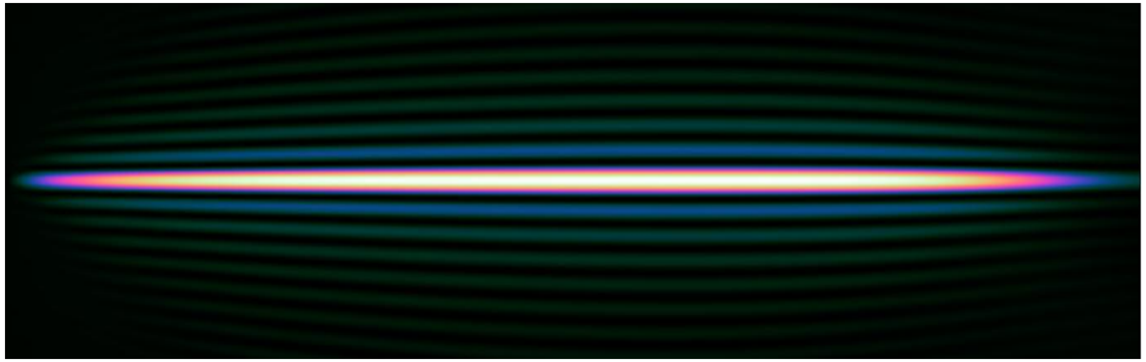
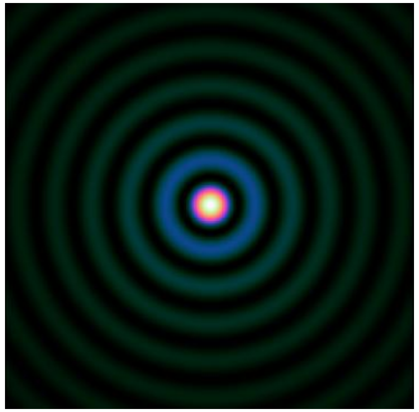
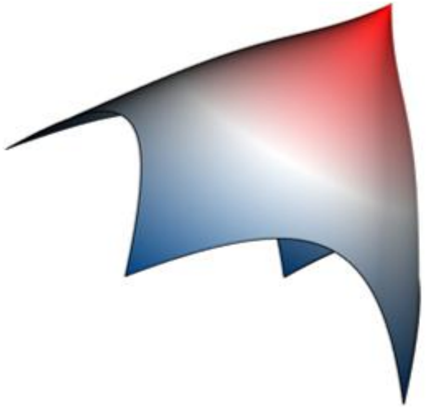
Axial Intensity Control of Gauss-Bessel Beams

Exponential phase modulation for axial intensity shaping.







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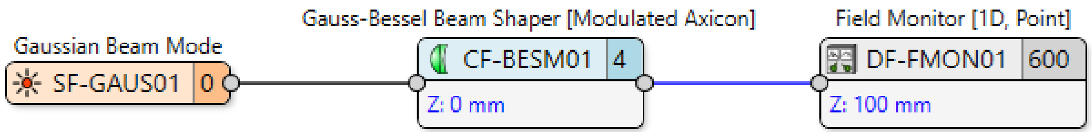
Doc. Version:	1.0
Date:	September, 18, 2026
Author	LightTrans International GmbH
SW Package:	VirtualLab Fusion Platform
SW Version:	2026.2 (Build 3.30)

Scenario: Gauss-Bessel Axial Intensity Control

Demonstrated Optical Setup

Component	Specification
Source	Gaussian beam, $\lambda = 1064\,\text{nm}$
Beam Radius	$w_0 = 2\,\text{mm}$
Beam Shaper	Gauss–Bessel Beam Shaper [Modulated Axicon]
Axicon Phase	Equivalent axicon: $\alpha_0 = 1.5°$, $n = 1.45$
Phase Modulation	Gaussian, with adjustable magnitude, width and radial displacement
Detector	1D Field Monitor and Point Evaluation



Description:

- A Gaussian input beam should be transformed into a Gauss–Bessel beam with a uniform axial intensity over an extended propagation region.
- Gaussian type phase modulation provides the parameters for controlling and optimizing this distribution[1].

Demonstration Goals:

- Show that modulated axicon twin controls the axial intensity distribution of Gauss-Bessel beams.
- Show that optimization method can be used to homogenize the axial intensity.

