

Feature.0013

Parametric Optimization of a Half-symmetric Two-mirror Resonator

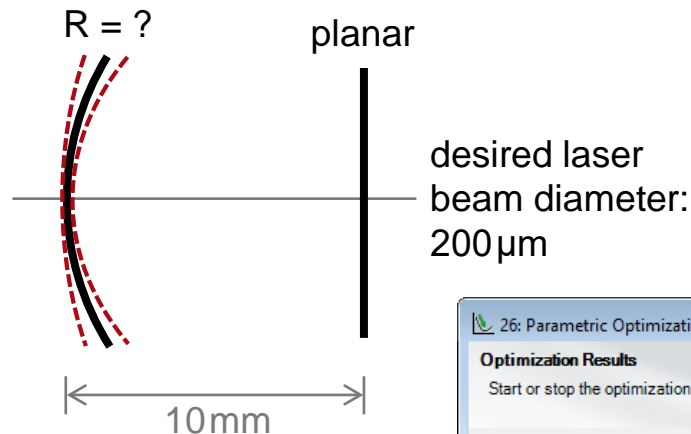
Construction of a two-mirror laser resonator in a half-symmetric configuration, and use of parametric optimization to find the mirror curvature for a desired output beam size

About This Use Case

- The following toolbox is required
 - Laser Resonator toolbox
- This use case is produced with VirtualLab Fusion (Build 7.0.0.35).
- Get your free Trial Version [here!](#)

This Use Case Shows ...

- 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)*

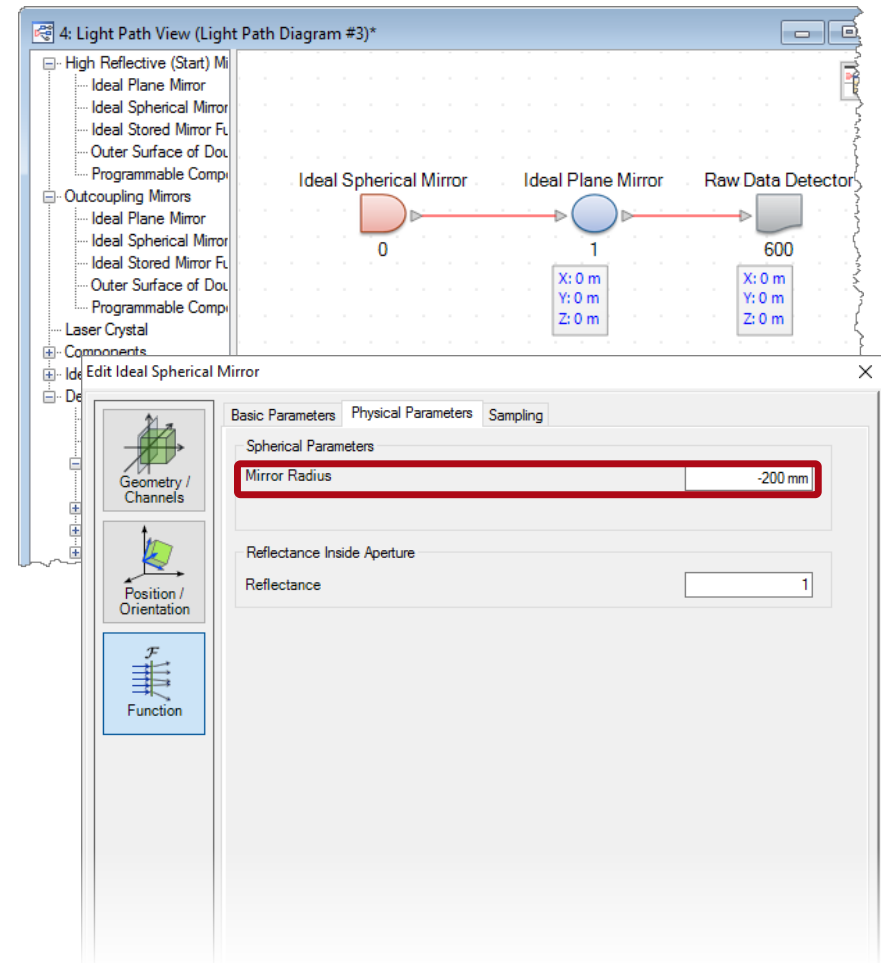
Optimization Results
Start or stop the optimization routine. The results are shown in the table.

