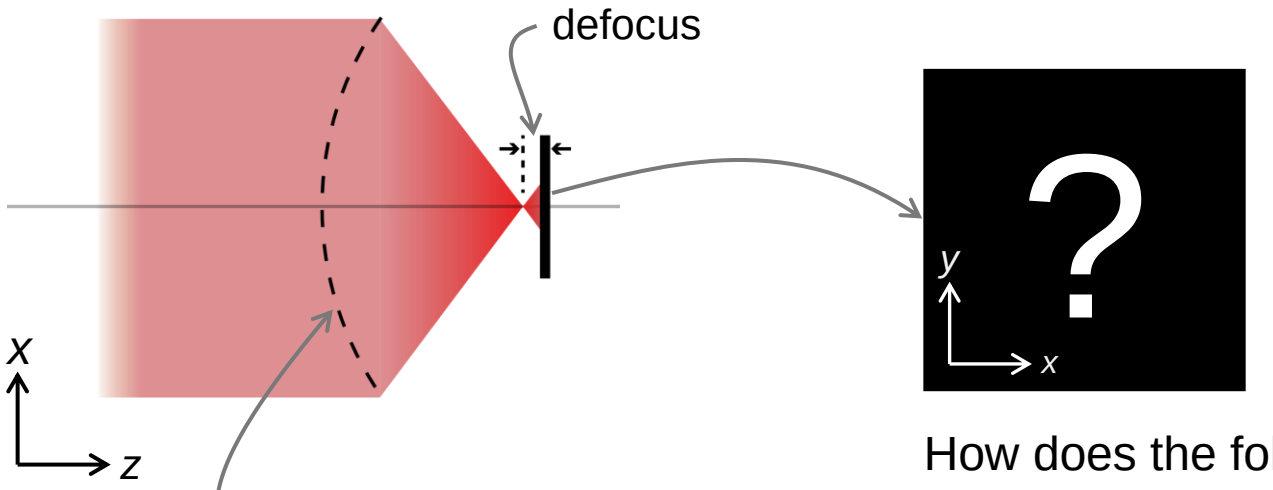
Abstract



Knowing the vectorial electric field distribution near the focus of a high-NA objective lens is of great importance for applications e.g. microscopy, optical tweezer, laser machining, etc. Debye-Wolf integral provides the semi-analytical solution of the vectorial field near the focal plane, and it is widely used in the community. We demonstrate how to use the Debye-Wolf integral calculator in VirtualLab Fusion to investigate focal field properties with respect to different parameters.

Modeling Task

input plane wave
- wavelength: 532nm, 632.8nm
- polarization: linearly polarized
  in *y* direction
  and in *x*-*y* diagonal direction

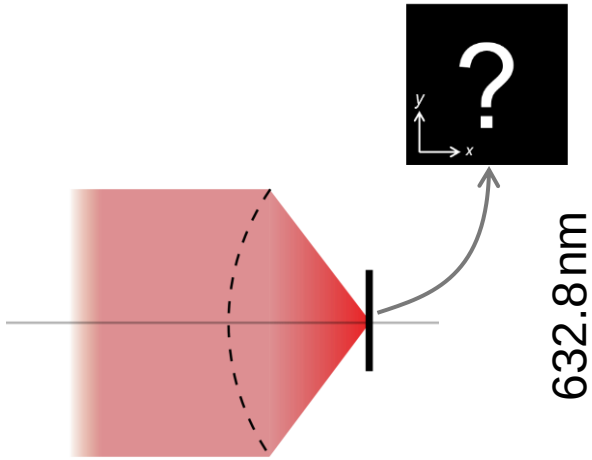


idealized high-NA
objective lens
- NA=0.9
- NA=0.5

How does the following parameters
- wavelength
- NA of objective
- polarization
- defocus

