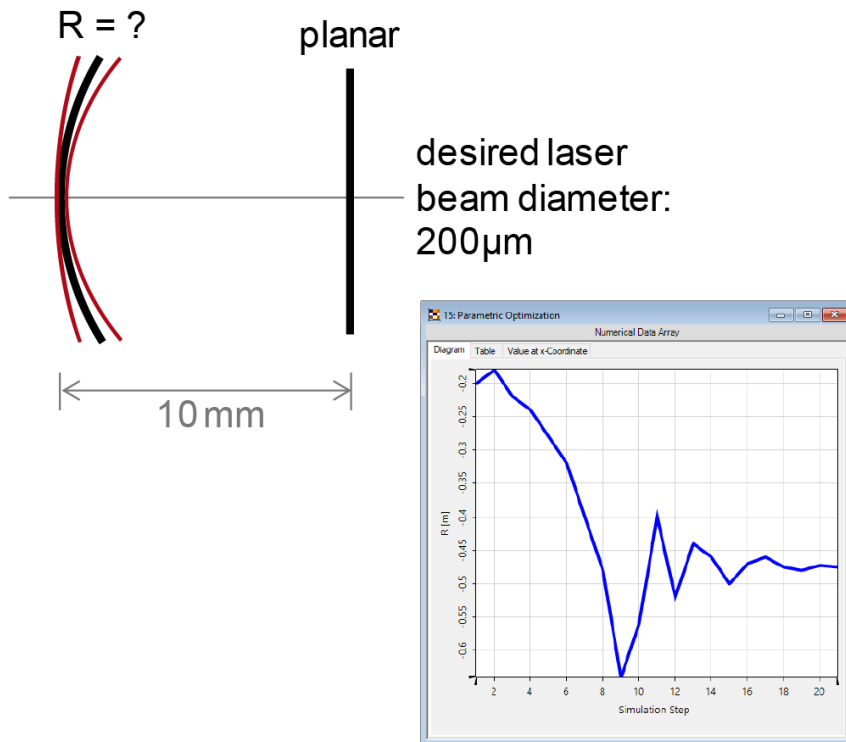


Parametric Optimization of a Half-Symmetric Two-Mirror Resonator

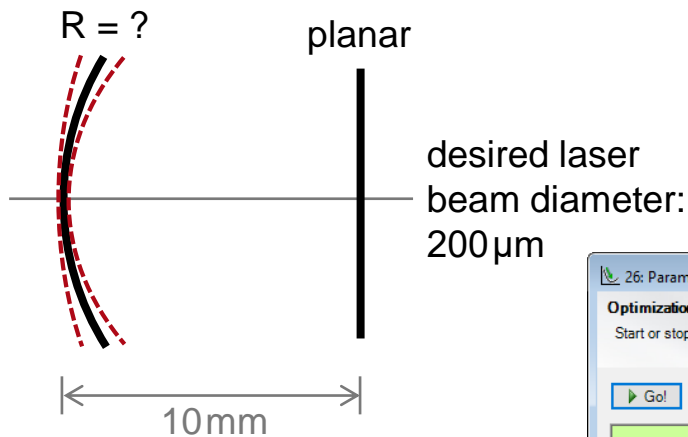
Abstract



In VirtualLab Fusion, users can easily construct a two-mirror laser resonator, and analyze the eigenmodes of it. In case of designing a resonator to generate a desired eigenmode, one can use the tool of parametric optimization conveniently. This use case shows firstly how to construct a half-symmetric resonator and analyze the eigenmodes of it, and then how to use parametric optimization for the design / optimization of this resonator.