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

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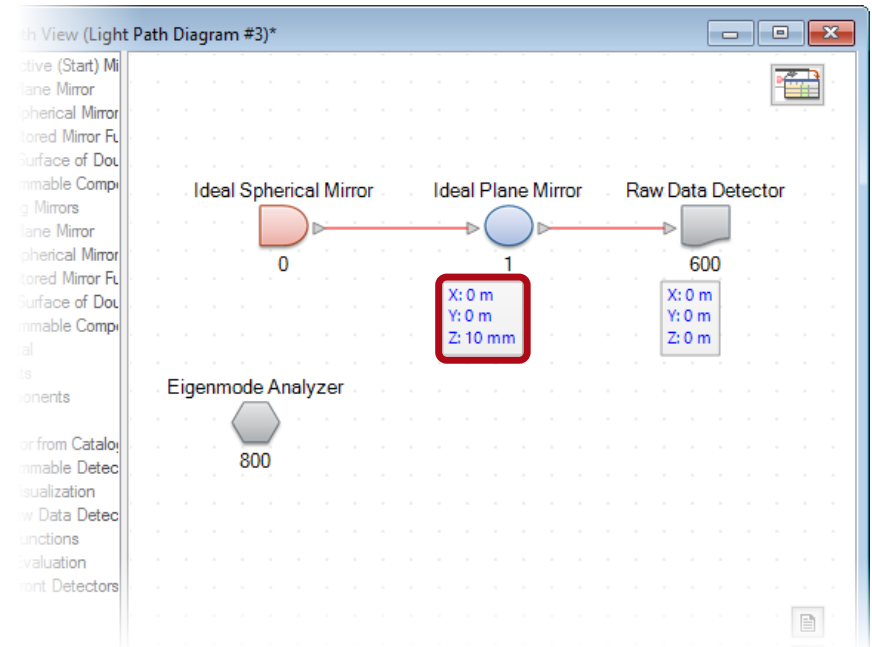
Initial Resonator Construction