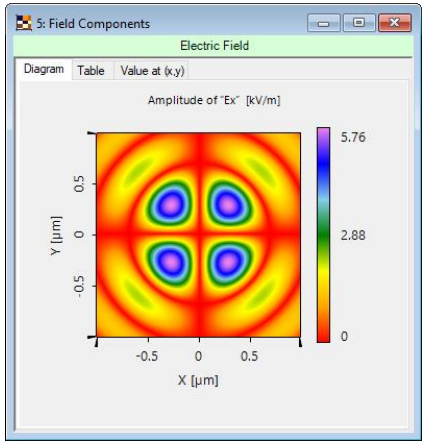
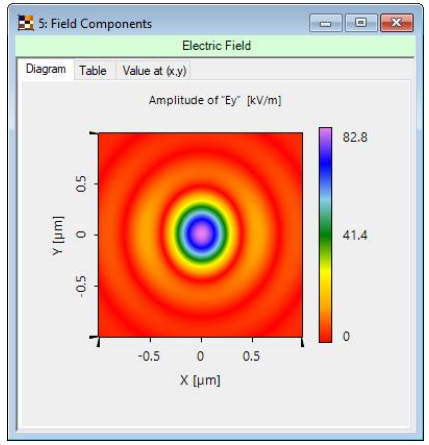
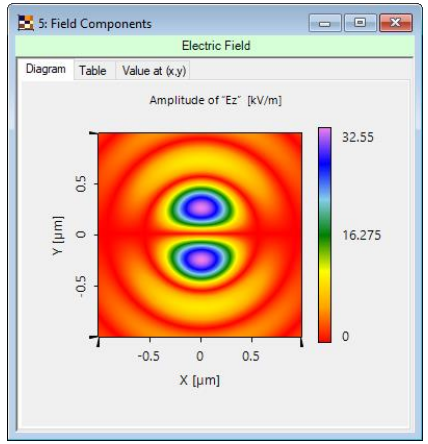
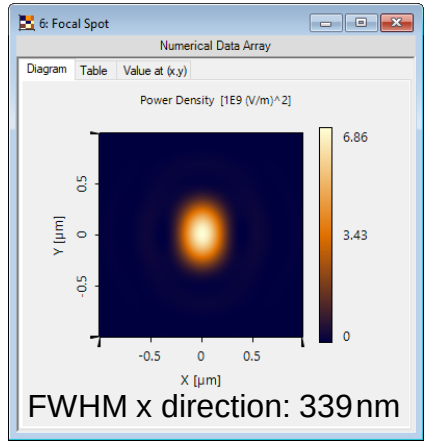
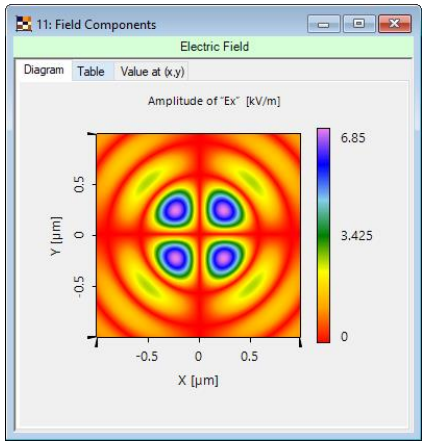
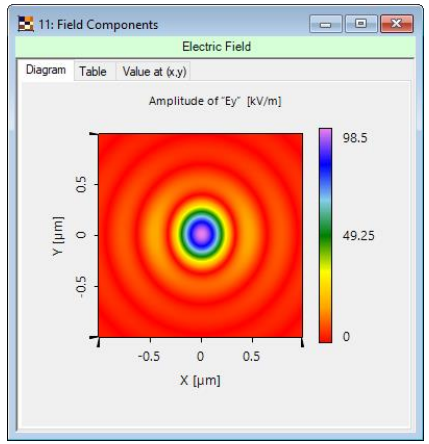
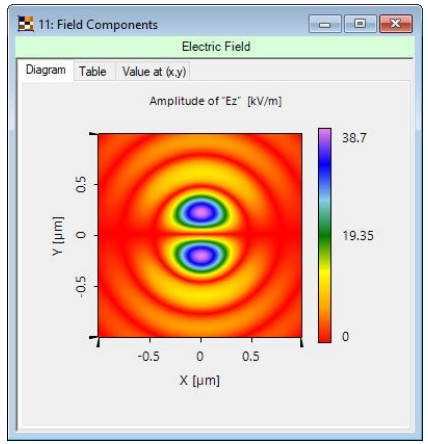
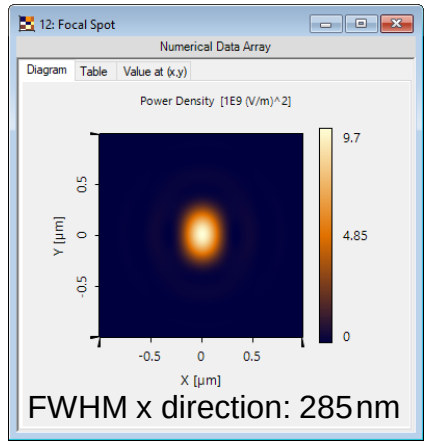
affect the focal spot distribution?

Influence from Wavelength

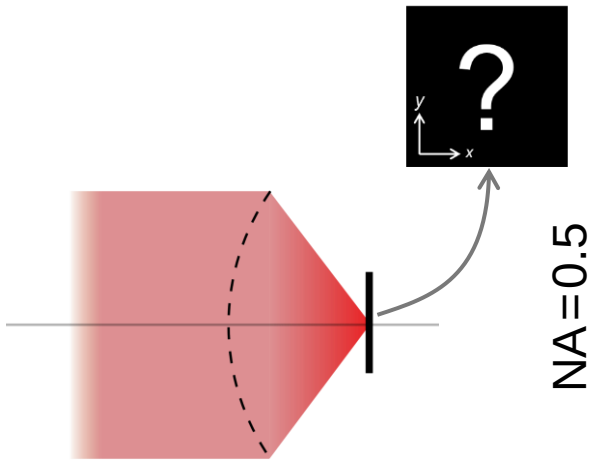


parameters

- varying wavelength: ***532 nm or 632.8 nm***
- fixed lens NA 0.9
- fixed linear polarization in y
- no defocus

