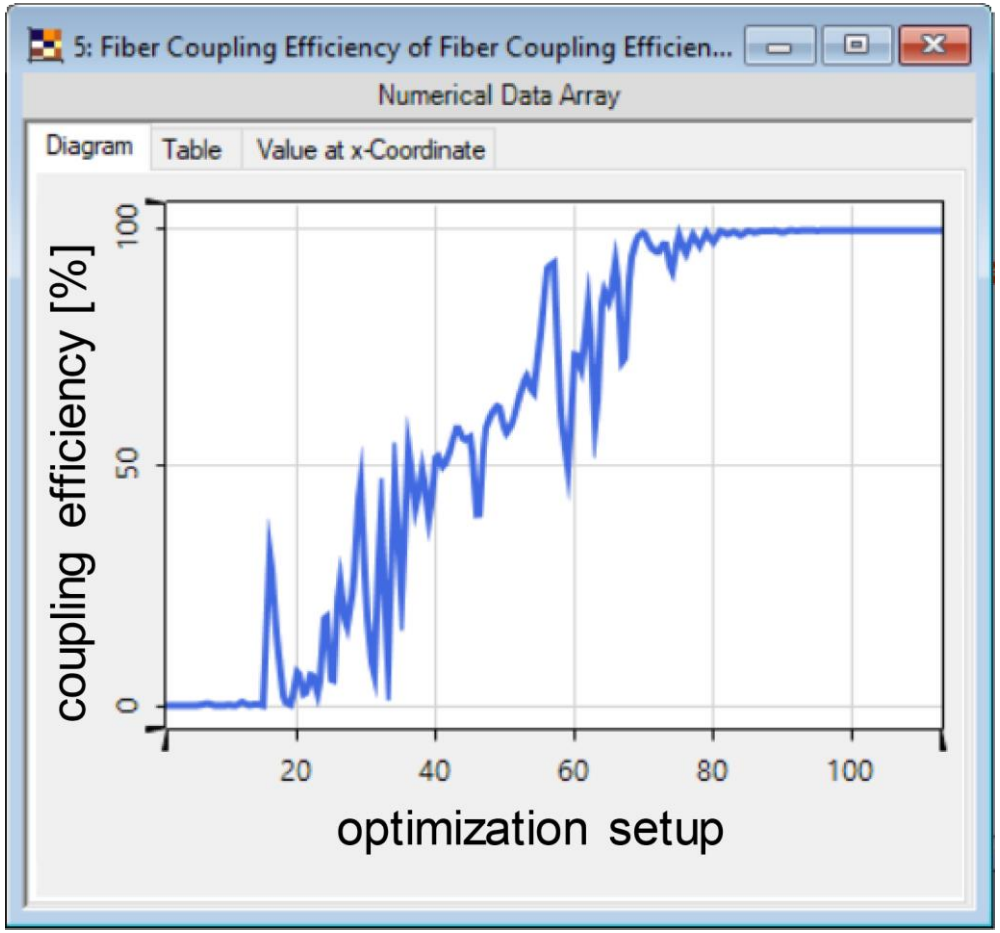
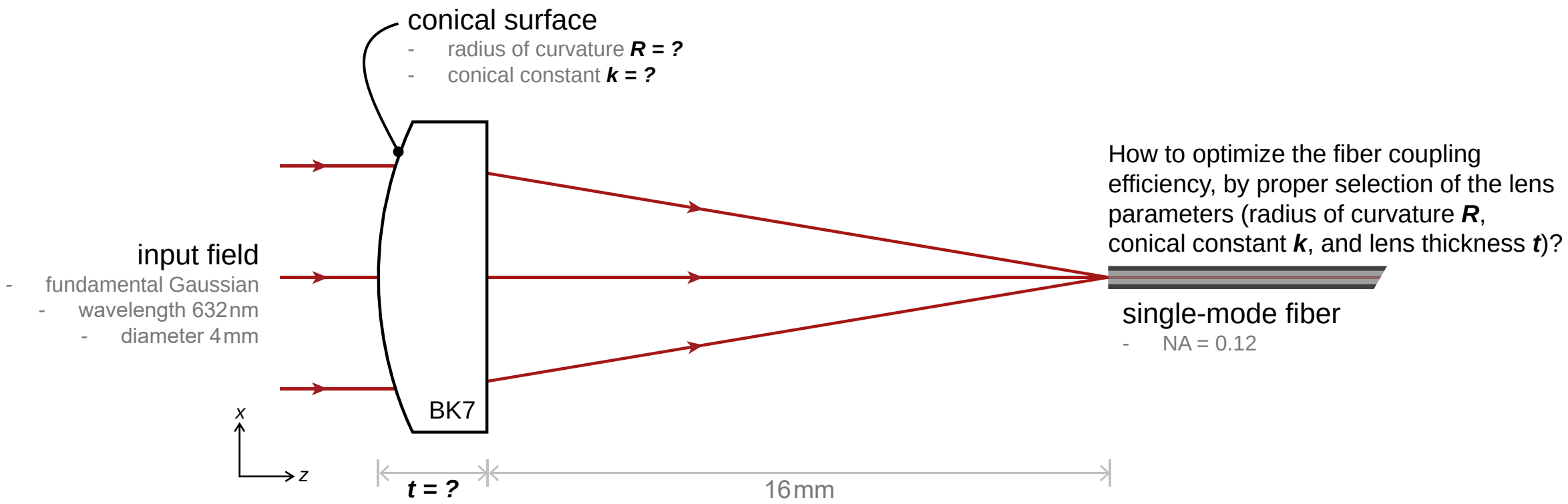
Parametric Optimization of Fiber Coupling Lens