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



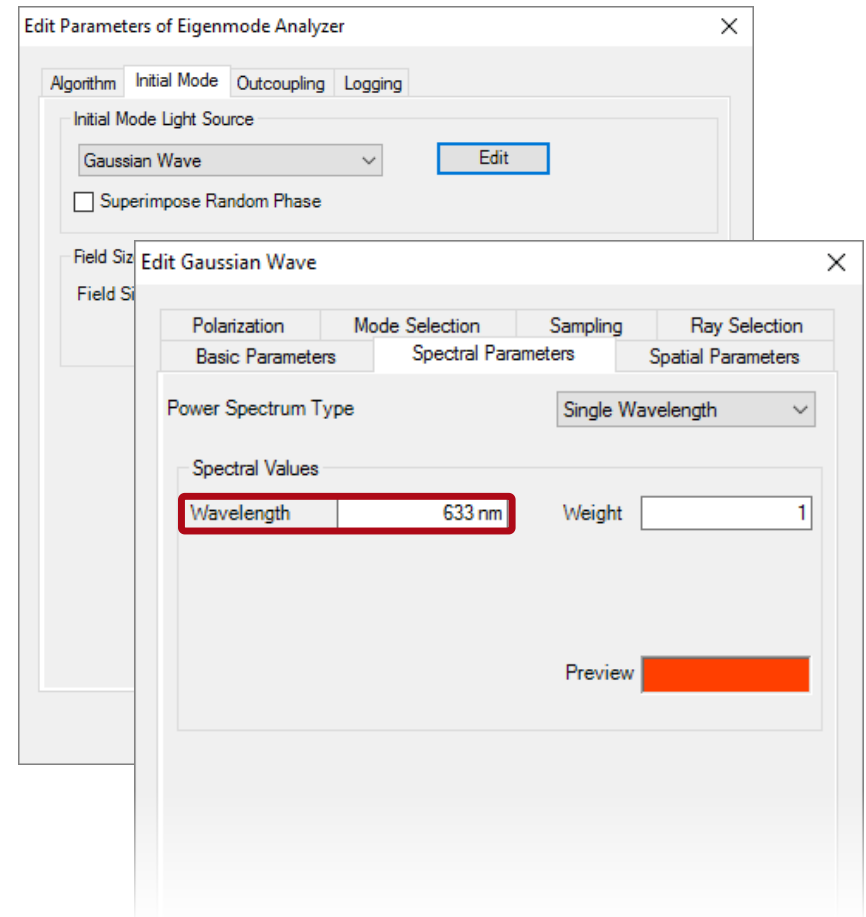
Initial Resonator Construction

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



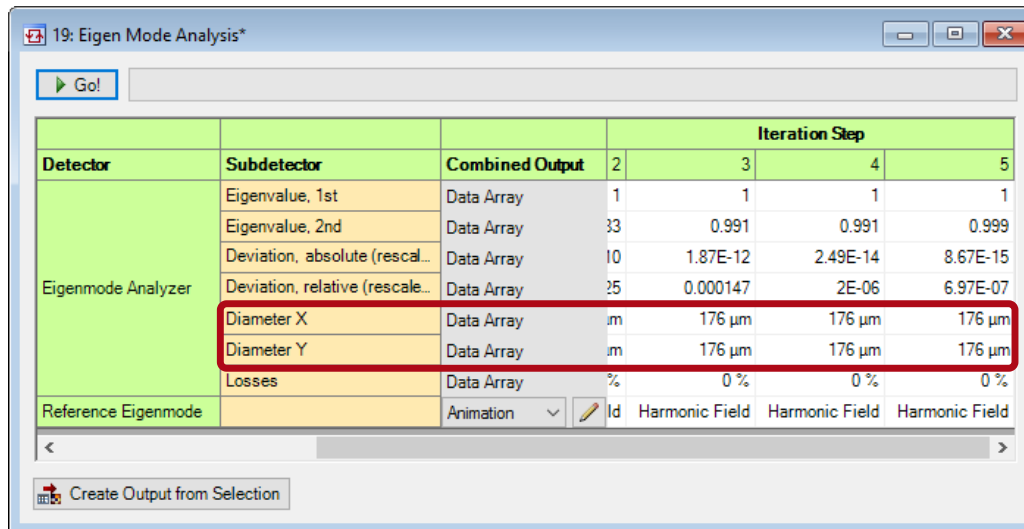
Initial Resonator Analysis

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



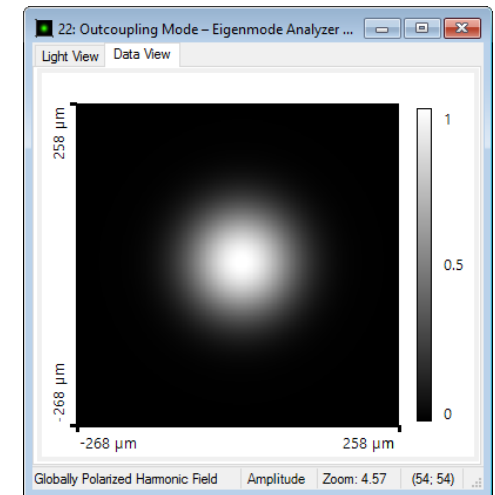
Initial Resonator Analysis

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



The screenshot shows the '19: Eigen Mode Analysis*' window. It contains a table with columns for 'Detector', 'Subdetector', 'Combined Output', and 'Iteration Step' (2, 3, 4, 5). The 'Eigenmode Analyzer' section is highlighted, and the 'Diameter X' and 'Diameter Y' rows are circled in red, showing a value of 176 μm for all iteration steps.

Detector	Subdetector	Combined Output	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



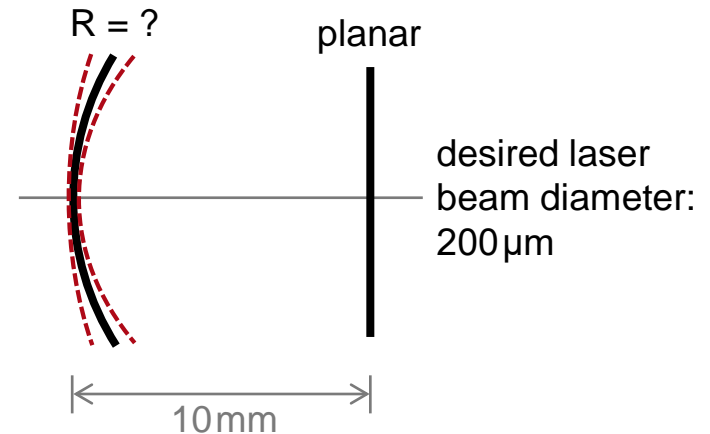
calculated eigenmode
amplitude after
interpolation

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 $200\mu\text{m}$ from the output mode.

