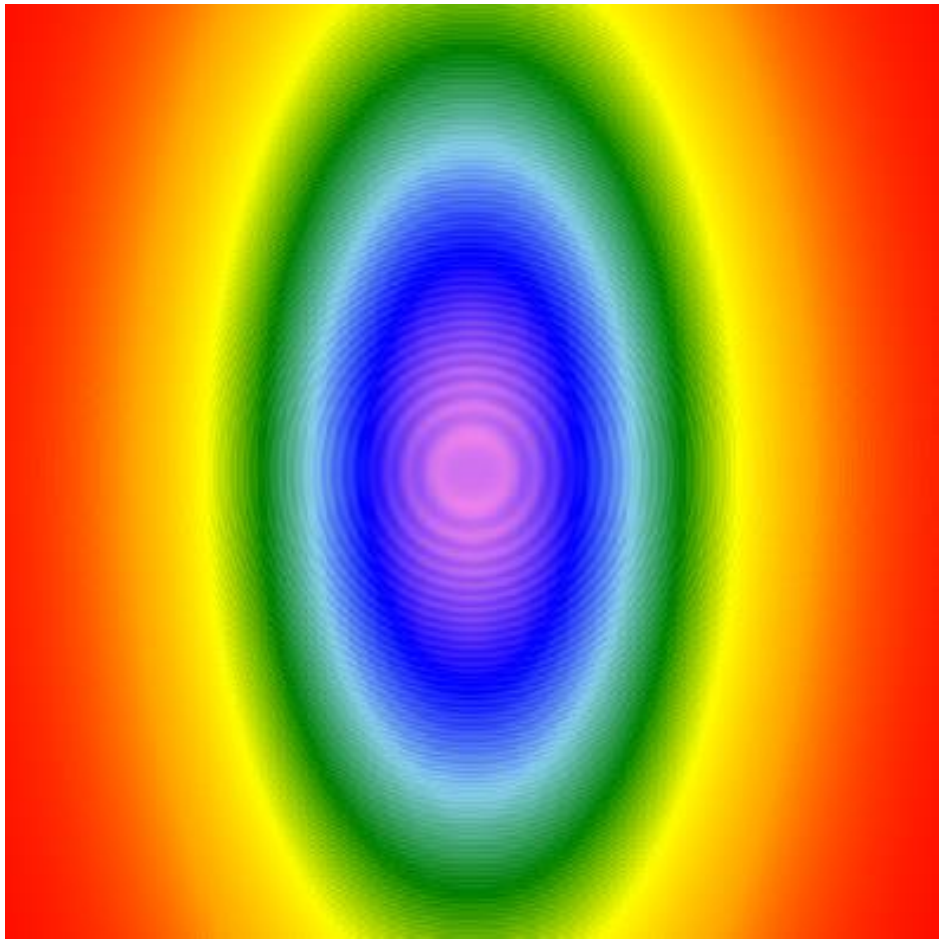
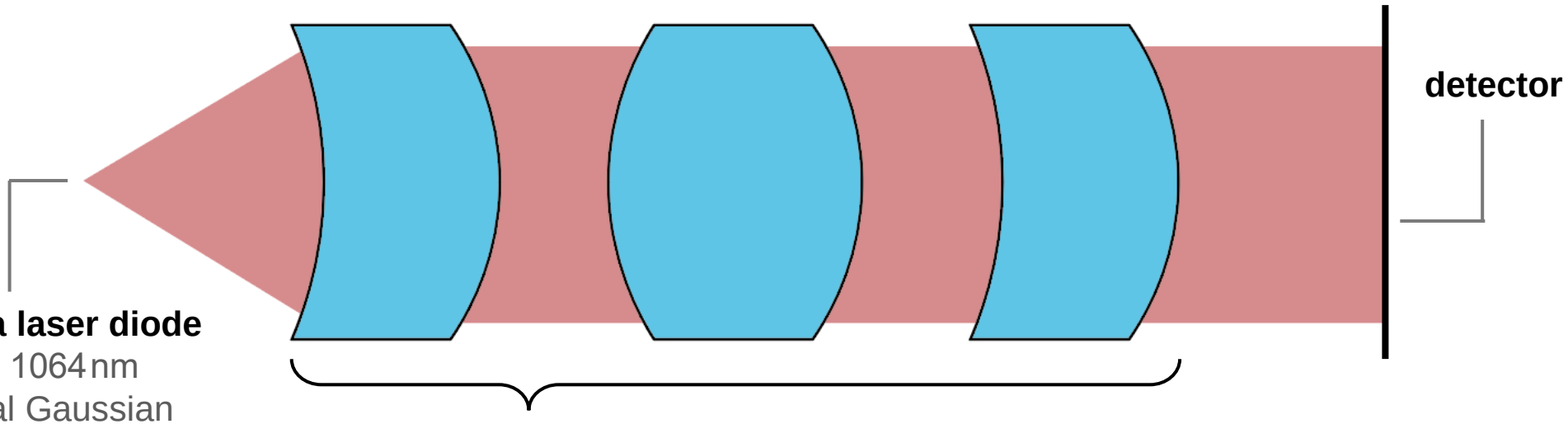
Investigation of Ghost Imaging Effects in Collimation System

