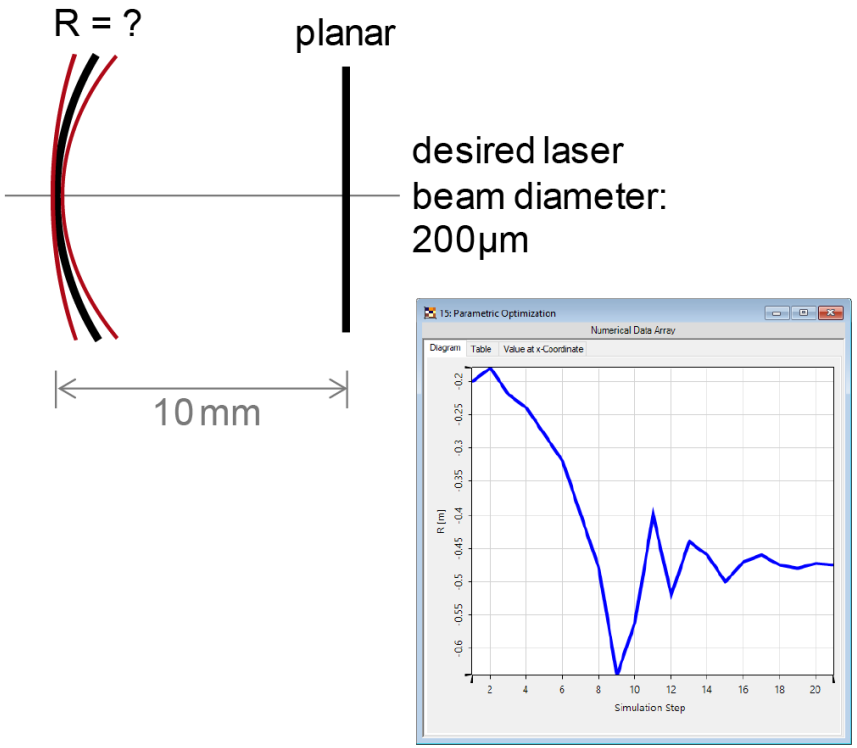
Parametric Optimization of a Half-Symmetric Two-Mirror Resonator

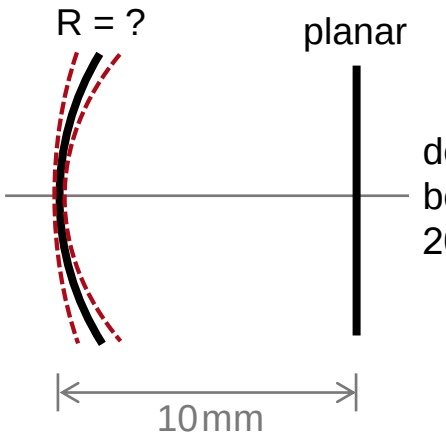
Abstract



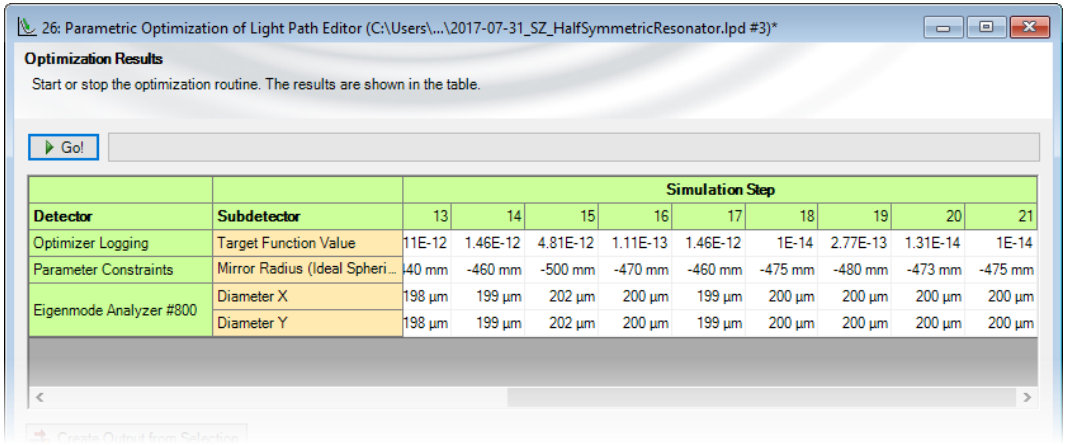
In VirtualLab Fusion, users can easily construct a two-mirror laser resonator, and analyze the eigenmodes of it. In case of designing a resonator to generate a desired eigenmode, one can use the tool of parametric optimization conveniently. This use case shows firstly how to construct a half-symmetric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



