

Parametric Optimization of Fiber Coupling Lens

Abstract



Using the simulation and optimization capabilities of VirtualLab Fusion, we present the design of a convex-plano lens with a conical surface for efficient light coupling into a single-mode fiber. To evaluate the performance, the fiber incoupling efficiency—quantified by the overlap integral—is compared between a commercially available spherical lens and the optimized conical lens.

Application Scenario

Application Scenario: Initial System



Application Scenario: Task



Simulation Results

Initial lens parameters

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

Evaluation of Initial Lens



coupling efficiency $\eta = 85.8\%$ (overlap integral calculation) The coupling efficiency obtained from the initial spherical lens is not optimal, due to mismatch between the focal spot of the lens and the propagating mode of the fiber.

Parametric Optimization

Initial lens parameters

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





Parametric optimization of coupling efficiency with downhill simplex algorithm



Optimized lens parameters

- radius of curvature R = 1.608 mm
- conical constant k = -0.7139
- lens thickness t = 0.6311 mm

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- radius of curvature R = 1.608 mm
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Evaluation of Optimized Lens



file: USC.0051_FiberLensOptimization_03_Optimized Lens.os

Workflow Steps





Getting it done in VirtualLab Fusion:

- Zemax import of lens group
- > <u>Position and orientation</u> of elements in the optical setup
- Find optimal working distance for fiber

Edit Lens System C	ompo	onent (B	dmund_6	5254)			×	Imported
Coordinate Systems								Lens
Position /		Index	Distance	Position	Туре	Homogeneous Medium	Comment	
Orientation		1	0 mm	0 mm	Conical Interface	N-LASF9_SCHOTT in Ho	Zemax Interface	
		2	800 µm	800 µm	Plane Interface	Air in Homogeneous M	Zemax Interface	



Getting it done in VirtualLab Fusion:

- Universal Detector
- Fiber Coupling Efficiency

E	dit Singlemode Fib	Singlemode			
	14	Detector Window and Resolution Detector Function			Fiber
		Specify Gaussian Mode Field			Coupling
	Coordinate				
	Systems	○ Fiber NA		0.002	Efficiency
		Mode Field Diameter (1/e^2)		3 µm	Detector
	Position /	Specify Customized Mode Field			
	Orientation	Mode Field	Set	Show	
	Detector	Efficiency Related to Incident Field of Optical System			
	Parameters				

Specific Workflow Steps Related to Use Case



Getting it done in VirtualLab Fusion:

Parametric Optimization document

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Required packages	-
Software version	2024.1 (Build 2.74)*
Category	Use Case
Further reading	 Optimal Working Distance for Coupling Light into Single-Mode Fibers Comparison of Different Lenses for Fiber Coupling Introduction to the Parametric Optimization Document

* The files attached to this document require the specific version or later.