Modeling Task

- how to construct a laser resonator
- how to use parametric optimization for the design / optimization of a laser resonator



26: Parametric Optimization of Light Path Editor (C:\Users\...\2017-07-31_SZ_HalfSymmetricResonator.lpd #3)*

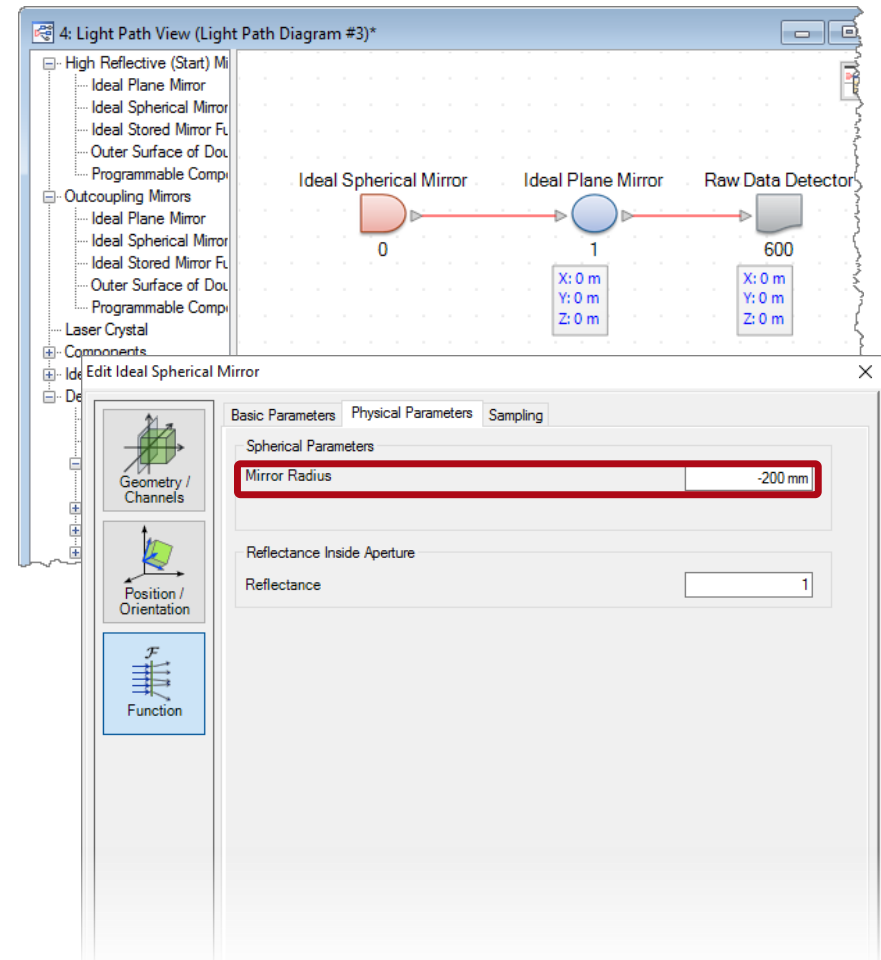
Optimization Results

Start or stop the optimization routine. The results are shown in the table.

Detector	Subdetector	Simulation Step								
		13	14	15	16	17	18	19	20	21
Optimizer Logging	Target Function Value	11E-12	1.46E-12	4.81E-12	1.11E-13	1.46E-12	1E-14	2.77E-13	1.31E-14	1E-14
Parameter Constraints	Mirror Radius (Ideal Spheri...	40 mm	-460 mm	-500 mm	-470 mm	-460 mm	-475 mm	-480 mm	-473 mm	-475 mm
Eigenmode Analyzer #800	Diameter X	198 μm	199 μm	202 μm	200 μm	199 μm	200 μm	200 μm	200 μm	200 μm
	Diameter Y	198 μm	199 μm	202 μm	200 μm	199 μm	200 μm	200 μm	200 μm	200 μm

