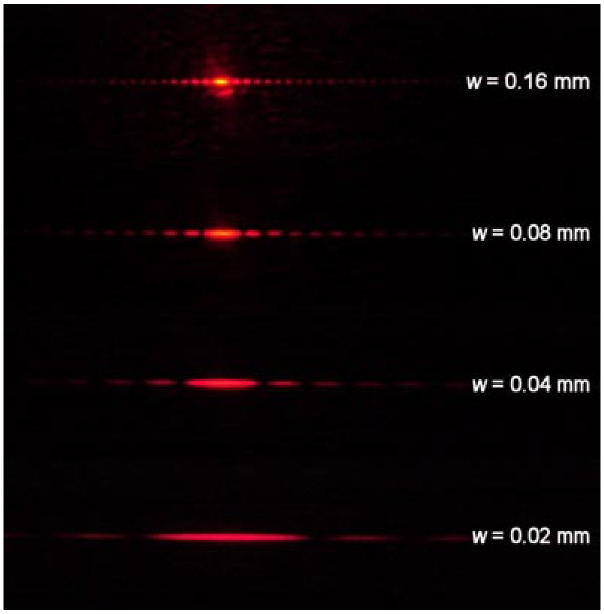
Diffraction patterns and Information obtained from it

Diffraction patterns :

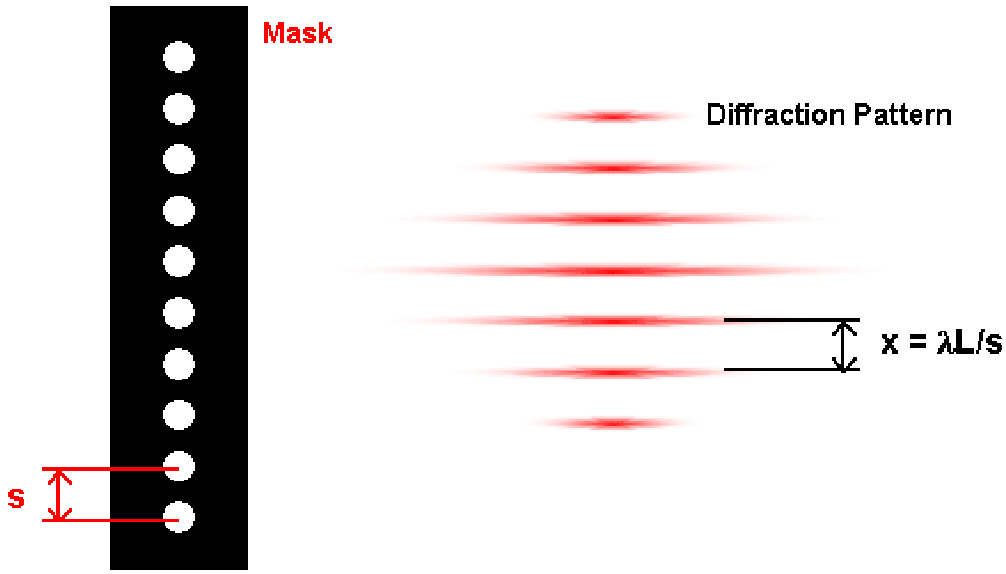
By considering diffraction from a grating, the reciprocal nature of the pattern can be derived. This relationship can be seen in the diffraction patterns of the slits: small features of the diffracting object give wide spacings in the diffraction pattern

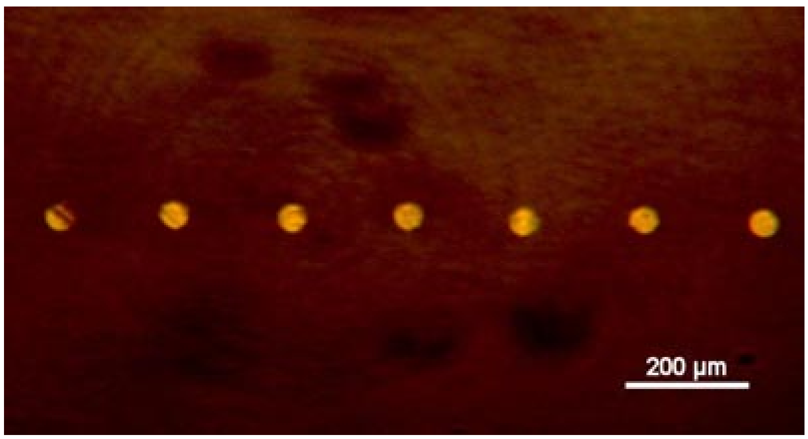
$$s = \frac{\lambda L}{x}$$



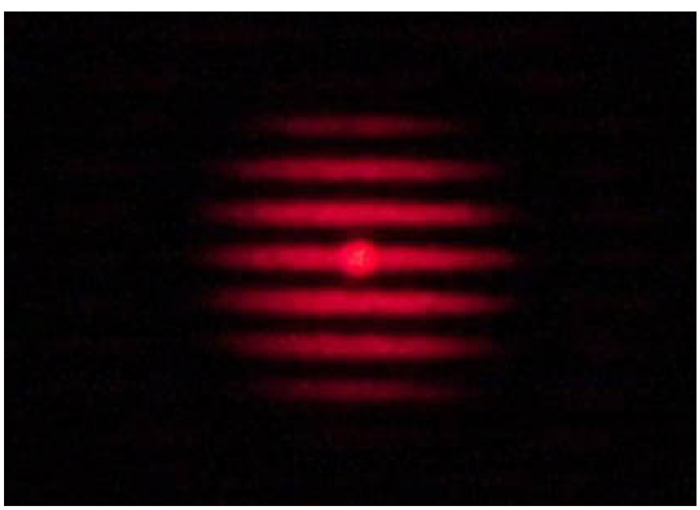
Diffraction patterns from slits of different widths. (Click on image to view a larger version.)