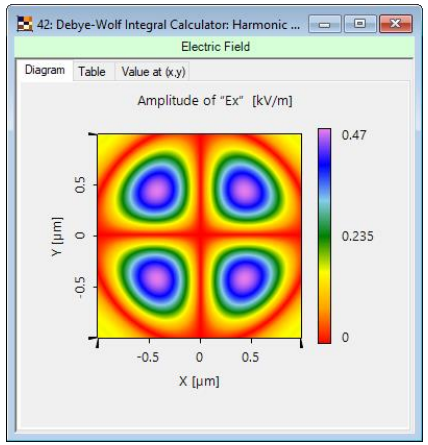
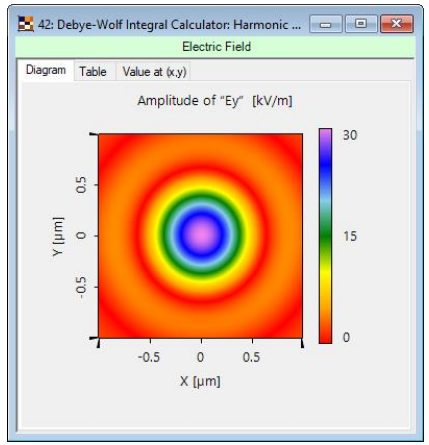
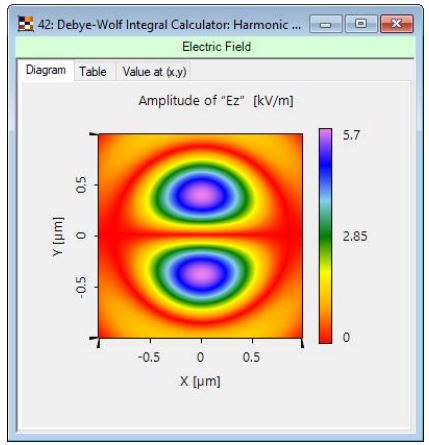
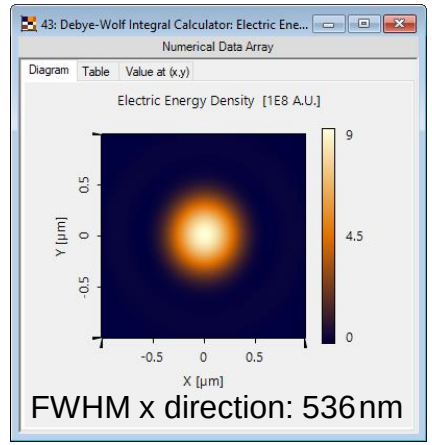
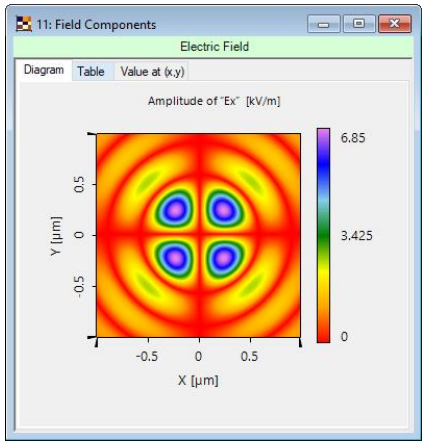
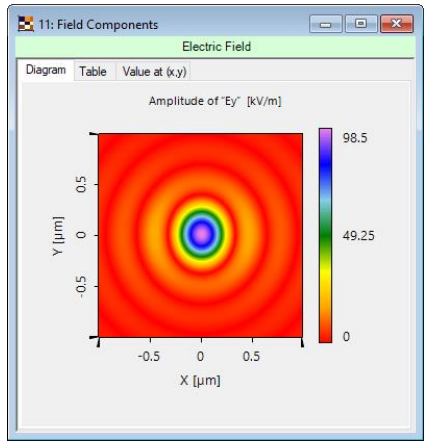
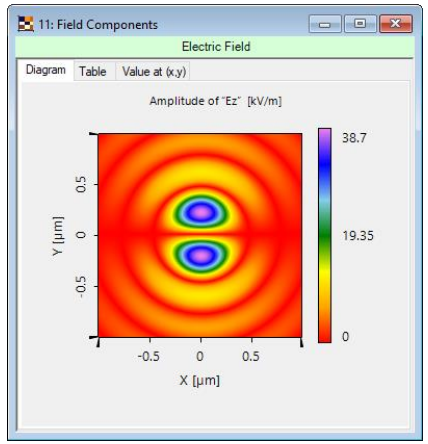
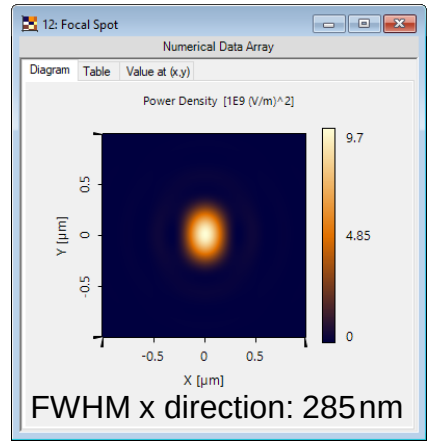
	$\lvert E_x \rvert$	$\lvert E_y \rvert$	$\lvert E_z \rvert$	$\lvert\lvert \boldsymbol{E} \rvert\rvert^2$
632.8 nm				
532 nm				