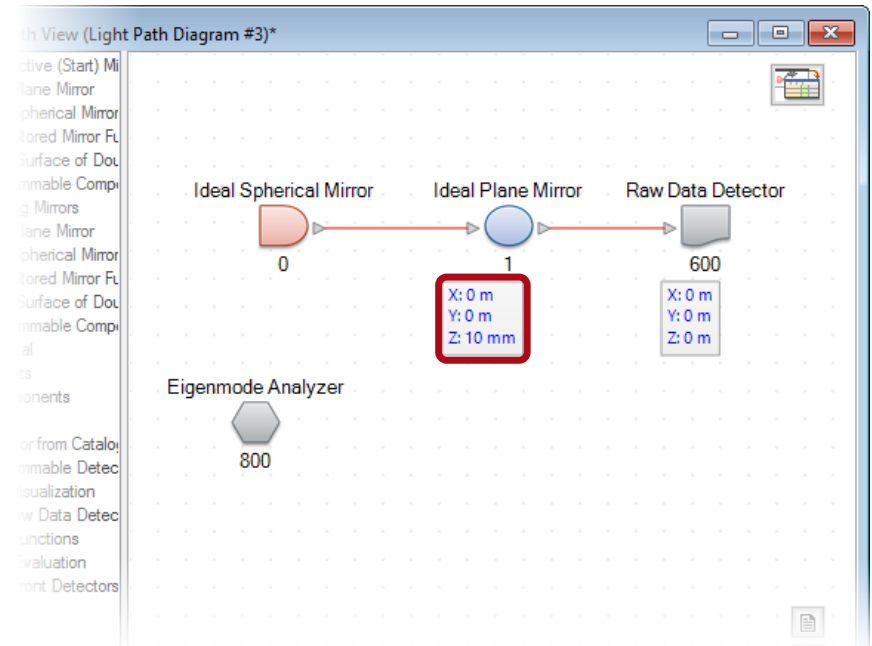
Laser Resonator Modeling

- Construction
 - In the laser resonator toolbox, we build up a half-symmetric resonator, with one spherical and one plane mirror.
 - Set the *Mirror Radius* of the ideal spherical mirror to -200 mm.



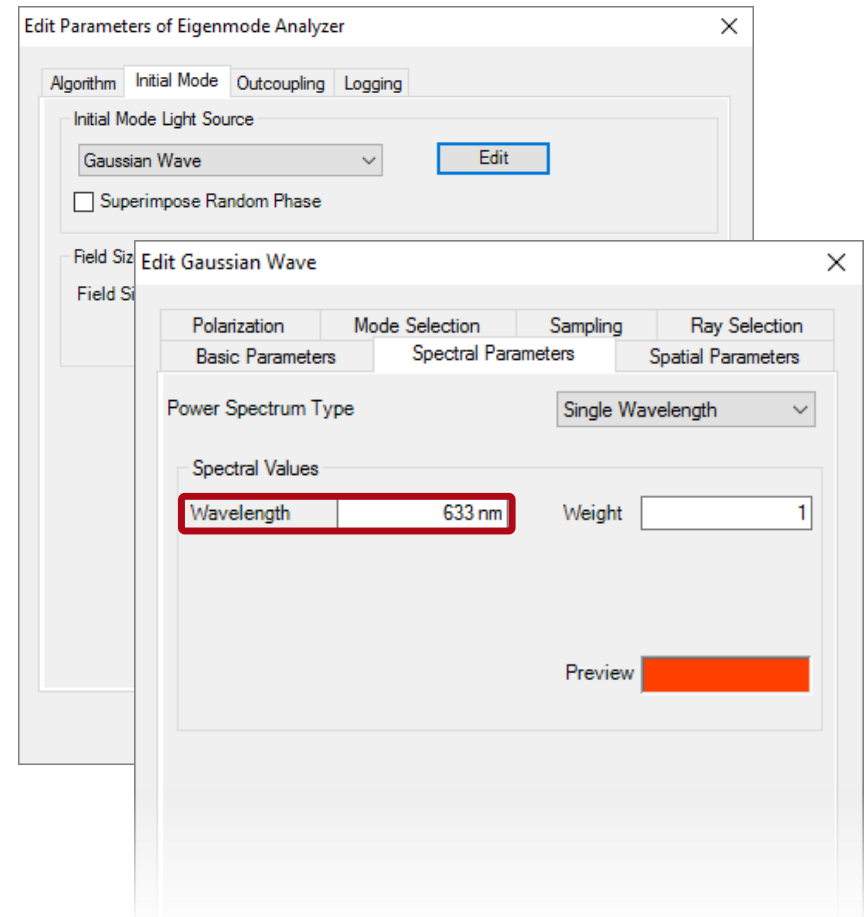
Laser Resonator Modeling

- Construction
 - In the laser resonator toolbox, we build up a half-symmetric resonator, with one spherical and one plane mirror.
 - Set the Mirror Radius of the ideal spherical mirror to -200 mm.
 - Set the distance between mirrors i.e., resonator length to 10 mm.



