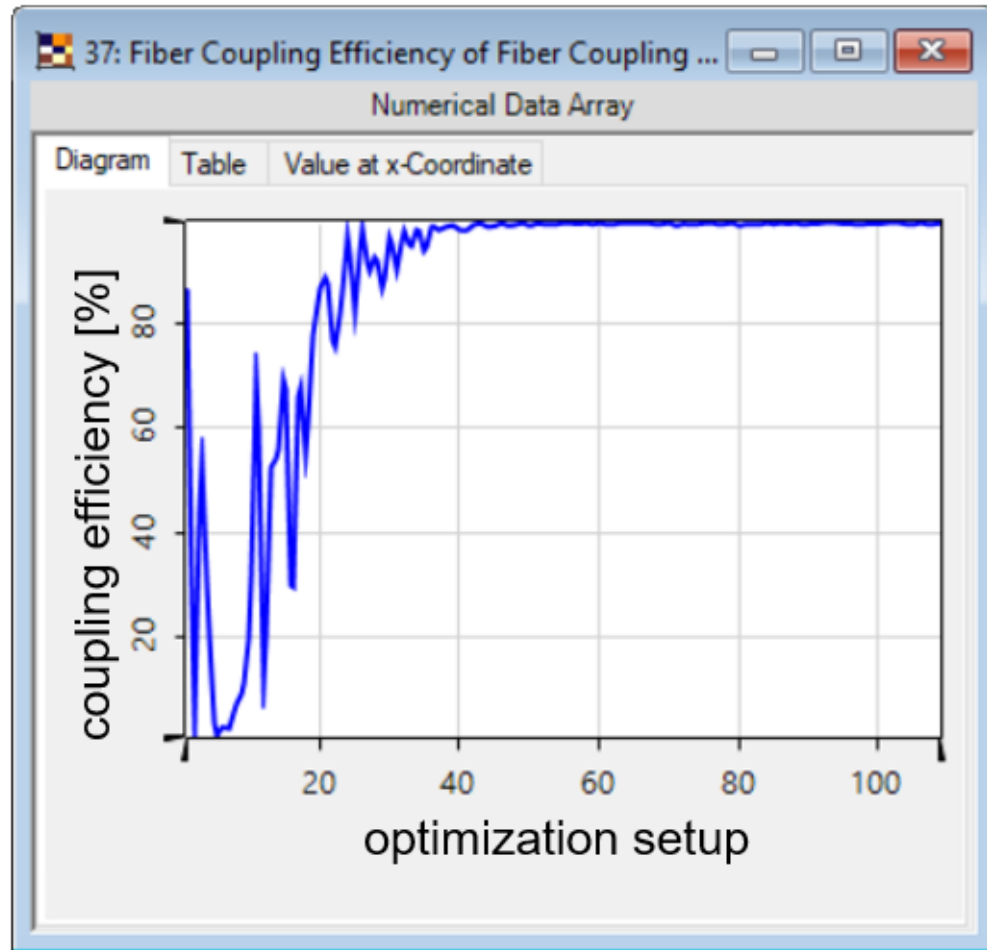


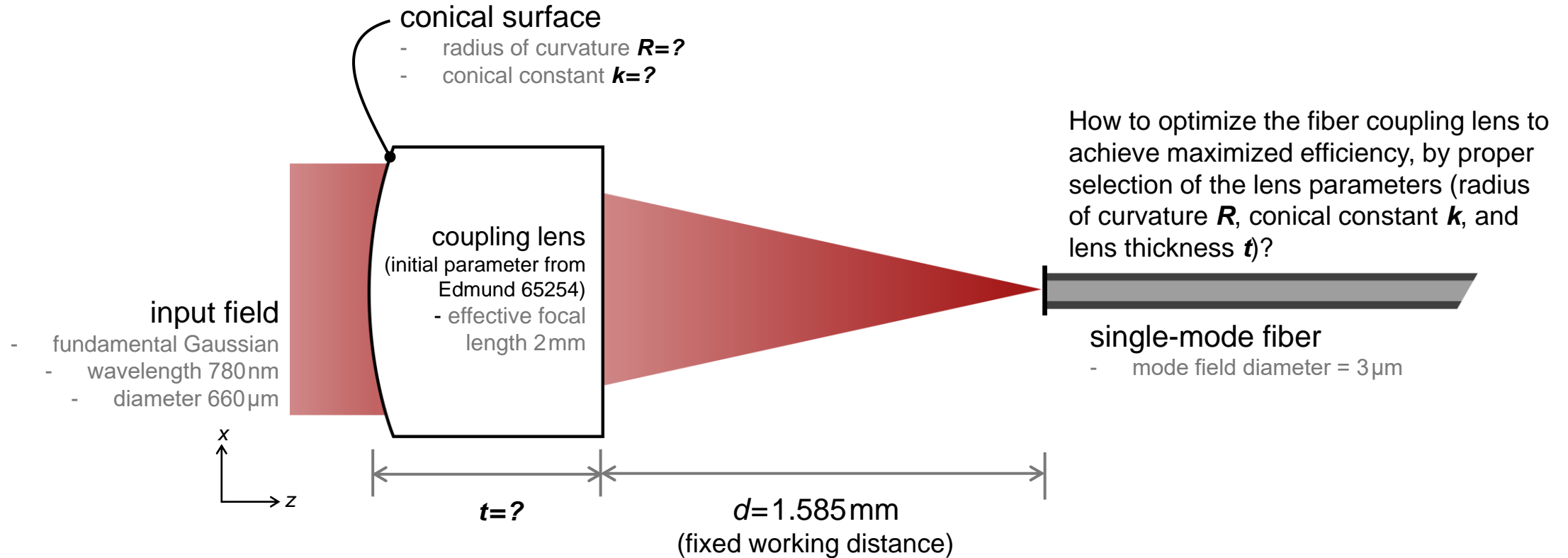
# Parametric Optimization of Fiber Coupling Lenses

# 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 to the propagating mode inside 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.

