Gaussian Beam Focused by a Thermal Lens
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

### Fundamental Gaussian Mode

- **Wavelength**: 632.8 nm
- **Polarization**: Linear in x-direction
- **Waist Radius**: 760 µm
- **Input Power $P_{in}$**: 8 to 20 kW

### Thermal Lens Refractive Index Distribution

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

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

### Tasks

**Task 1**: Evaluation of the variation of focal length with varying $P_{in}$

**Task 2**: Evaluation of the variation of beam size with varying $P_{in}$
When input power $P_{in}$ increases, thermal lens effect becomes stronger and the focal length reduces;

- When NA of thermal lens increases, beam diameter in focal plane reduces.
Peek into VirtualLab Fusion

customizable graded-index media

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

Field Solver

1. crystals & anisotropic components
2. lenses & freeforms

- free space
- prisms, plates, cubes, ...
- apertures & boundaries
- gratings
- diffractive, Fresnel, meta lenses
- HOE, CGH, DOE
- micro lens & freeform arrays
- SLM & adaptive components
- diffractive beam splitters
- waveguides & fibers
- scatterer
- diffusers

# idealized component
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