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Exercises
Lecture Optical design with Zemax– Part 4

4 Aberrations

4.1 Strehl ratio and geometrical vs diffraction Psf spot size

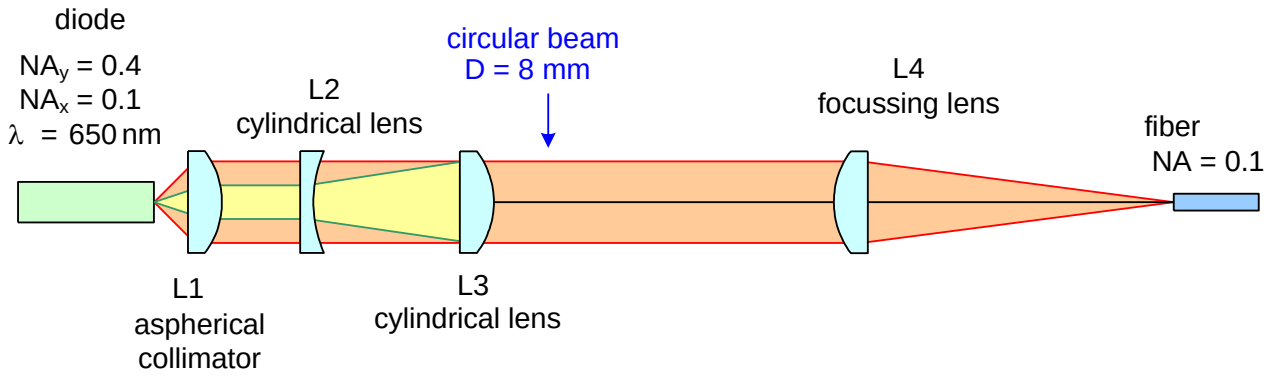
A single lens made of K5 with focal length f = 25 mm and thickness d = 5 mm is illuminated by a diverging beam with numerical aperture NA = 0.1. After the lens the light should be collimated. If the collimated beam is refocussed without further aberrations, the point spread function is not diffraction limited.
a) Calculate the accurate Strehl ratio, the estimated Strehl ratio and the geometrical and diffraction encircled energy inside the ideal Airy diameter.
b) If now the numerical aperture is reduced, the Marechal estimation becomes better. Calculate the largest NA, for which the relative error is smaller then 2%. What amount for geometrical and diffraction encircled energy is inside the Airy diameter is obtained here ?

4.2 Aberrations and Performance of an Diode Collimator

Load the lens GLC-6.5-8.0-830 DIODE LASER COLLIMATING LENS from the catalog of CVI Melles Griot.
a) What is the numerical aperture of the lens in the image? Determine the Strehl ratio and compare the estimated and the exact value.
b) What are the two surfaces with the largest contribution to the spherical aberration ? The first lens groups looks like an achromate. Corresponds the correction of this part of the system to an achromate ?
c) Show, that all intersection points of the spot diagram are inside the Airy diameter. If the spot is analysed it is seen, that there is a bright kernel with a surrounding halo. What is the relative power content of the inner kernel region ? What is the diameter of this inner part ?
d) What is the image contrast of a grating object with 100 line pairs per millimeter of this system ? Determine the MTF of the lens for defocussing. What is the depth of focus intervall, where inside the contrast is larger than 50% ? Explain the asymmetry of the curve.

4.3 Anamorphotic Diode collimator

A semiconductor diode with wavelength 650 nm and the divergence / aperture values 0.4 / 0.1 in the fast ans slow axis respectively should be collimated in a circular beam with a diameter of approximarely 8 mm. The collimated beam is now focussed into a fiber with numerical aperture of NA = 0.1.



Find a solution for this problem with only available catalog lenses.
Is the setup diffraction limited ? Explain the shape of the residual spot pattern. What are the reasons for the residual aberrations in the system ? What can be done to further improved the result ?
Discuss possible steps to get a shorter system. What are the consequences of a compact layout ?