Influence from NA of Objective

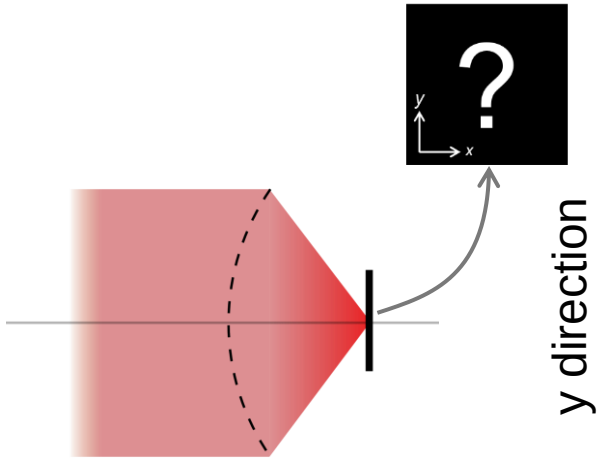


parameters

- fixed wavelength 532 nm
- varying lens NA: ***0.5 or 0.9***
- fixed linear polarization in y
- no defocus

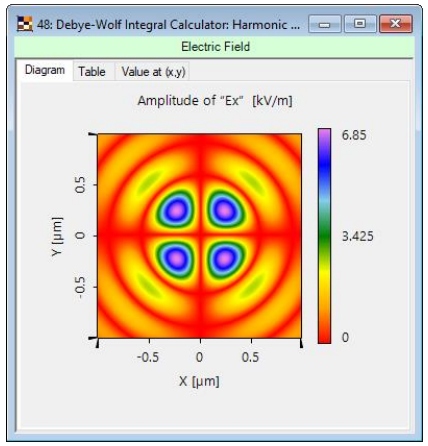
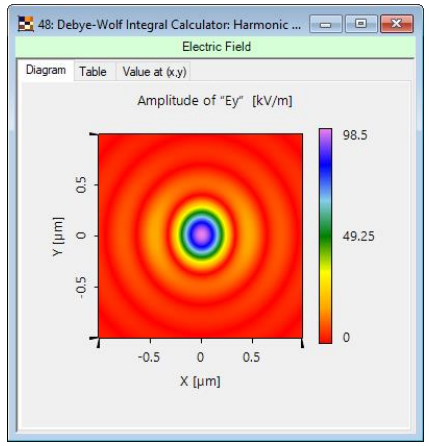
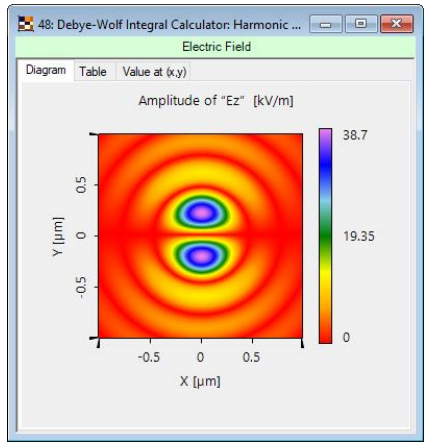