Abstract



One of the principal roles of simulation technology is to provide a platform on which to study the performance of a system before that system is manufactured, in order to preempt as many potential pitfalls as possible. One of the most common phenomena that can detrimentally affect the performance of a system is stray light, which may have multiple sources, spurious internal reflections in the system among them. In this use case we analyze the presence of such reflections in a collimation lens system for a high-NA laser diode, we model the effect the resulting ghost images have on the detected field (a concentric ring pattern caused by the interference of the main collimated beam and a secondary divergent one produced by the stray light), and identify the need for an antireflection coating on key surfaces of the lens system in question.

Modeling Task



high-Na laser diode

- wavelength 1064 nm
- fundamental Gaussian
- divergence: 20° × 10°

collimating objective lens

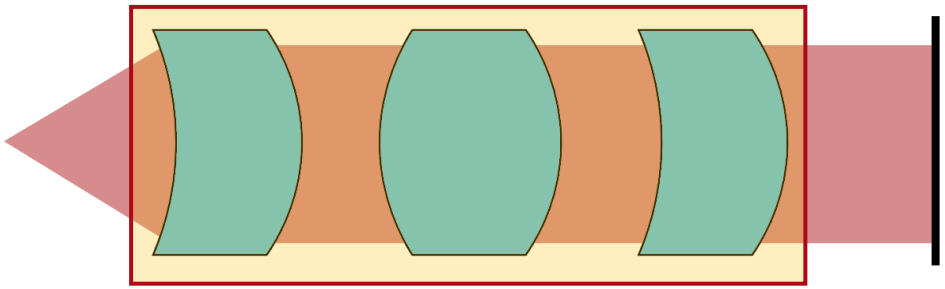
NA = 0.63

a) perfect antireflection-coating (sequential modeling)

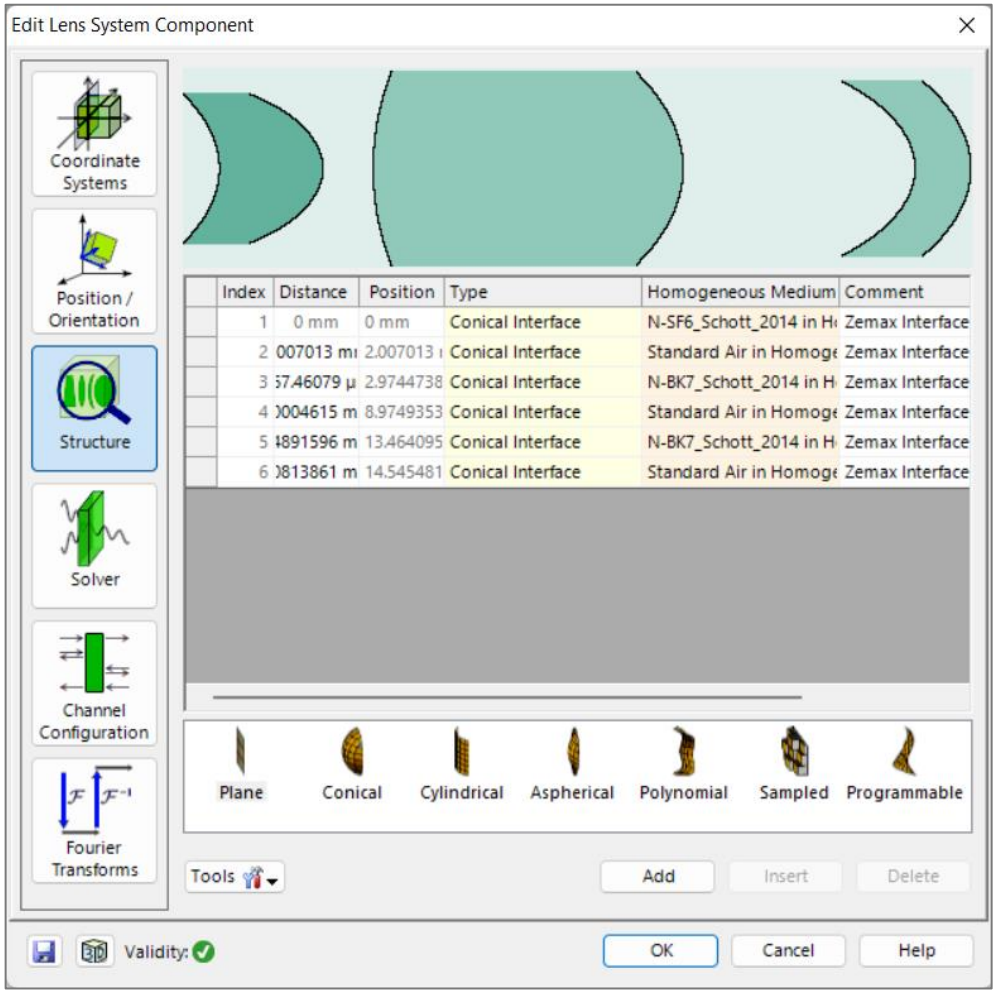
b) uncoated (internal reflections included)

