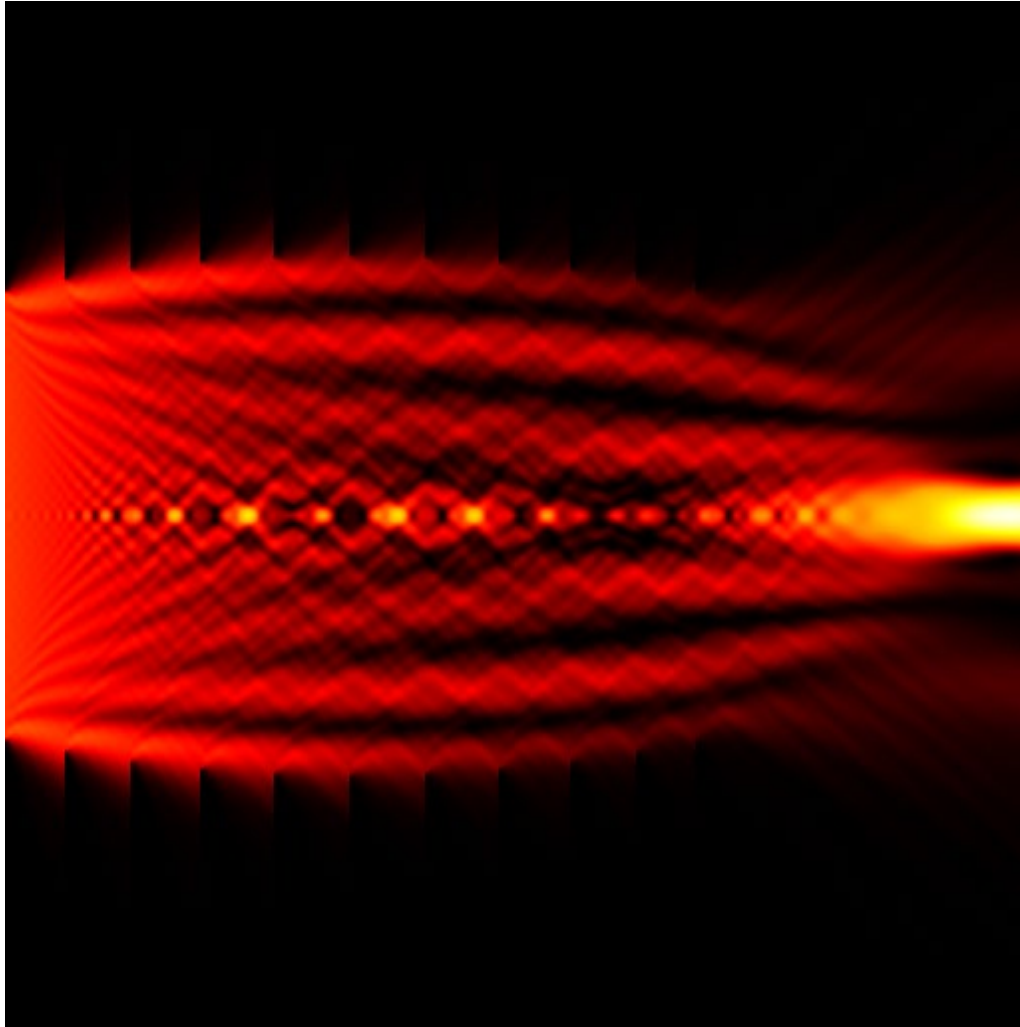


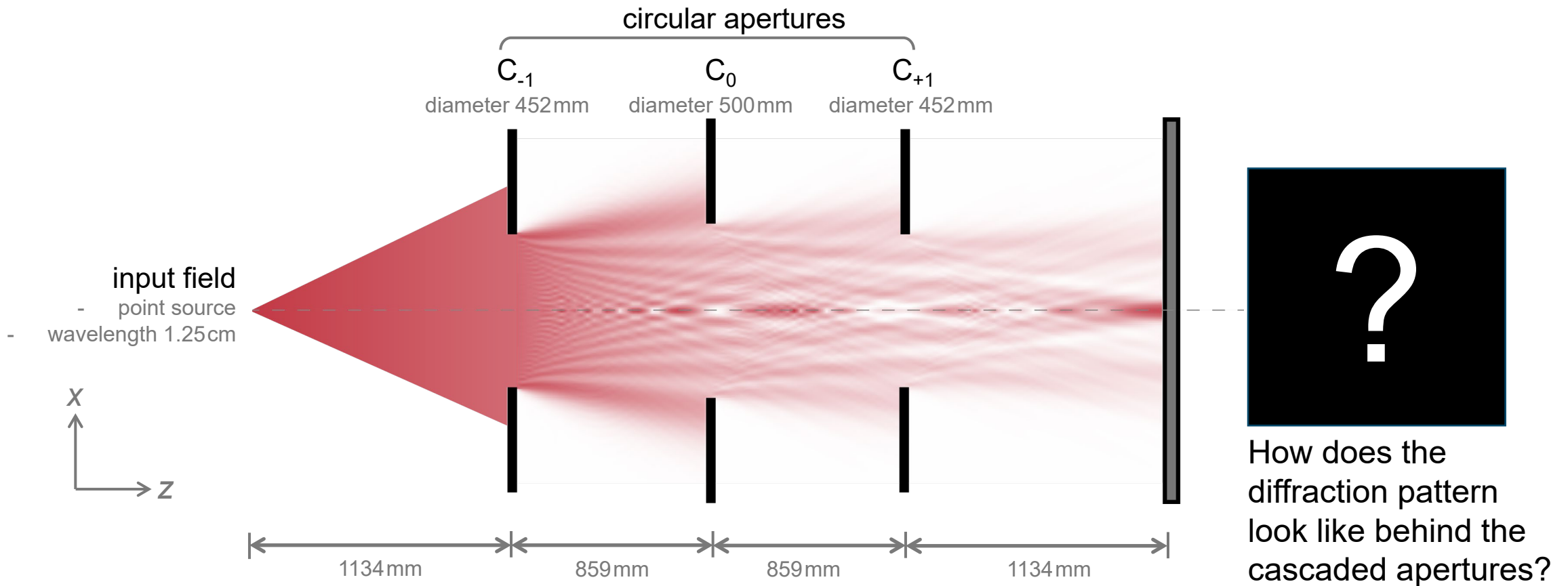
# **Focusing Electromagnetic Fields with Cascaded Circular Apertures**

