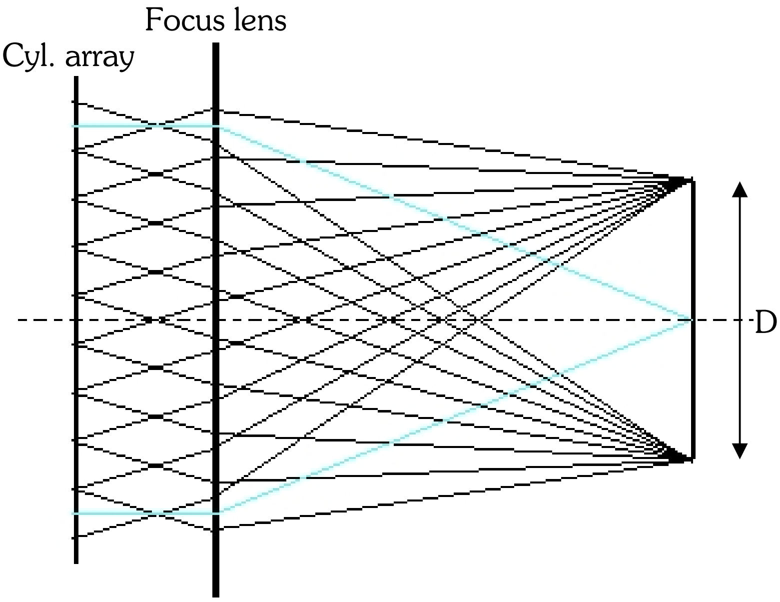
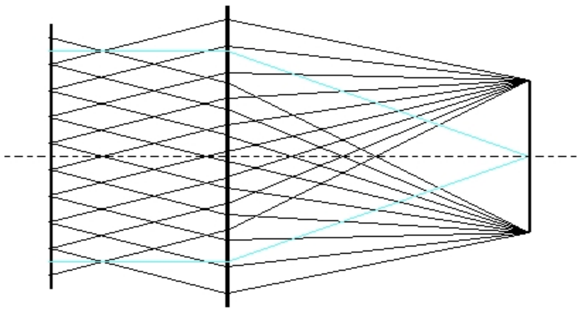
Design Rules for Cylinder Array Homogenizers

Cylinder array homogenizers are used to create uniform intensity illumination of a part, or mask, whose image is projected onto the part.



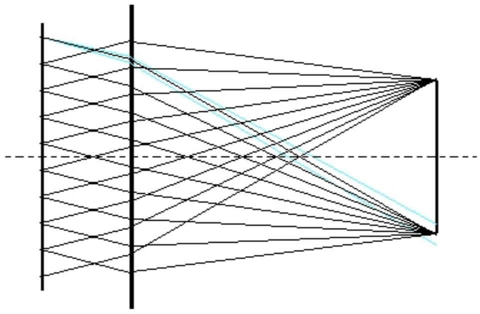
A single cylindrical lens array can be used used to create multiple line sources (homogenization in 1 dimension); a crossed cyl. array is used to create multiple point sources(2D case).

The focus lens ensures that each location on the target is illuminated by contributions from different parts of the beam, hence smoothing out the effect of inhomogeneities in the original beam profile.



The degree of homogenization depends on the number of segments, in general more is better, but 7x7 or 9x9 is already acceptable for many applications.

The size D of the homogenized beam on the target is given by cyl. segment size magnified by ratio of cyl. & collimating lens powers.



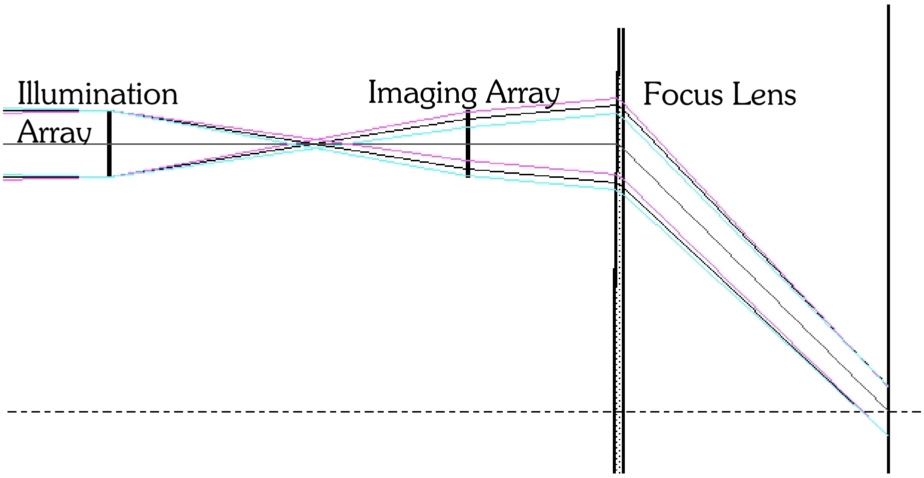
As shown, the position of collimating lens w.r.t. homogenizer is not at all critical, and does not affect D; however size requirements of the focus lens favour a relatively short distance from array to lens.

