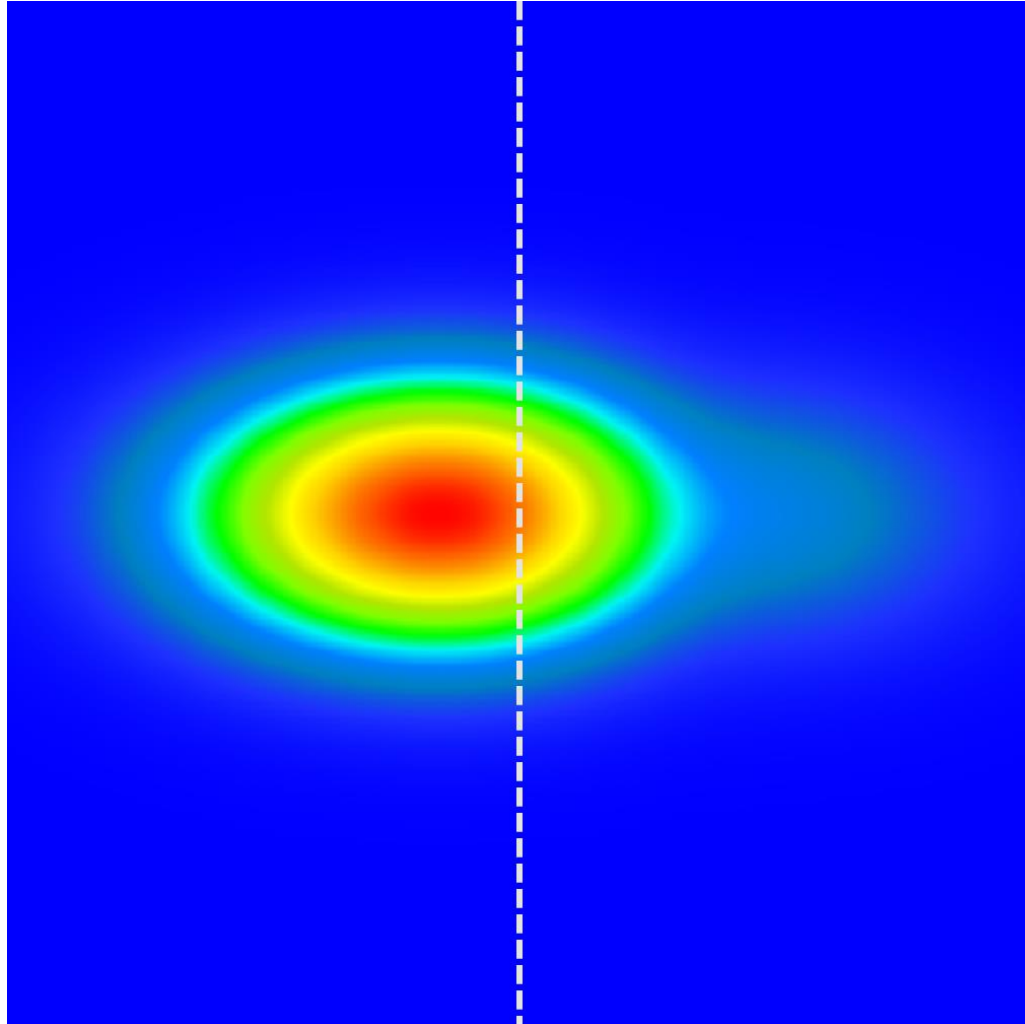


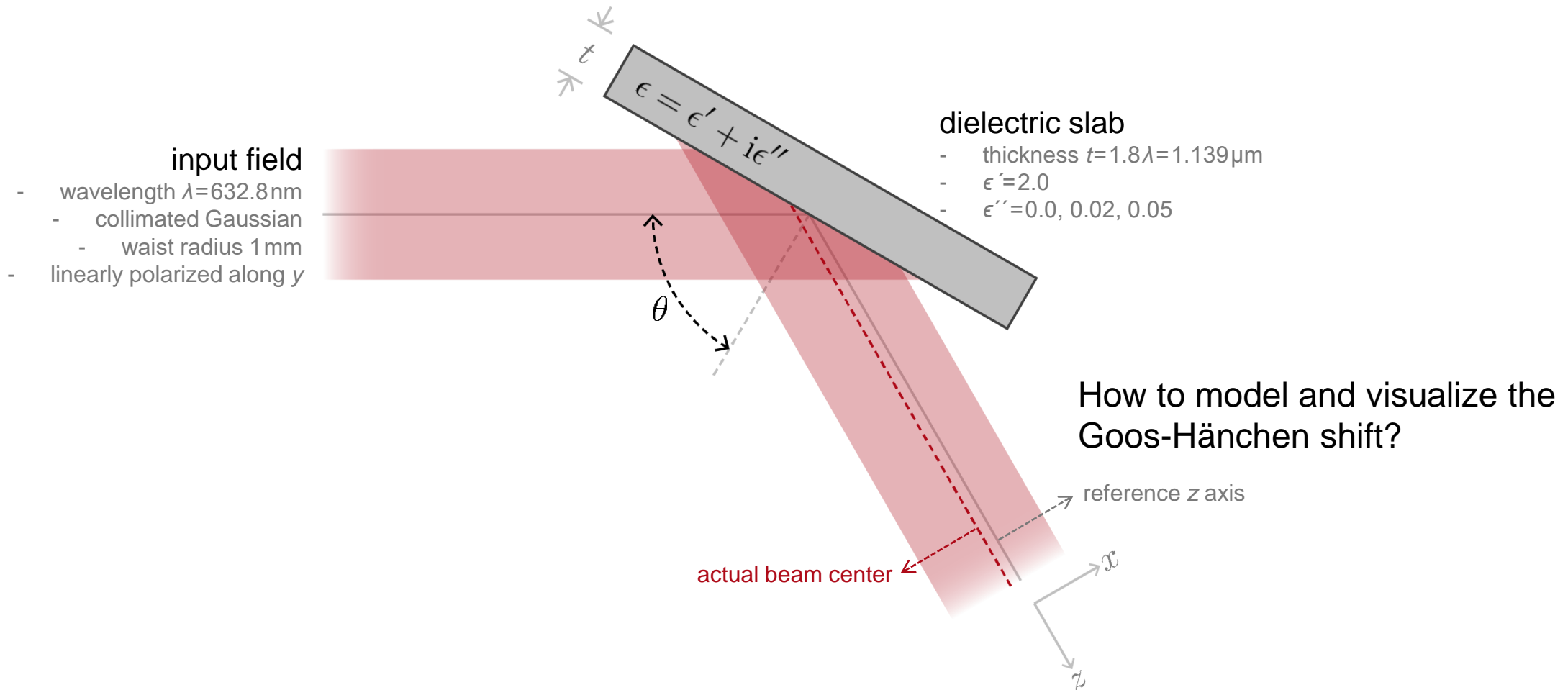
# **Precise Measurement of Goos-Hänchen Shift from Weakly Absorbing Slab**