Abstract



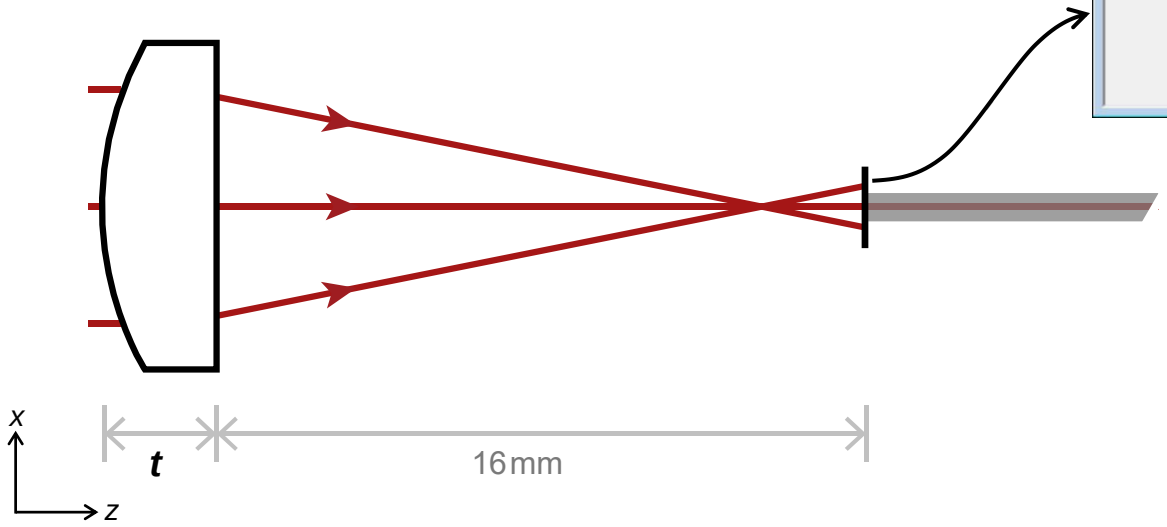
In modern optics, fibers can be found in various optical system. To have an efficient use of light power, the fiber coupling lens must be well designed, to ensure that the focal spot matches with the mode of the fiber. With the fast physical optics simulation and the parametric optimization in VirtualLab, we show the design of a lens with conical surface for the task of coupling light into a single-mode fiber.