One or Two arrays?

Both single and double homogenization can be used; it is important to understand that according to the simple theory above, there should be NO fundamental difference in homogeneity between the two, the difference concerns only the sharpness of the edge of the profile, which of course may be of low importance if a mask is to be used, and may even be a desirable feature for some processing situations.

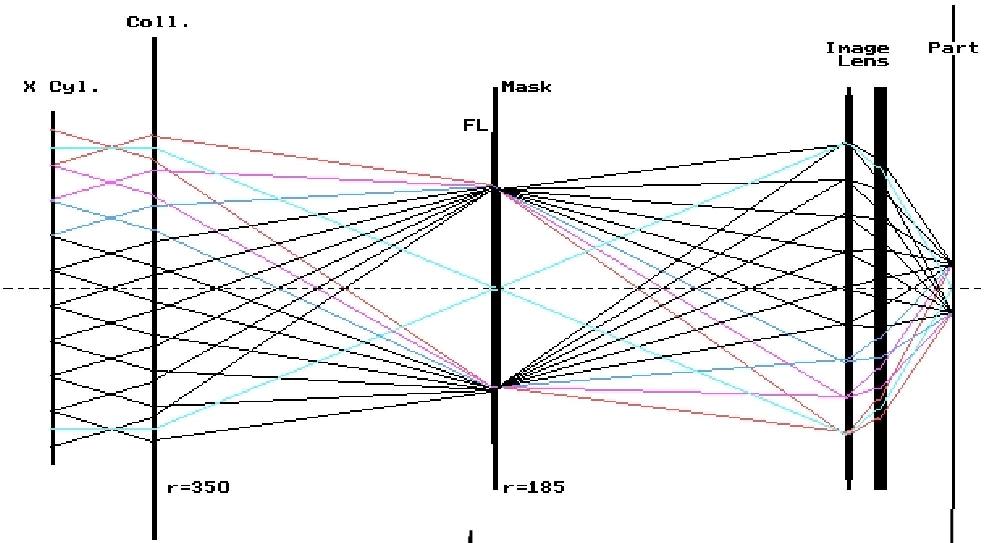
However, in practical arrays the exact shape of the interstices between the lenslets has an influence on the homogeneity, and at small array pitch interference effects may also appear. .

With double homogenization the first (illumination) array serves simply to direct the beamlets into the corresponding lenslets of the imaging array. The illumination array is placed at the back focus of the imaging array so that illumination array and target are conjugates in the focal system consisting of the imaging array and the focus lens, thus ensuring that marginal rays(blue) are focussed on the part rather than leading to divergence softening. D is given by the optical ratio of imaging array & focus lens.

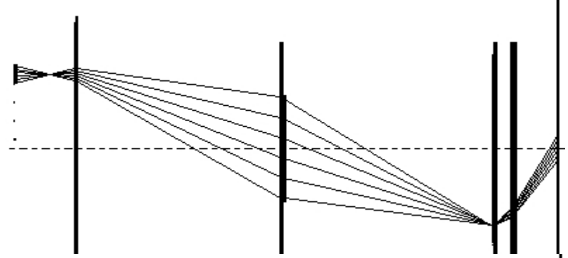


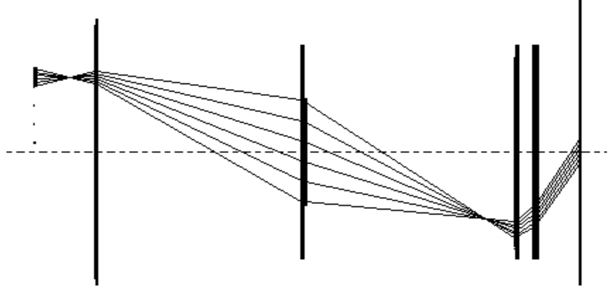
Illumination array f.l. is uncritical, and may be either geater or less than the imaging array, - whatever is necessary to optimise transport of the divergent beamlets into the imaging lenslets without excessive e.d. on the latter, and depends on the characteristics of the input beam. If input beam divergence is such that some illumination enters neighbouring lenslets, then the effect will be to produce 'satellite' spots in the final intensity distribution. The true remedy here is to spatially filter the input beam to remove high divergence components.

Where homogenizers are used to illuminated masks in projection systems, a field lens is often used just before the mask to optimize pupil filling in the projection lens, leading to the complete layout shown here.



However, note that perfect matching of ray bundles to projection lens aperture means that the cyl foci are imaged onto the image lens first element,- not nice. The solution is to place the focus array in a pupil a little in front of the image lens, as shown here.





In any particular case, Optec will be happy to advise on suitable optics layout & component selection.