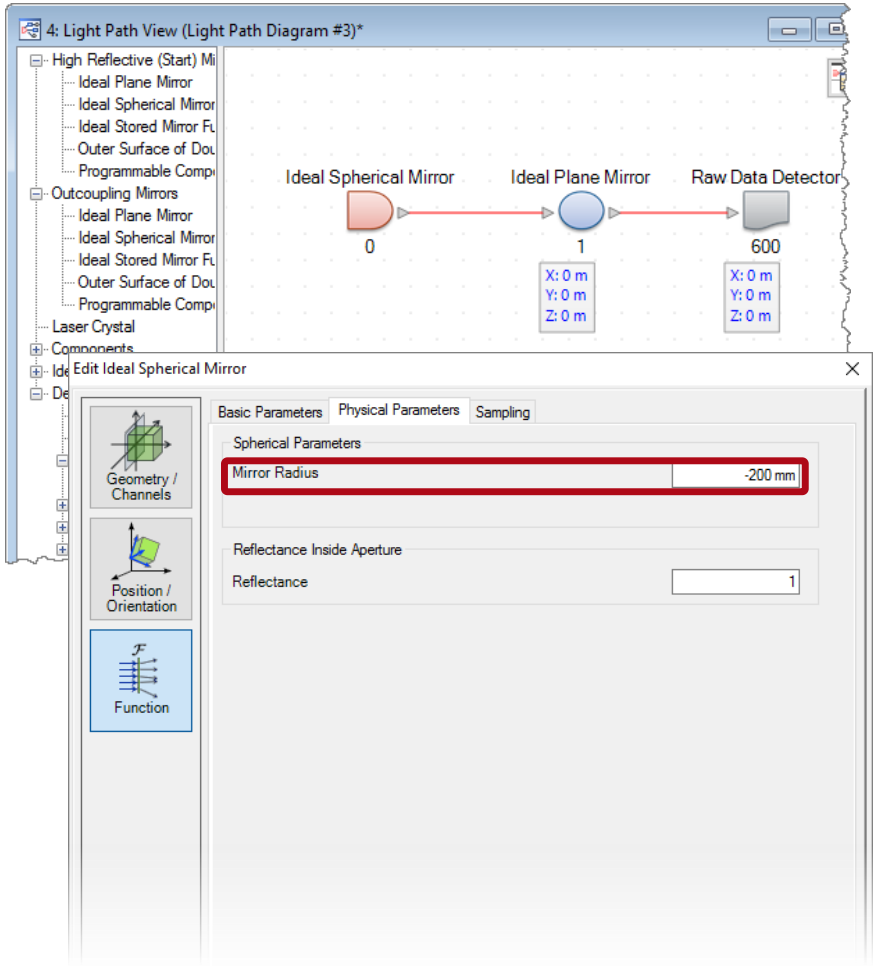
desired laser beam diameter: 200 µm



		Simulation Step								
Detector	Subdetector	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

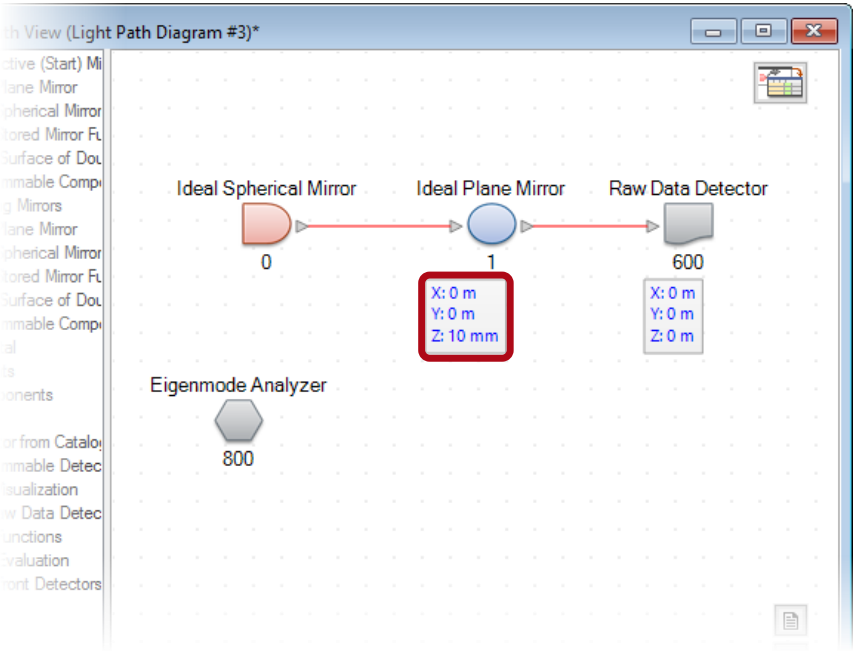
Laser Resonator Modeling

- 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.