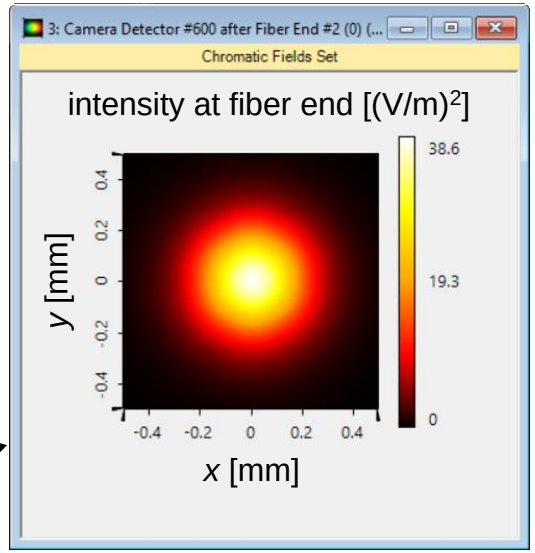
Design Task


conical surface
- radius of curvature R = ?
- conical constant k = ?
input field
- fundamental Gaussian
- wavelength 632 nm
- diameter 4 mm
BK7
x
z
t = ?
16 mm
How to optimize the fiber coupling efficiency, by proper selection of the lens parameters (radius of curvature R, conical constant k, and lens thickness t)?
single-mode fiber
- NA = 0.12

Evaluation of Initial Setup

initial lens parameters
- radius of curvature ***R***=8mm
- conical constant ***k***=0
- lens thickness ***t***=3mm



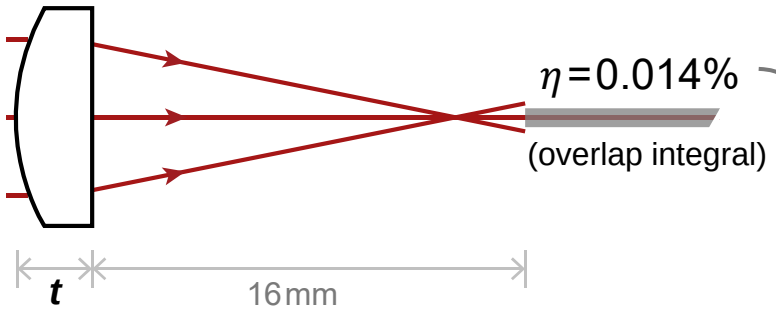


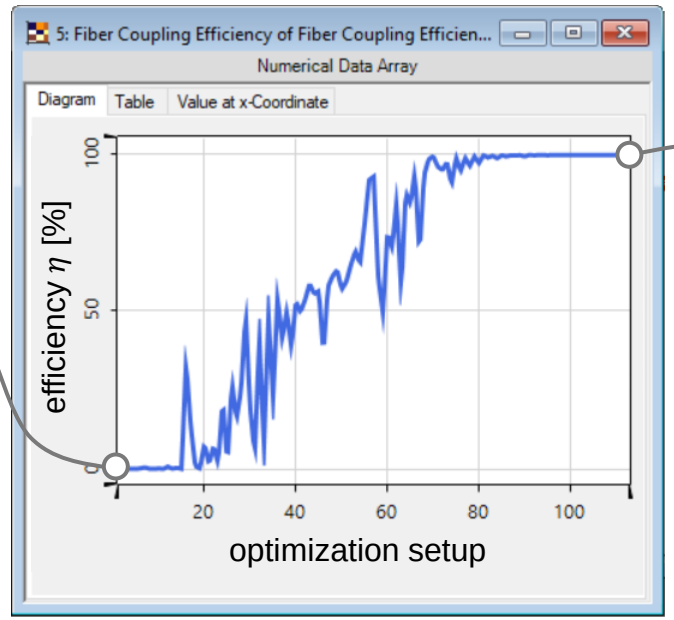
Focal plane is in front of the end of the fiber, and the spot size is much large than the fiber core. It leads to almost zero coupling efficiency.

coupling efficiency η=0.014%
(overlap integral calculation)

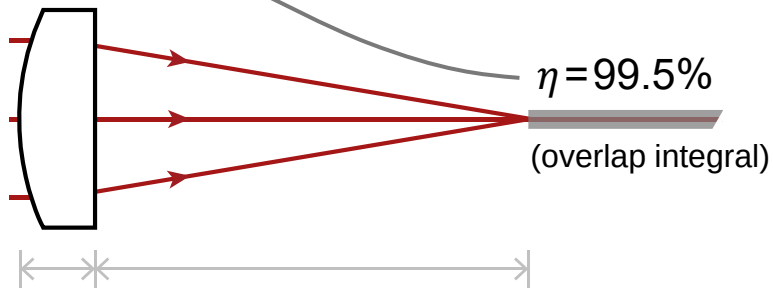
Parametric Optimization

initial lens parameters
- radius of curvature ***R***=8mm
- conical constant ***k***=0
- lens thickness ***t***=3mm