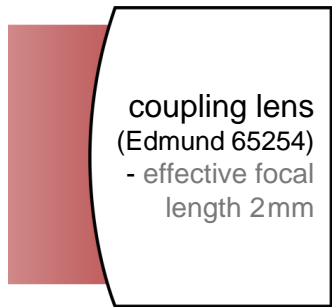
# Design Task



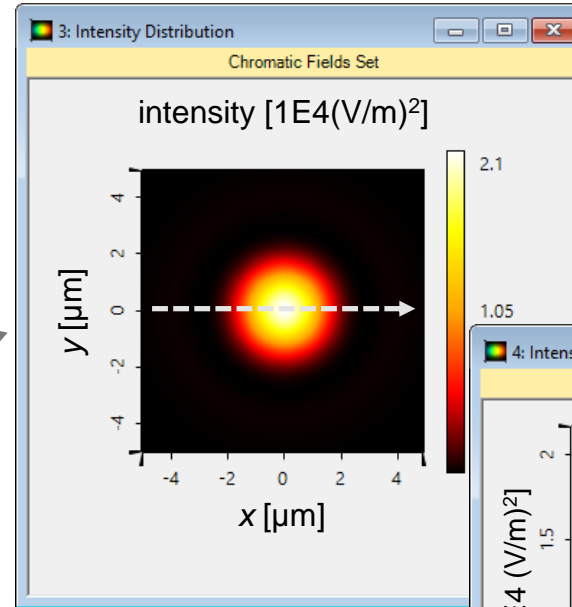
# Evaluation of Initial Lens

## initial lens parameters

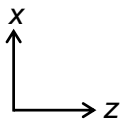
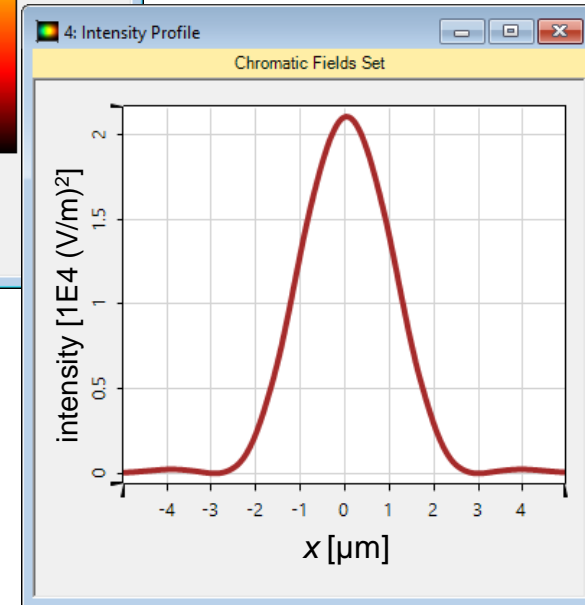
- radius of curvature  $R=1.7\text{mm}$
- conical constant  $k=0$
- lens thickness  $t=0.8\text{mm}$



coupling efficiency  $\eta=88.6\%$   
(overlap integral calculation)