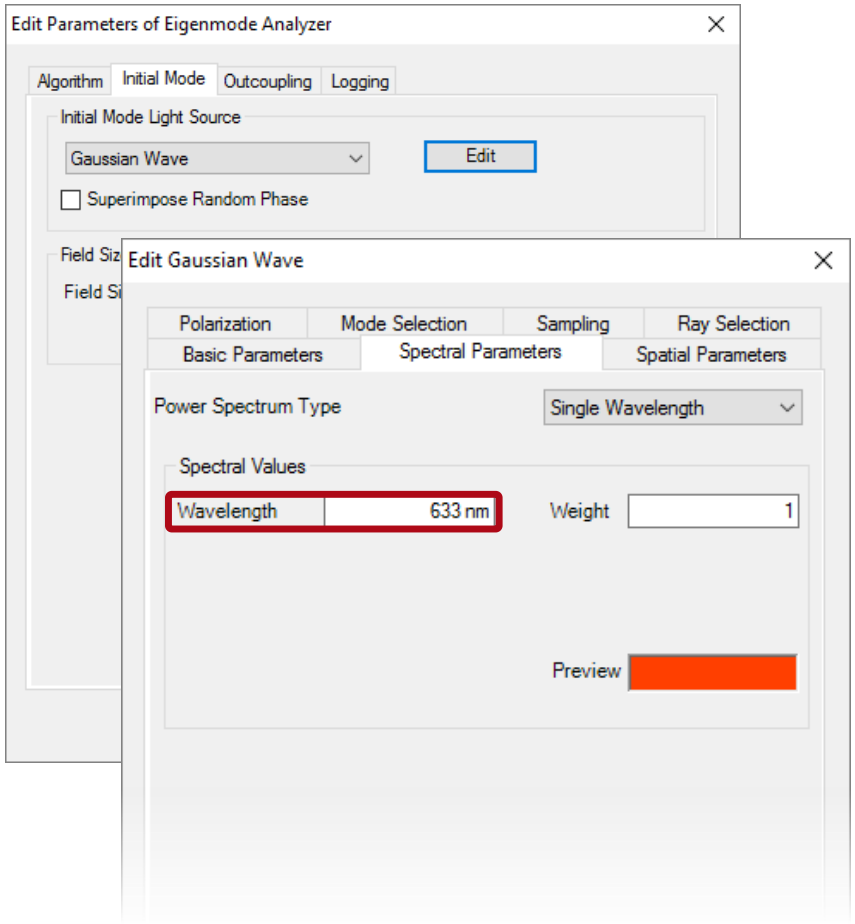
Laser Resonator Modeling

- 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.



