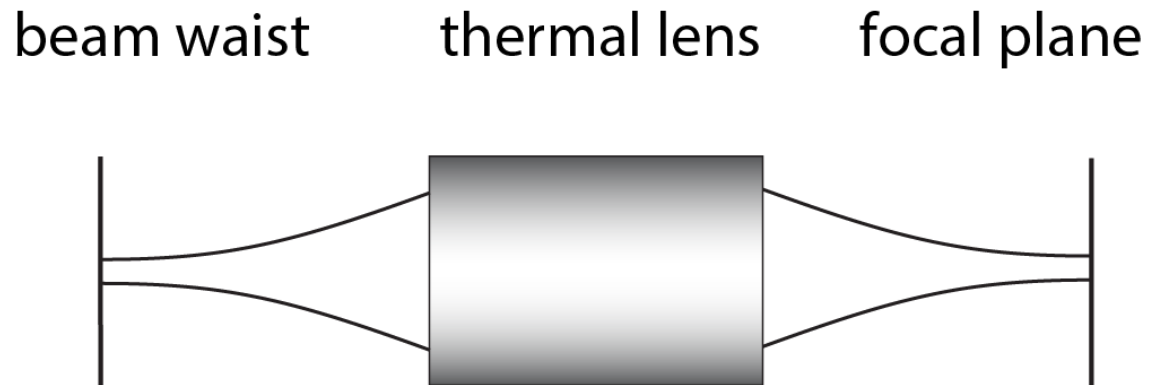


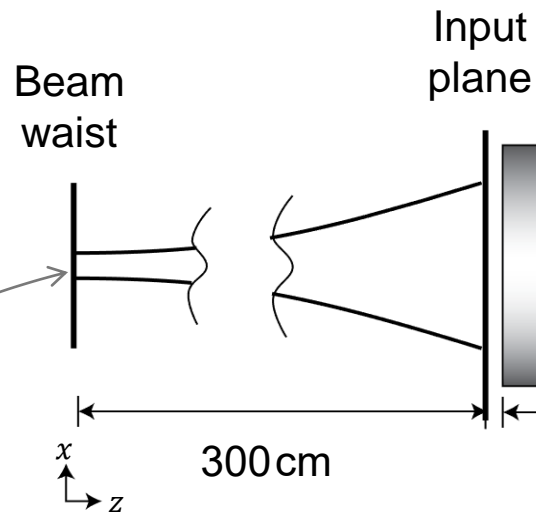
Gaussian Beam Focused by a Thermal Lens

Abstract



Thermal lens effect describes the inhomogeneity of refractive index of medium, which is induced by thermal gradient of a high-power incident laser beam. For a Gaussian beam with specified parameters, the refractive index is mathematically represented as a function of temperature and input power [W. Koechner, Appl. Opt. **9**, 2548–2553 (1970)]. This use case shows the variation of the focal length of the thermal lens, as well as the focus beam diameter when the input power changes. This example is published in [H. Zhong, J. Opt. Soc. Am. A **35**].

Modeling Task



Thermal lens
refractive index distribution

$$n(x, y) = n_0 - \frac{\eta P_{\text{in}}}{4K\pi d} \cdot \frac{\delta n}{\delta T} \cdot \frac{r^2}{r_0^2}$$

r_0	0.31 cm
K	11.1 W/(cm°C)
η	0.05
$\delta n/\delta T$	$7.3 \times 10^{-6} \text{ °C}^{-1}$