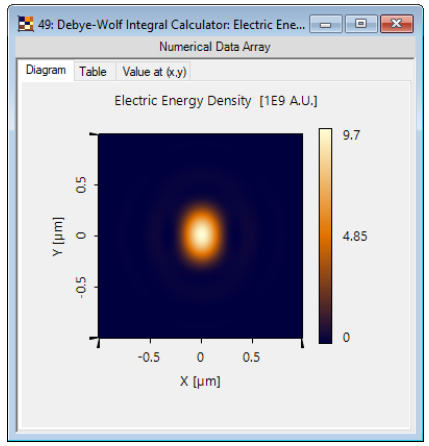
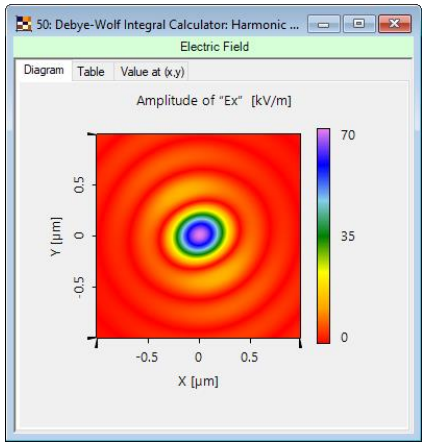
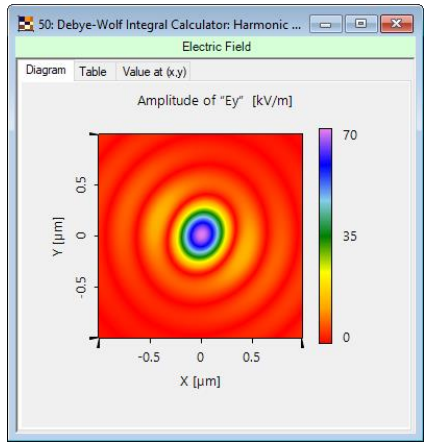
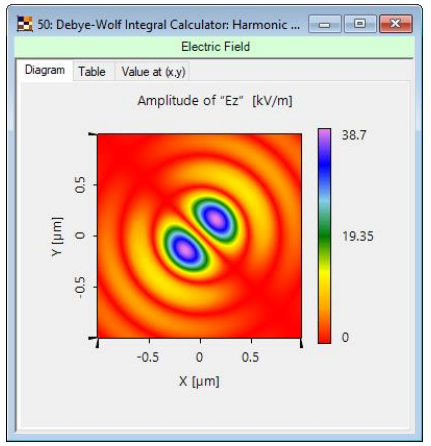
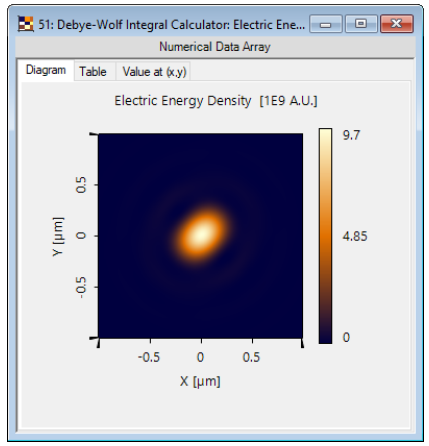
	$\lvert E_x \rvert$	$\lvert E_y \rvert$	$\lvert E_z \rvert$	$\lvert\lvert \boldsymbol{E} \rvert\rvert^2$
NA=0.5				
NA=0.9				