# Abstract



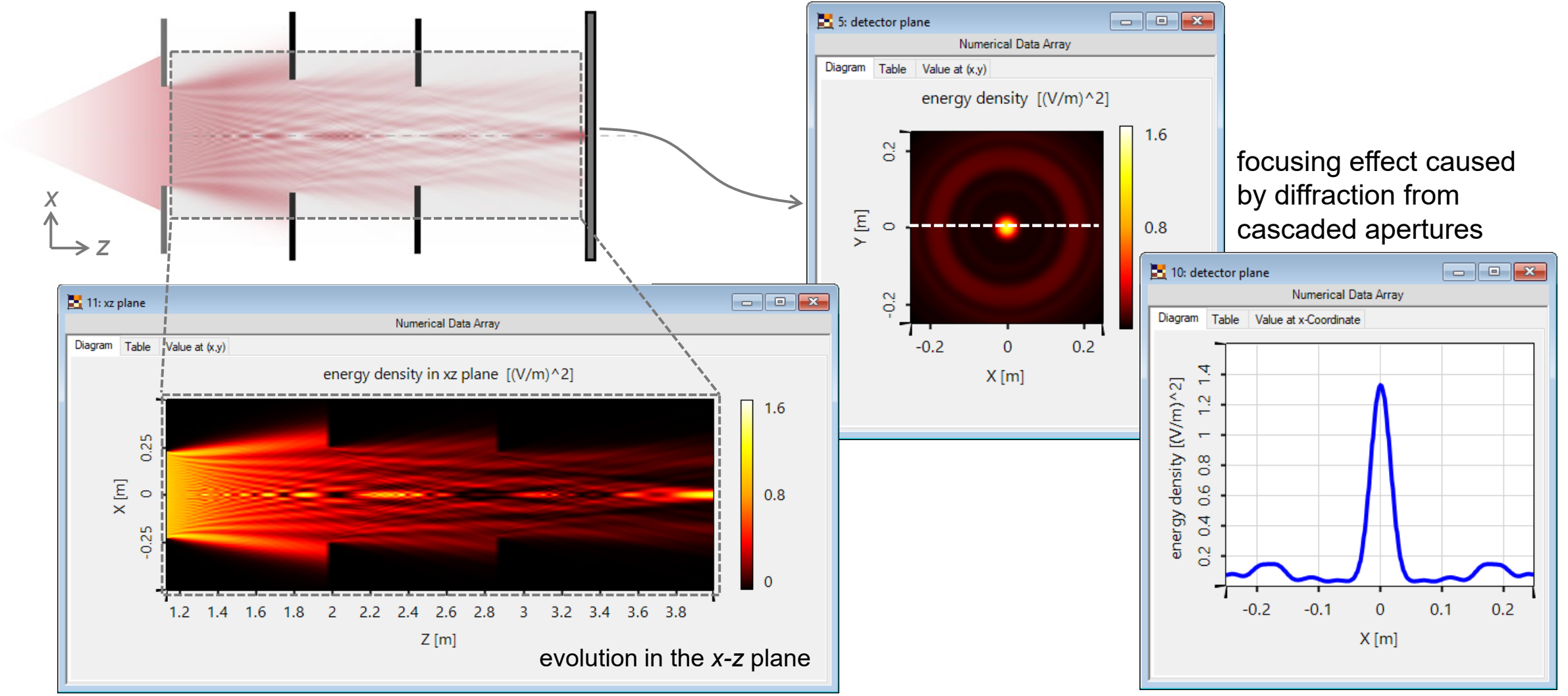
Diffraction from apertures – often understood as a detrimental effect that makes the beam size larger – can be used to focus light in proper configurations. Following the theory of M. De, *et al.*, *Appl. Opt.* 7, 483-488 (1968), and J. W. Y. Lit, *et al.*, *J. Opt. Soc. Am.* 59, 559-567 (1969), we demonstrate such effects in VirtualLab Fusion with its flexible Fourier transform settings. In the following two examples, we show the field along z axis, analyze it on the focal plane, and compare it with the reference.

# Modeling Task – Three Cascaded Circular Apertures

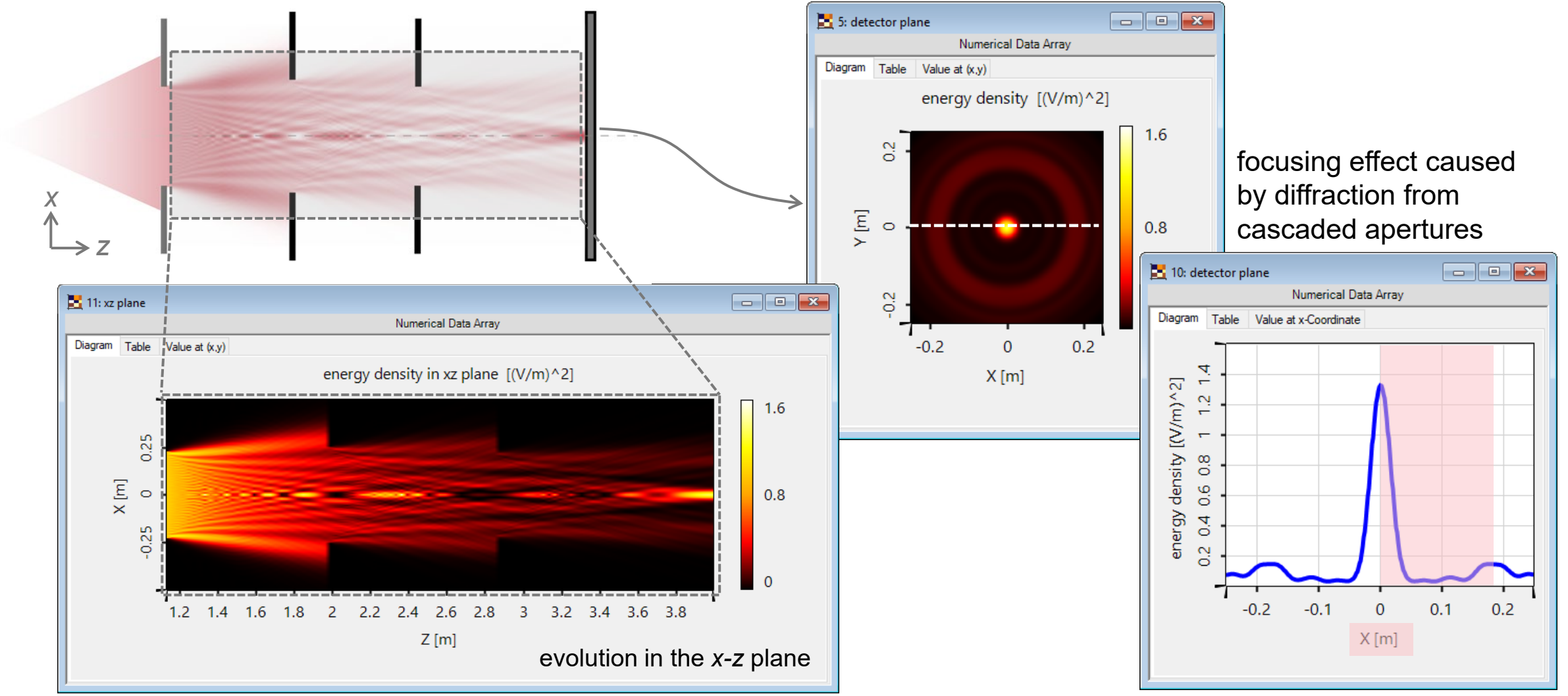


system configuration, including aperture sizes and distances, based on M. De, *et al.*, *Appl. Opt.* 7, 483-488 (1968), and J. W. Y. Lit, *et al.*, *J. Opt. Soc. Am.* 59, 559-567 (1969)