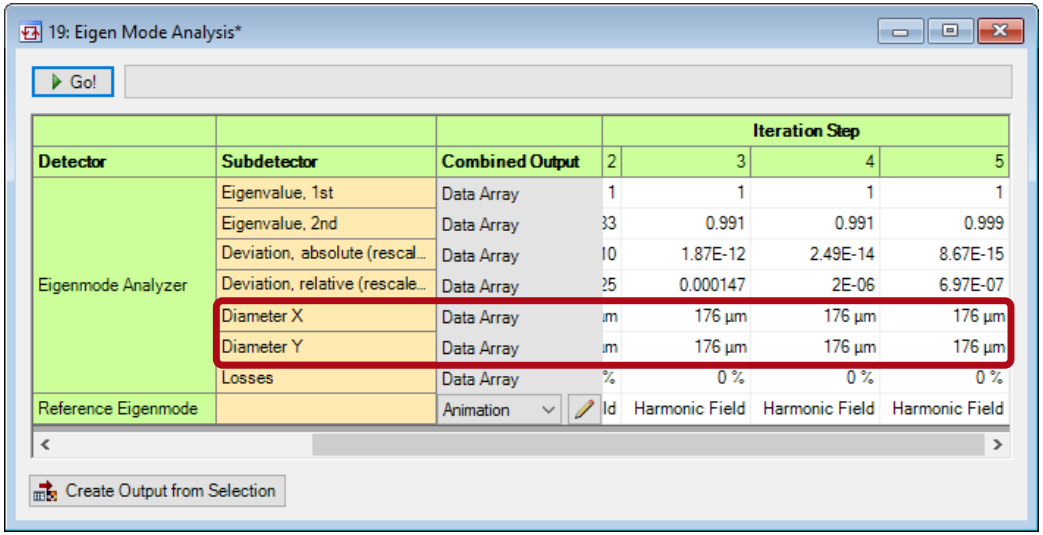
Laser Resonator Modeling

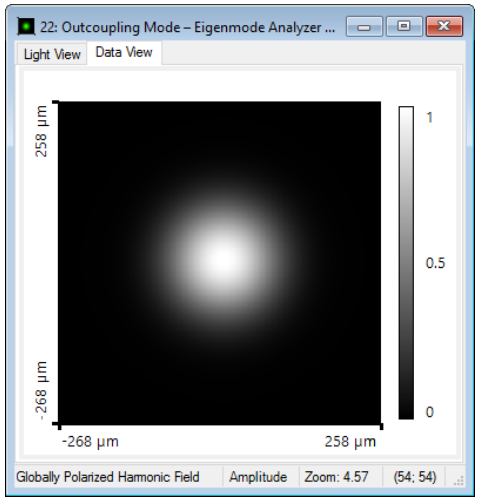
- Eigenmode analyzer
  - Set up the eigenmode analyzer, set the *Wavelength* to be 633 nm for the Initial Mode.
  - Keep other settings like iteration number and threshold as default in this example.



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 µm.



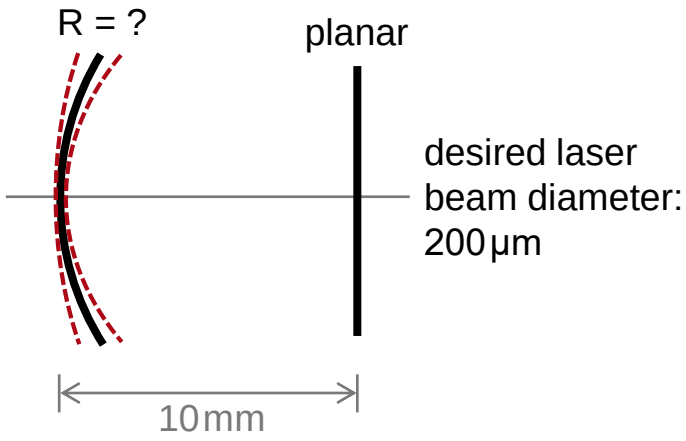


calculated eigenmode amplitude after interpolation

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

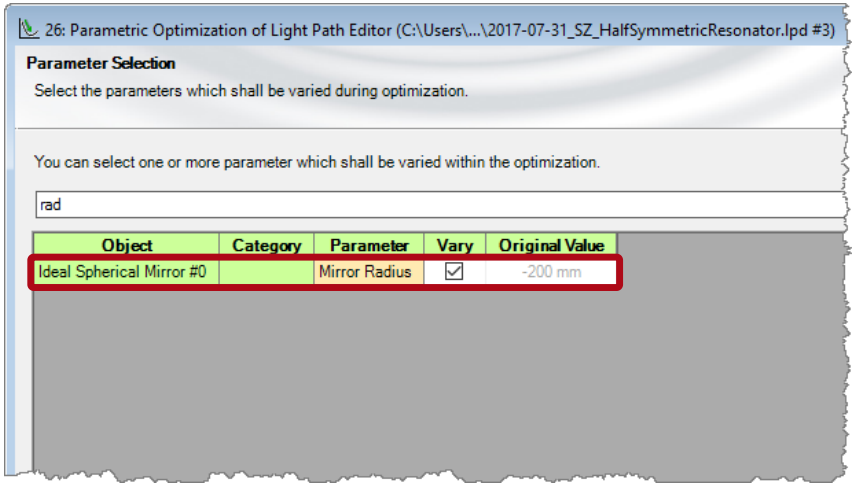
- Beam size optimization
  - It is often required to obtain a desired beam size for certain applications.
  - In this example, we expect a diameter of the output mode to be 200 µm.



- 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.