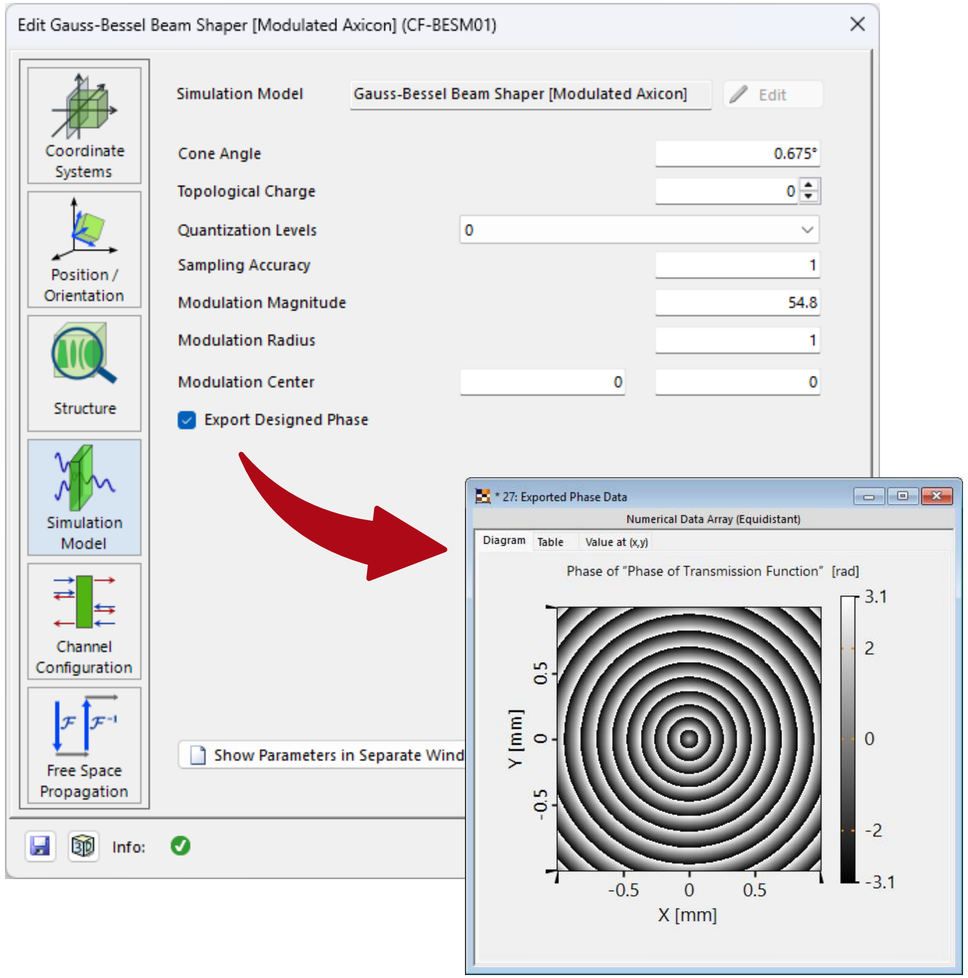
[1] Quasi-Bessel beam generation by a diffractive axicon with an exponential phase function" Moon et al., Optics & Laser Technology 177, 111059 (2024)

What Twin Is Used in This Demonstration?

Gauss–Bessel Beam Shaper [Modulated Axicon] (*)

- Applies a conical phase to the incident Gaussian beam to generate a Gauss–Bessel beam.
- Adds Gaussian phase modulation to control the axial intensity distribution.
- Provides adjustable modulation magnitude, width, and radial displacement.
- Allows these parameters to be varied and optimized for axial intensity homogenization.
- Optionally exports the designed phase profile for use on an SLM.

Gauss-Bessel Shaper Configuration



Exported Phase

 * *Find the specification sheets in the Document Center using the twin code* CF-BESM01.