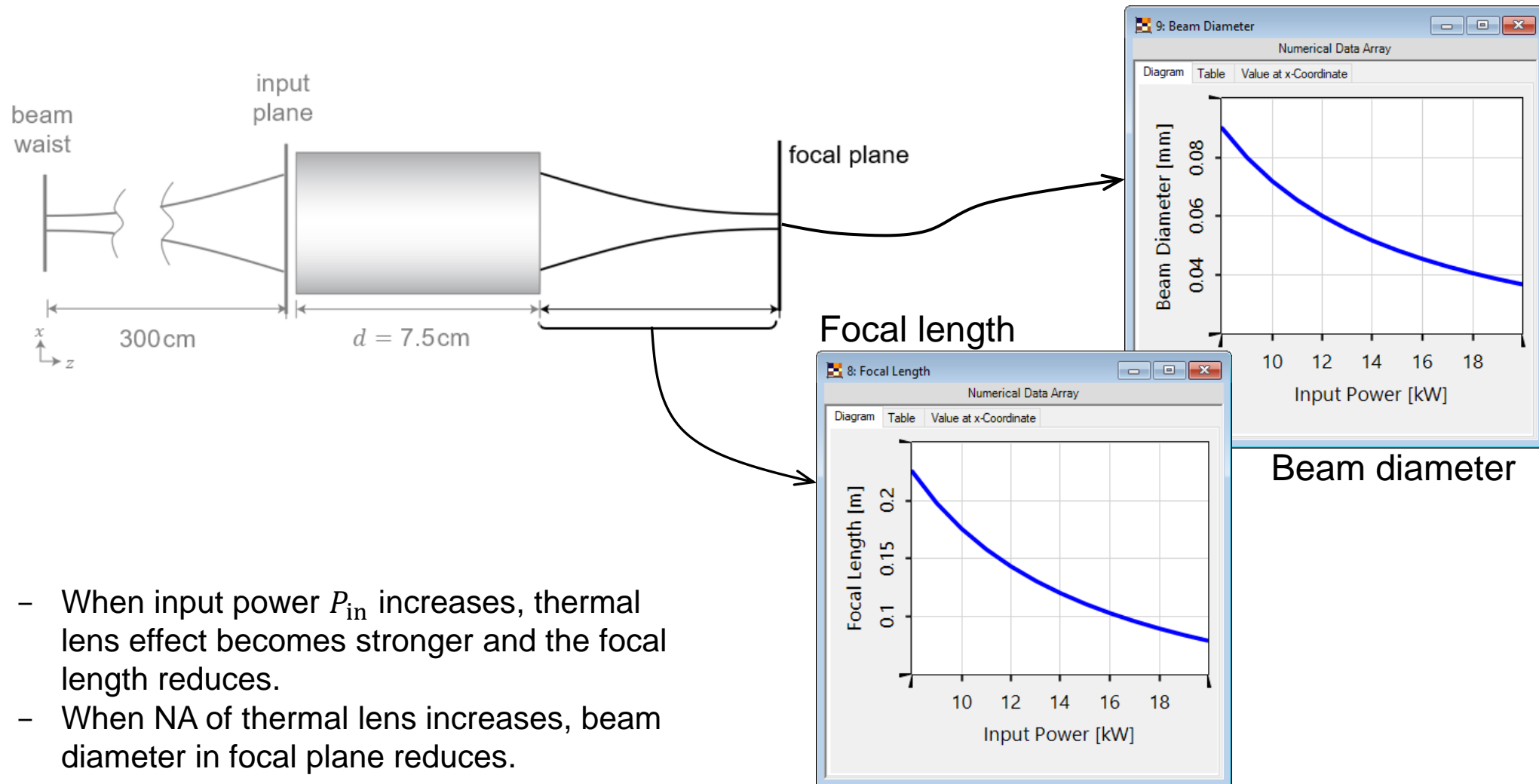
Fundamental Gaussian mode

Wavelength	632.8 nm
Polarization	Linear in x-direction
Waist radius	760 μm
Input power P_{in}	8 to 20 kW

Task 1: evaluation of
the variation of focal
length with varying P_{in}

Task 2: evaluation of
the variation of beam
size with varying P_{in}

Results



Peek into VirtualLab Fusion

**Customizable
graded-index
media**

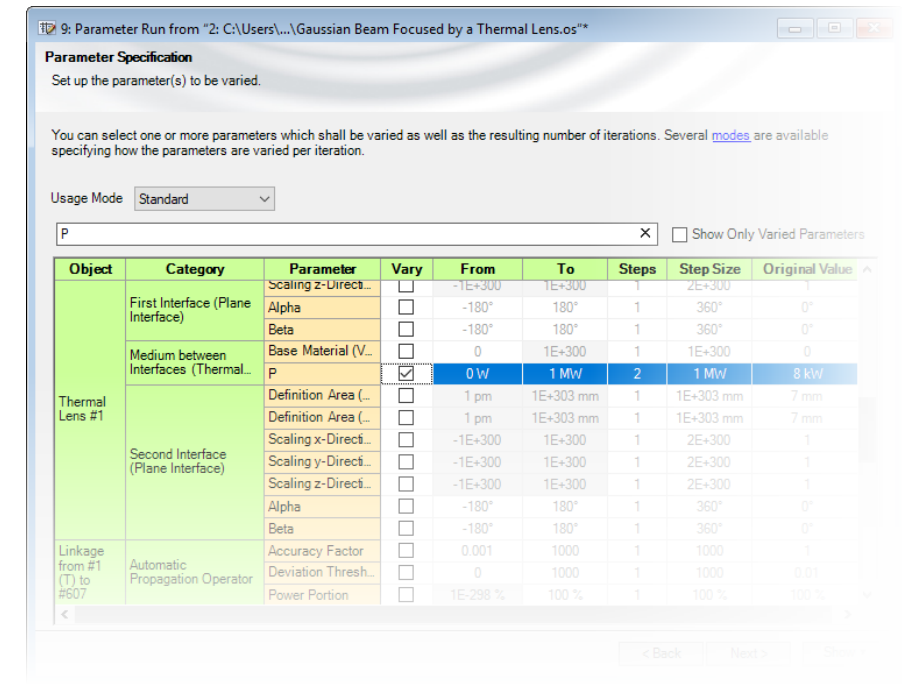
The image displays four overlapping windows from the VirtualLab Fusion software interface:

- Edit Programmable Medium (x-y-z-Modulated):** Shows the 'Basic Parameters' tab with 'Base Material' set to 'Vacuum' and 'State of Matter' set to 'Gas or Vacuum'. The 'Index Modulation' section has 'Index Distribution' selected. The 'Parameters' section shows 'P' as '8 kW' and 'r0' as an empty field.
- Source Code Editor:** Displays a script for defining a graded-index medium. The code includes comments and variables for material properties and refractive index modulation.
- Preview for Thermal Lens:** Shows a 2D plot of the 'Real Part of "Refractive Index"' as a function of 'X [mm]'. The plot shows a constant value of 1.8229 across the range from -0.4 to 0.4 mm.
- Edit Beam Parameters:** Shows the 'Detector Window and Resolution' tab. It lists various beam parameters (Diameter X, Diameter Y, Waist Diameter X, etc.) and selection tools. The 'Calculate Beam Parameters Relative to the Centroid' checkbox is checked.