# Abstract



For a linearly polarized light, when total internal reflection takes place, the reflected beam undergoes a small lateral shift, which is known as the Goos-Hänchen shift. In this example, we demonstrate similar effects for a weakly absorbing dielectric slab, following the theoretical work of L. Wang, *et al.*, but using the numerical modeling technologies in VirtualLab Fusion. The influence from the absorption of the slab medium is investigated. For different medium absorptions, we measure the center of the reflected beam with respect to the incidence angle, and we compare the result with the reference.

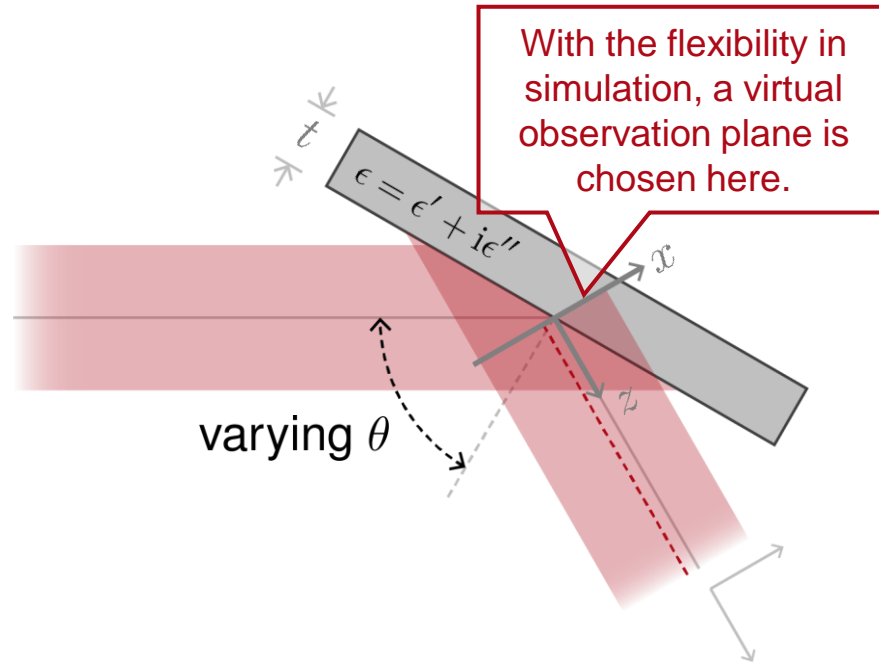
# Modeling Task



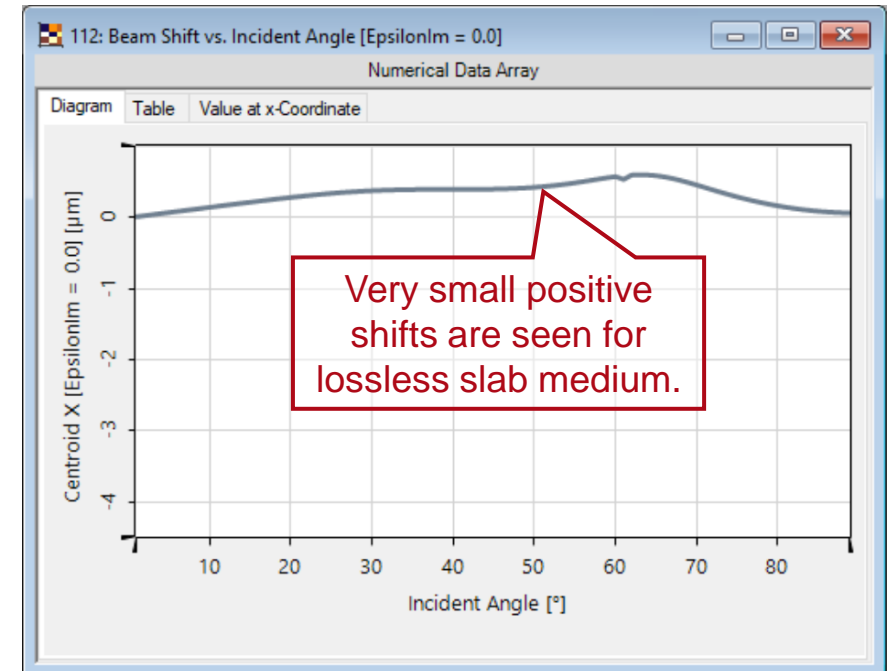
system parameters adapted from L. Wang, *et al.*, Opt. Lett. 30, 2936-2938 (2005)

# Beam Shift vs. Incident Angle

- input field
- wavelength  $\lambda = 632.8 \text{ nm}$
  - collimated Gaussian
    - waist radius 1 mm
  - linearly polarized along y