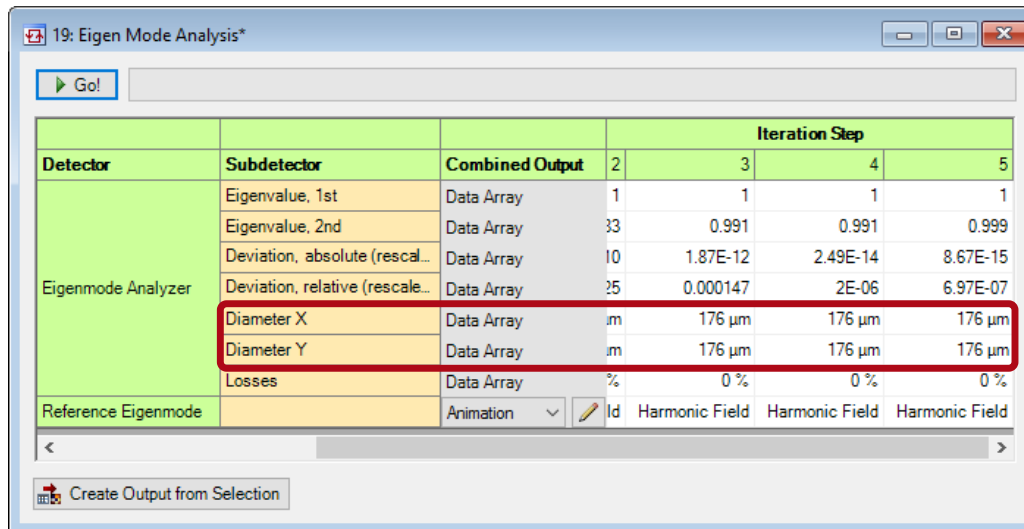
Laser Resonator Modeling

- Eigenmode analyzer
 - Set up the eigenmode analyzer, set the *Wavelength* to be 633nm for the Initial Mode.
 - Keep other settings like iteration number and threshold as default in this example.



Laser Resonator Modeling

- Eigenmode analyzer
 - Run the simulation, and we obtain the converged mode calculation after a few iterations.
 - The mode has a beam diameter of about $176\ \mu\text{m}$.

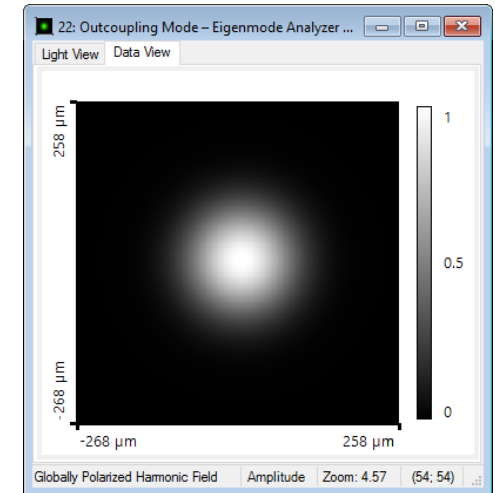


19: Eigen Mode Analysis*

Go!