surface	#1	#2	#3	#4	#5	#6
Radius of Curvature	-6.8 mm	-3.9 mm	21.1 mm	-8.7 mm	-5.0 mm	-7.1 mm
material behind surface	N-SF6	air	N-BK7	air	N-BK7	air

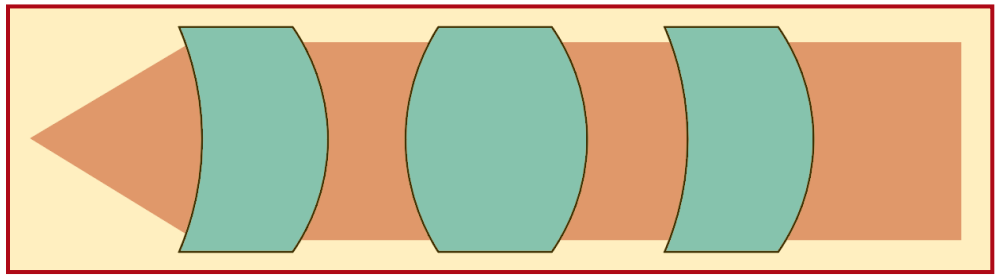
Collimation System



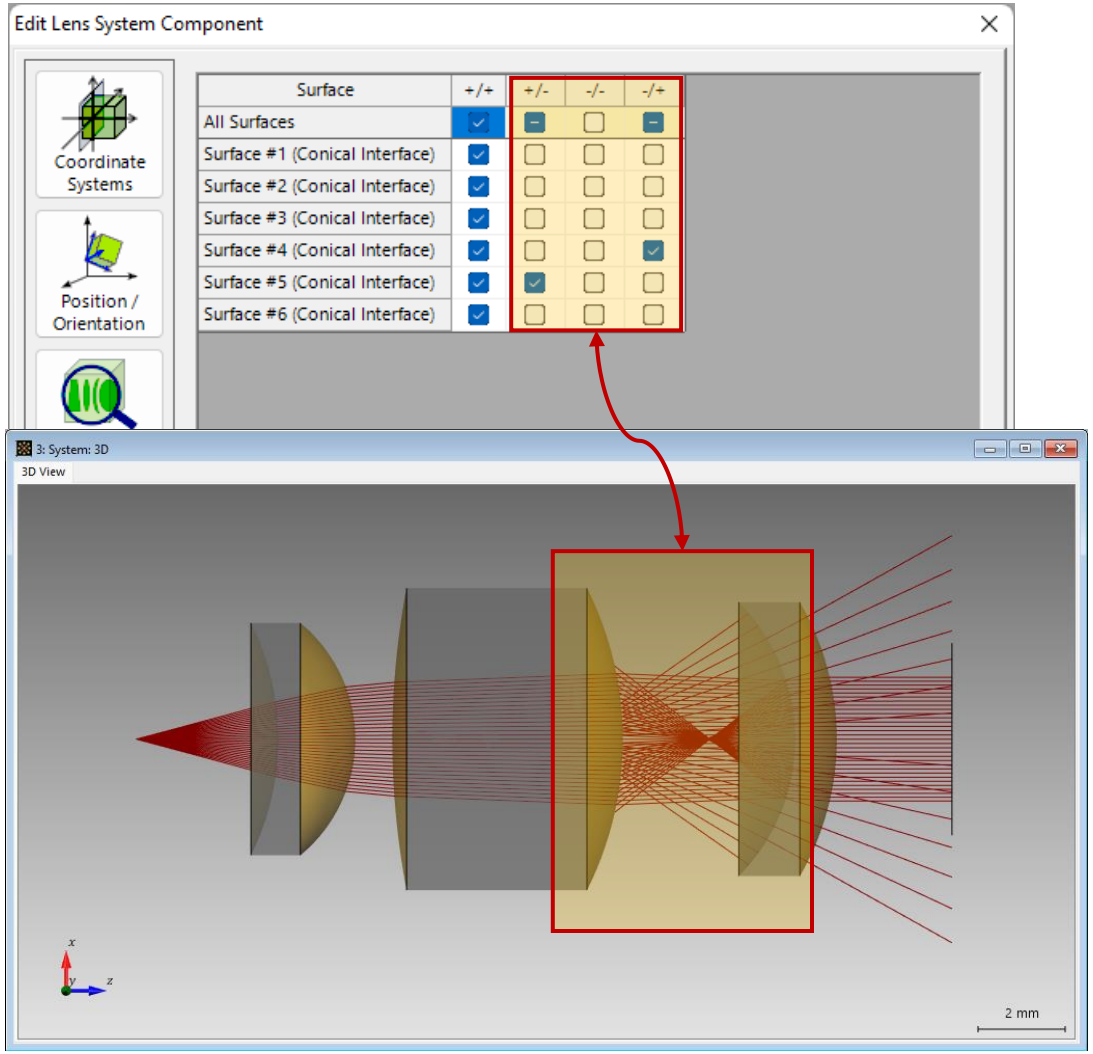
The *Lens System Component* allows for the easy definition of a component consisting of an alternating sequence of smooth surfaces and homogeneous, isotropic media. In terms of both the interfaces and the materials, it is possible to choose ready made entries from the in-built catalogs or to customize your own for maximum flexibility.