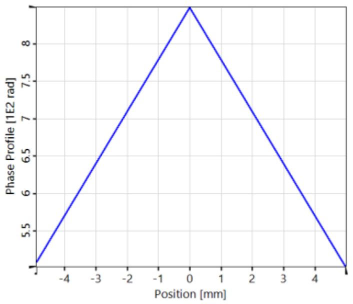
Results – Irradiance Along Propagation

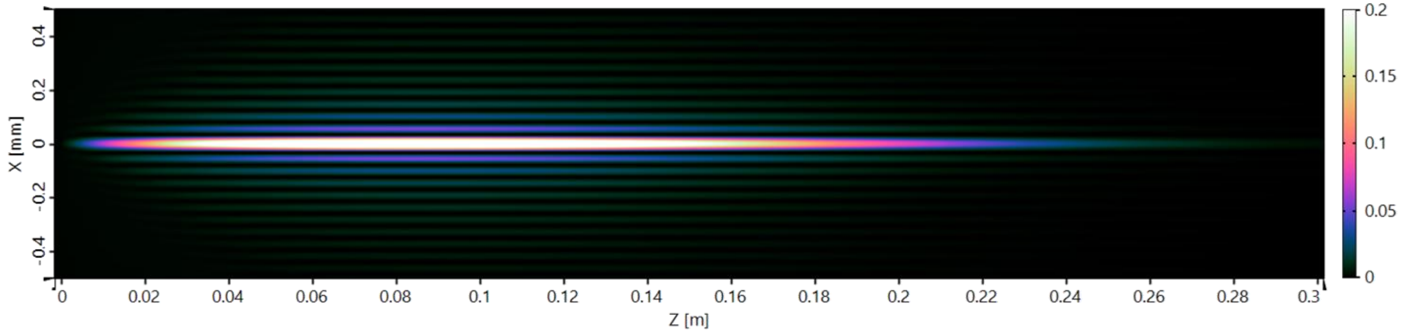
Phase Profile

Irradiance

Unmodulated

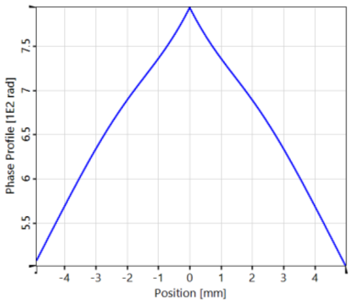
Magnitude: 0
Relative radius: 1.0
Relative center: $(0,\ 0)$

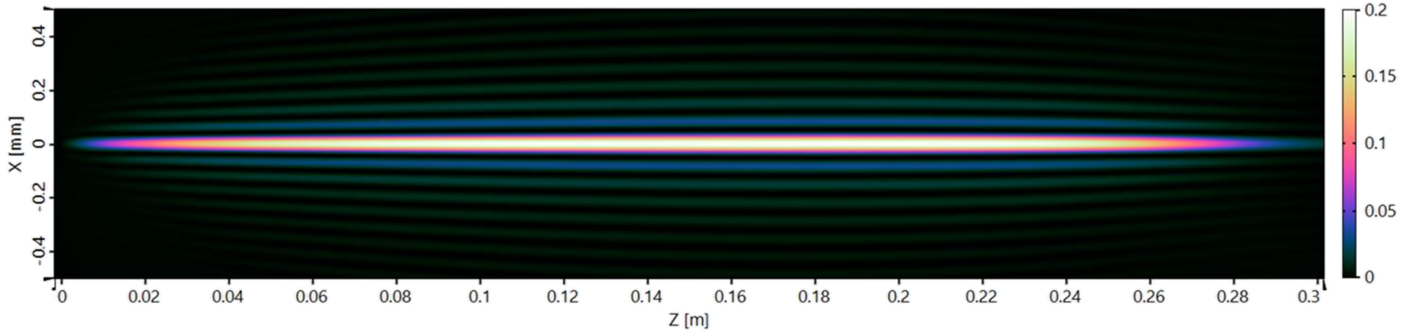




Modulated: Homogenized

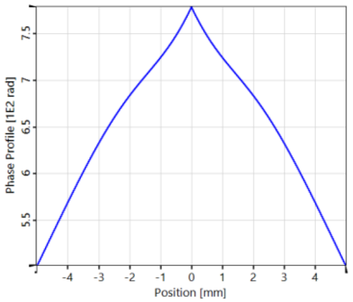
Magnitude: 54.8
Relative radius: 1.0
Relative center: $(0,\ 0)$