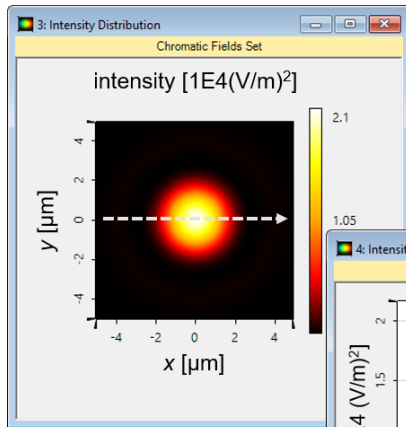
The coupling efficiency obtained from the initial spherical lens is not optimal, due to mismatch to the mode inside the single-mode fiber.



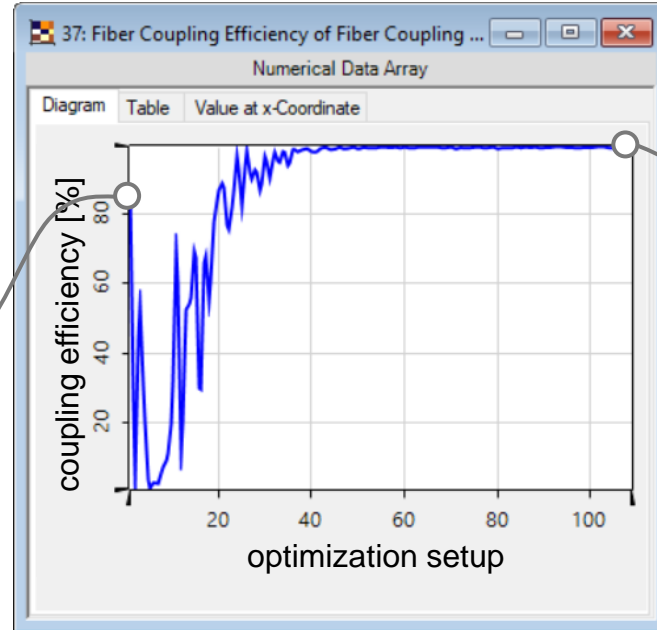
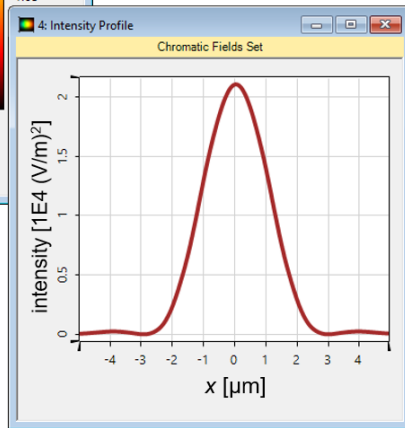
# Parametric Optimization

initial lens parameters

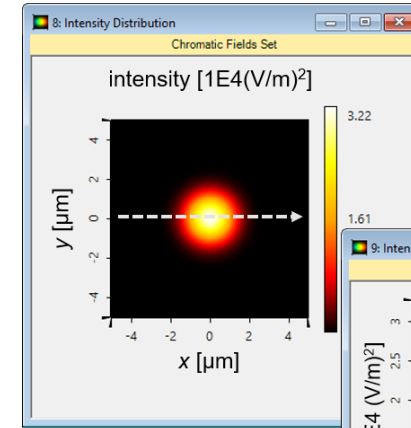
- radius of curvature  $R=1.7$  mm
- conical constant  $k=0$
- lens thickness  $t=0.8$  mm