Influence from Polarization

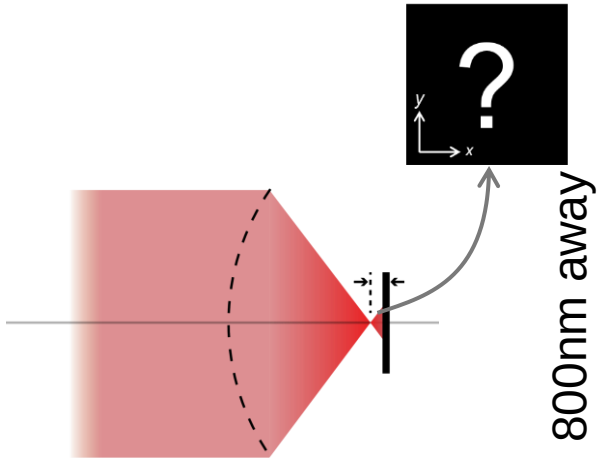


parameters

- fixed wavelength 532 nm
- fixed lens NA 0.9
- varying linear polarization: ***in y, or x-y diagonal***
- no defocus

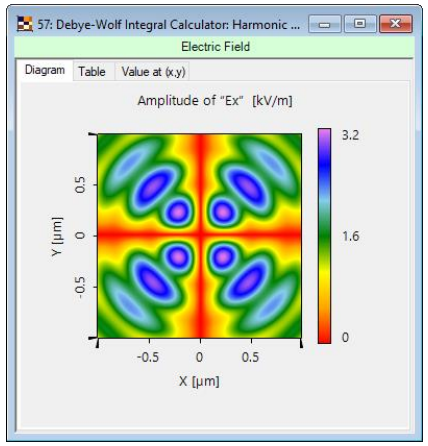
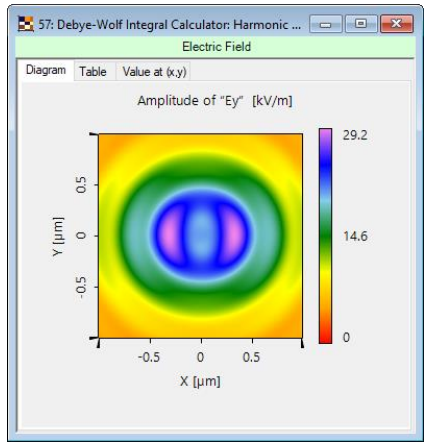
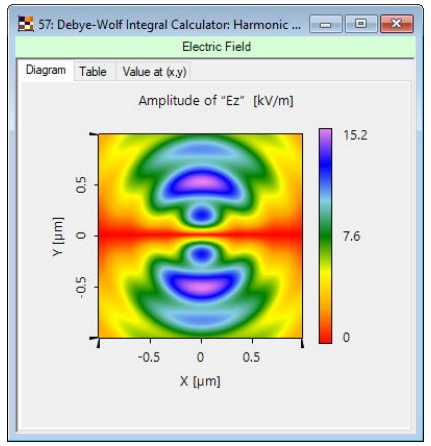
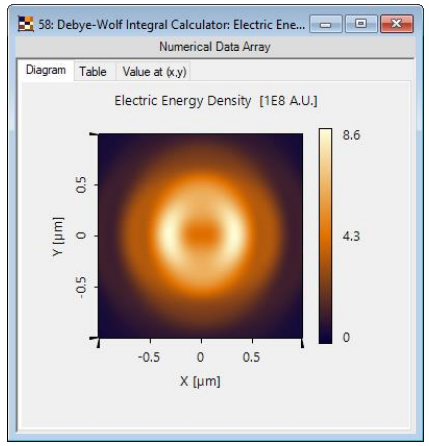
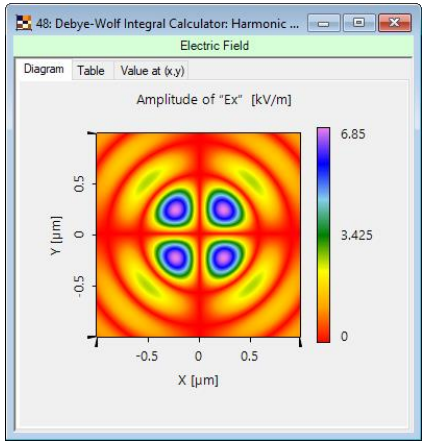
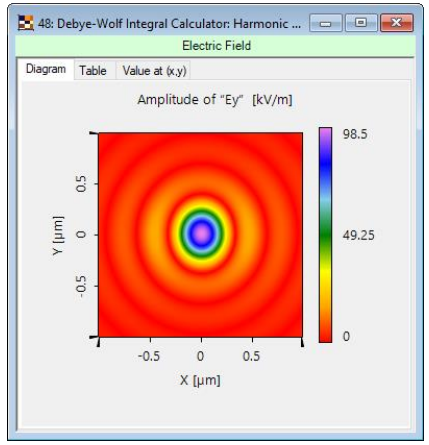
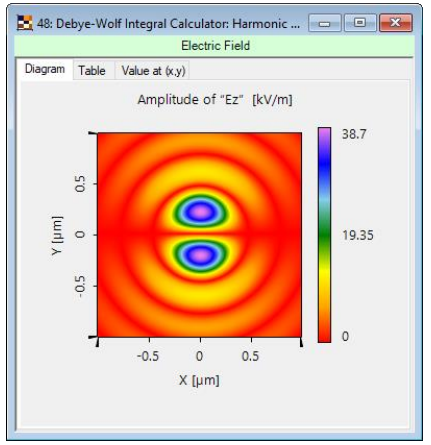
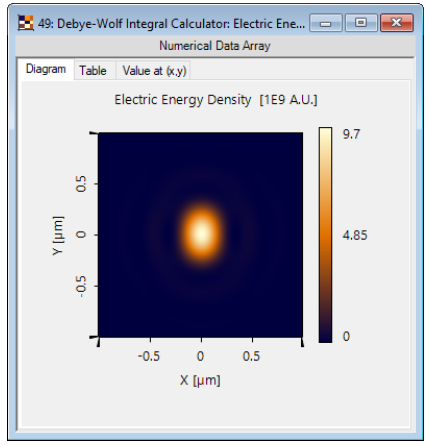
	$\lvert E_x \rvert$	$\lvert E_y \rvert$	$\lvert E_z \rvert$	$\lvert\lvert \boldsymbol{E} \rvert\rvert^2$
y direction				
x-y diagonal				