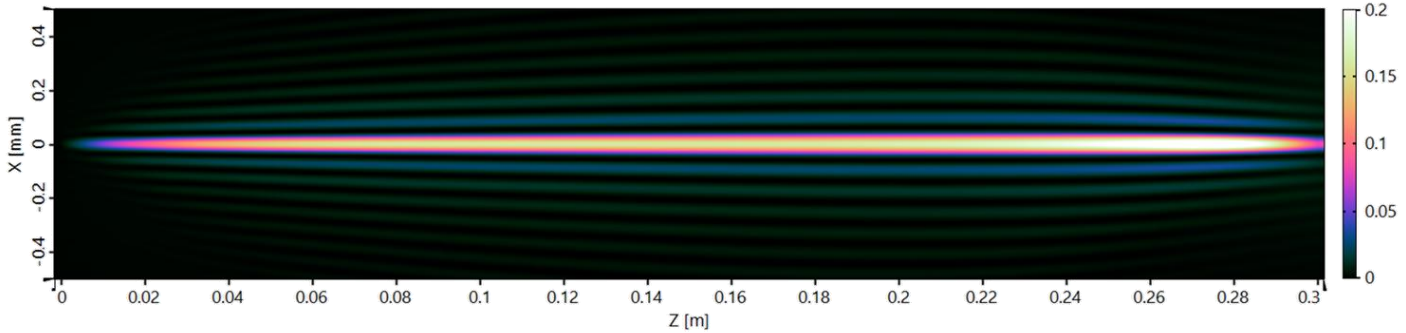




Modulated: Not homogenized

Magnitude: 70
Relative radius: 1
Relative center: $(0,\ 0)$





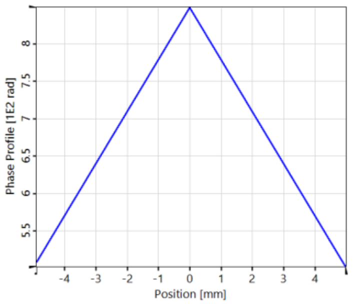
Results – Irradiance Along Propagation

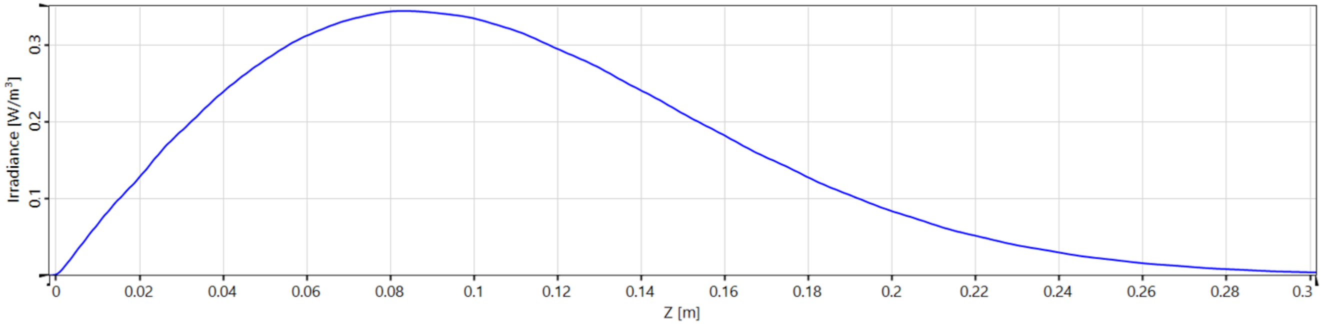
Phase Profile

Irradiance

Unmodulated

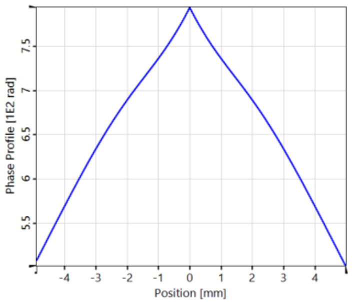
Magnitude: 0
Relative radius: 1.0
Relative center: $(0,\ 0)$