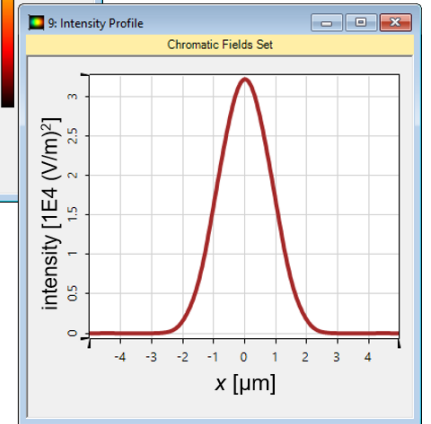
$\eta=88.6\%$



parametric optimization of coupling efficiency with downhill simplex algorithm



$\eta=99.4\%$



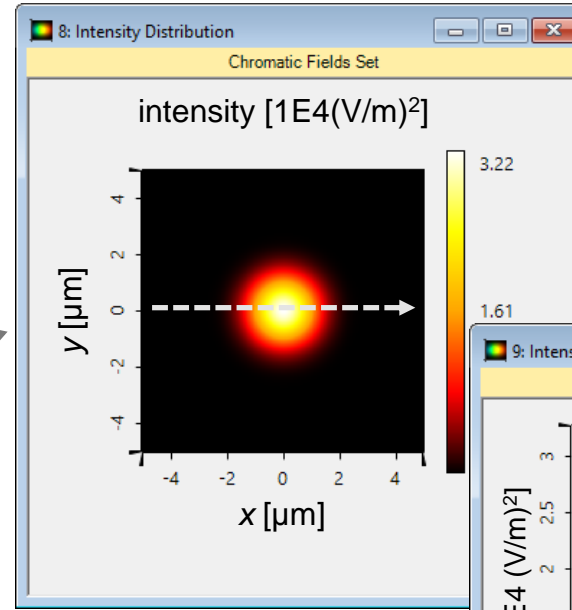
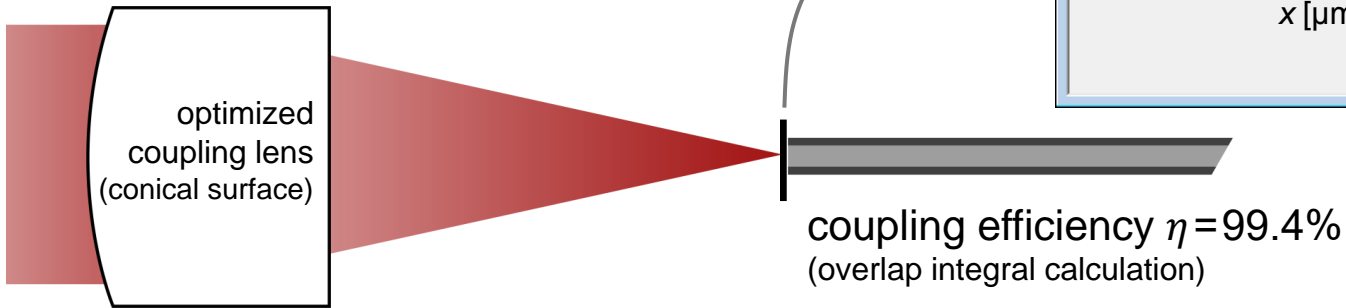
optimized lens parameters

- radius of curvature  $R=1.704$  mm
- conical constant  $k=-0.67278$
- lens thickness  $t=0.841$  mm