Non-Sequential Tracing

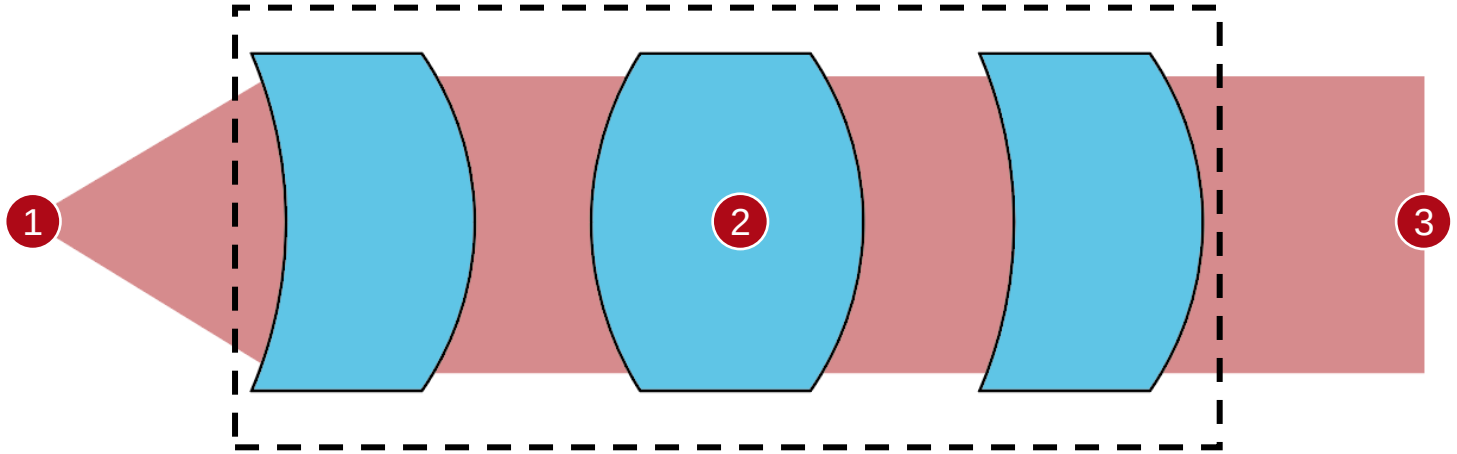


With the channel configuration mode toggle set to *Manual Configuration*, the user can specify, for each surface in the system, which channels to open for the simulation. When the simulation is run, a preliminary analysis of the active light paths will be performed (by the so-called *Light Path Finder*). The field will then be traced along these light paths by the engine, to the detectors present in the system.