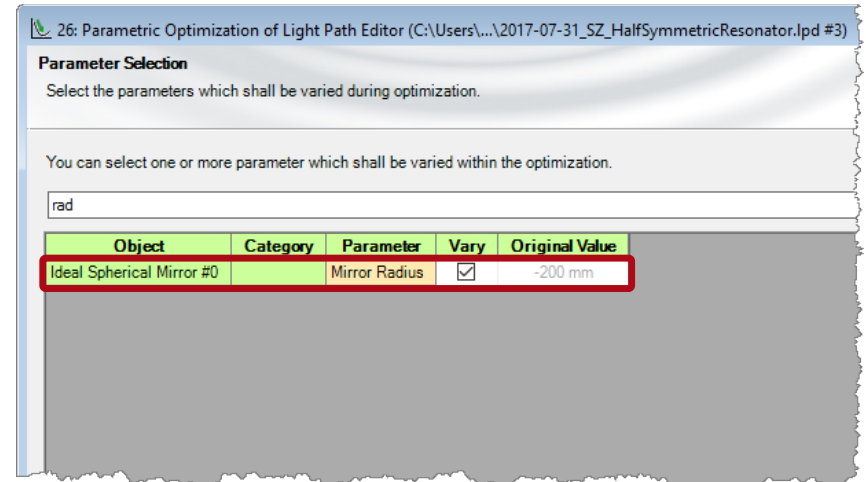


- Parametric optimization

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

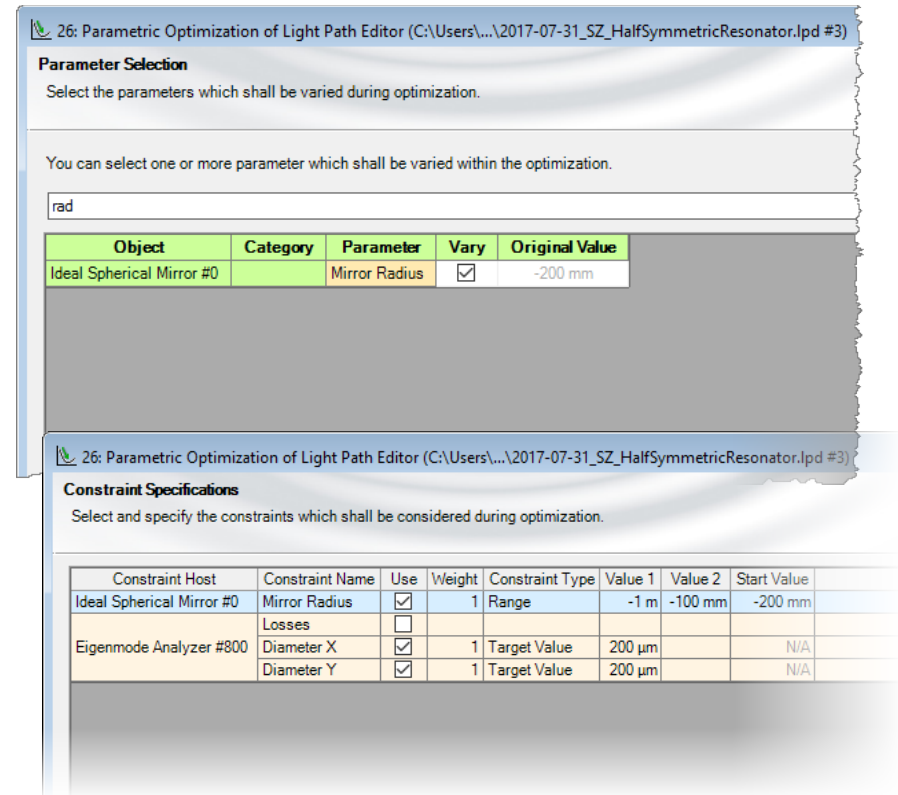
Laser Resonator Design / Optimization

- 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 -100 mm; *Diameter X/Y* should reach the target value of 200 μm .