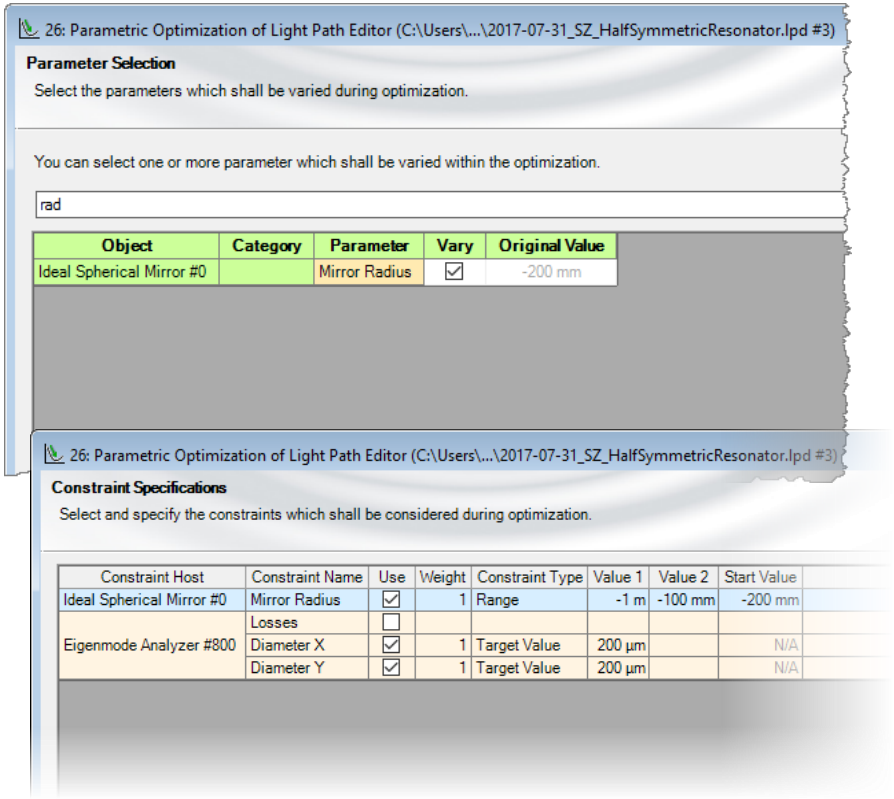
Laser Resonator Design / Optimization

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



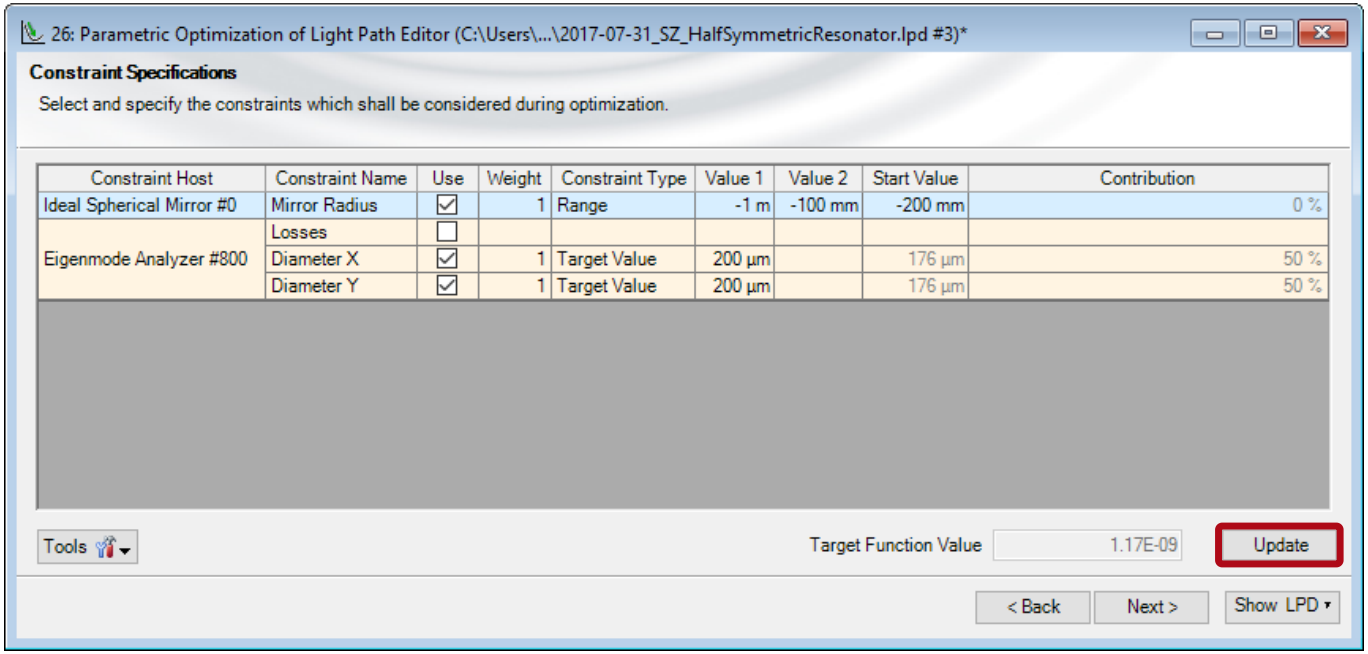
Laser Resonator Design / Optimization

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



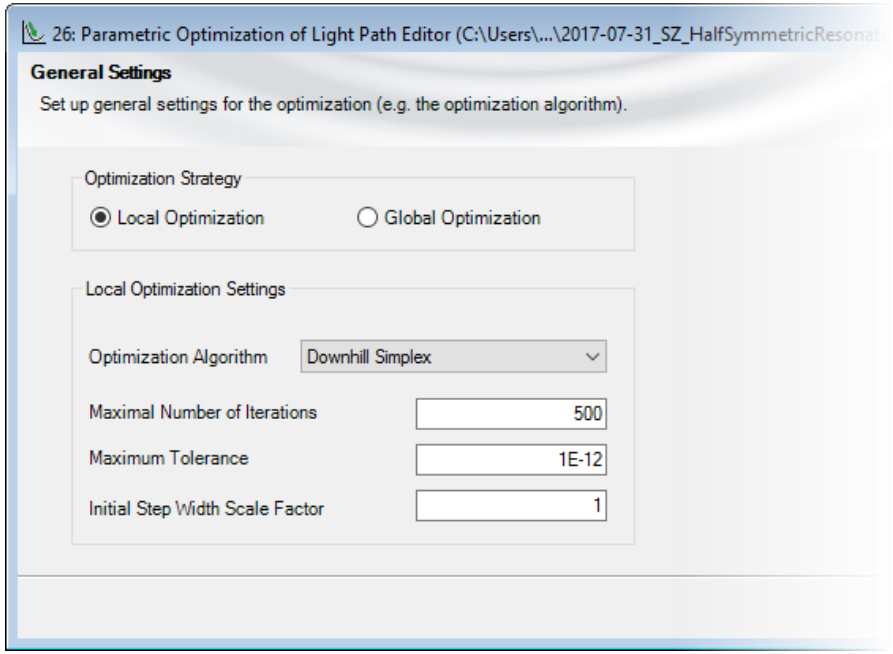
Laser Resonator Design / Optimization