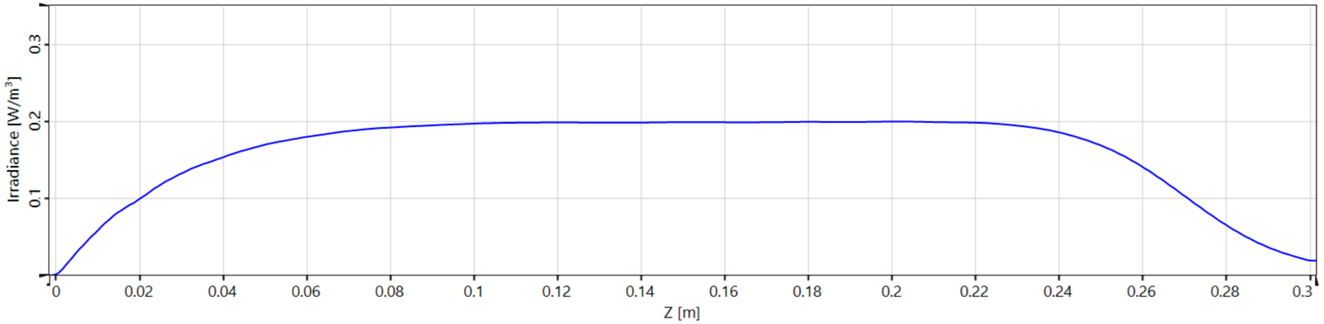




Modulated:
Homogenized

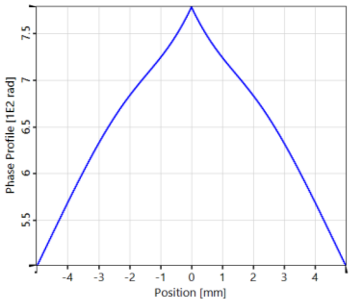
Magnitude: 54.8
Relative radius: 1.0
Relative center: $(0,\ 0)$