Influence from Defocus

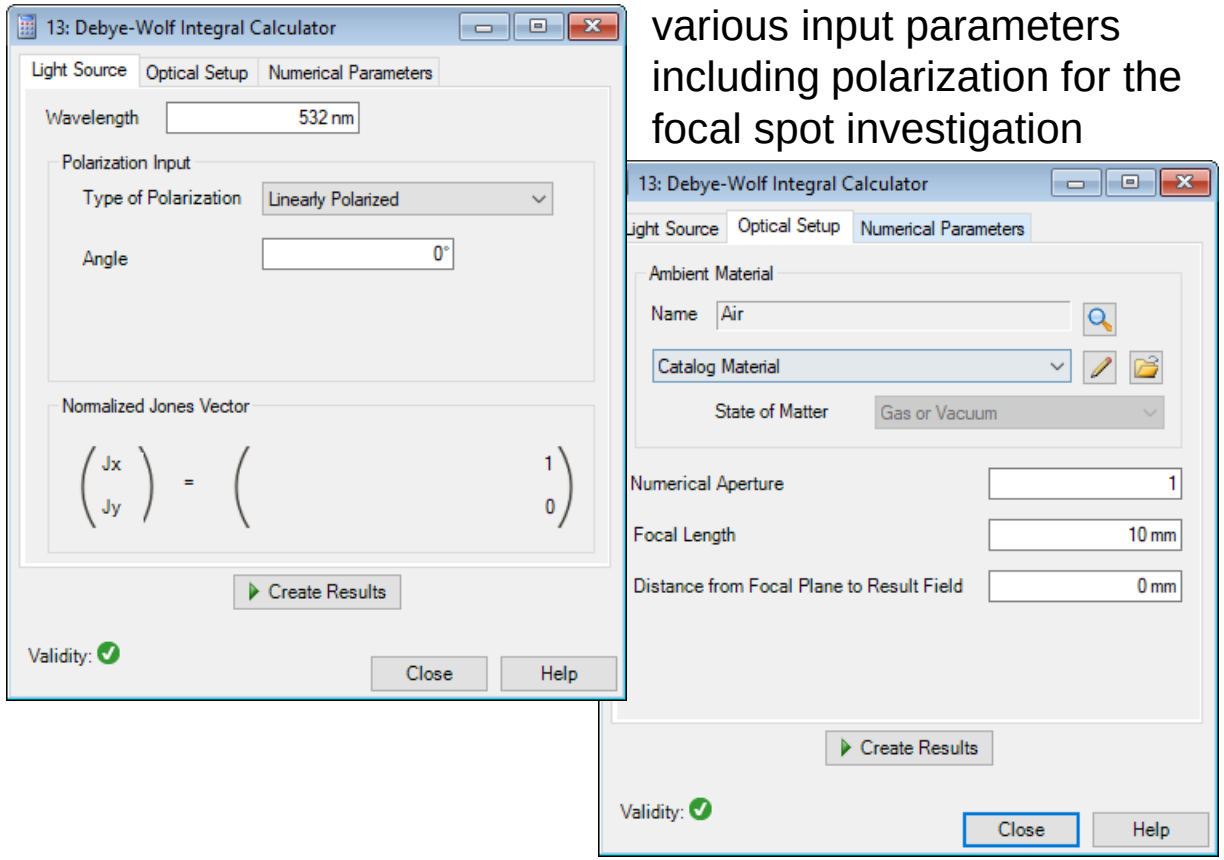


parameters

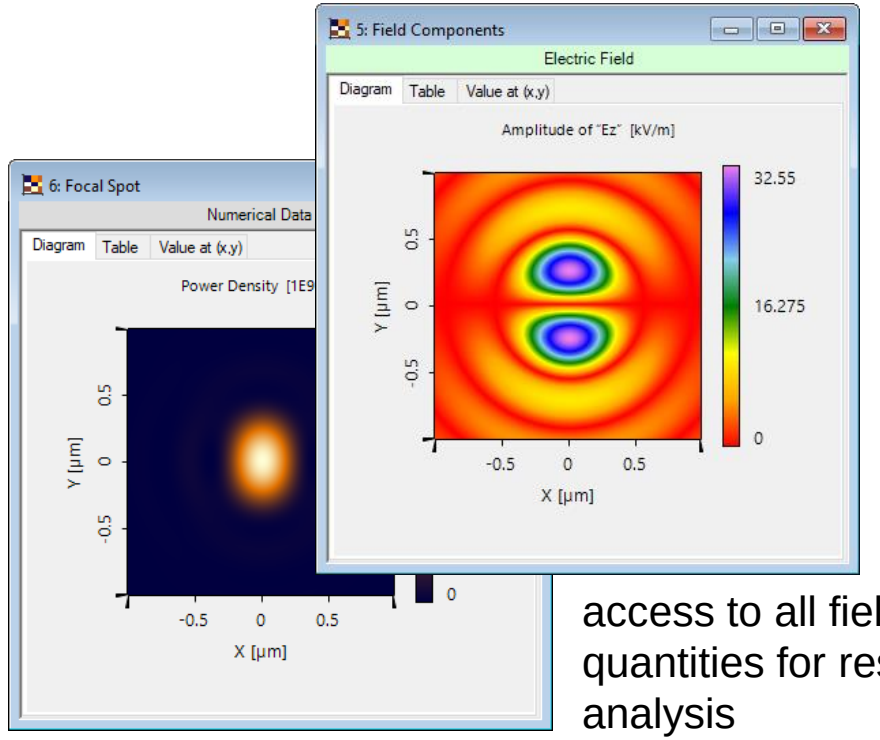
- fixed wavelength 532nm
- fixed lens NA 0.9
- fixed linear polarization in y
- ***defocus with 800nm or exactly at focus***

	$\lvert E_x \rvert$	$\lvert E_y \rvert$	$\lvert E_z \rvert$	$\lvert\lvert \boldsymbol{E} \rvert\rvert^2$
800nm away				
at focus				