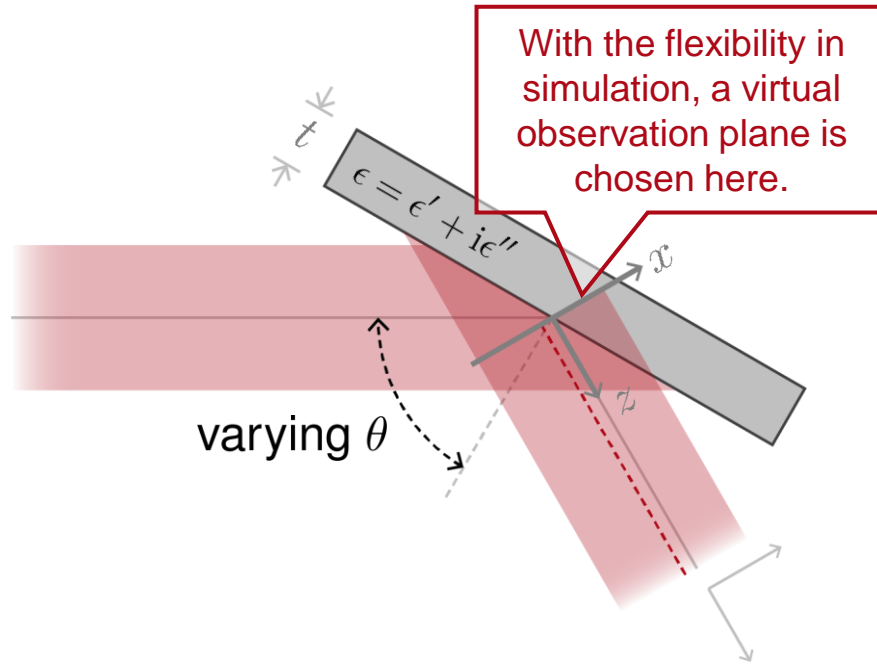


beam shift vs. incident angle ( $\epsilon'' = 0$ )

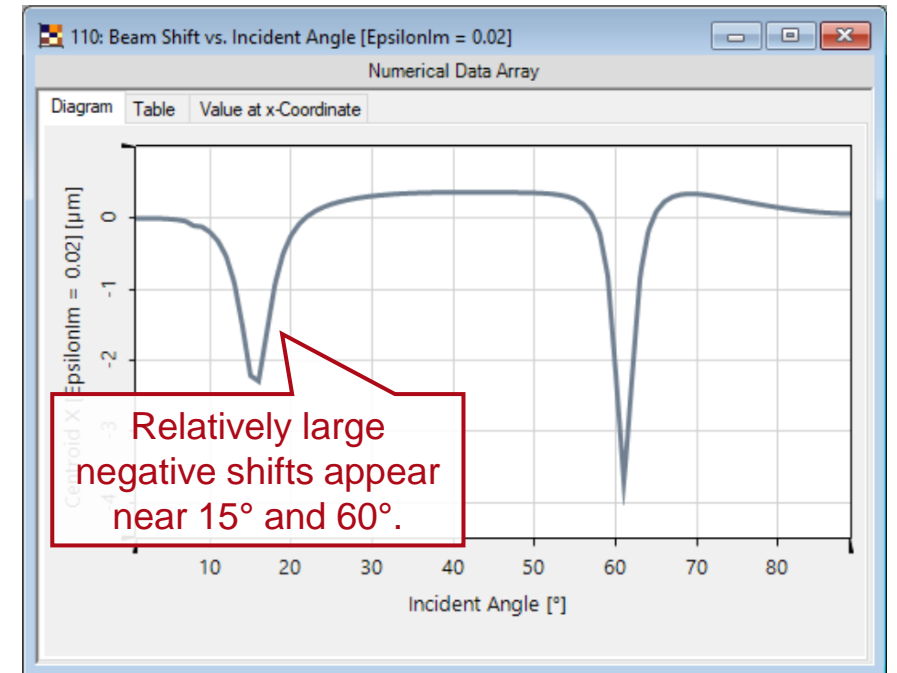


# Beam Shift vs. Incident Angle

- input field
- wavelength  $\lambda=632.8\text{nm}$
  - collimated Gaussian
    - waist radius 1 mm
  - linearly polarized along y

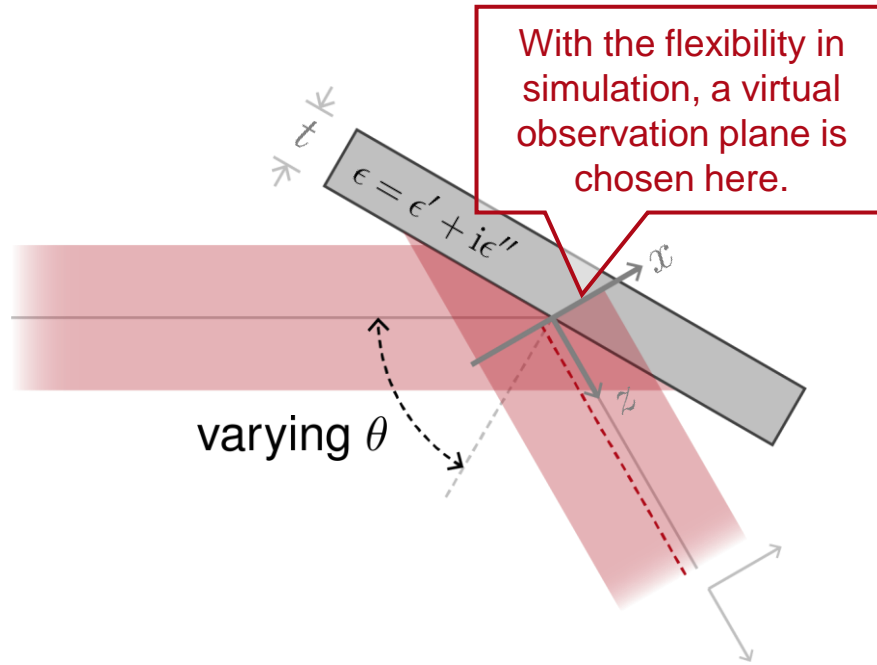


beam shift vs. incident angle ( $\epsilon'' = 0.02$ )

