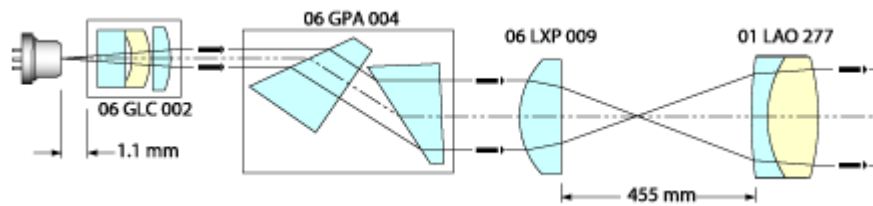


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Examples

Collimating a Diode Laser

Collimating a diode laser presents a particular unique challenges. In this example we will collect and collimate the output of a diode laser to a 25-mm-diameter diffraction-limited beam. The output wavelength is 780 nm and has a full-angle divergence of 60°x 20° (see the figure below)



Collimating a diode laser with standard Melles Griot components

The first step is to determine the numerical aperture needed to collect all the light from a source with a 60-degree divergence angle. Since numerical aperture is defined to be the sine of the half angle of divergence,

$$NA = \sin 30^\circ = 0.5$$

Stated in terms of f-number, $1/(2 NA)$, this is $f/1$. At this low f-number we can immediately rule out virtually any simple lens or achromat; even if a simple lens were available at this low f-number, it would not provide the performance level required. The best choice would be a highly corrected, multielement diode laser collimating lens, such as the 06 GLC 002, which has a numerical aperture of 0.5.

The 06 GLC 002 yields a collimated elliptical beam with dimensions of 8 mm x 2.7 mm. The smaller dimension of this beam must be expanded to match the larger dimension; otherwise, it will have a larger beam divergence because of diffraction. Since there is approximately a 3:1 ratio in the two dimensions, we will use a 3x anamorphic prism pair, 06 GPA 004, to accomplish the expansion. This will now yield a collimated beam 8 mm in diameter.

The next step is to expand the beam by a factor of 3.125x in order to get to the desired 25-mm beam diameter. Since no constraint has been given on the length of our optical system, we'll play it safe and operate our beam expander at a minimum of $f/10$. This virtually ensures diffraction-limited performance, even with singlets.

At $f/10$ and an 8-mm-diameter input beam, we would need a focal length of 80 mm for the input lens of our collimator. Since we are looking for diffraction-limited performance, our best choice would be one of the precision diode laser singlets (06 LXP series). Once again, we choose a high-precision lens because our beam has a fairly large diameter and the effects of manufacturing tolerances must be considered.

The closest focal length we have in this series of lenses is the 06 LXP 009 with a focal length of 110 mm. Operating at $f/13.75$, we will have diffraction-limited performance, which can be verified by using the formula for spherical aberration. We now need a collimating lens with a focal length of $3.125 \times 110 \text{ mm} = 344 \text{ mm}$. The best choice is probably the 01 LAO 277 because there is no

precision singlet lens with the necessary focal length. The achromat is also manufactured to tighter tolerances.

The final system would then consist of the 06 GLC 002 mated directly to the 06 GPA 004, followed by the 06 LXP 009 with its curved surface facing toward the diode laser. The spacing between the 06 LXP 009 and 06 GPA 004 is not critical. Finally, the 01 LAO 277 would follow, spaced approximately 455 mm from the singlet, with its flint surface facing toward the diode laser

Since the standard coating supplied with the 01 LAO series achromats does not perform very well at 780 nm, this lens should be specified with a /076 coating, which is optimized for performance at 780 nm.

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