# Diffraction from Three Cascaded Circular Apertures



# Diffraction from Three Cascaded Circular Apertures



# Diffraction from Three Cascaded Circular Apertures

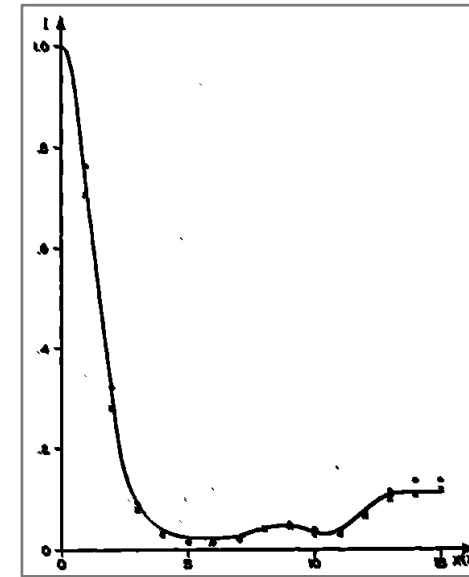
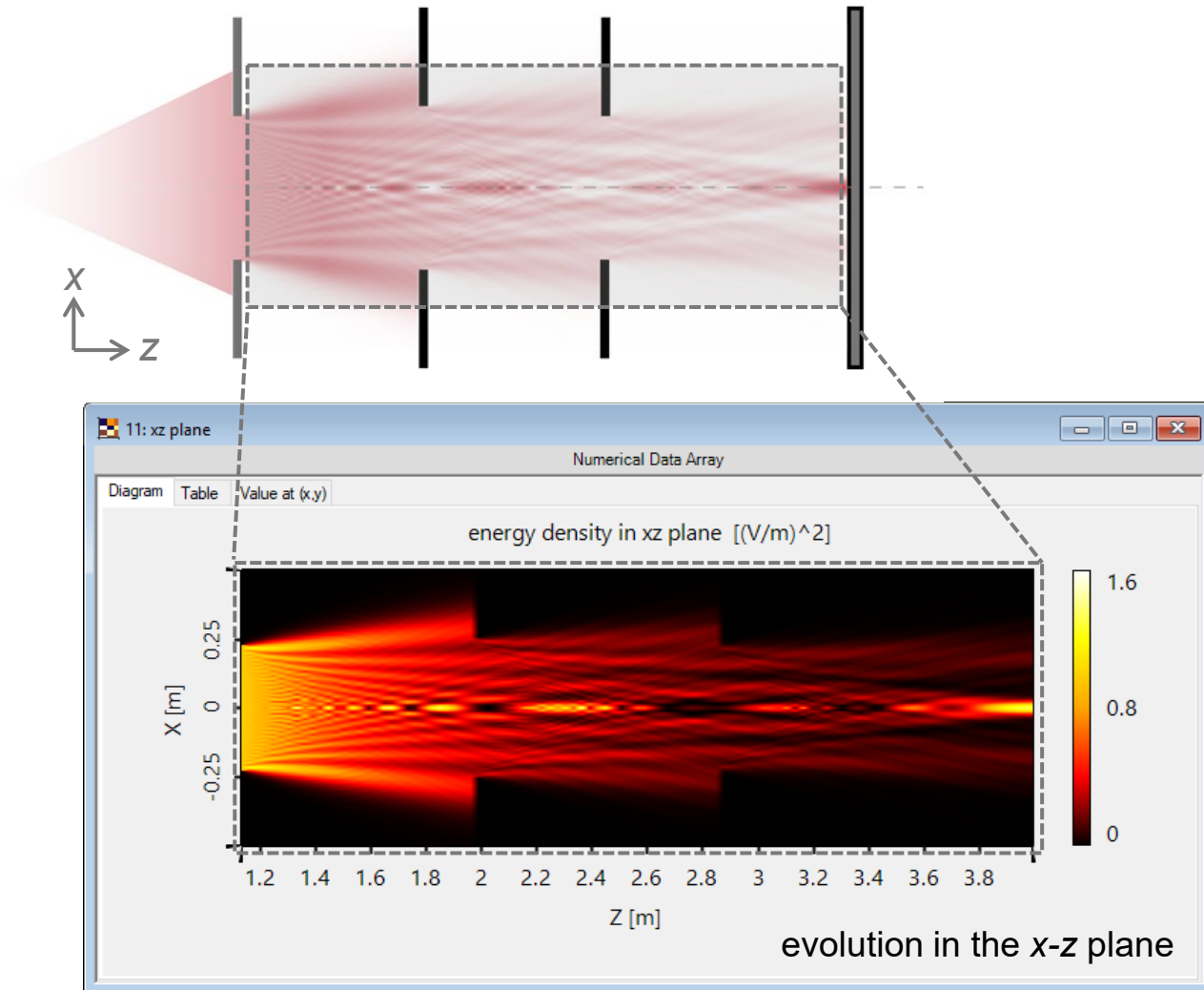
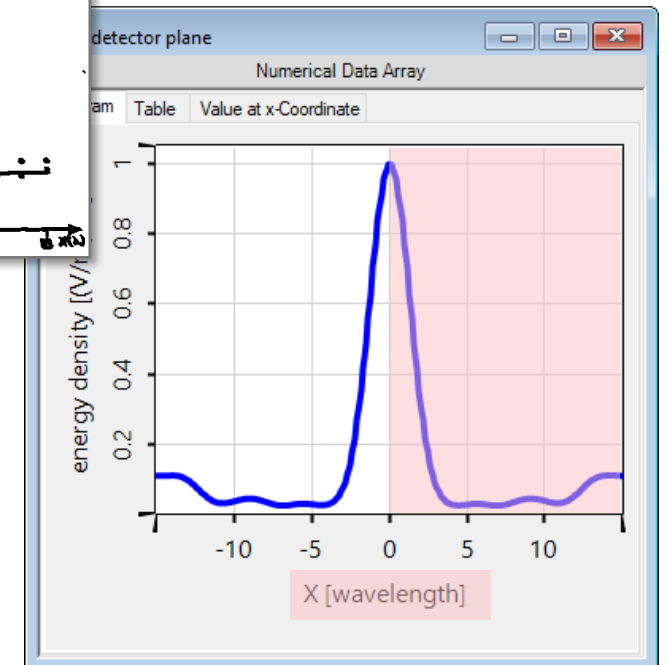
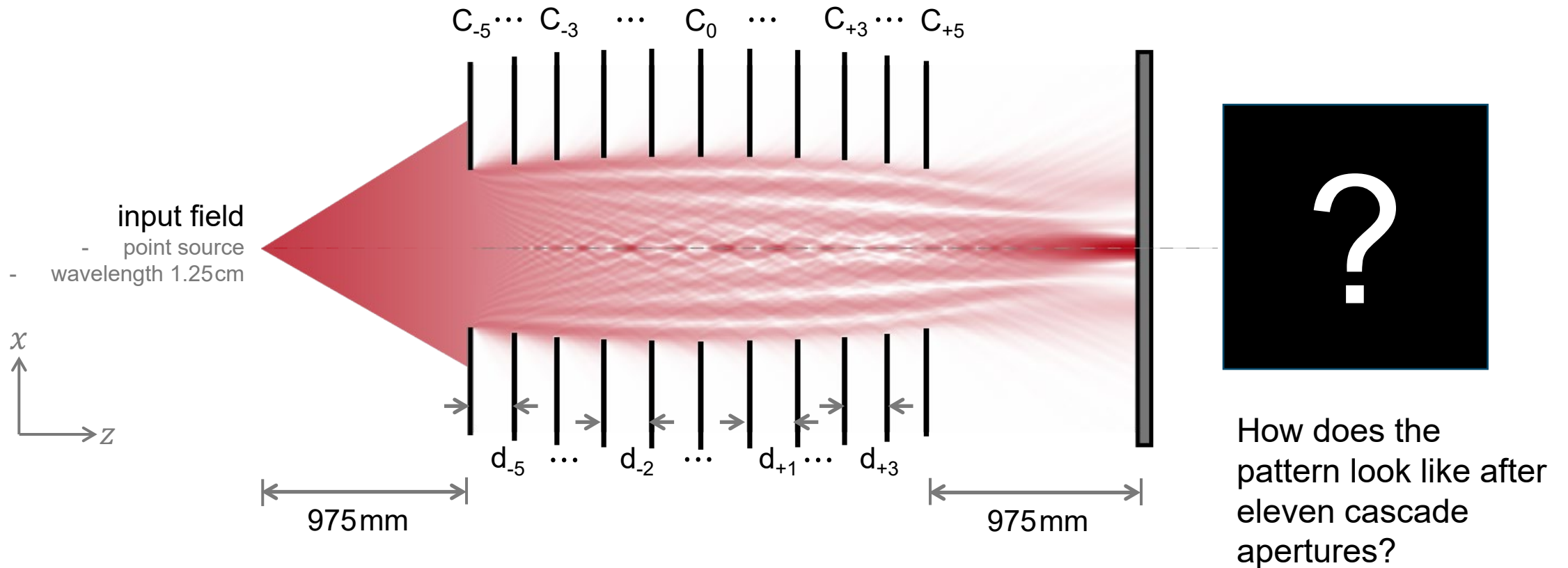