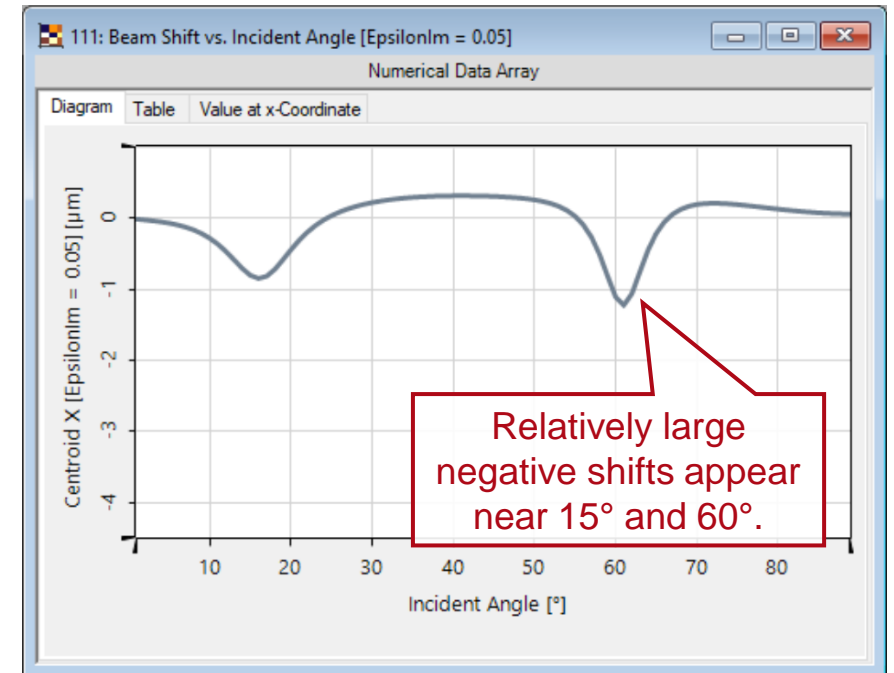


# Beam Shift vs. Incident Angle

- input field
- wavelength  $\lambda=632.8\text{nm}$
  - collimated Gaussian
    - waist radius 1 mm
  - linearly polarized along y



beam shift vs. incident angle ( $\epsilon'' = 0.05$ )



# Beam Shift vs. Incident Angle

- input field
- wavelength  $\lambda=632.8\text{nm}$
  - collimated Gaussian
    - waist radius 1 mm
  - linearly polarized along y