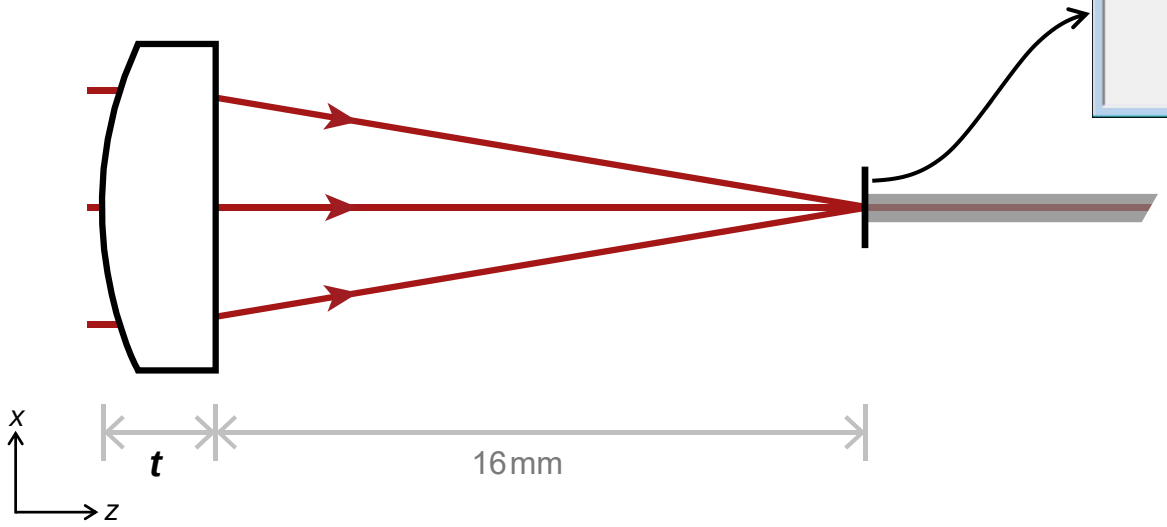
parametric optimization of coupling efficiency with downhill simplex algorithm

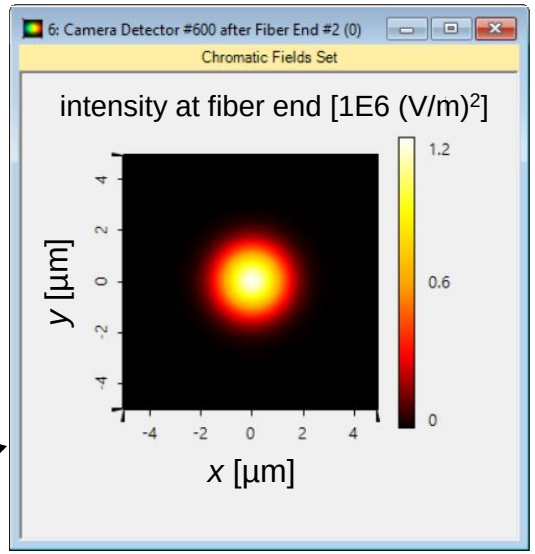


optimized lens parameters
- radius of curvature ***R***=9.1789mm
- conical constant ***k***=-0.57508
- lens thickness ***t***=2.756mm

Evaluation of Optimization Result

initial lens parameters
- radius of curvature ***R***= 9.1789mm
- conical constant ***k***=-0.57508
- lens thickness ***t***= 2.756mm





After optimization, the focal plane lies on the end of the fiber and a small Gaussian-shape spot is generated. That gives a high coupling efficiency.

coupling efficiency η = 99.5%
(overlap integral calculation)

Document Information

title	Parametric Optimization of Fiber Coupling Lens
version	1.0
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category	Application Use Case