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 %

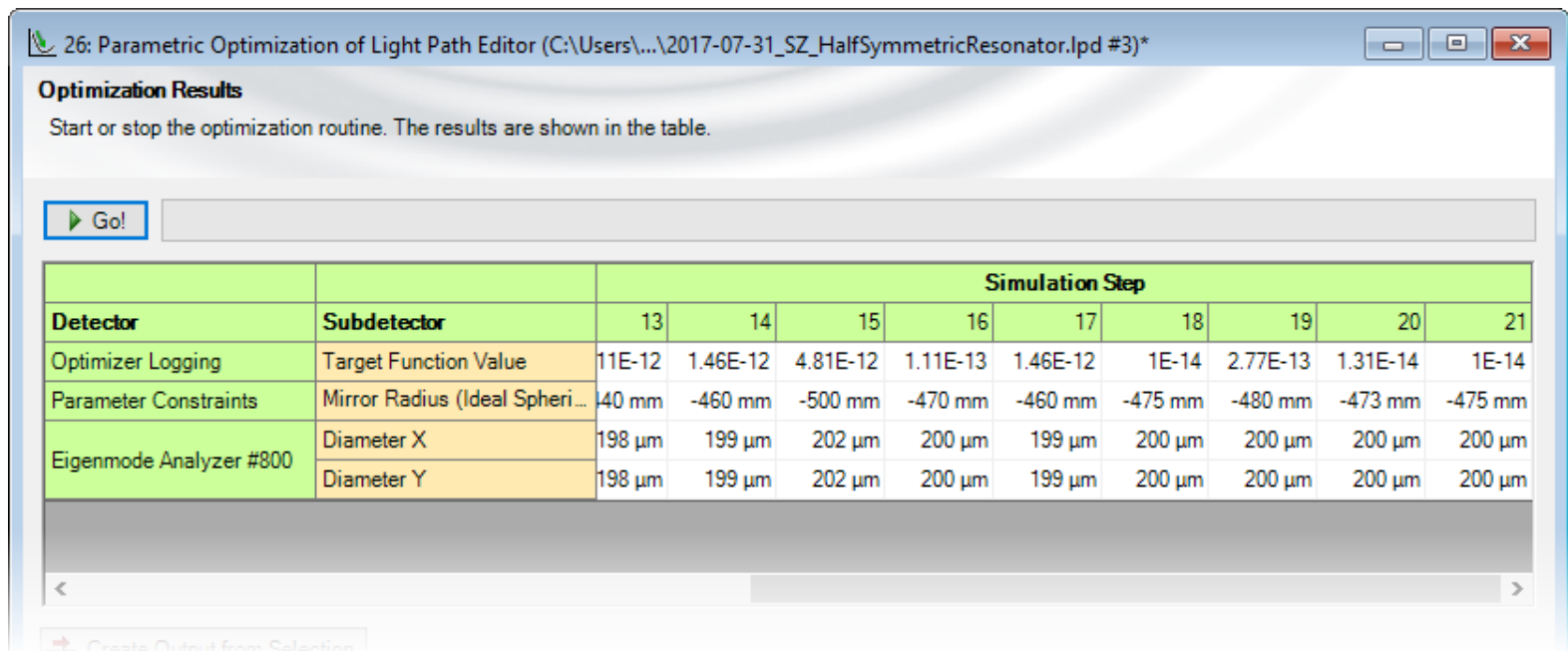
Tools 

Target Function Value **Update**

< Back Next > Show LPD ▾

Laser Resonator Design / Optimization

- Optimization 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 .



The screenshot shows a software window titled "26: Parametric Optimization of Light Path Editor (C:\Users\...\2017-07-31_SZ_HalfSymmetricResonator.lpd #3)*". It contains a section for "Optimization Results" with a "Go!" button and a table of results.