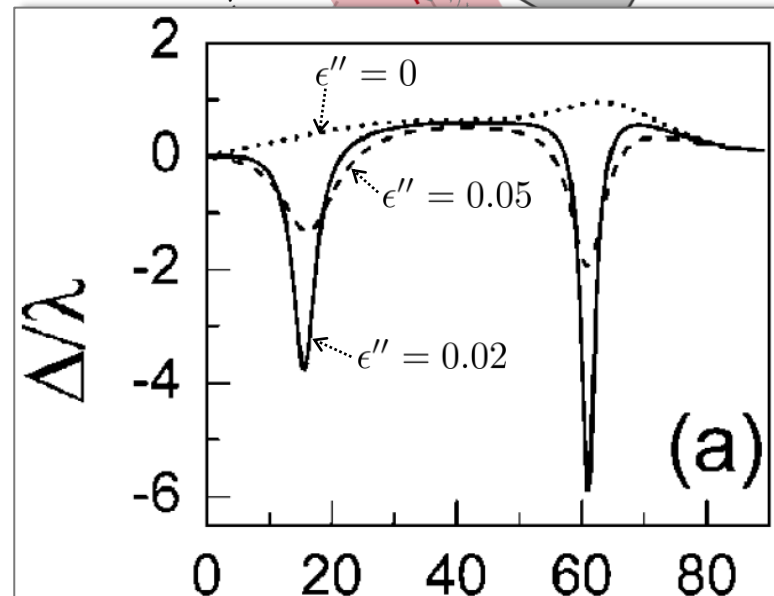
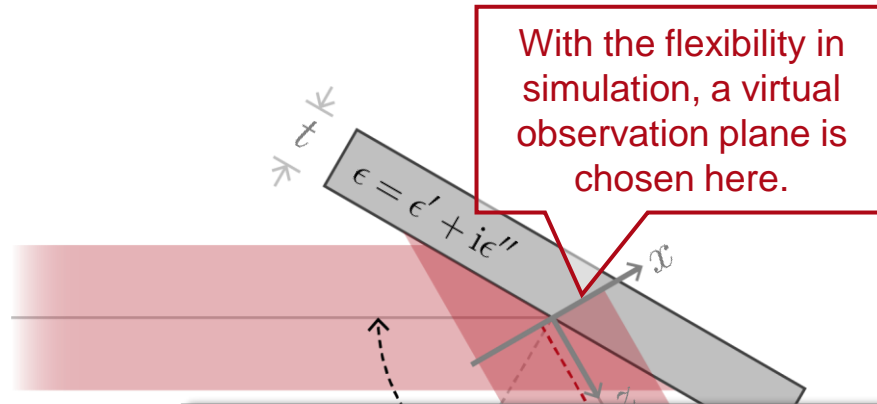
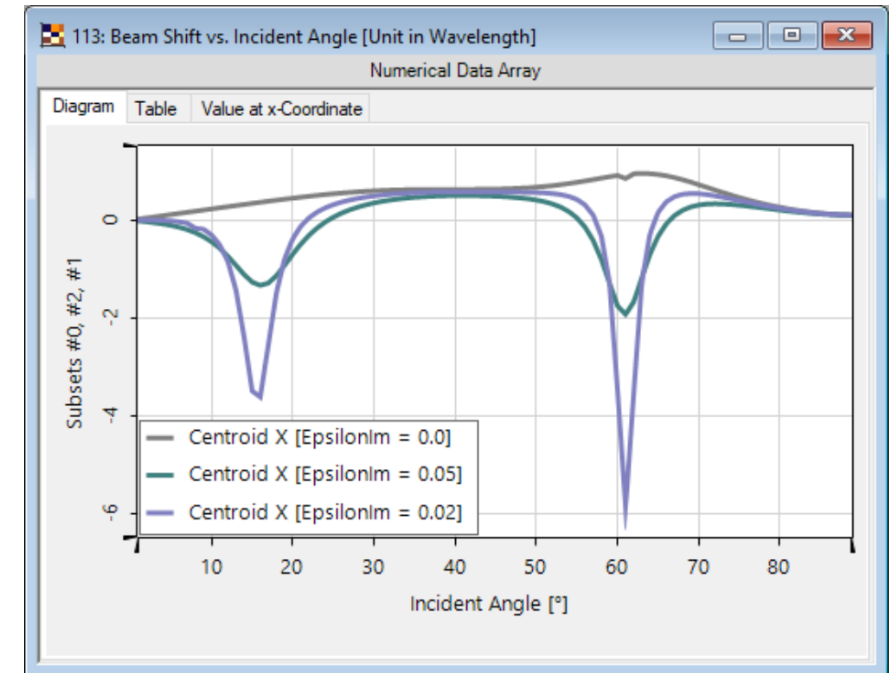
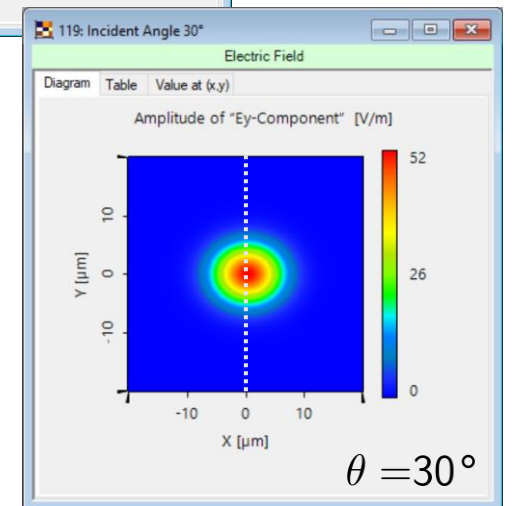
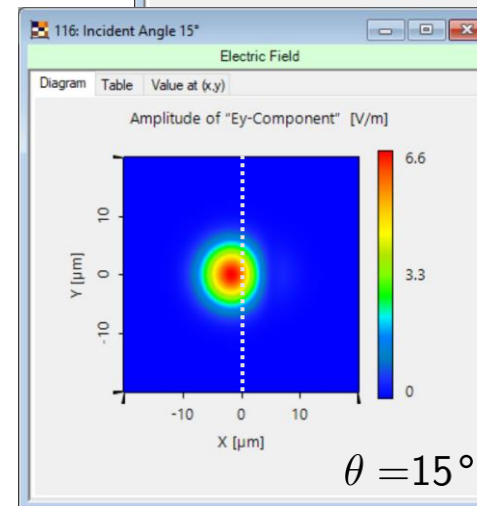
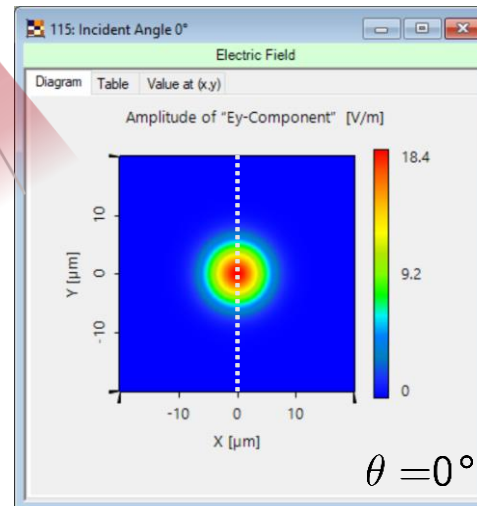
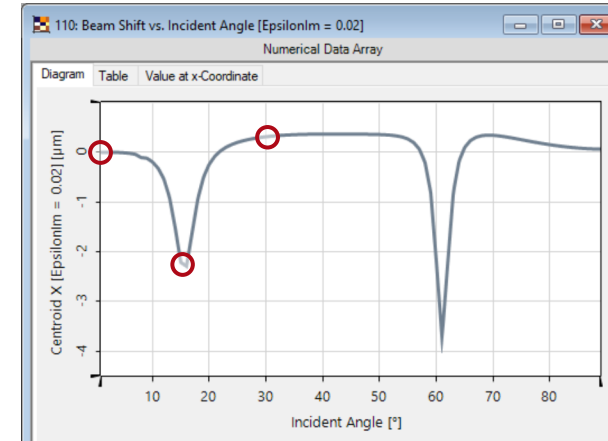
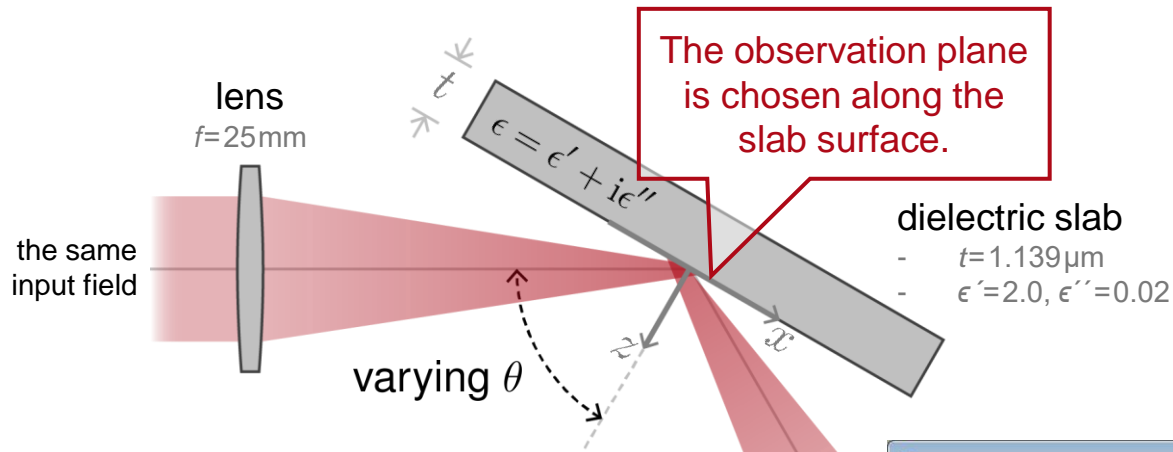


