Beam Shaper

Ziyi Xiong

January 15, 2026

Contents

1 Keplerian Type Beam Shaper

Simulation with parameters and lens data sheet given in *Laser Beam Shaping Techniques*

$$w_0 = 2.366\,\text{mm};\ R_{max} = 4.05\,\text{mm};\ r_{max} = 4.05\,\text{mm};\ d = 150\,\text{mm};\ n = 1.46071$$

Figure 1: Parameters of Keplerian type beam shaper system.

The parameters gives the apodization factor as:

$$G = \left(\frac{r_{max}}{\omega_0}\right)^2 \approx 2.93 \tag{1}$$

1.1 Initial system

The lens data sheet given in *Laser Beam Shaping Techniques*:

TABLE 7.1
Design Data for Plano-Aspheric Lens Pair of Keplerian Beam Shaper Calculated Based on the Third-Order Aberration Theory

No.	r_c	t_c	Glass	k	n_{532}
		Infinity			1
1	Infinity	3	Fused silica		1.46071
2	−20.182	150		−48.71	1
3	48.925	3	Fused silica	17.08	1.46071
4	Infinity				1

Figure 2: Initial Keplerian type beam shaper system.

This system gives a profile as below in Zemax OpticStudio:

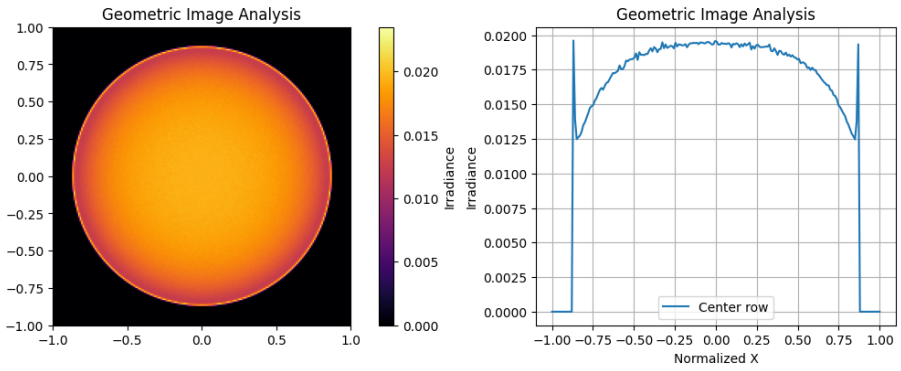

Figure 3: Initial beam profile at the output plane.

1.2 Optimized with only conic constant

The lens data sheet given in *Laser Beam Shaping Techniques*:

TABLE 7.2
Design Data for Plano-Aspheric Lens Pair of Keplerian Beam Shaper with the Second-Order Aspheric Surfaces Whose Parameters Are Corrected by Optimization Method

No.	r_c	t_c	Glass	k	n_{532}
		Infinity			1
1	Infinity	3	Fused silica		1.46071
2	−20.182	150		−54.8	1
3	48.925	3	Fused silica	29.5	1.46071
4	Infinity				1

Figure 4: Optimized Keplerian type beam shaper system with only conic constant as variable.

In Zemax OpticStudio, the output profile given by this is:

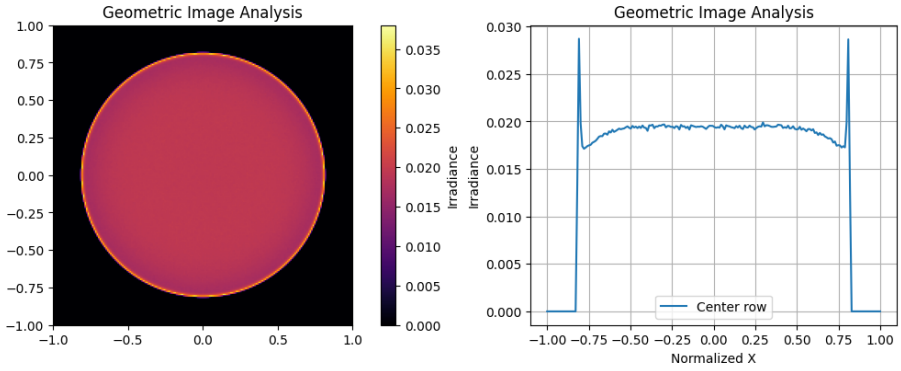

Figure 5: Output beam profile at the output plane after optimization with only conic constant as variable.

