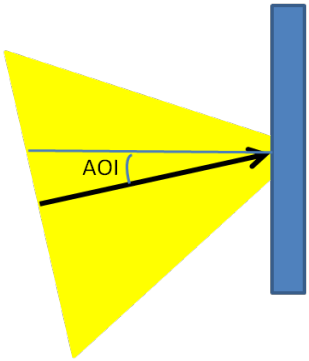
OMEGA OPTICAL
Custom Thin-Film Filters

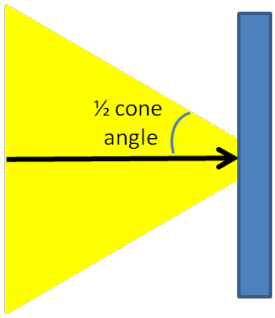
TECHNICAL NOTE

Effects of AOI, f/# and Cone Angle on Filter Performance



Angle of incidence (AOI) describes the angle of the primary beam and the normal to the surface of the filter.

The AOI is zero when the beam is hitting the filter perpendicular to the surface.



½ cone angle describes the beam convergence or divergence as it hits the filter.

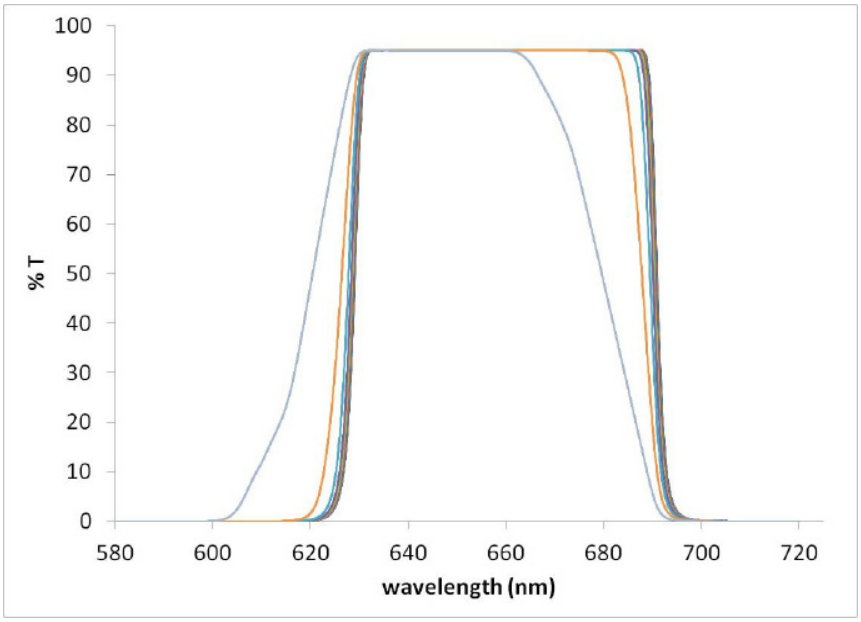
f/# and ½ cone angle are related as shown in the table to the right. A collimated beam has a ½ cone angle of zero. Another common term in use is numerical aperture (NA) which is equal to sin(half angle).

Conversion Table

f/#	Numerical Aperture	1/2 Cone Angle (deg)
12	0.041	2.4
11	0.045	2.6
10	0.050	2.9
9	0.055	3.2
8	0.062	3.6
7	0.071	4.1
6	0.083	4.8
5	0.100	5.7
4	0.124	7.1
3	0.164	9.4
2	0.242	14.0
1	0.447	26.6

Effect of Angle on Filter Performance

As f/# decreases (NA and half cone angle increase), the range of angles incident on the filter increases, resulting in a degradation of performance as seen in the figure below.



We have plotted the spectral response of a filter at f/#s ranging from 12 to 1. At low angles (up to about f/3, 9 °), the spectral response remains relatively unaffected in this particular example. However, at larger angles, significant deviations from the expected spectral response are observed, particularly in a design like this which contains steep edges, neutral (flat) transmission bands, and high transmission bandwidths. Different filter designs have different angle sensitivities. Extremely narrow-bandpasses also exhibit a strong angle-dependent shift.

For more information about angle-dependence on filters and their measurements, see our paper "Measuring Sharp Spectral Edges to High Optical Density" in the Resources section of omegafilters.com.

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