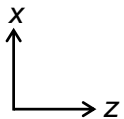
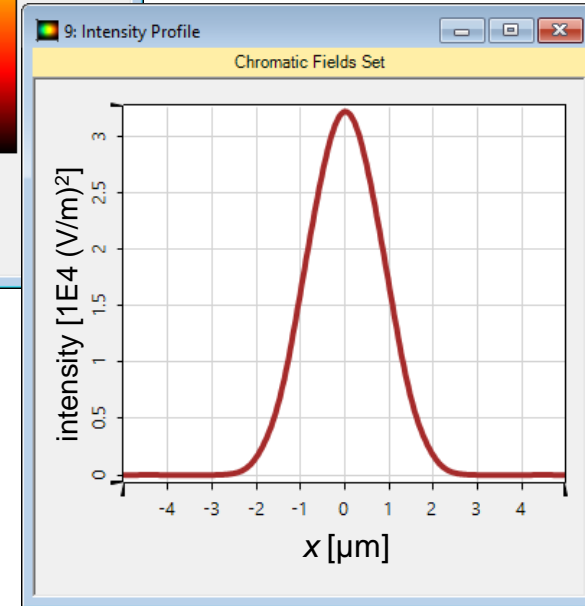
# Evaluation of Optimized Lens

optimized lens parameters

- radius of curvature  $R=1.704$  mm
- conical constant  $k=-0.67278$
- lens thickness  $t=0.841$  mm