1.3 Optimized with up to 4th order

The lens data sheet given in *Laser Beam Shaping Techniques*:

TABLE 7.3
Design Data for Plano-Aspheric Lens Pair of Keplerian Beam Shaper Where First Aspheric Has the Second-Order and the Second Aspheric Has the Fourth Order

No.	r_c	t_c	Glass	Asphere Coefficients	n_{532}
		Infinity			1
1	Infinity	3	Fused silica		1.46071
2	−20.1	150		$k = -55.62$	1
				$A_4 = -6.27 \times 10^{-5}$	
3	48.75	3	Fused silica	$K = 67.22$	1.46071
4	Infinity				1

Figure 6: Optimized Keplerian type beam shaper system with up to 4th order as variable.

In Zemax OpticStudio, the output profile given by this is:

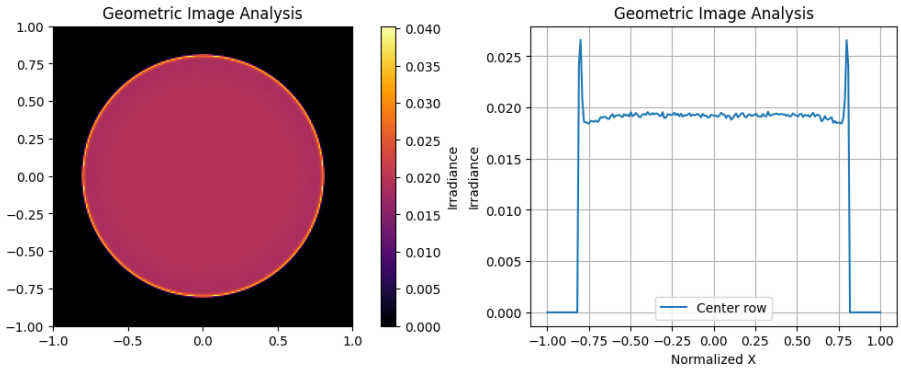

Figure 7: Output beam profile at the output plane after optimization with up to 4th order as variable.

1.4 Optimized with up to 6th order

The lens data sheet given in *Laser Beam Shaping Techniques*:

TABLE 7.4
Design Data for Plano-Aspheric Lens Pair of Keplerian Beam Shaper When the First Aspheric Has the Second Order and the Second Aspheric Has the Sixth Order

No.	r_c	t_c	Glass	Asphere Coefficients	n_{532}
		Infinity			1
1	Infinity	3	Fused silica		1.46071
2	−20.1	150		$k = -55.6$	1
				$A_4 = -6.27 \times 10^{-5}$	
				$A_6 = -2.06 \times 10^{-6}$	
3	49.11	3	Fused silica	$k = 86.42$	1.46071
4	Infinity				1

Figure 8: Optimized Keplerian type beam shaper system with up to 6th order as variable.

In Zemax OpticStudio, the output profile given by this is:

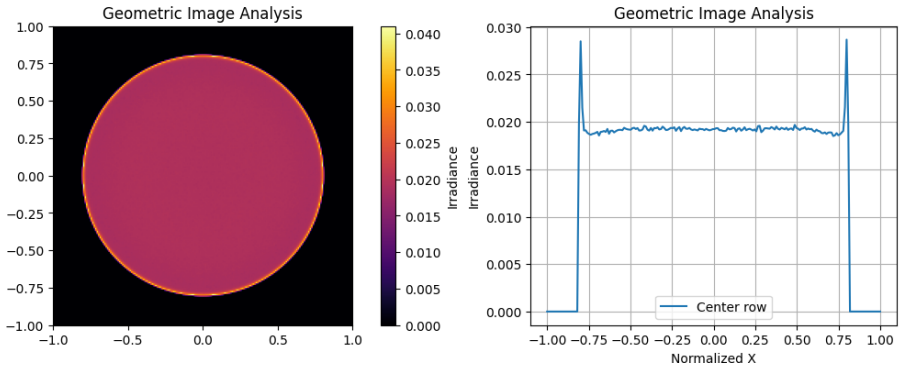

Figure 9: Output beam profile at the output plane after optimization with up to 6th order as variable.

2 Galilean Type Beam Shaper

Since the Galilean type beam shaper can not result in a 1:1 beam size conversion, for making a better comparison, the R_max is timed by 3 to make the marginal ray get bent the same size of angle with respect to the optical axis but in an opposite direction.

So the parameters are modified as below:

$$\omega_0 = 2.366 \quad R_{max} = 12.15 \quad r_{max} = 4.05 \quad n = 1.46071 \quad d = 150 \tag{2}$$

2.1 Initial system