- 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.



Laser Resonator Design / Optimization

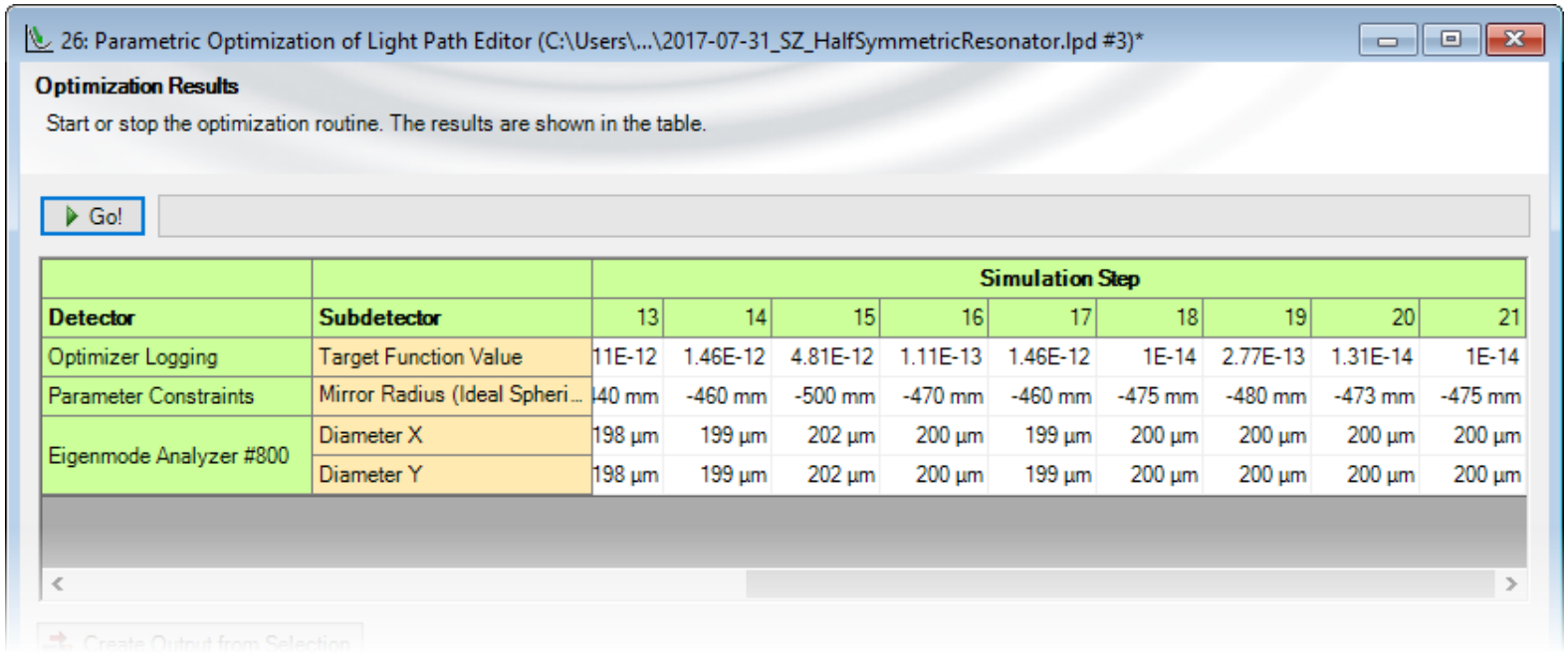
- Optimization settings
  - Click on Update button, and have an overview on the optimization: e.g., to check the contribution of each constraint according to their weight.
  - Set the algorithm parameters and start the optimization