Detector	Subdetector	Combined Output	Iteration Step			
			2	3	4	5
Eigenmode Analyzer	Eigenvalue, 1st	Data Array	1	1	1	1
	Eigenvalue, 2nd	Data Array	33	0.991	0.991	0.999
	Deviation, absolute (rescal...	Data Array	10	1.87E-12	2.49E-14	8.67E-15
	Deviation, relative (rescale...	Data Array	25	0.000147	2E-06	6.97E-07
	Diameter X	Data Array	μm	176 μm	176 μm	176 μm
	Diameter Y	Data Array	μm	176 μm	176 μm	176 μm
Losses	Data Array	%	0 %	0 %	0 %	
Reference Eigenmode		Animation	Id	Harmonic Field	Harmonic Field	Harmonic Field

Create Output from Selection

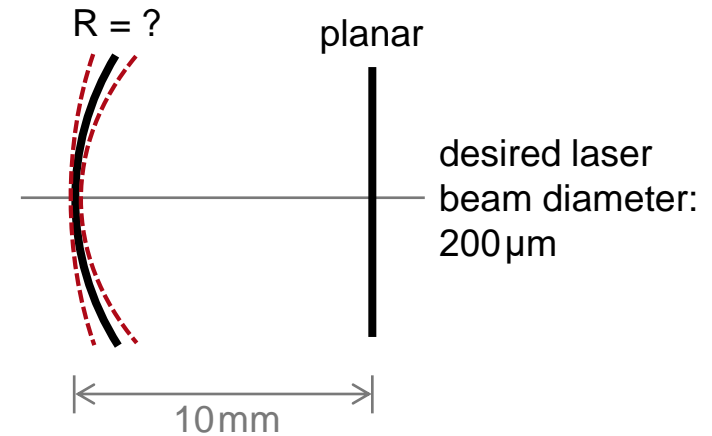


calculated eigenmode
amplitude after
interpolation

In this example, the number of displayed digits (global settings) is set to 3. With a different setting, the displayed results may look different.

Laser Resonator Design / Optimization

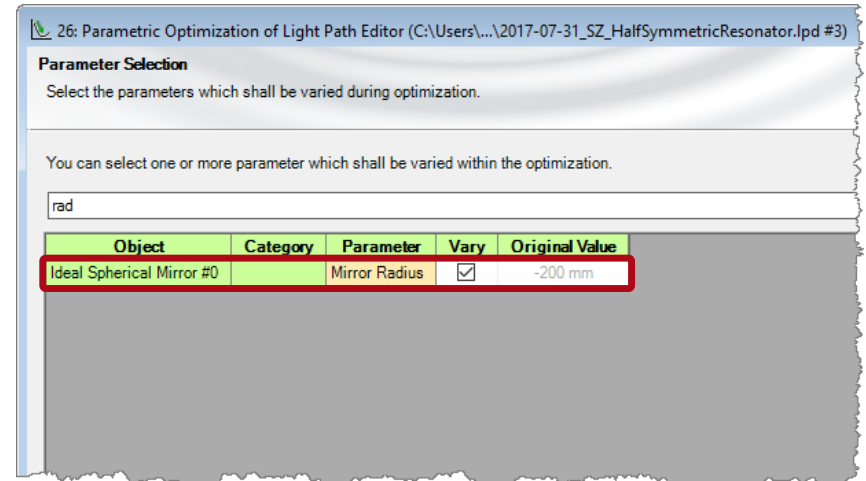
- Beam size optimization
 - It is often required to obtain a desired beam size for certain applications.
 - In this example, we expect a diameter of the output mode to be $200\mu\text{m}$.



- Parametric optimization
 - For this task, we use the parametric optimization, in which the mirror radius will be varied so to find the proper value that delivers the expected beam diameter.