Peek into VirtualLab Fusion

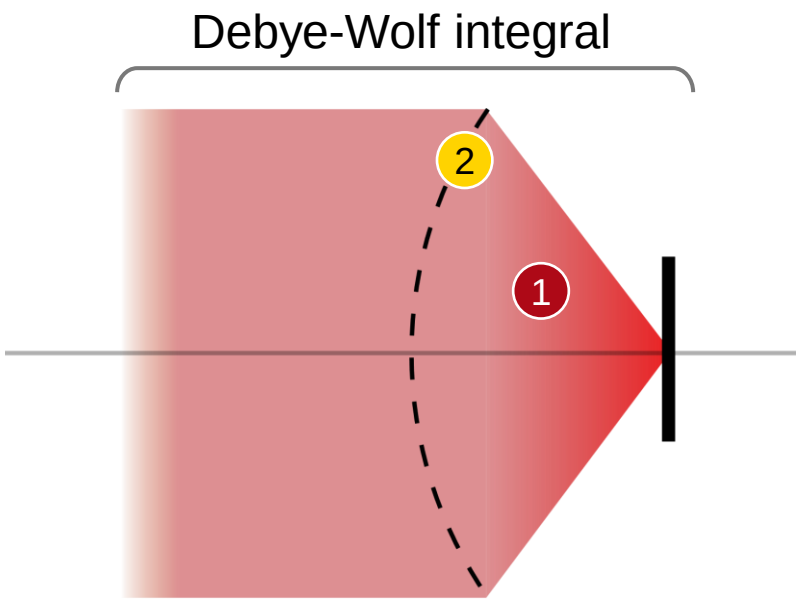


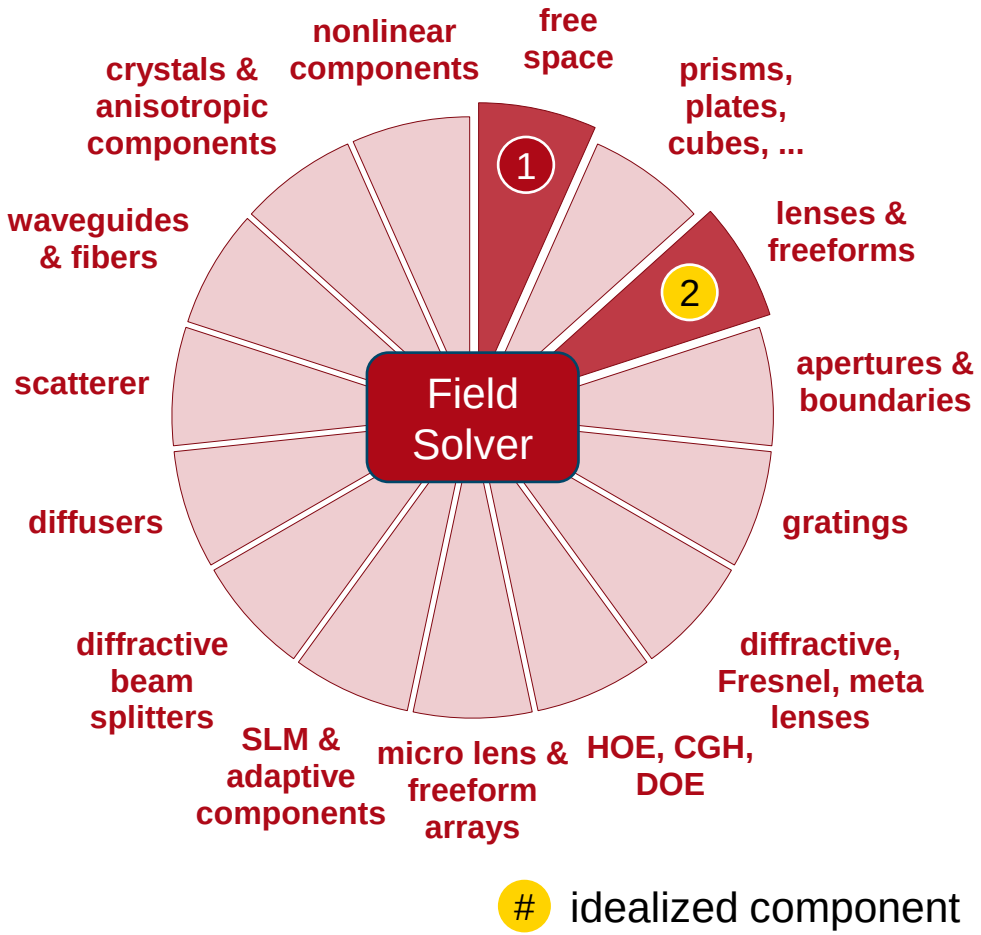
various input parameters including polarization for the focal spot investigation



access to all field quantities for result analysis

VirtualLab Fusion Technologies





Document Information

title	Investigation of Idealized Vectorial Focusing Situation Using Debye-Wolf Integral
document code	MIC.0001
version	1.2
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software version	2020.1 (Build 1.202)
category	Application Use Case
further reading	- Usage of Debye-Wolf Integral Calculator - Analyzing High-NA Objective Lens Focusing