PRACTICAL RESOLUTION

Lenses hardly ever meet the diffraction limit. Here is a page from OPTICS GUIDE 5 from Melles Griot where they measure the spot size of a variety of their lenses. The test is described below.

Remember that resolution is measured in line pairs per millimeter; 100 lp/mm means each pair is 1/100 mm, which means 10 microns; then a bright or dark bar is 5 microns in width.

LENS SELECTION

In general, the performance of a lens or lens system in a specific circumstance should be determined by an exact trigonometric raytrace. Melles Griot applications engineers can supply raytrace data for particular lenses and systems of catalog components on request. However, for certain situations, some simple guidelines can be used for lens selection. The optimum working conditions for some of the lenses in this catalog has already been presented. The following tables give some quantitative results for a variety of simple and compound lens systems that can be constructed from catalog optics.

In interpreting these tables, remember that these are theoretical values obtained from computer raytracing. They consider only the effects of ideal geometric optics; performance effects of the manufacturing tolerances for these elements has not been considered. Furthermore, remember that using more than one element provides for a higher degree of correction, but makes alignment more difficult. When actually choosing a lens or lens system, it is important to note the tolerances and specifications, clearly described for each Melles Griot lens in the product listings.

The tables give spot size for a variety of lenses used at several different f-numbers; all the tables are for on-axis, uniformly illuminated, collimated input light of wavelength 632.8nm. They assume that the lens is facing in the direction which produces a minimum spot size. When the spot size due to aberrations is smaller than or equal to the diffraction limited spot size, the notation "DL" appears in the entry. Note that the shorter focal length lenses produce smaller spot sizes; this is because aberrations increase linearly as a lens is scaled up. There is a strong dependence of spot size on f-number. For a plano-convex singlet, spherical aberration is inversely dependent on the cube of the f-number. For doublets, this relationship can be even higher. These results cannot be generalized to situations in which the lenses are used off-axis. This is particularly true of the achromat/aplanatic meniscus lens combinations whose performance degrades rapidly off-axis.

Focal Length = 10mm

	Spot Size (microns)		
	01 LDX 055 Double-Convex	01 LPX 005 Plano-Convex	01 LAO 001 Precision Achromat
f/2	550	95	11
f/3	120	25	8
f/5	30	DL	DL
f/10	DL	DL	DL

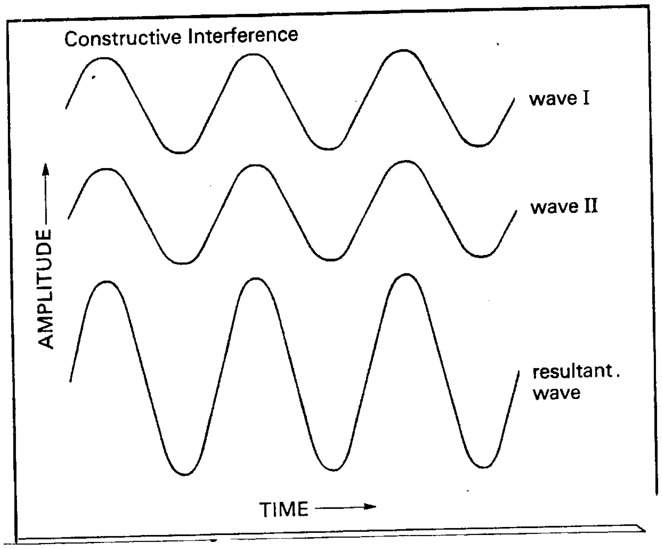
Focal Length = 30mm

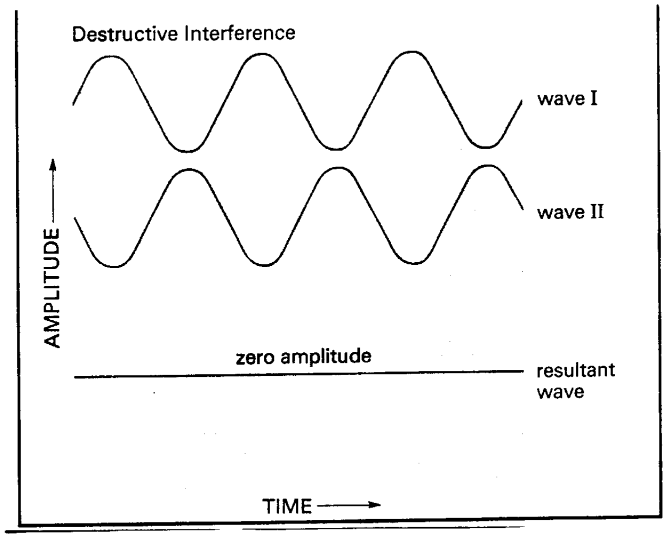
	Spot Size (microns)		
	01 LPX 049 Plano-Convex	Precision Achromat 01 LAO 024	01 LAO 059 & 01 LAM 059 Precision Achromat & Field Flattener
f/2	350	80	4
f/3	90	11	DL
f/5	17	DL	DL
f/10	DL	DL	DL