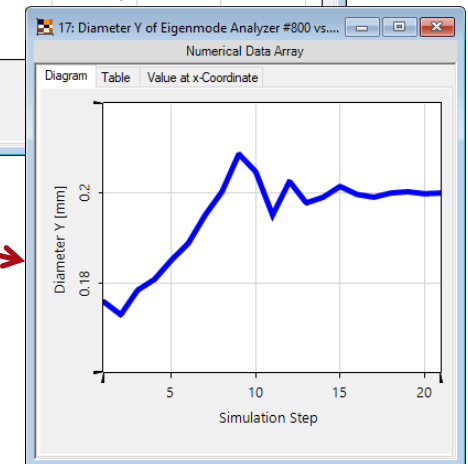
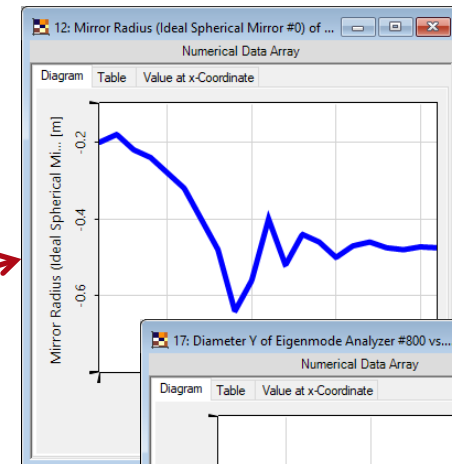
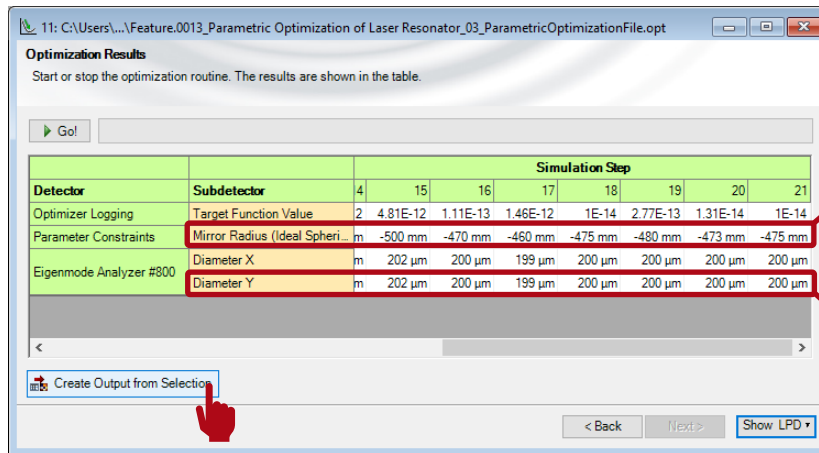
Start or stop the optimization routine. The results are shown in the table.

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

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Laser Resonator Design / Optimization

- Optimization result
 - By selecting a certain row of data, and clicking on the icon Create Output from Selection, one can examine the convergence of a selected parameter during optimization.



Laser Resonator Design / Optimization

- Optimization result
 - Finally, we extract the LPD containing the optimized laser resonator from the optimization.



	Simulation Step								
Detector	13	14	15	16	17	18	19	20	21
Target 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
Error Radius (Ideal Spheri...	140 mm	-460 mm	-500 mm	-470 mm	-460 mm	-475 mm	-480 mm	-473 mm	-475 mm
Parameter X	198 μm	199 μm	202 μm	200 μm	199 μm	200 μm	200 μm	200 μm	200 μm
Parameter 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

Initial, intermediate, and final systems can be extracted from the optimization file for further analysis.

Optimized Resonator Analysis

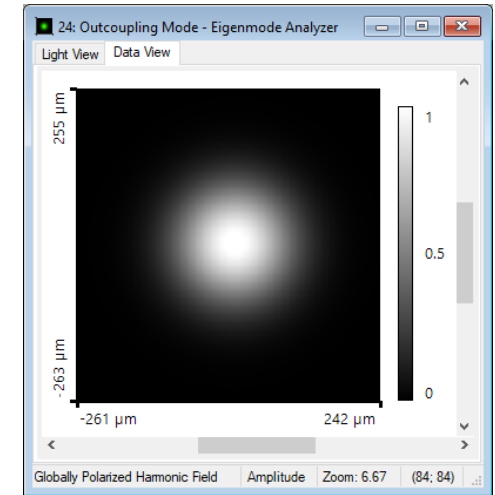
- Eigenmode analyzer
 - Similarly as before, we perform eigenmode analysis for the optimized resonator.
 - After a few iterations, the mode of the optimized resonator is calculated with a beam diameter of $200\mu\text{m}$, as desired.

20: Eigen Mode Analysis*

Go!

Detector	Subdetector	Combined Output	Iteration Step			
			3	4	5	6
Eigenmode Analyzer	Eigenvalue, 1st	Data Array	1	1	1	1
	Eigenvalue, 2nd	Data Array	31	0.987	0.99	0.992
	Deviation, absolute (rescal...	Data Array	13	9.75E-14	2.6E-14	9.89E-15
	Deviation, relative (rescale...	Data Array	05	6.2E-06	1.65E-06	6.26E-07
	Diameter X	Data Array	μm	200 μm	200 μm	200 μm
	Diameter Y	Data Array	μm	200 μm	200 μm	200 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

Document & Technical Info

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