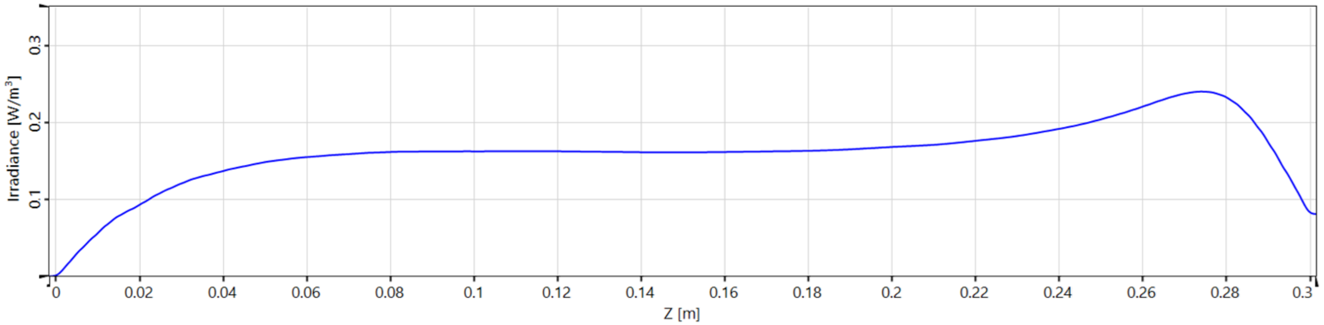




Modulated:
Not homogenized

Magnitude: 70
Relative radius: 1
Relative center: $(0,\ 0)$

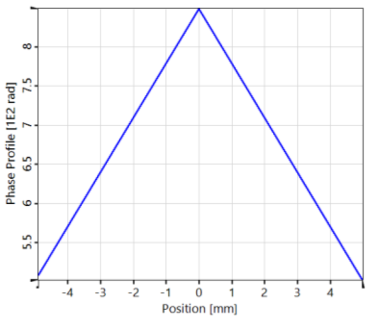


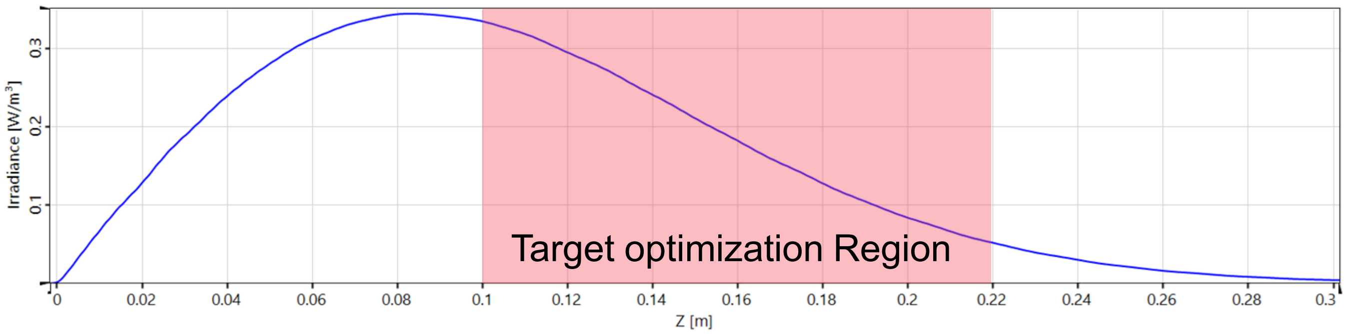


Task – Optimize Modulation Magnitude for Homogenization

Before Optimization

Magnitude: 0
Relative radius: 1.0
Relative center: $(0,\ 0)$

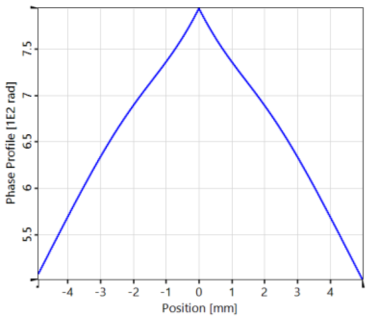


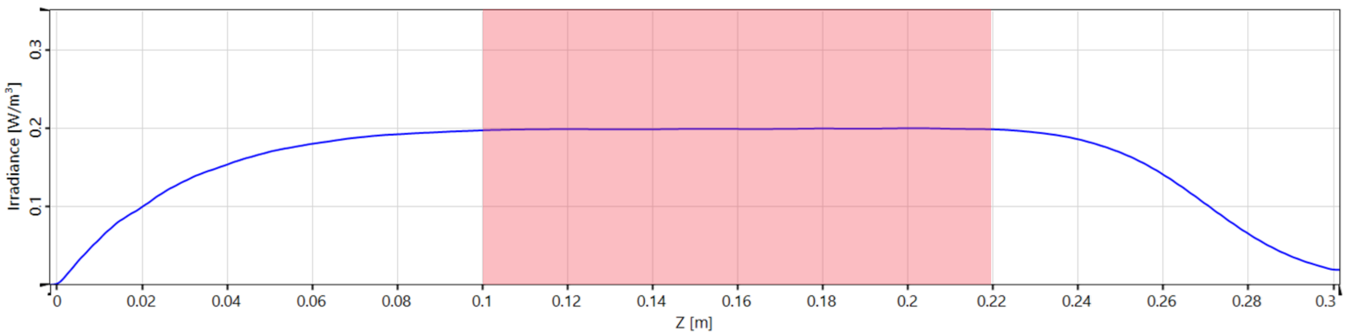


Parameter Variation Analyzer:
Evaluates the merit functions in the region
+
Parametric Optimization:
Optimizes the Modulation Magnitude