Fig. 4 from J. W. Y. Lit, *et al.*,  
J. Opt. Soc. Am. 59, 559-567 (1969)



# Modeling Task – Eleven Cascaded Circular Apertures



# Aperture Sizes and Locations

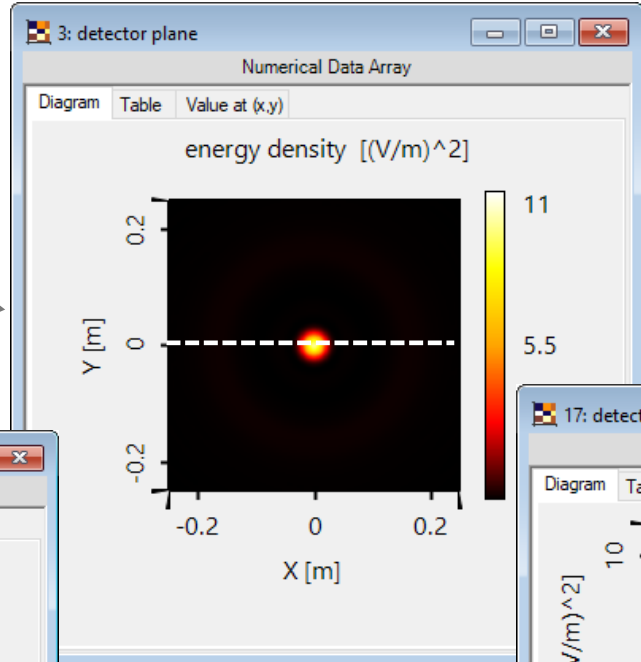
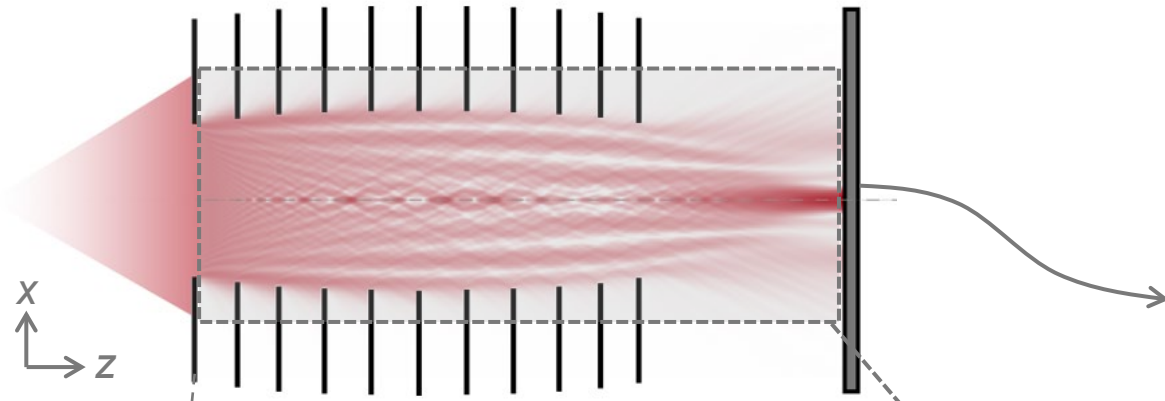
aperture index	diameter
$C_{-5}$	431 mm
$C_{-4}$	454 mm
$C_{-3}$	473 mm
$C_{-2}$	488 mm
$C_{-1}$	497 mm
$C_0$	500 mm
$C_{+1}$	497 mm
$C_{+2}$	488 mm
$C_{+3}$	473 mm
$C_{+4}$	454 mm
$C_{+5}$	431 mm

distance between neighbour apertures	
$d_{-5}$	176 mm
$d_{-4}$	193 mm
$d_{-3}$	207 mm
$d_{-2}$	217 mm
$d_{-1}$	222 mm
$d_0$	222 mm
$d_{+1}$	217 mm
$d_{+2}$	207 mm
$d_{+3}$	193 mm
$d_{+4}$	176 mm