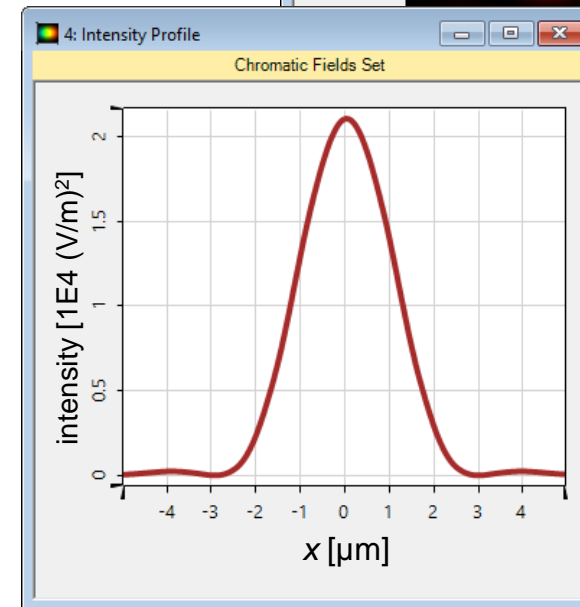
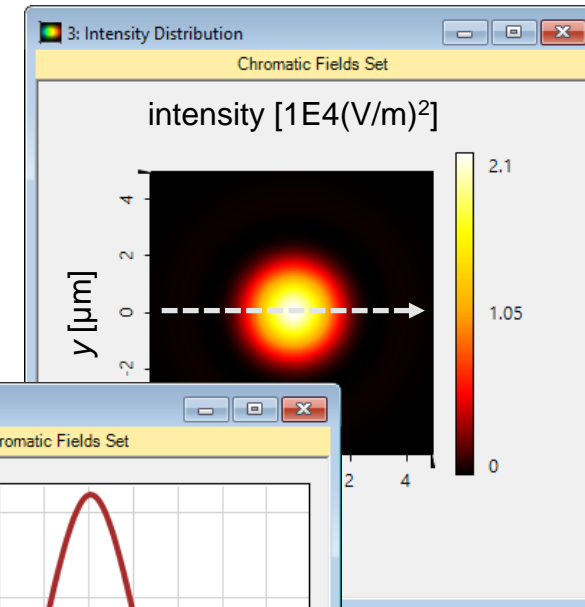
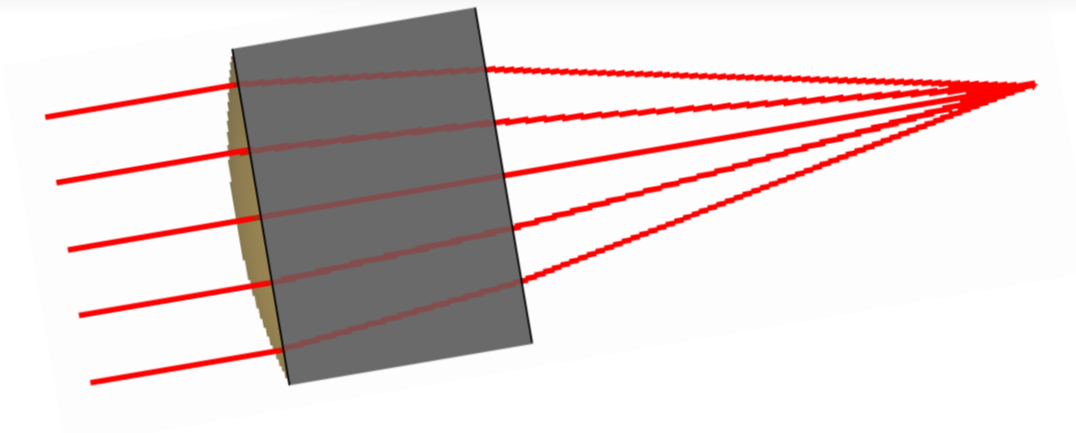
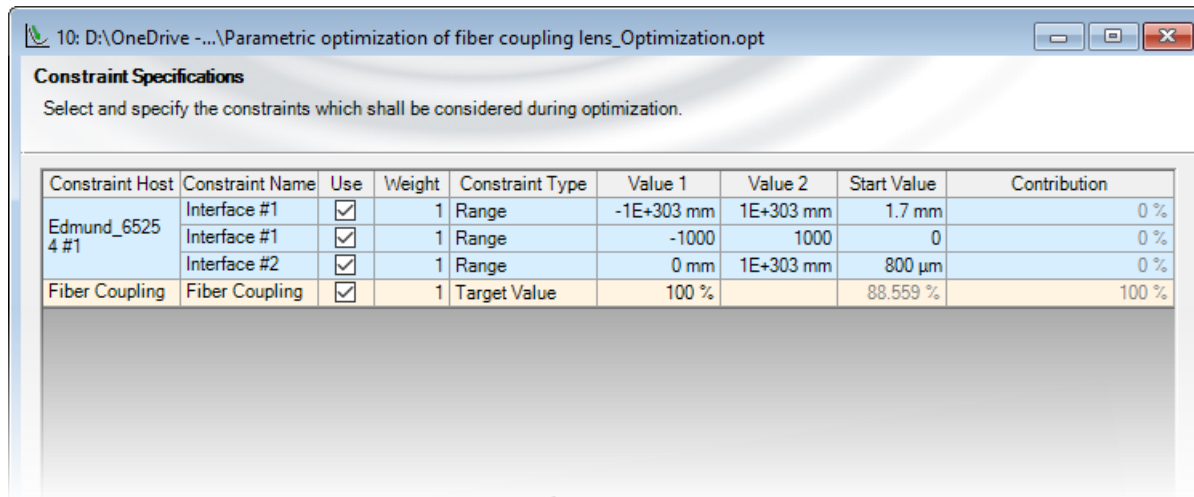


The coupling efficiency increases to almost the ideal theoretical value after optimization of the lens.