**Detector for Gaussian beam
parameters**

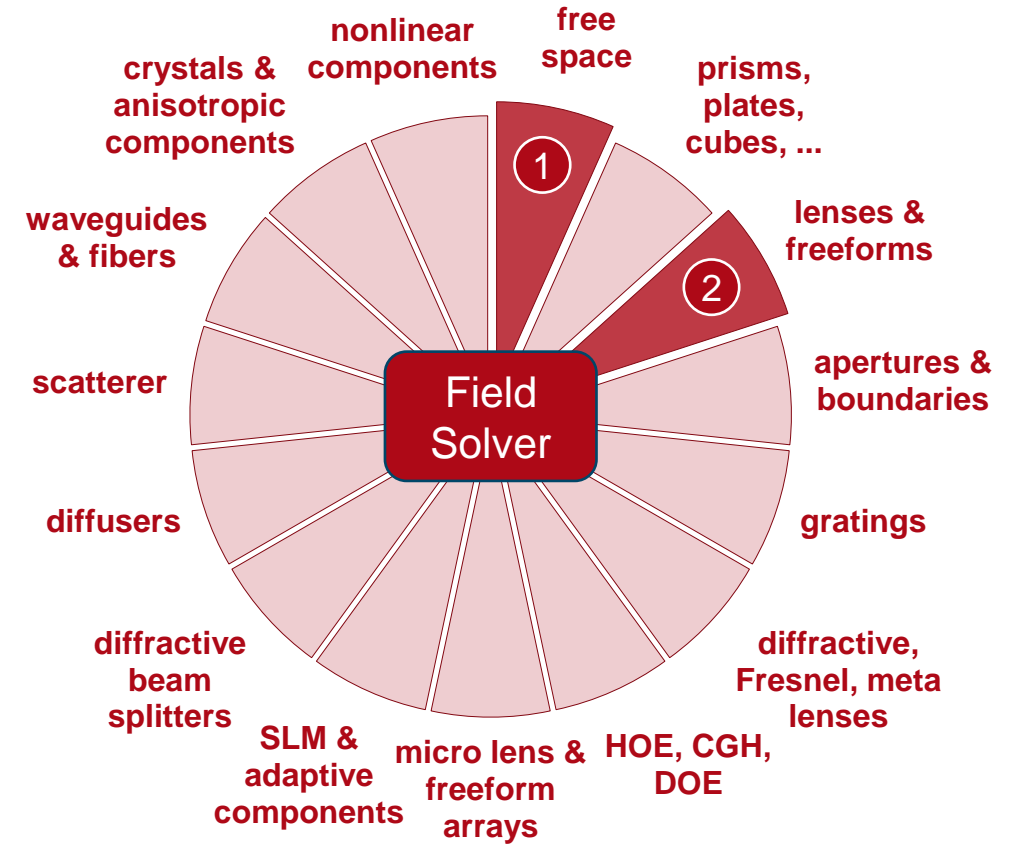
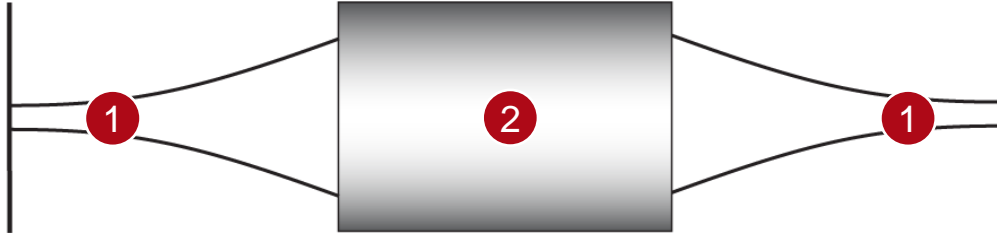
Workflow in VirtualLab Fusion

- Set up input Gaussian field
 - [Basic Source Models](#) [Tutorial Video]
- Customize the graded-index medium
 - [How to Work with the Programmable Medium and Example \(Thermal Lens\)](#) [Use Case]
- Use the Parameter Run
 - [Usage of Parameter Run](#) [Use Case]



VirtualLab Fusion Technologies

beam waist thermal lens focal plane



idealized component

Document Information

title	Gaussian Beam Focused by a Thermal Lens
document code	GRIN.0004
version	1.2
edition	VirtualLab Fusion Basic
software version	2020.1 (Build 1.202)
category	Application Use Case
further reading	<ul style="list-style-type: none">- <u>Construction and Modeling of a Graded-Index Lens</u>- <u>Modeling of Graded-Index (GRIN) Multimode Fiber</u>