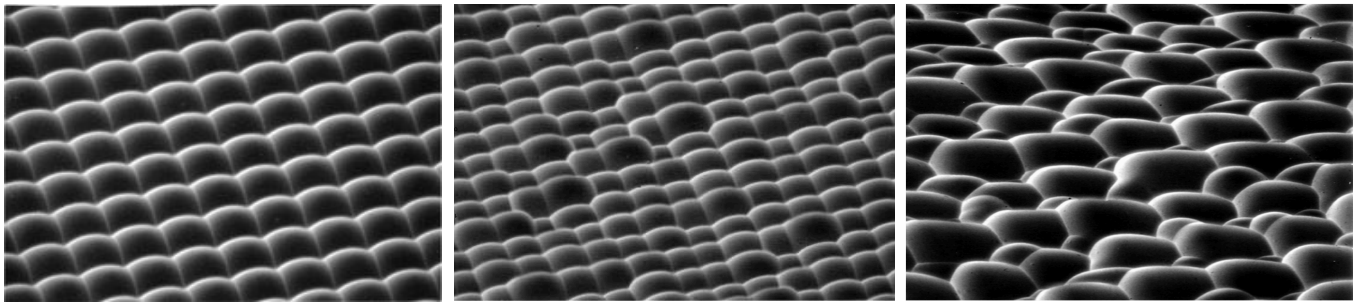
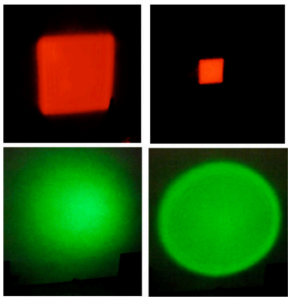
Using Diffusers for Beam Homogenization

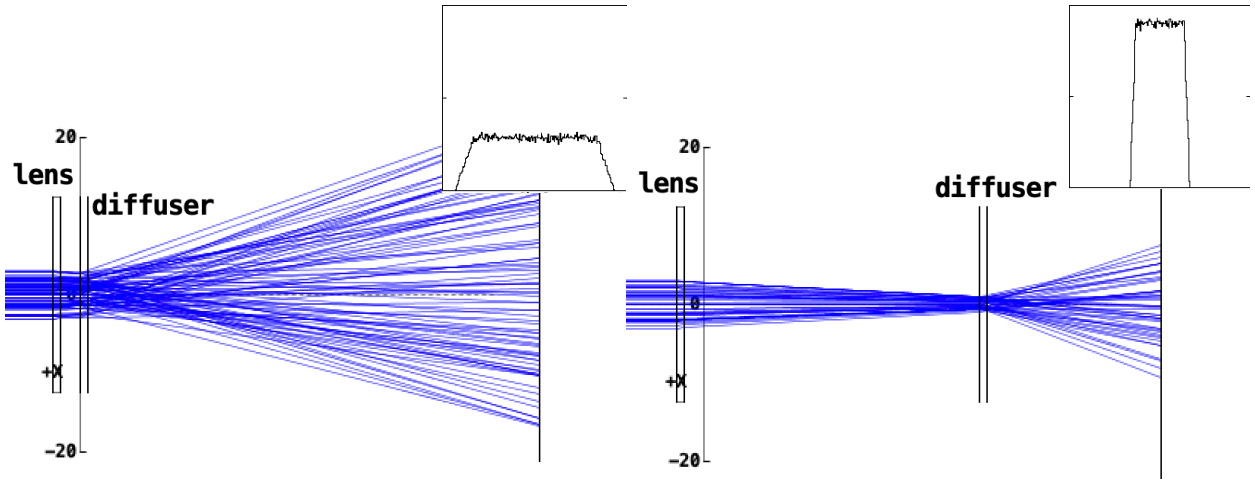
A limitation of homogenizers based on microlens arrays is that when spatial coherence exceeds, or is on the order of, the pitch of the array then contributions from neighbouring array elements can interfere & produce fringes which defeat the purpose. This effect results from the regular periodicity of the array (left) and can be reduced or eliminated by lowering or eliminating periodicity (centre & right); such optical elements are described as engineered diffusers; speckle remains.



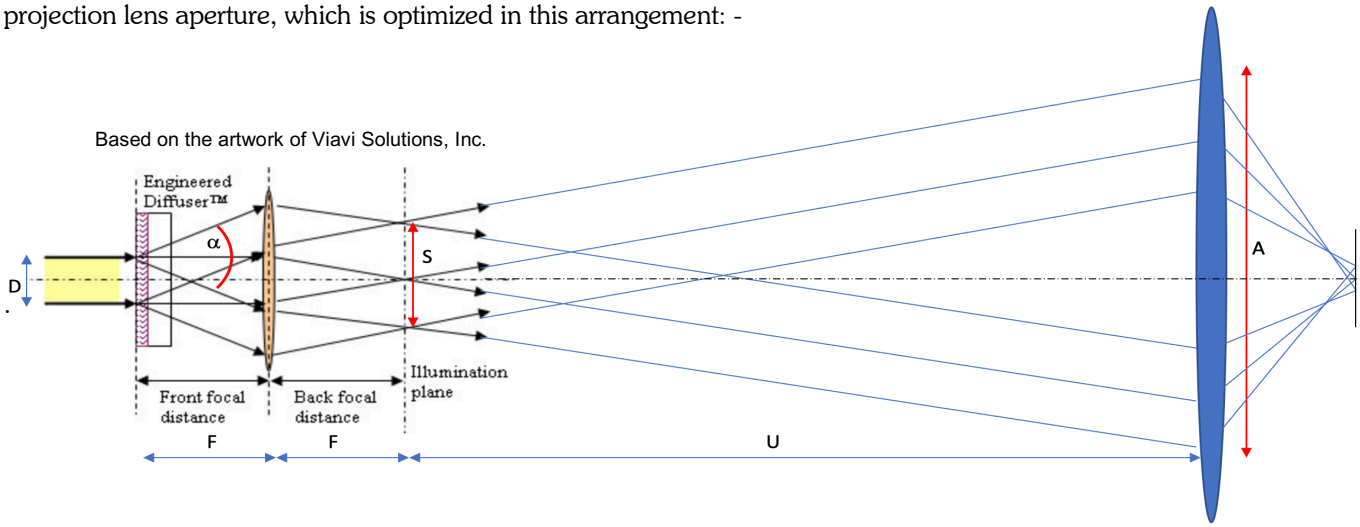
Unlike ground glass or Opal diffusers which produce a Lambertian distribution in the scattered beam,- i.e. intensity depends on cosine of the scattered angle,- engineered diffusers can be designed for a specific angular distribution, in this context most usefully uniform up to a sharp cut-off. When used with a lens,- termed a Fourier lens,- that angular distribution is then copied as a spatial distribution in the focal plane of the lens, and the shape of that illumination spot can also be engineered at design stage.



N.B. lens & diffuser can be placed in either order; if diffuser is placed after the lens and the former moved closer to the focal plane then the result is a smaller spot of higher intensity.



When used to illuminate the mask in a projection system with demagnification then one has to think about filling of the projection lens aperture, which is optimized in this arrangement: -



..where basic geometry can be applied to determine the appropriate scattering angle α as a function of other parameters.