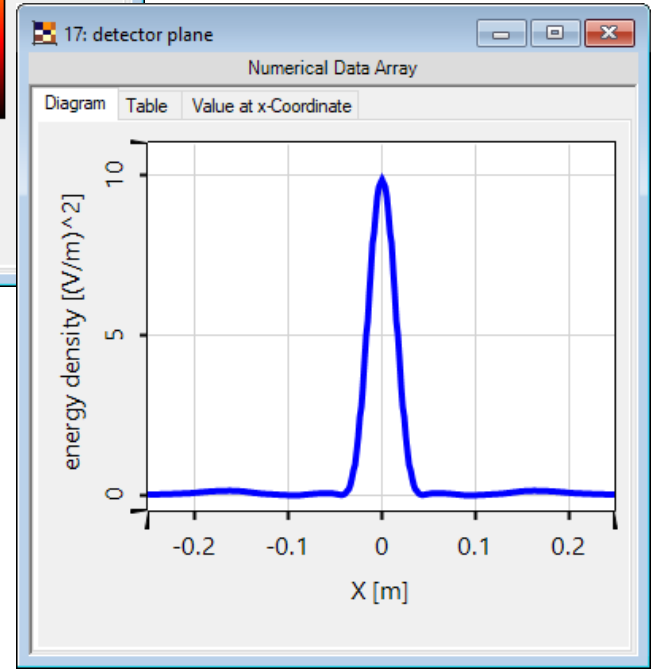
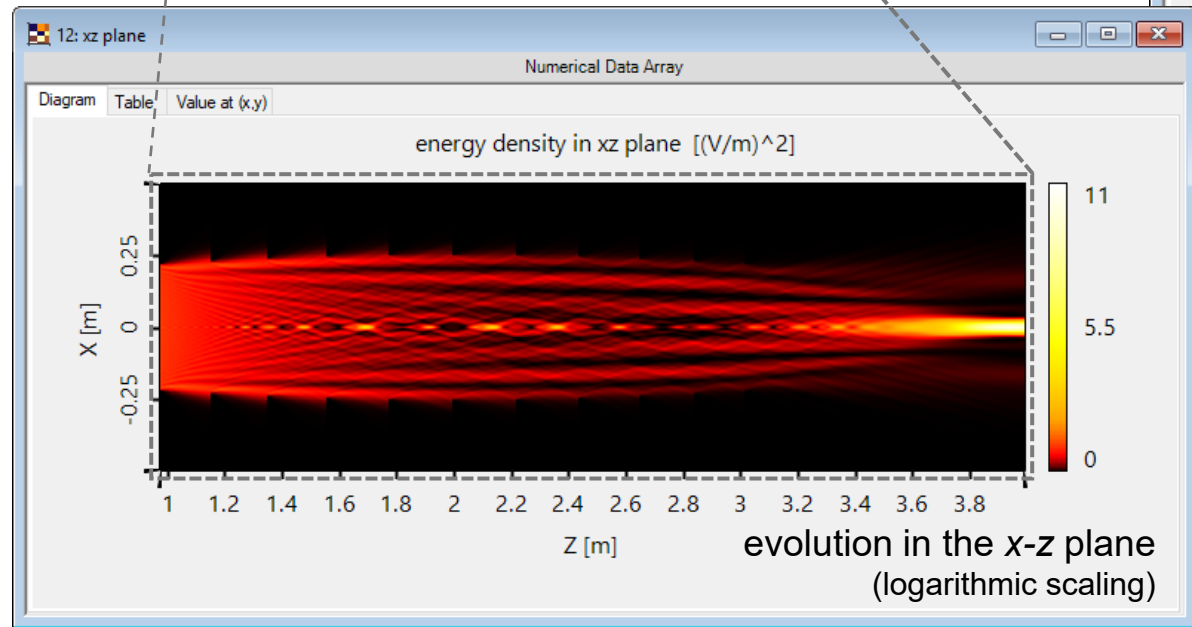
based on De *et al.* Appl. Opt. 7, 483-488 (1968)



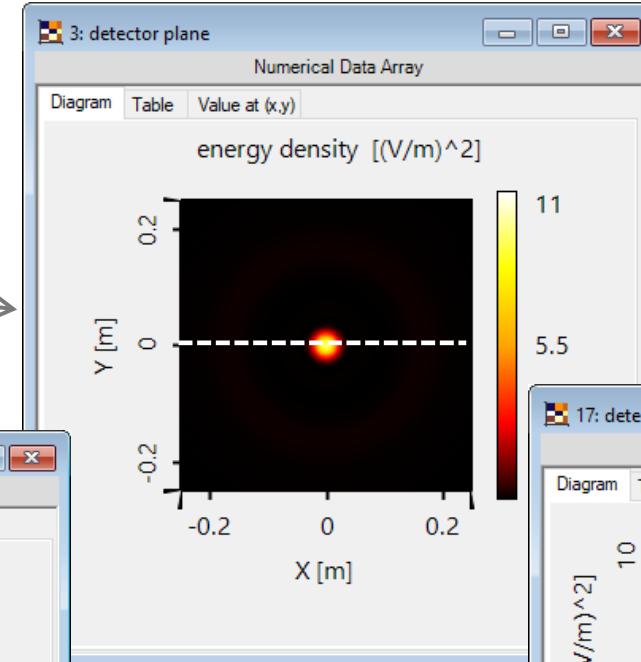
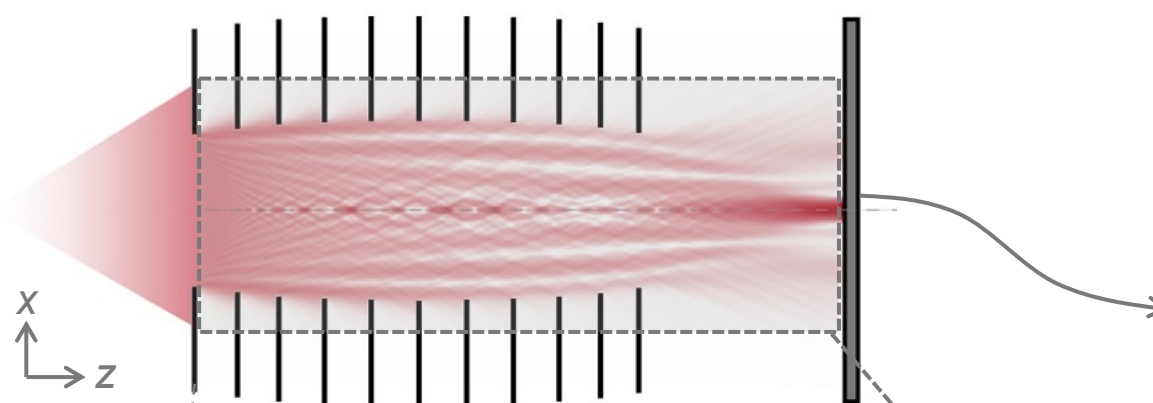
# Results Energy Density in Detector and xz Plane