Fig. 2(a) from L. Wang, *et al.*,  
Opt. Lett. 30, 2936-2938 (2005)

beam shift in  $\lambda$  for different values of  $\epsilon''$

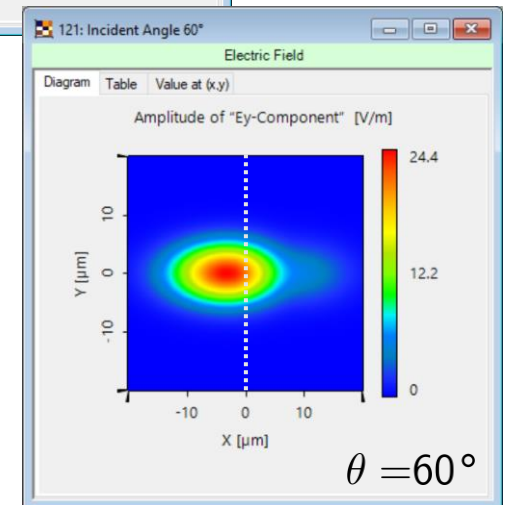
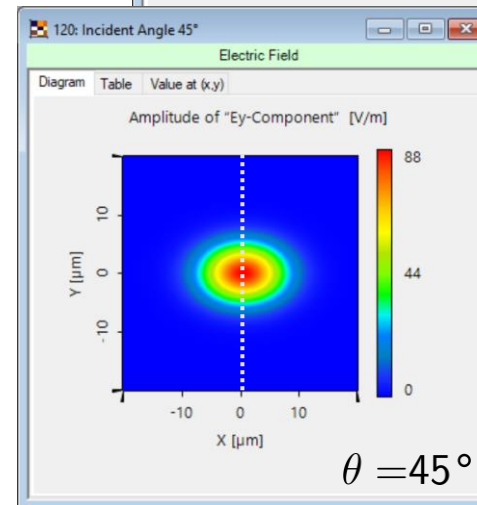
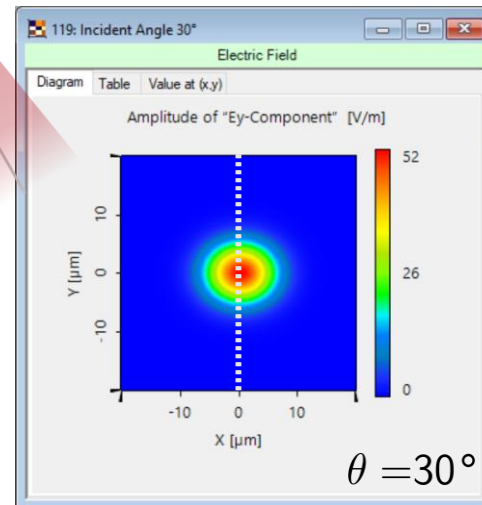
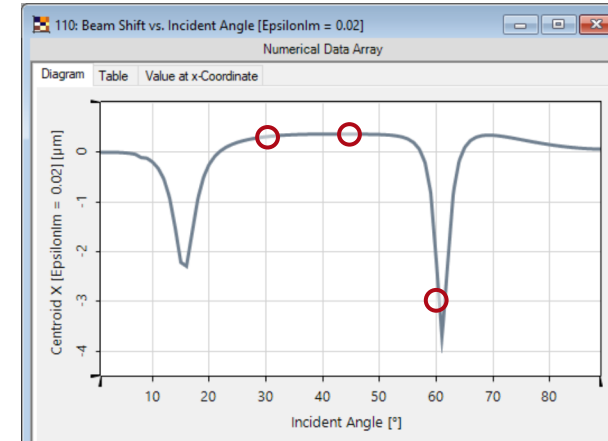
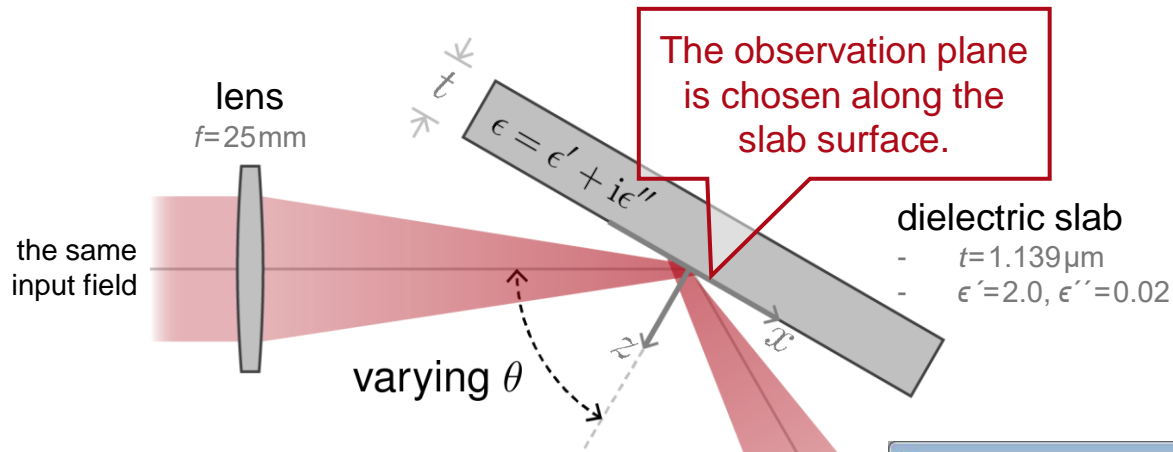