# Peak into VirtualLab

parametric optimization with flexible variables and merit functions definition



result visualization in various formats

# Workflow in VirtualLab

- Set up input Gaussian field
  - [Basic Source Models](#)
- Import initial coupling lens from Zemax file
  - [Import Optical Systems from Zemax](#)
- Evaluate fiber coupling efficiency with initial lens
- Use Parametric Optimization to find proper values for selected lens parameters

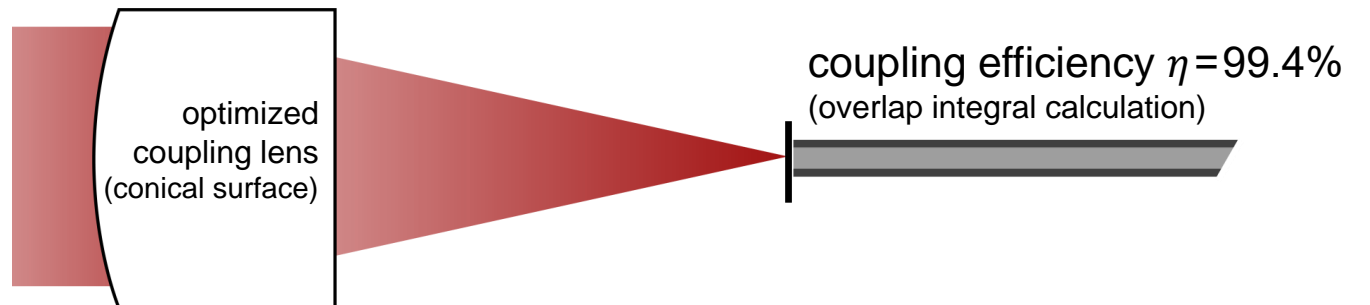
10: D:\OneDrive -... \Parametric optimization of fiber coupling lens\_Optimization.opt

**Constraint Specifications**  
Select and specify the constraints which shall be considered during optimization.

Constraint Host	Constraint Name	Use	Weight	Constraint Type	Value 1	Value 2	Start Value
Edmund_6525 4 #1	Interface #1	<input checked="" type="checkbox"/>	1	Range	-1E+303 mm	1E+303 mm	1.7 mm
	Interface #1	<input checked="" type="checkbox"/>	1	Range	-1000	1000	0
	Interface #2	<input checked="" type="checkbox"/>	1	Range	0 mm	1E+303 mm	800 $\mu$ m
Fiber Coupling	Fiber Coupling	<input checked="" type="checkbox"/>	1	Target Value	100 %		88.559 %