After Optimization

Magnitude: 54.8
Relative radius: 1.0
Relative center: $(0,\ 0)$

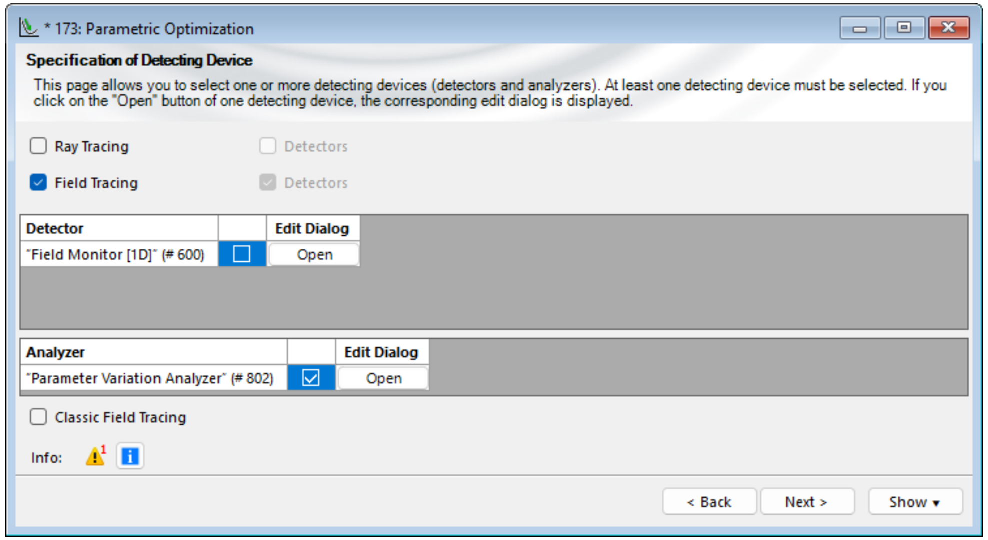




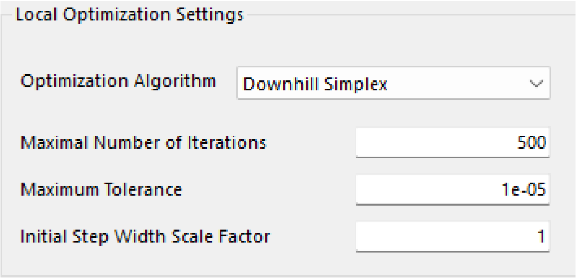
Workflow

What the User Does

1. Open the “Optical Setup Gauss-Bessel.os” file.
2. To optimize the modulation magnitude for a homogenized beam, start a new Parametric Optimization.
3. Choose Modulation Magnitude as the parameter.
4. Use the Parmeter Variation Analyzer as the detecting device.
5. Set the optimization constraints as in the table.
6. Set to Simplex with 500 iterations.
7. Start optimization



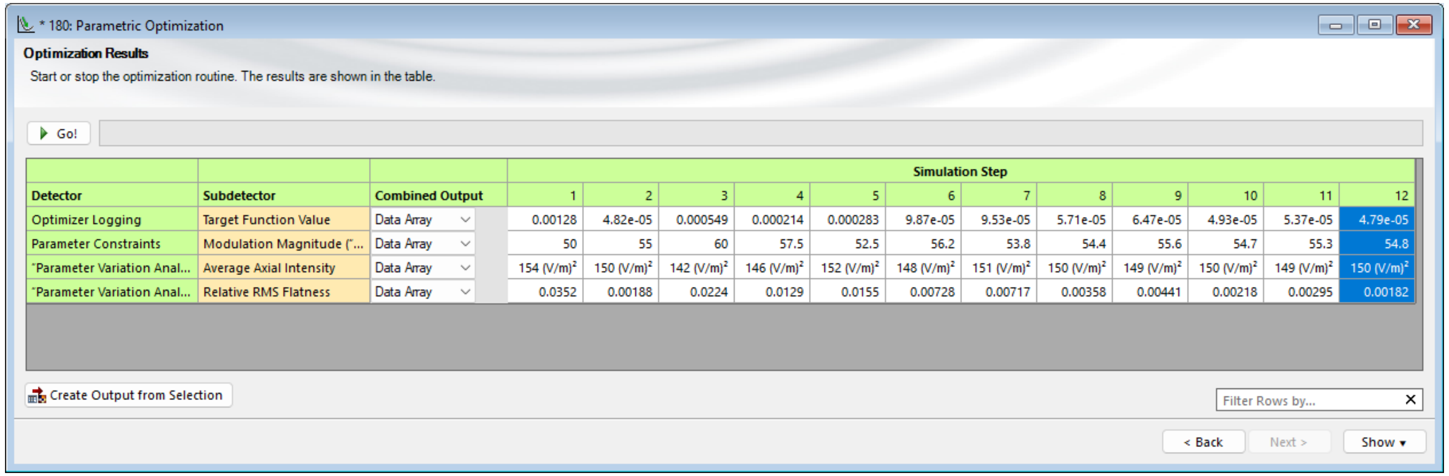
Constraint Name	Use	Weight	Constraint Type	Value 1	Value 2	Start Value
Operator | Modulation Magnitude	☑	1	Range	0	100	50
Relative RMS Flatness	☑	1	Target Value	0		N/A
Average Axial Intensity	☑	1	Target Value	Infinity $(V/m)^2$		N/A



Workflow

What the User Does

7. Once the optimization finishes, open the optimized setup.
8. Then, use a Parameter run to visualize the Irradiance in (X-Z).
9. Observe the homogenized axial irradiance distribution.



For convivence, the optimized Gauss-Bessel shaper is provided in “Optimized Optical Setup.os”