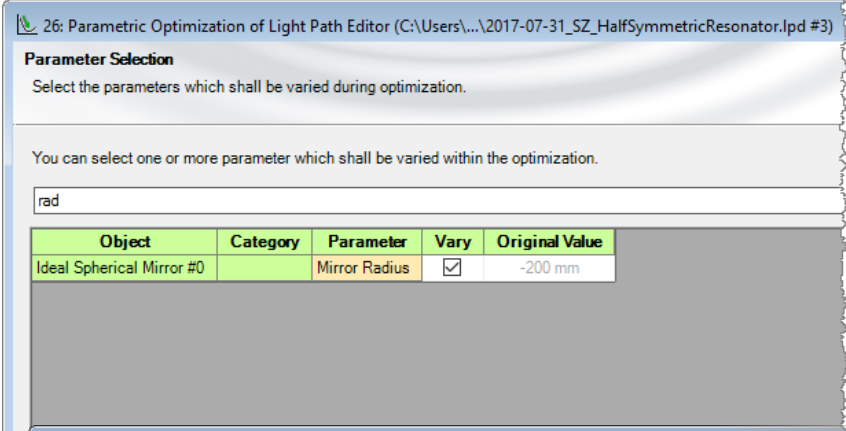
Laser Resonator Design / Optimization

- Optimization settings
 - Check *Mirror Radius* of the spherical mirror as the variable (type in keywords to locate the parameter quickly).



Laser Resonator Design / Optimization

- Optimization settings
 - Check Mirror Radius of the spherical mirror as the variable (type in keywords to locate the parameter quickly).
 - Set the constraints for the optimization: *Mirror Radius* in the range between -1 m and -100mm; *Diameter X/Y* should reach the target value of 200 μ m.



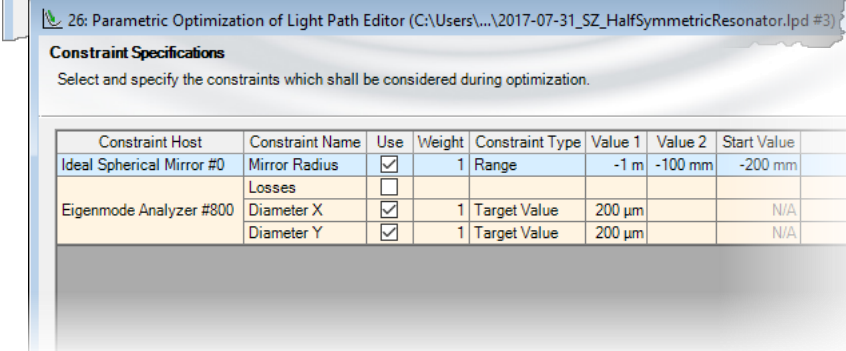
26: Parametric Optimization of Light Path Editor (C:\Users\...\2017-07-31_SZ_HalfSymmetricResonator.lpd #3)

Parameter Selection
Select the parameters which shall be varied during optimization.

You can select one or more parameter which shall be varied within the optimization.

rad

Object	Category	Parameter	Vary	Original Value
Ideal Spherical Mirror #0		Mirror Radius	<input checked="" type="checkbox"/>	-200 mm



26: Parametric Optimization of Light Path Editor (C:\Users\...\2017-07-31_SZ_HalfSymmetricResonator.lpd #3)

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
Ideal Spherical Mirror #0	Mirror Radius	<input checked="" type="checkbox"/>	1	Range	-1 m	-100 mm	-200 mm
	Losses	<input type="checkbox"/>					
Eigenmode Analyzer #800	Diameter X	<input checked="" type="checkbox"/>	1	Target Value	200 μ m		N/A
	Diameter Y	<input checked="" type="checkbox"/>	1	Target Value	200 μ m		N/A



Laser Resonator Design / Optimization

- Optimization settings
 - Click on *Update* button, and have an overview on the optimization: e.g., to check the contribution of each constraint according to their weight.


26: Parametric Optimization of Light Path Editor (C:\Users\...\2017-07-31_SZ_HalfSymmetricResonator.lpd #3)*

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	Contribution
Ideal Spherical Mirror #0	Mirror Radius	<input checked="" type="checkbox"/>	1	Range	-1 m	-100 mm	-200 mm	0 %
	Losses	<input type="checkbox"/>						
Eigenmode Analyzer #800	Diameter X	<input checked="" type="checkbox"/>	1	Target Value	200 μm		176 μm	50 %
	Diameter Y	<input checked="" type="checkbox"/>	1	Target Value	200 μm		176 μm	50 %