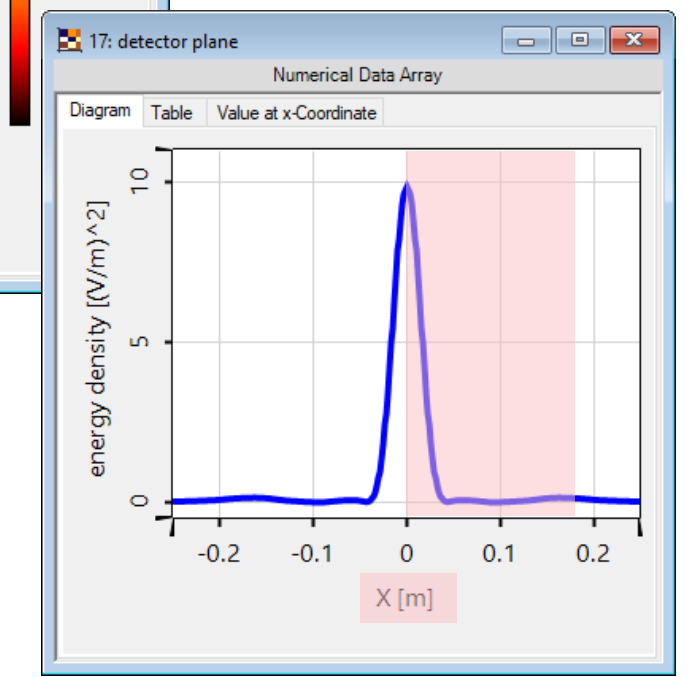
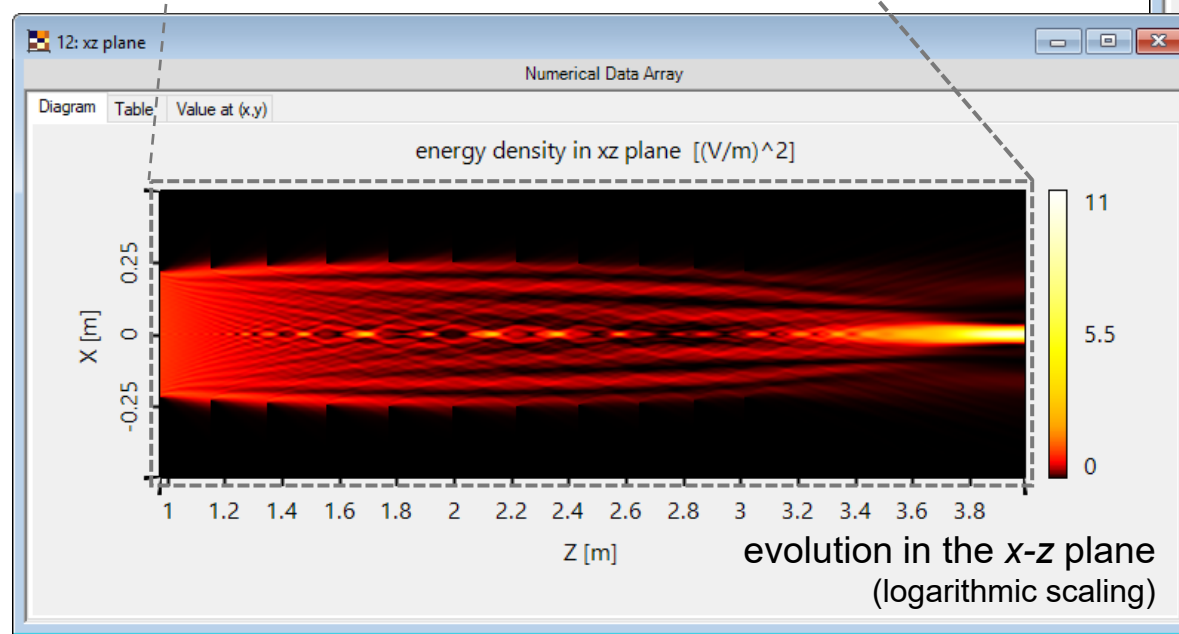
focusing effect caused by diffraction from cascaded apertures