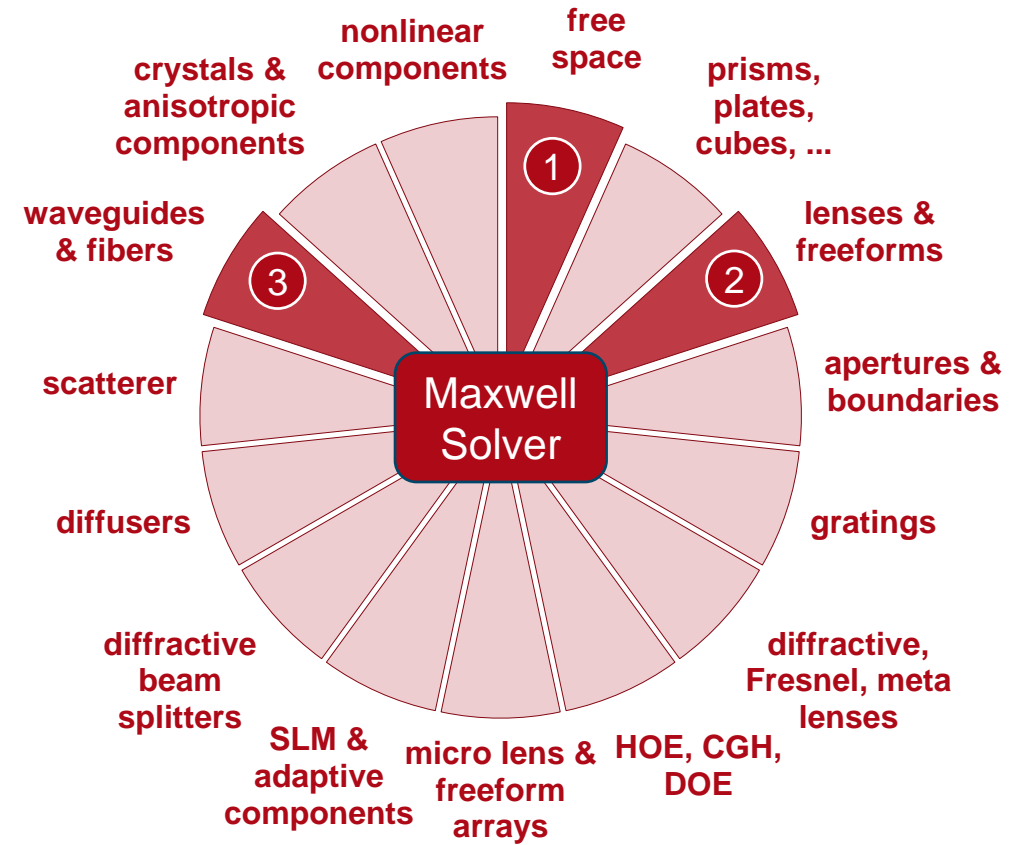
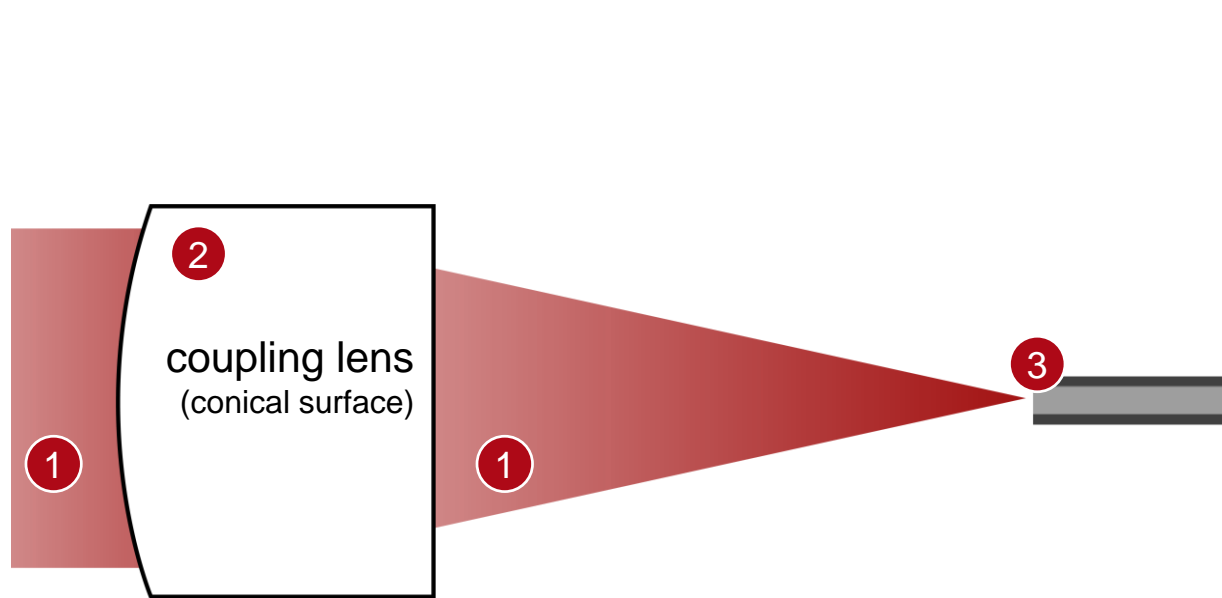
optimized lens parameters

- radius of curvature  $R=1.704$  mm
- conical constant  $k=-0.67278$
- lens thickness  $t=0.841$  mm





# VirtualLab Technologies



# Document Information

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title	Parametric Optimization of Fiber Coupling Lenses
document code	FCP.0003
version	2.0
toolbox(es)	Starter Toolbox
VL version used for simulations	7.4.0.49
category	Application Use Case
further reading	<ul style="list-style-type: none"><li>- <a href="#"><u>Optimal Working Distance for Coupling Light into Single-Mode Fibers</u></a></li><li>- <a href="#"><u>Comparison of Different Lenses for Fiber Coupling</u></a></li></ul>