Tools  

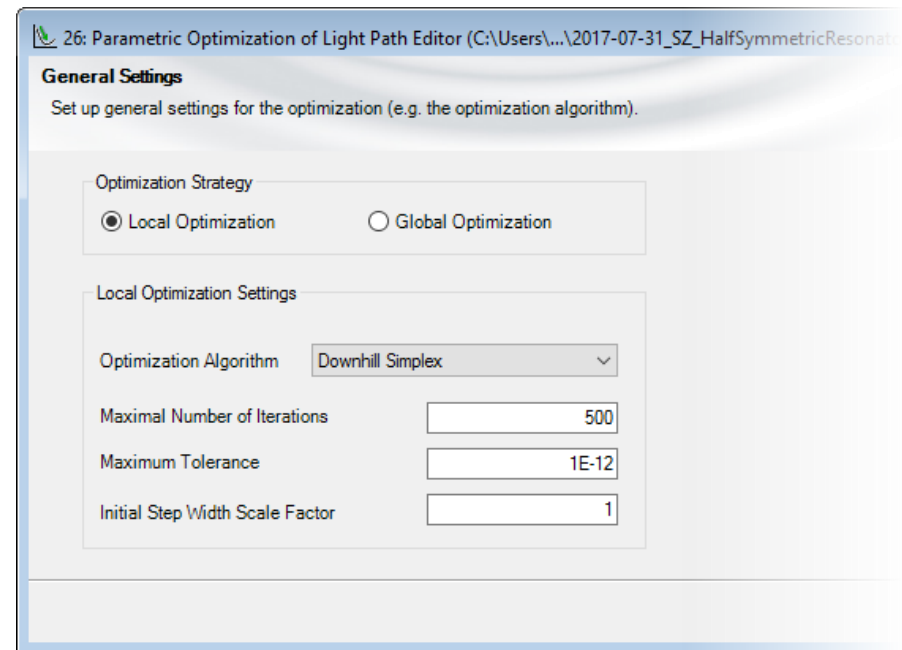
Target Function Value **Update**

< Back Next > Show LPD 

Laser Resonator Design / Optimization

- Optimization settings
 - Click on Update button, and have an overview on the optimization: e.g., to check the contribution of each constraint according to their weight.
 - Set the algorithm parameters and start the optimization

In this example, we use the default local optimization and keep the default parameters



Laser Resonator Design / Optimization

- Optimization result
 - After a few iterations, the mirror radius is found to be -475 mm, so the resonator delivers an output beam with the diameter of 200 μm .

26: Parametric Optimization of Light Path Editor (C:\Users\...\2017-07-31_SZ_HalfSymmetricResonator.lpd #3)*

Optimization Results
Start or stop the optimization routine. The results are shown in the table.