# Results Energy Density in Detector and xz Plane



focusing effect caused by diffraction from cascaded apertures



# Results Energy Density in Detector and xz Plane

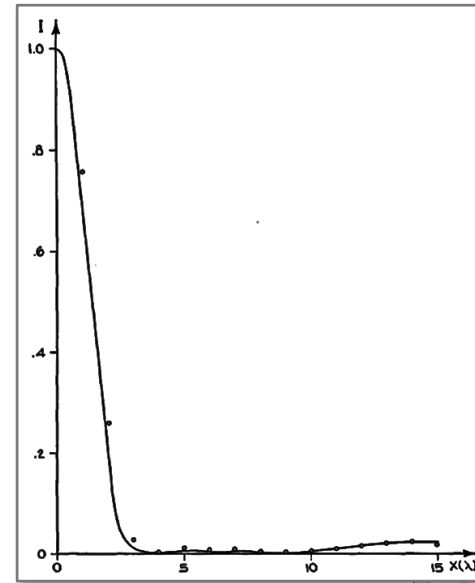
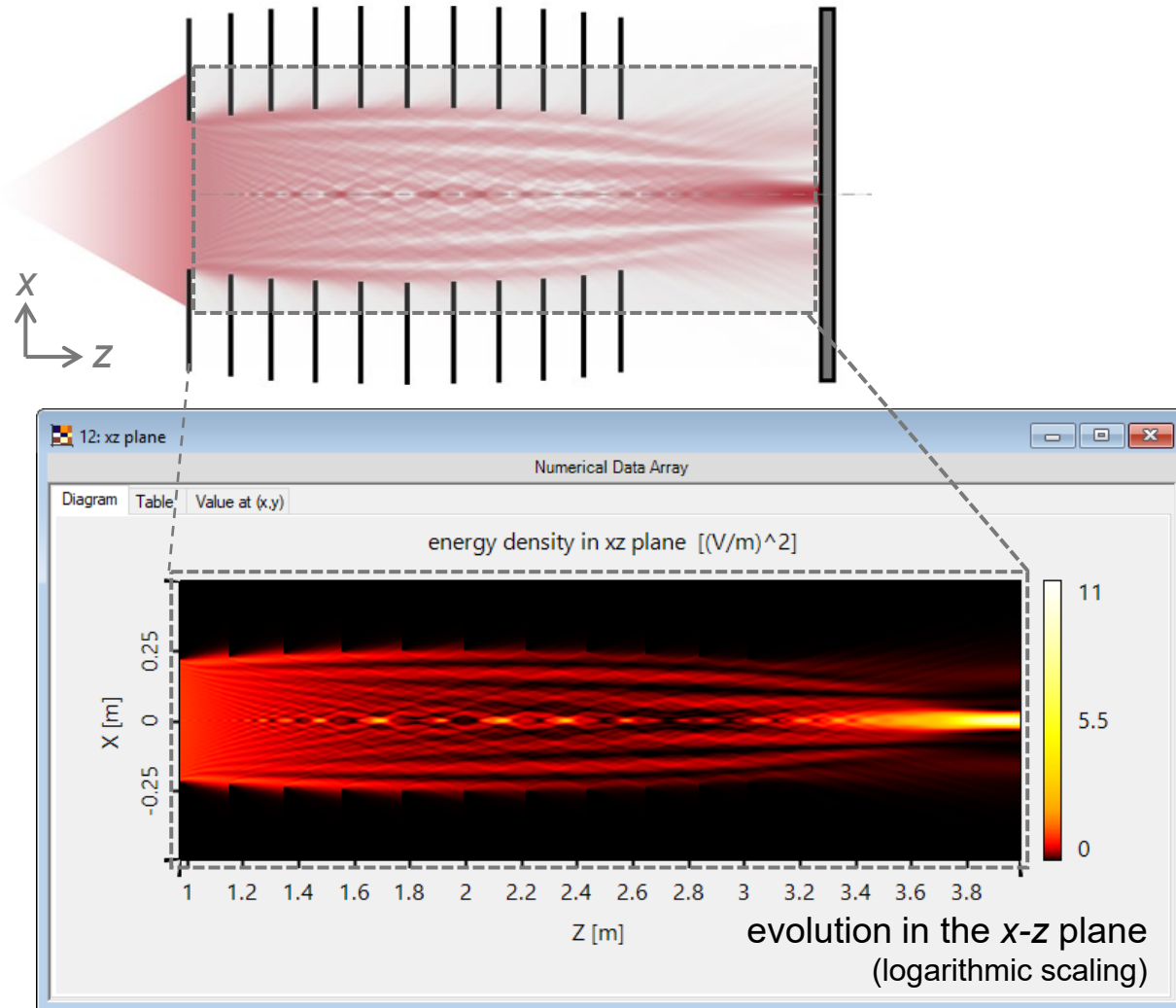
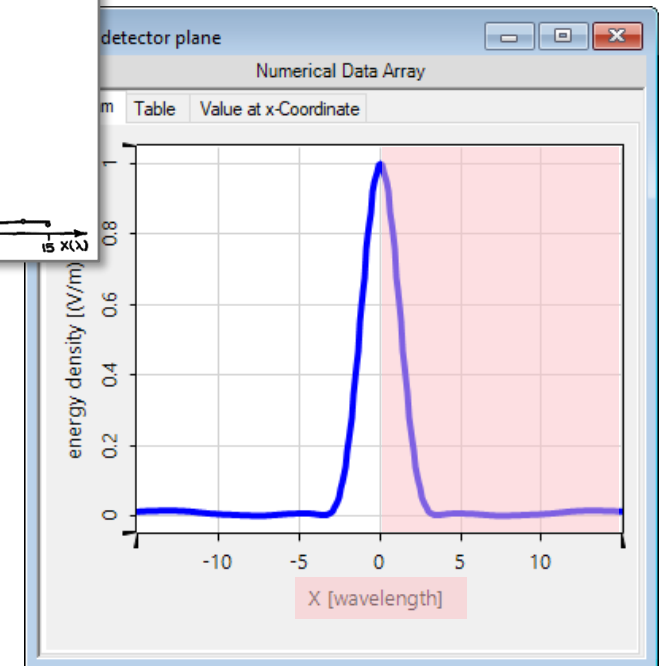


Fig. 5 from J. W. Y. Lit, *et al.*,  
J. Opt. Soc. Am. 59, 559-567 (1969)



# Peek into VirtualLab Fusion

Parameter Overview for fast accessing system parameters

Parameter Overview

aperture

Object	Category	Parameter	Value
C_Minus5 #1	Aperture	Diameter X	431.17 mm
		Diameter Y	431.17 mm
		Relative Edge Width	1 %
C_Minus4 #2	Aperture	Diameter X	454.12 mm
		Diameter Y	454.12 mm
		Relative Edge Width	1 %
C_Minus3 #3	Aperture	Diameter X	473.34 mm
		Diameter Y	473.34 mm
		Relative Edge Width	1 %
C_Minus2 #4	Aperture	Diameter X	487.87 mm
		Diameter Y	487.87 mm
		Relative Edge Width	1 %
C_Minus1 #5	Aperture	Diameter X	496.93 mm
		Diameter Y	496.93 mm
		Relative Edge Width	1 %
C_0 #6	Aperture	Diameter X	500 mm
		Diameter Y	500 mm
		Relative Edge Width	1 %

Show Minimum and Maximum...

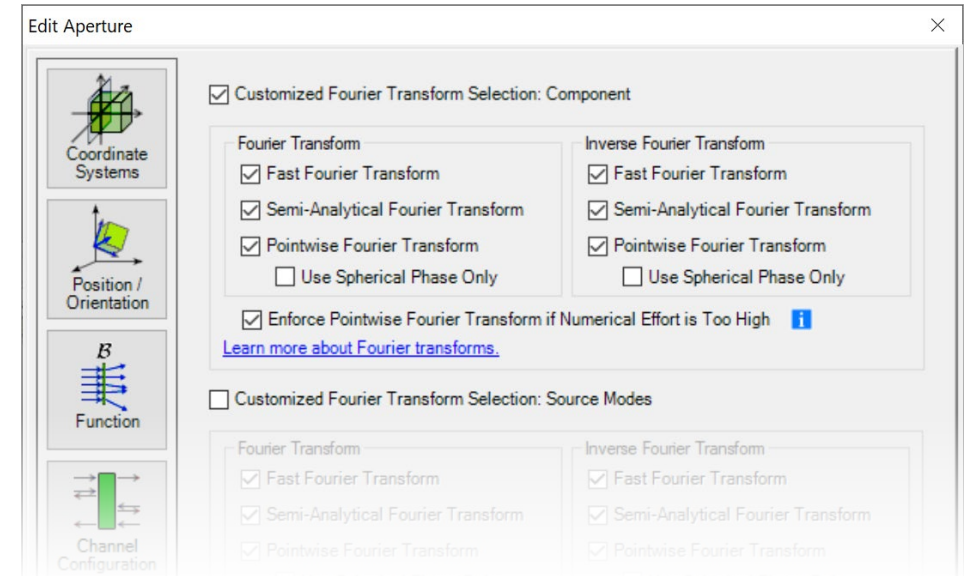
The screenshot displays the 'Optical Setup View #3' window with a diagram of a cascaded aperture system. A 'Spherical Wave' source (0) passes through five apertures (C\_Minus5 to C\_Minus1) and then through three more (C\_0, C\_Plus1, C\_Plus2) before reaching a 'Detector' (601). The 'Edit Aperture' dialog box is open, showing Fourier Transform settings. The 'Customized Fourier Transform Selection: Component' section is checked, and the 'Enforce Pointwise Fourier Transform if Numerical Effort is Too High' option is also checked. The 'Customized Fourier Transform Selection: Source Modes' section is unchecked.