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.



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Laser Resonator Design / Optimization

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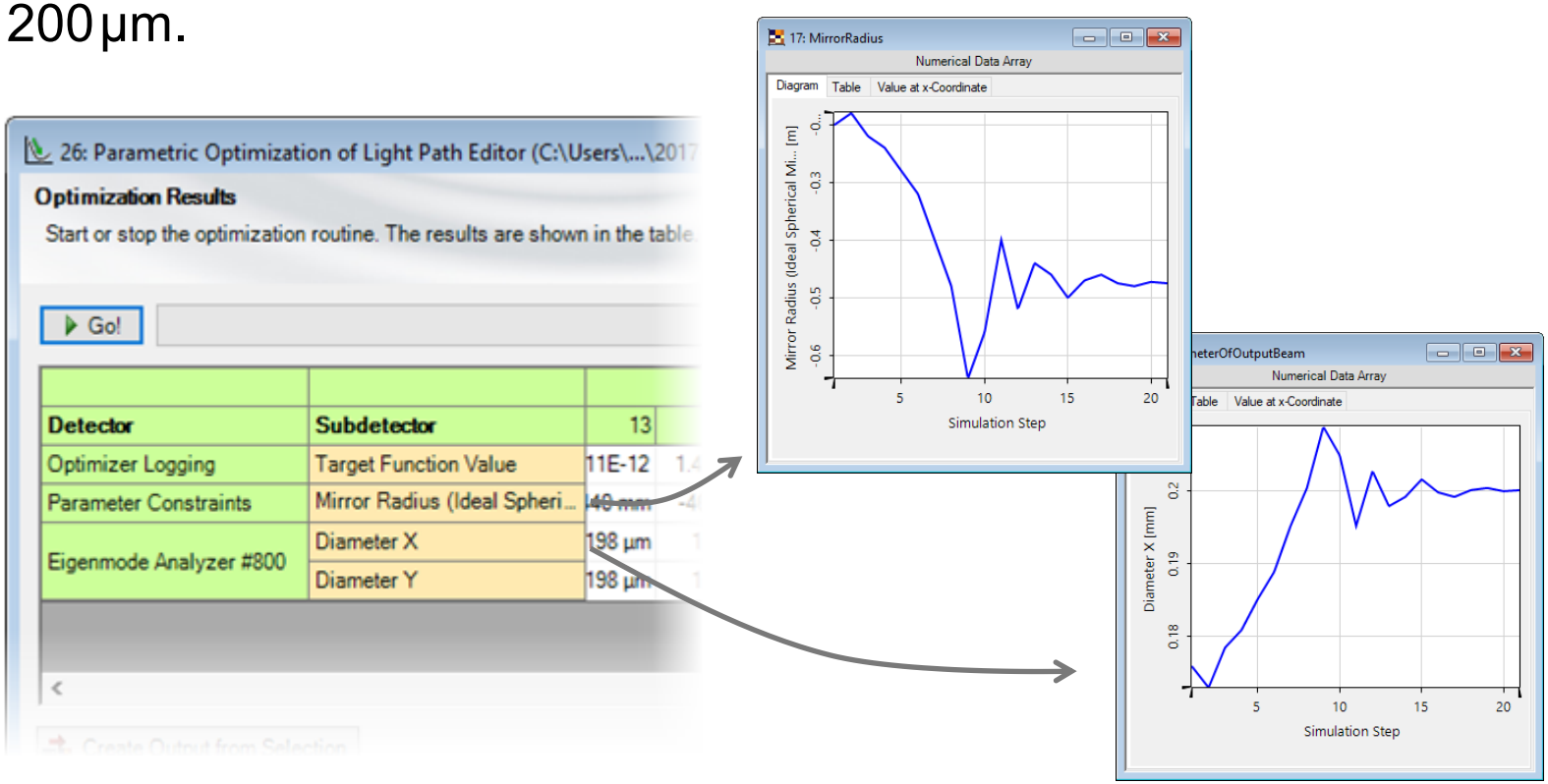