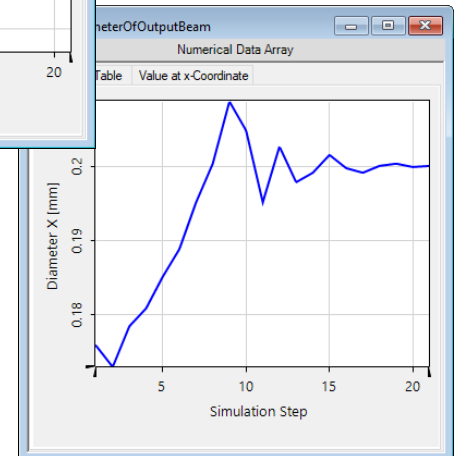
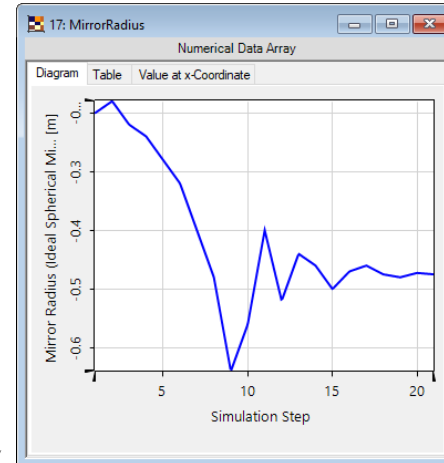
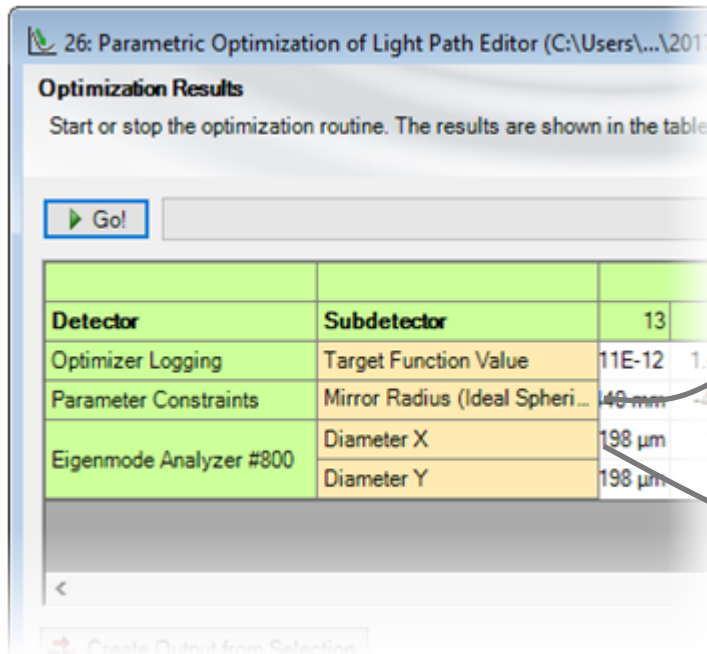
Go!

Detector	Subdetector	Simulation Step								
		13	14	15	16	17	18	19	20	21
Optimizer Logging	Target Function Value	11E-12	1.46E-12	4.81E-12	1.11E-13	1.46E-12	1E-14	2.77E-13	1.31E-14	1E-14
Parameter Constraints	Mirror Radius (Ideal Spheri...	40 mm	-460 mm	-500 mm	-470 mm	-460 mm	-475 mm	-480 mm	-473 mm	-475 mm
Eigenmode Analyzer #800	Diameter X	198 μm	199 μm	202 μm	200 μm	199 μm	200 μm	200 μm	200 μm	200 μm
	Diameter Y	198 μm	199 μm	202 μm	200 μm	199 μm	200 μm	200 μm	200 μm	200 μm

Create Output from Selection

Laser Resonator Design / Optimization

- Optimization result
 - After a few iterations, the mirror radius is found to be -475 mm, so the resonator delivers an output beam with the diameter of 200 μm .



Laser Resonator Design / Optimization

- Optimization result
 - After a few iterations, the mirror radius is found to be -475 mm, so the resonator delivers an output beam with the diameter of 200 μm .

	Simulation Step									
Detector	13	14	15	16	17	18	19	20	21	
Objective Function Value	1.1E-12	1.46E-12	4.81E-12	1.11E-13	1.46E-12	1E-14	2.77E-13	1.31E-14	1E-14	
Mirror Radius (Ideal Spheri...	140 mm	-460 mm	-500 mm	-470 mm	-460 mm	-475 mm	-480 mm	-473 mm	-475 mm	
Beam Diameter X	198 μm	199 μm	202 μm	200 μm	199 μm	200 μm	200 μm	200 μm	200 μm	
Beam Diameter Y	198 μm	199 μm	202 μm	200 μm	199 μm	200 μm	200 μm	200 μm	200 μm	

< Back Next > Show LPD ▾

- Show Initial Light Path Diagram
- Show Light Path Diagram for Certain Simulation Step...
- Show Optimized Light Path Diagram

The LPD containing the optimized system can be easily extracted at last

Document Information

title	Parametric Optimization of a Half-Symmetric Two-Mirror Resonator
version	1.0
VL version used for simulations	7.0.3.4
category	Feature Use Case