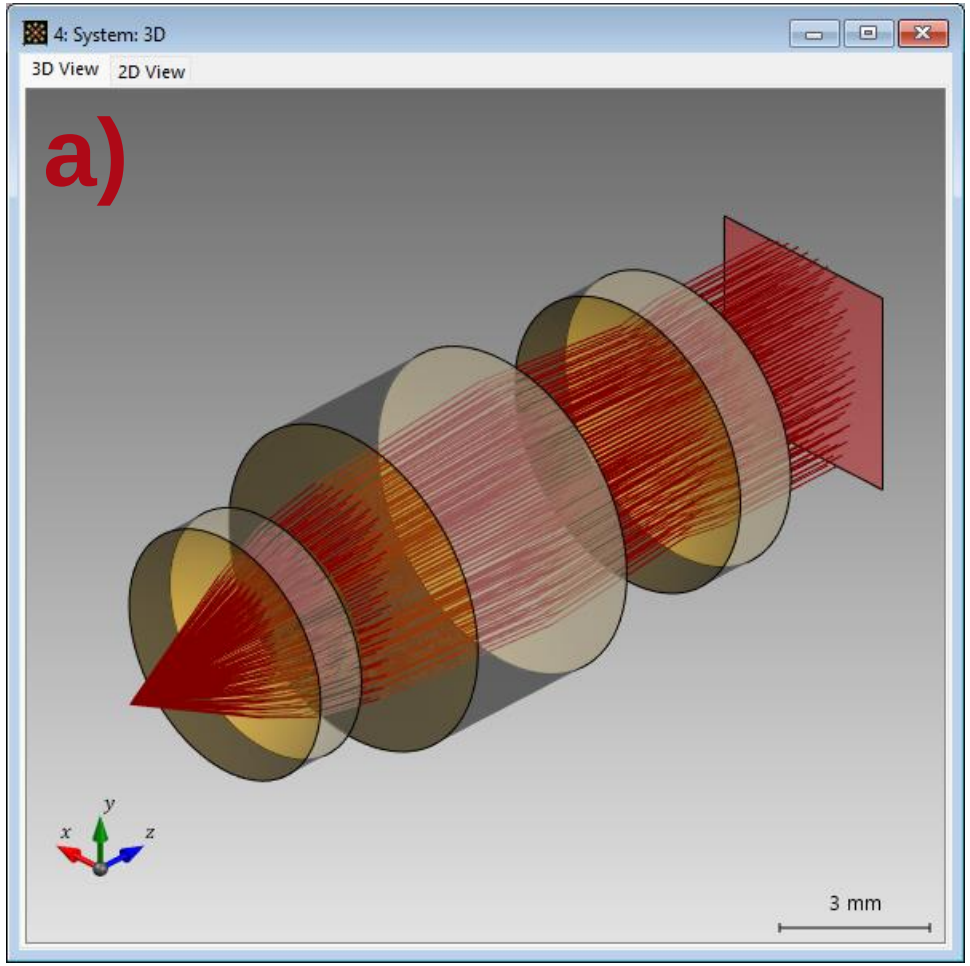
[Channel Setting for Non-Sequential Tracing]

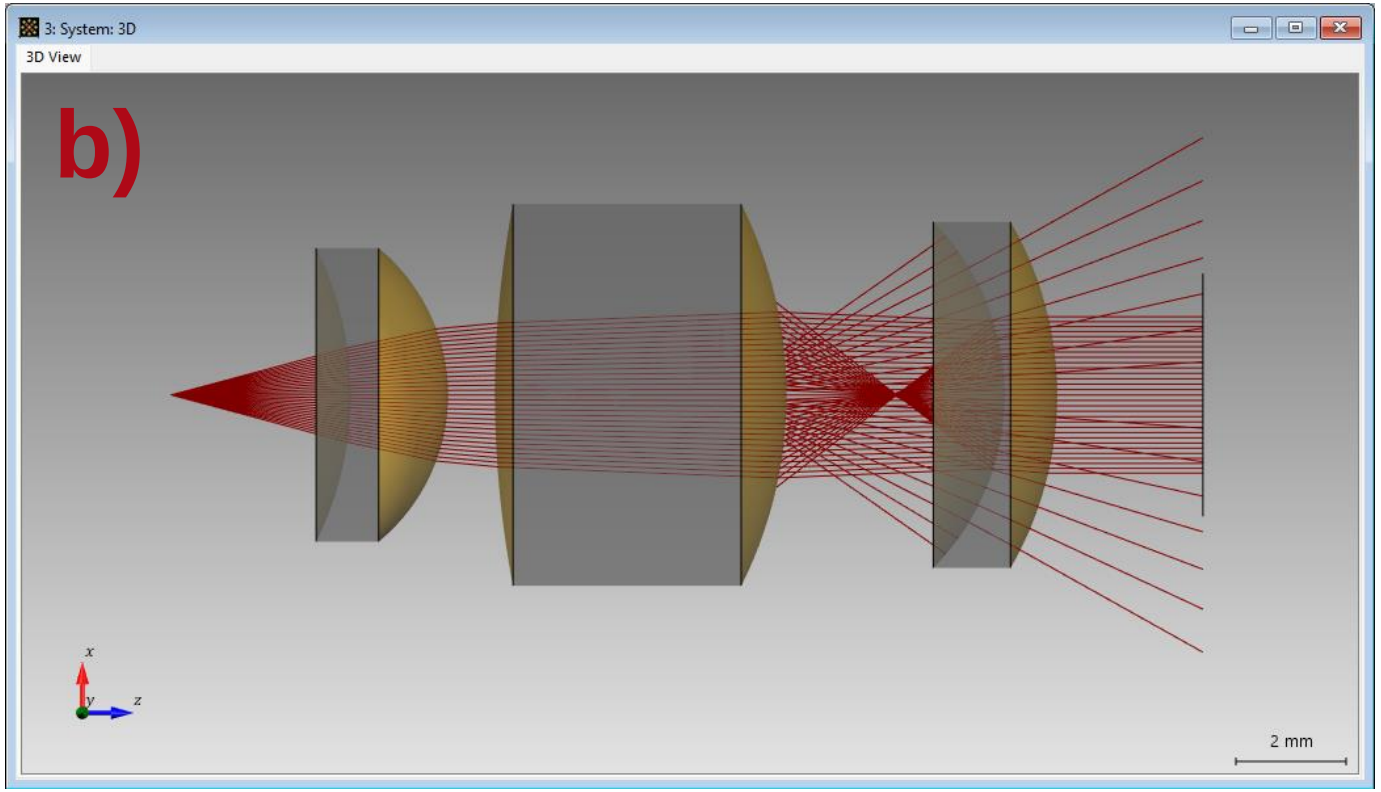
Summary – Components...