# Observation with Focused Gaussian Beam





# Observation with Focused Gaussian Beam



# Peek into VirtualLab Fusion

## S-Matrix modeling in the k domain for stratified medium

Edit Stratified Media Component

Solver Sampling

Component Solver Layer Matrix [S-Matrix] Edit

The layer matrix solver works in the spatial frequency domain (**k domain**). It consists of

1. an eigenmode solver for each homogeneous layer and
2. an S-matrix for matching the boundary conditions at all surfaces.

The eigenmode solver computes the field solution in the k domain for the homogeneous medium in each layer. The S-matrix algorithm calculates the response of the whole layer system by matching the boundary conditions in a recursive manner. It is well-known for its unconditional numerical stability since, unlike the traditional transfer matrix, it avoids the exponentially growing functions in the calculation steps. [Learn more about this solver.](#)

convenient sweeping over selected parameter(s)

11: C:\Users\...\Goos Hanchen Shift\_02b\_Angle Sweep\_EpsilonIm=0.02.run

Parameter Specification

Set up the parameter(s) to be varied.

You can select one or more parameters which shall be varied as well as the resulting number of iterations. Several [modes](#) are available specifying how the parameters are varied per iteration.

Usage Mode Standard

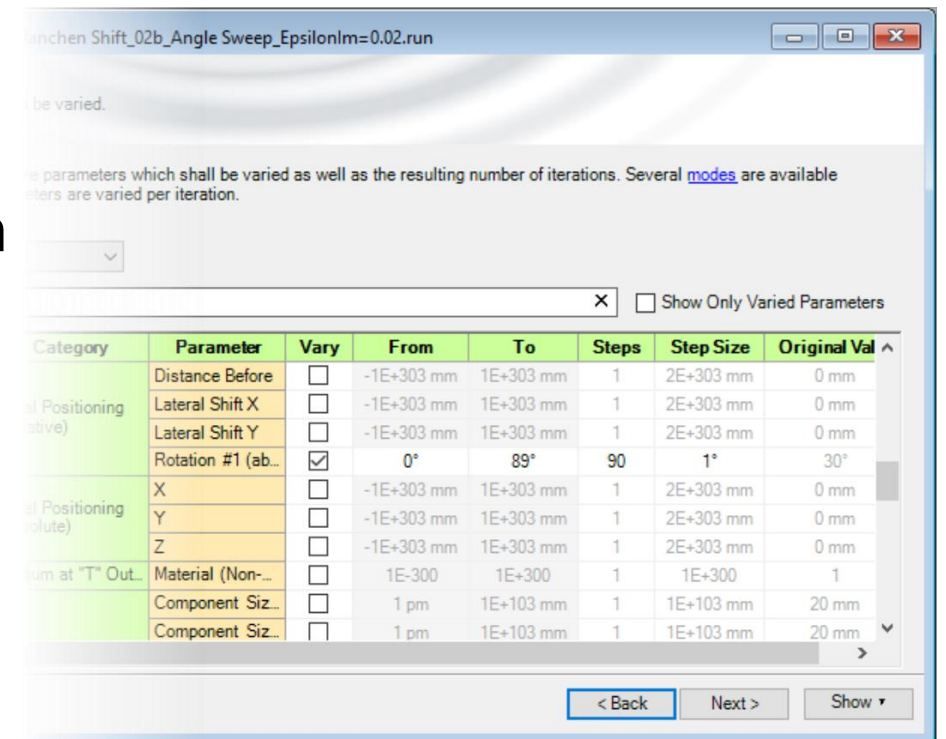
Filter by\_ Show Only Varied Parameters

1	2	Object	Category	Parameter	Vary	From	To	Steps	Step Size	Original Val
		Slab #4	Basal Positioning (Relative)	Distance Before	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	0 mm
	Lateral Shift X			<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	0 mm	
	Lateral Shift Y			<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	0 mm	
				Rotation #1 (ab...	<input checked="" type="checkbox"/>	0°	89°	90	1°	30°
			Basal Positioning (Absolute)	X	<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	0 mm
	Y			<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	0 mm	
	Z			<input type="checkbox"/>	-1E+303 mm	1E+303 mm	1	2E+303 mm	0 mm	
			Medium at "T" Out.	Material (Non-...	<input type="checkbox"/>	1E-300	1E+300	1	1E+300	1
				Component Siz...	<input type="checkbox"/>	1 pm	1E+103 mm	1	1E+103 mm	20 mm
				Component Siz...	<input type="checkbox"/>	1 pm	1E+103 mm	1	1E+103 mm	20 mm