distance between point source and C-5:0.97556036813700 m; distance between C-5 and C-4:0.176447709833221 m; ape distance between C-4 and C-3:0.193305022099978 m; ape distance between C-3 and C-2:0.207294870740666 m; ape distance between C-2 and C-1:0.217264206783573 m; ape distance between C-1 and C-0:0.222315322405558 m; ape distance between C-0 and C+1:0.222315322405558 m; ape distance between C+1 and C+2:0.217264206783573 m; ape distance between C+2 and C+3:0.207294870740666 m; ape distance between C+3 and C+4:0.193305022099978 m; ape distance between C+4 and C+5:0.176447709833221 m

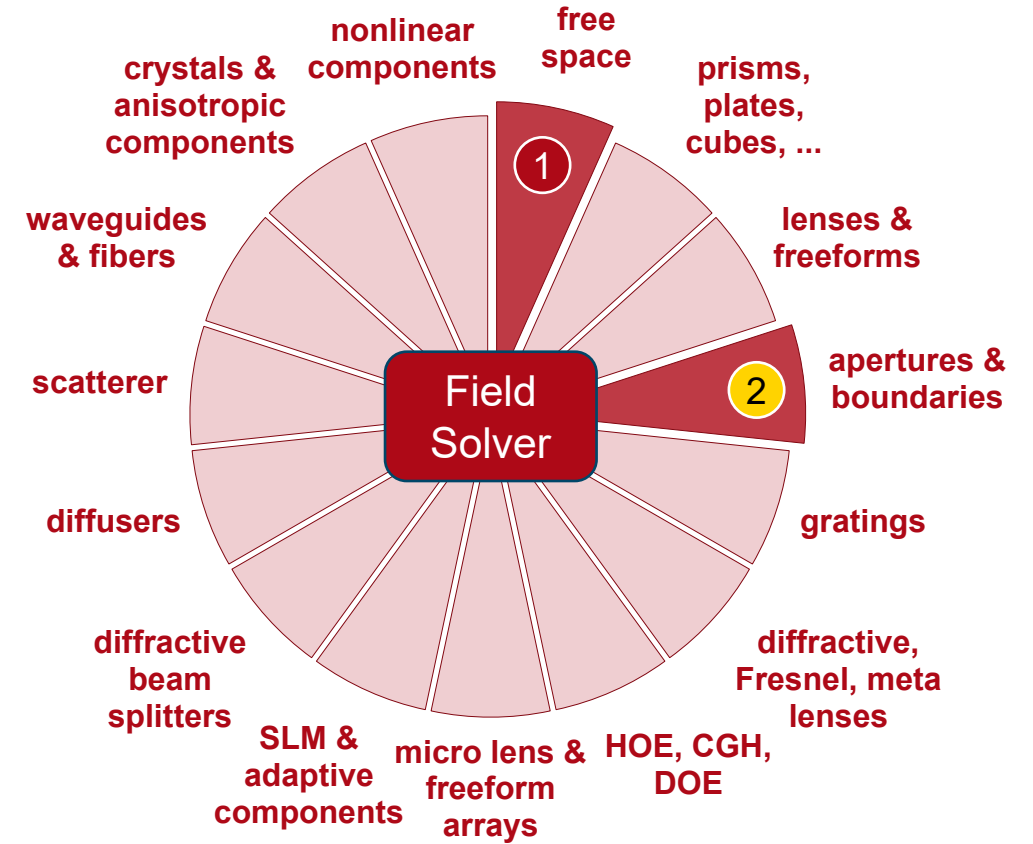
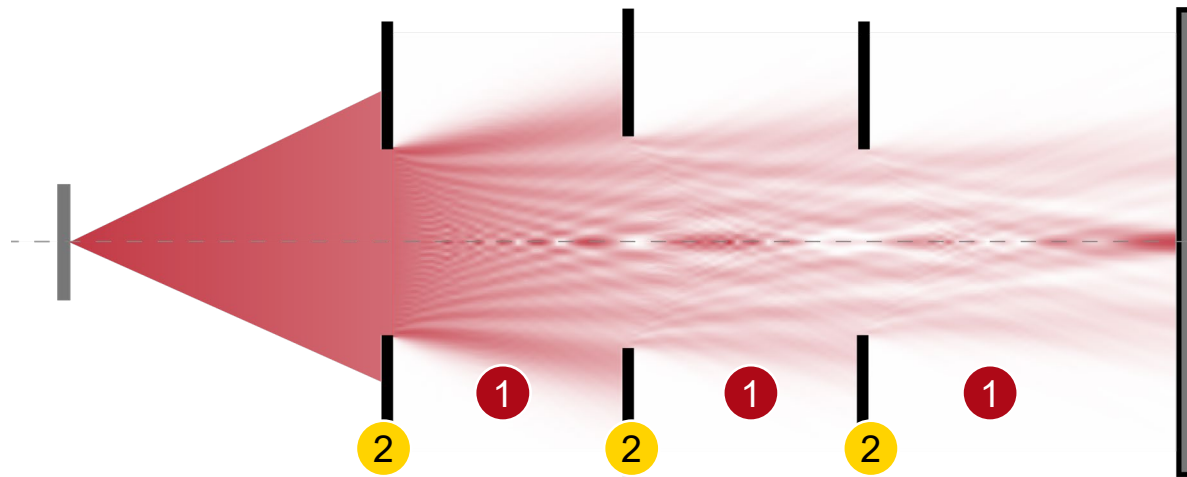
flexible Fourier transform settings for diffraction consideration

# Workflow in VirtualLab Fusion

- Set the Fourier transforms properly
- Select proper detector for field visualization
  - Usage of Cameral Detector [Use Case]
- Use Parameter Run to scan along z axis
  - Usage of Parameter Run [Use Case]



# VirtualLab Fusion Technologies



# idealized component

# Document Information

title	Focusing Electromagnetic Fields with Cascaded Circular Apertures
document code	MISC.0081
version	1.0
edition	VirtualLab Fusion Basic
software version	2020.1 (Build 1.202)
category	Application Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#">Pinhole Modeling in a Low-Fresnel-Number System</a></li><li>- <a href="#">Diffraction Patterns behind Different Apertures</a></li></ul>