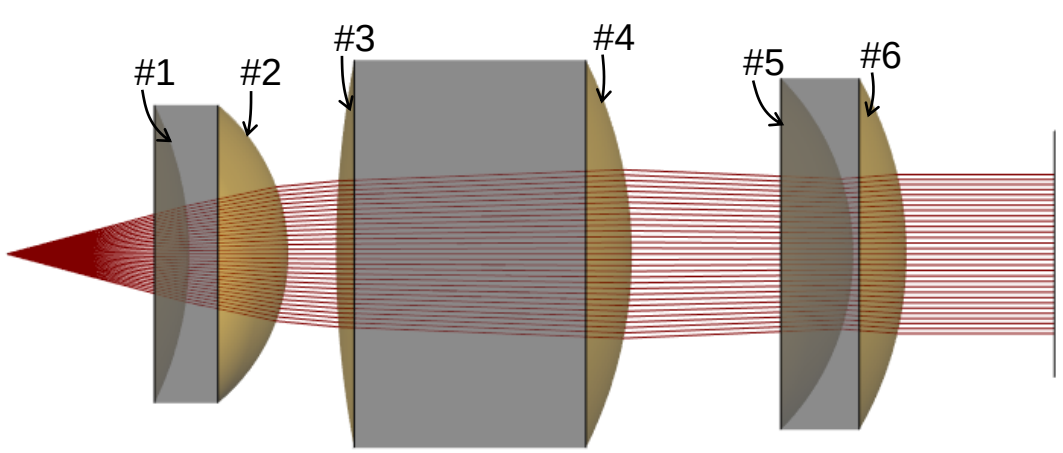
… of Optical System	… in VirtualLab Fusion	Model/Solver/Detected Magnitude
1. source	*Gaussian Wave*	spatial Gaussian formula
2. collimation system	*Lens System Component*	Linear Plane Interface Approximation (LPIA)
3. detector	*Camera Detector*	energy density measurement