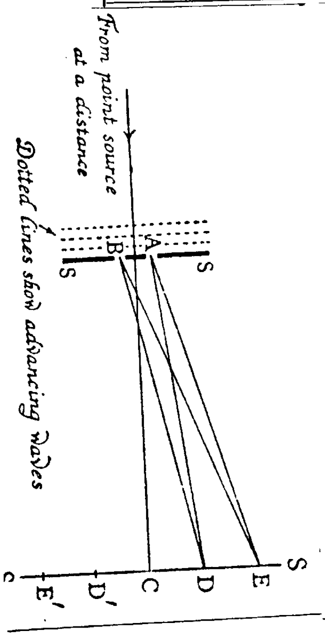
Focal Length = 60mm

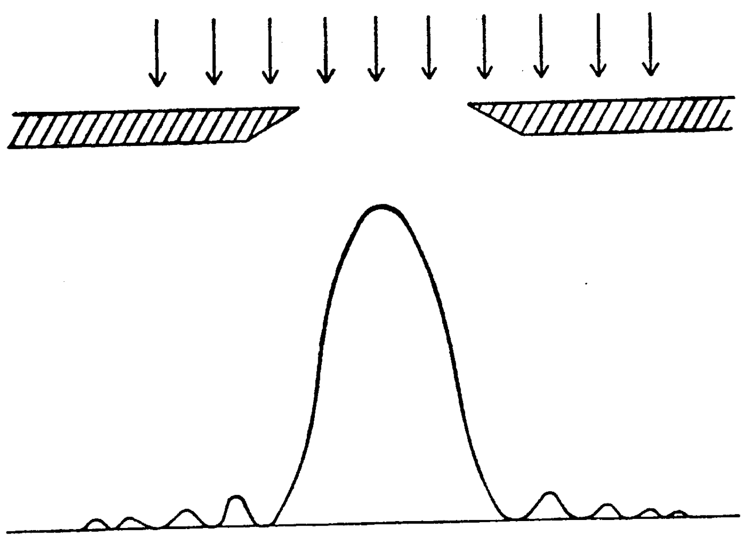
	Spot Size (microns)			
	01 LDX 123 Double-Convex	01 LPX 127 Plano-Convex	01 LAO 079 Precision Achromat	01 LAO 126 & 01 LAM 126 Precision Achromat & Field Flattener
f/2	800	600	80	6
f/3	225	200	35	DL
f/5	42	30	9	DL
f/10	DL	DL	DL	DL

(See the Handout, AIRY'S DISC, for the values of the diffraction limit at the listed f/#'s)



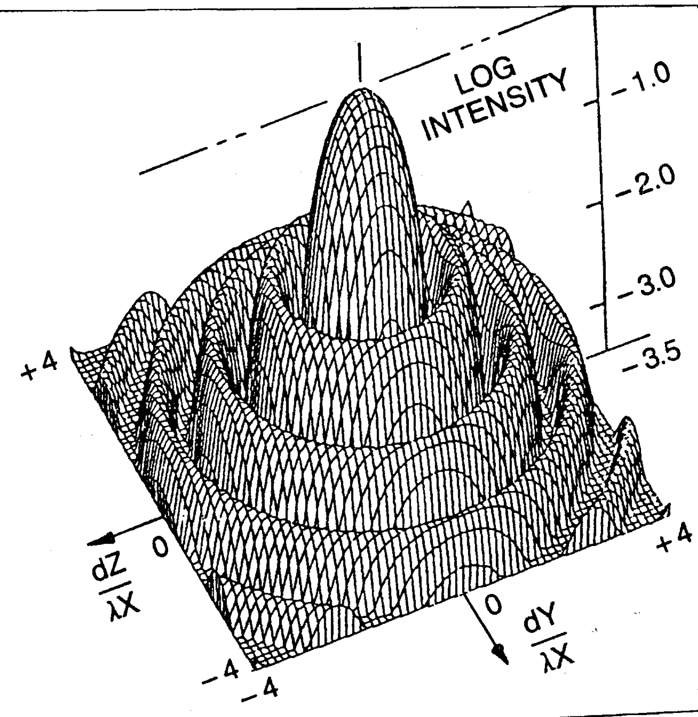






Airy Disc

31. **Diffraction at a circular aperture. Illumination area is a round patch (the Airy disc) surrounded by dark and light rings.**



TOP: Wave Interference. CENTER LEFT: If BD - AD = 1/2 wavelength, dim fringe is formed. If BD - AD = 1 wavelength, a bright fringe is formed. CENTER RIGHT: Intensity profile of the cross-section of an Airy Disc. RIGHT: Three-dimensional intensity map of Airy Disc.