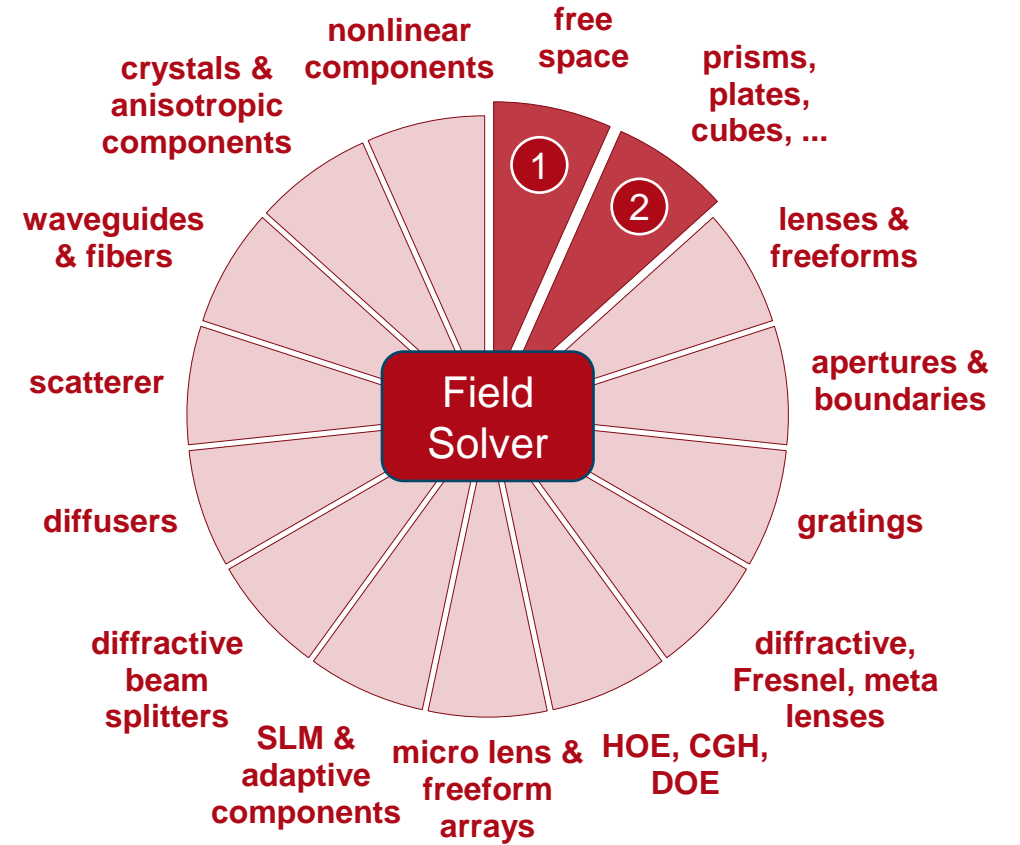
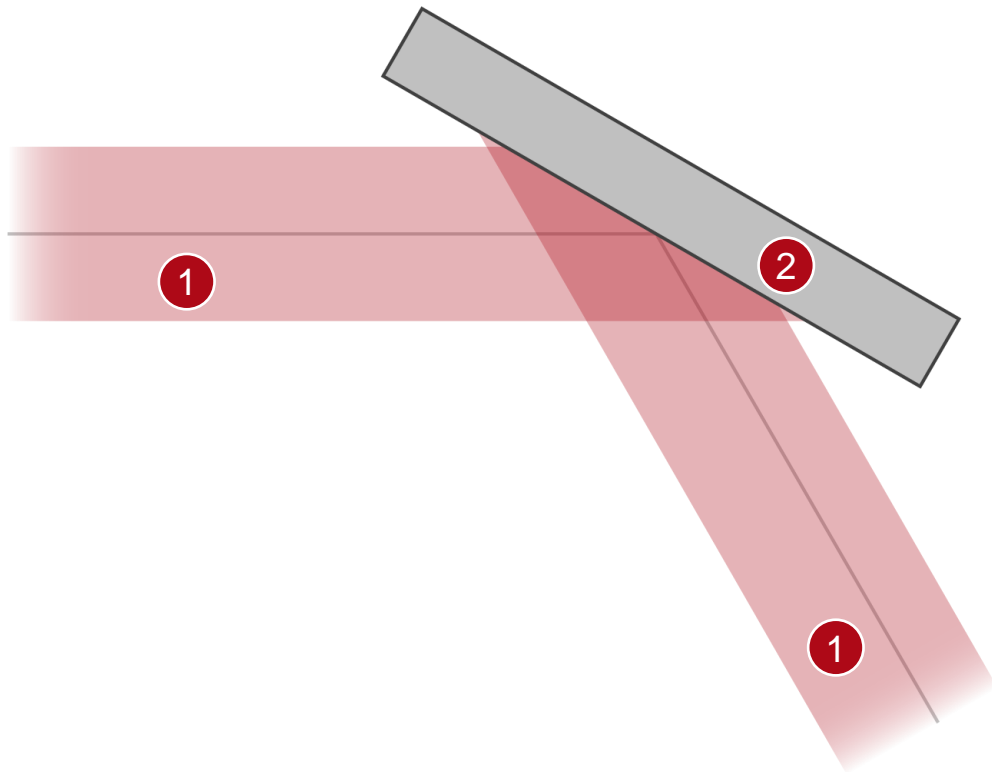
< Back Next > Show ▾

# Workflow in VirtualLab Fusion

- Set the position and orientation of components
  - [LPD II: Position and Orientation](#) [Tutorial Video]
- Construct a stratified medium
- Check influence from selected parameters with Parameter Run
  - [Usage of the Parameter Run Document](#) [Use Case]



# VirtualLab Fusion Technologies



# Document Information

title	Precise Measurement of Goos-Hänchen Shift form Weakly Absorbing Slab
document code	MISC.0084
version	1.0
edition	VirtualLab Fusion Basic
software version	2020.1 (Build 1.238)
category	Application Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#">VirtualLab Fusion Technology – Layer Matrix [S-Matrix]</a></li><li>- <a href="#">VirtualLab Fusion Technology – Fresnel Matrix</a></li></ul>