Laser Resonator Design / Optimization

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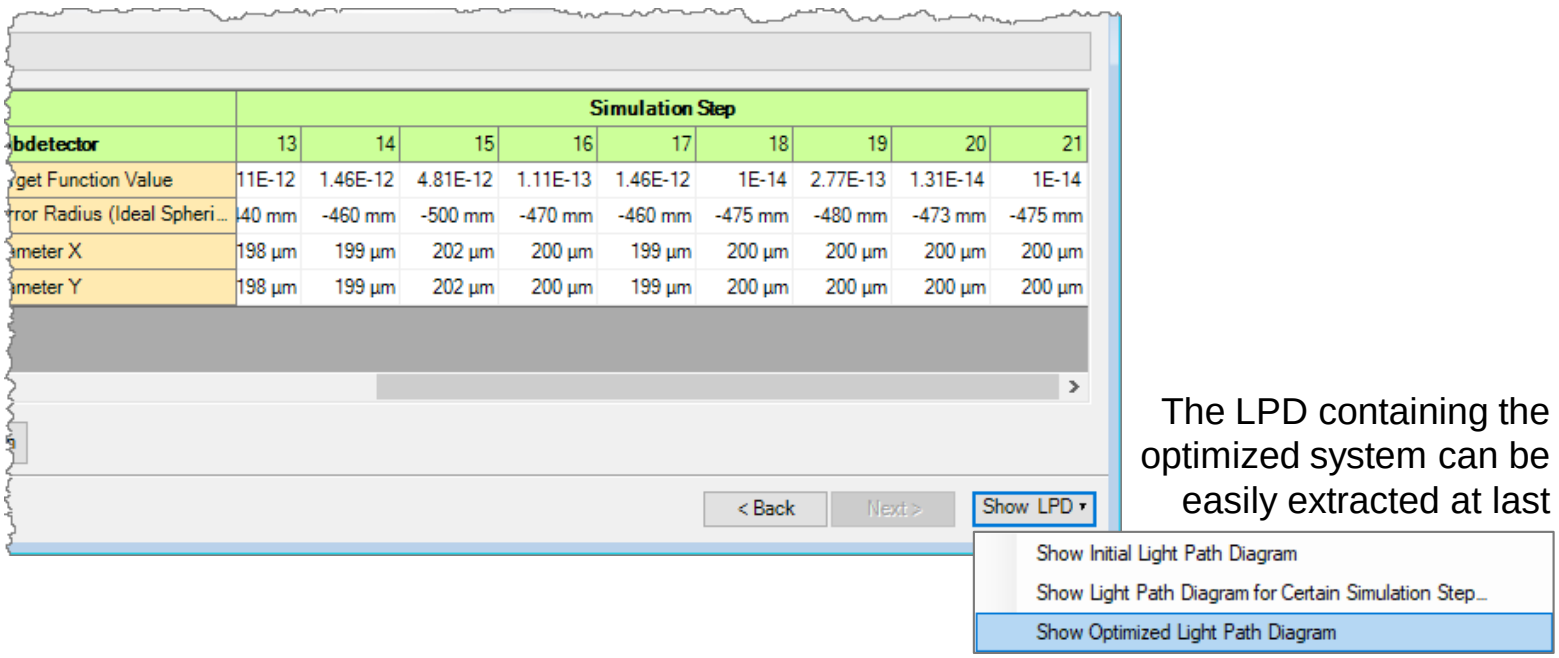

The LPD containing the optimized system can be easily extracted at last

Document Information

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