System Impressions





Perfect Antireflection (AR) Coating



	#1	#2	#3	#4	#5	#6
+/+	√	√	√	√	√	√
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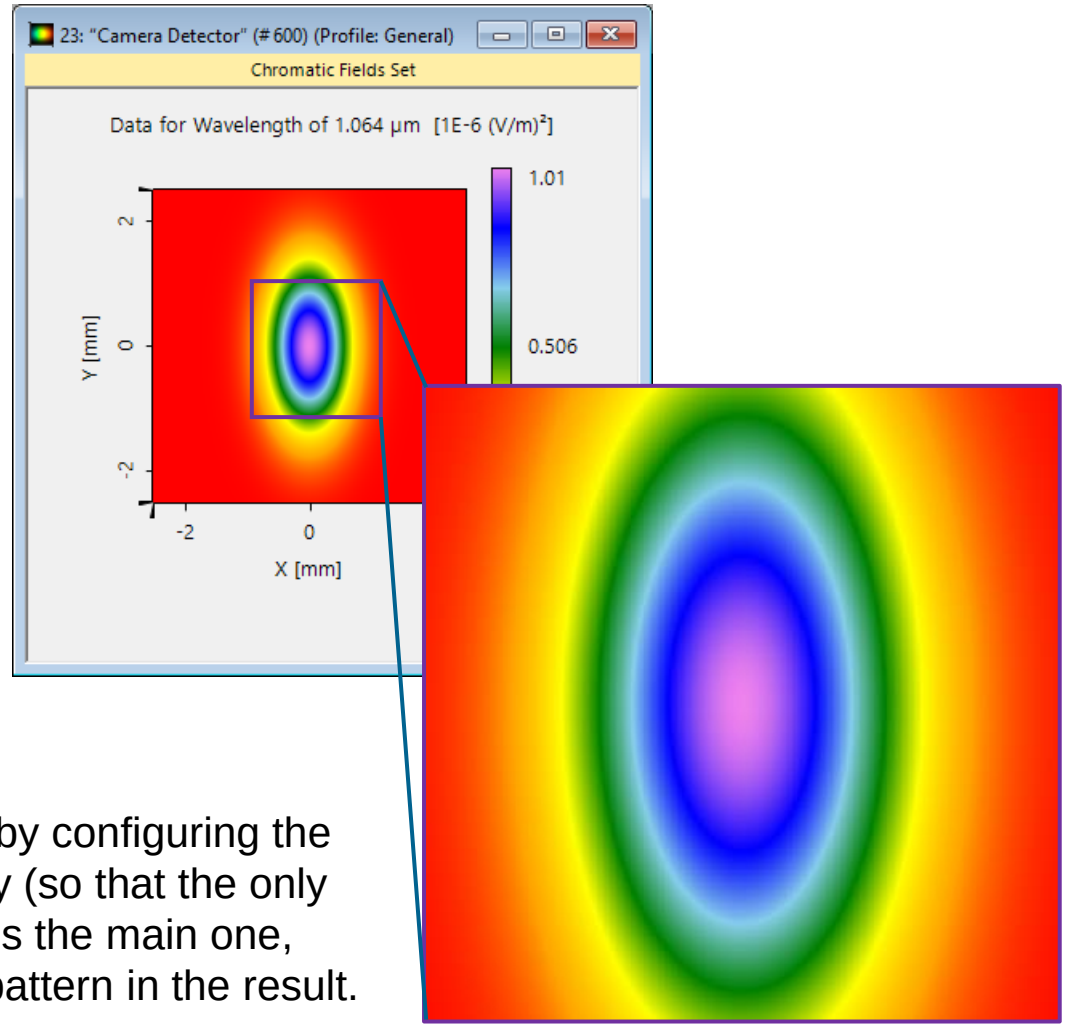
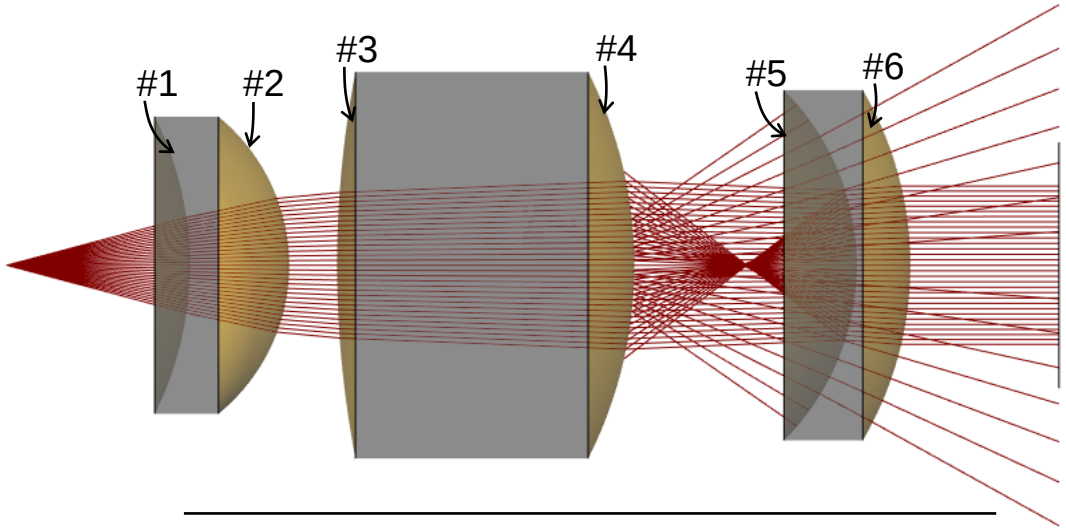
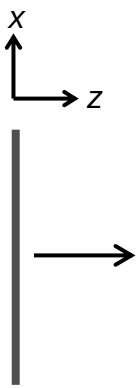
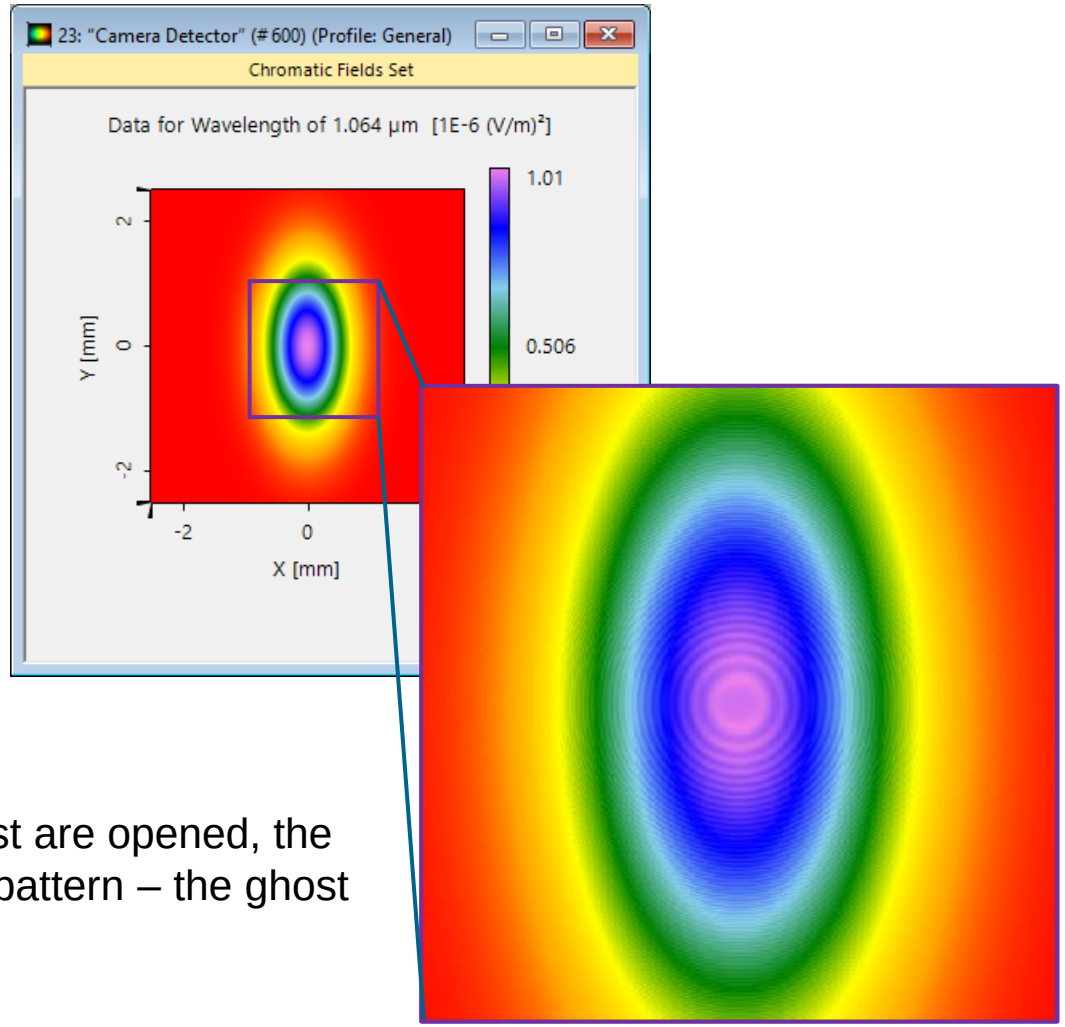


A perfect AR coating is assumed and is modeled here by configuring the surface channels for non-sequential tracing accordingly (so that the only light path allowed in the system by the open channels is the main one, straight through). In this case there is no interference pattern in the result.

With Internal Reflections







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+/+	√	√	√	√	√	√
+/-					√	
-/-						
-/+				√		

When the reflection channels for the surfaces of interest are opened, the multiple internal reflections will create the interference pattern – the ghost images – which appear in the result.

Document Information

title	Investigation of Ghost Imaging Effects in Collimation System
document code	MISC.0021
document version	1.1
software edition	VirtualLab Fusion Basic
software version	2021.1 (Build 1.180)
category	Application Use Case
further reading	• Modeling of Etalon with Planar or Curved Surfaces • Channel Setting for Non-Sequential Tracing