More complicated masks, for example a periodic row of apertures, will show more intricate diffraction patterns, but still follow the same basic inverse relationship.





Mask consisting of periodic row of apertures

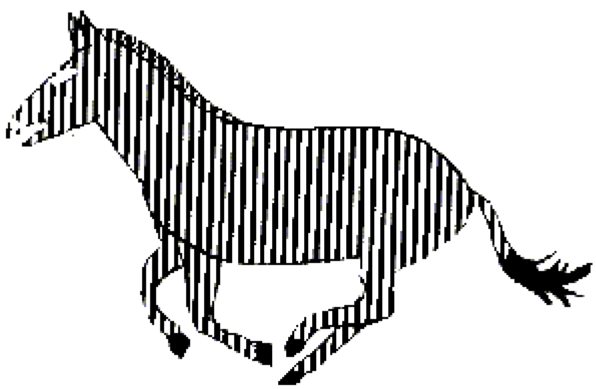


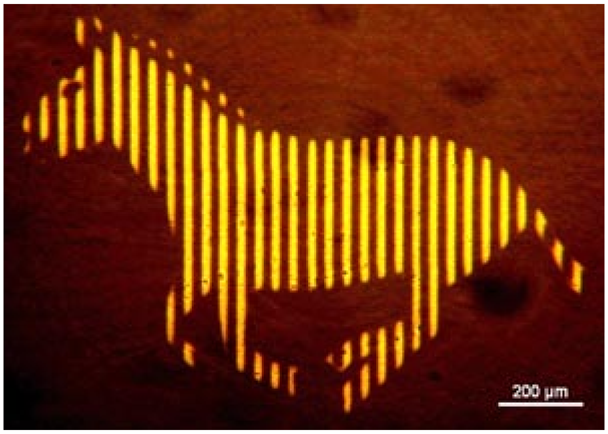
Diffraction pattern for periodic row of apertures

Information obtained from diffraction pattern

The nature of the diffraction pattern (shape, symmetry, dimensions, etc.) is determined by the nature of the mask that diffracts the light. A lens can recombine the (accessible) diffracted light to generate a magnified image of the mask. However, by forming the image from a limited proportion of the pattern, then elements of the mask can be enhanced.

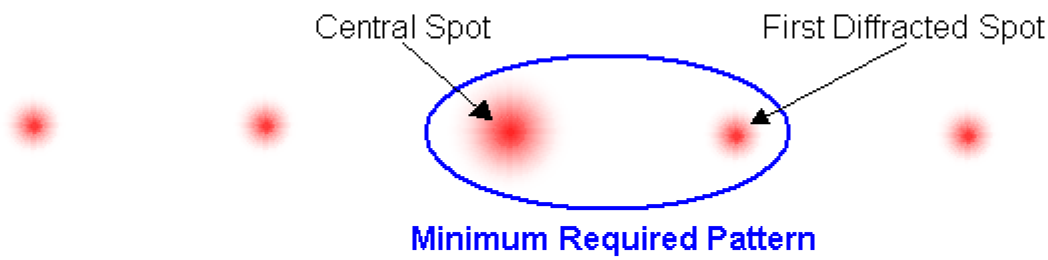
A mask containing many different geometrical elements is shown here:





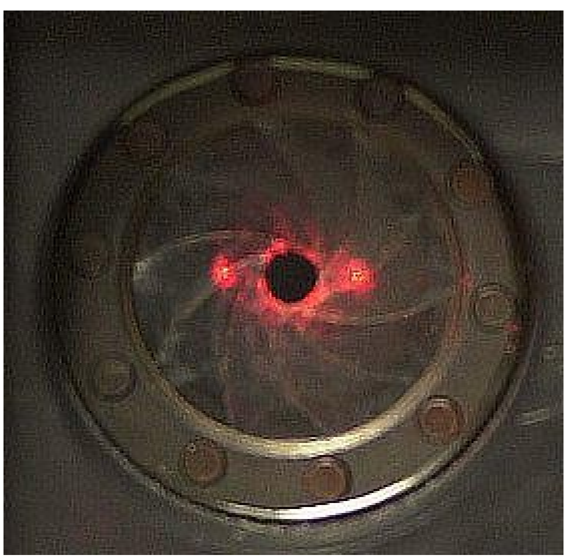
The zebra (Click on image to view larger version)

A variable aperture can be placed at the back focal plane. Thus the aperture can be adjusted to limit the region of the diffraction pattern that goes on to form the image. The minimum area of the pattern necessary to form a “full” image of the zebra (with overall shape and stripes visible) contains the undiffracted beam and one of the first diffraction spots. In order to properly resolve the features of the mask, both first order diffracted spots should be included.

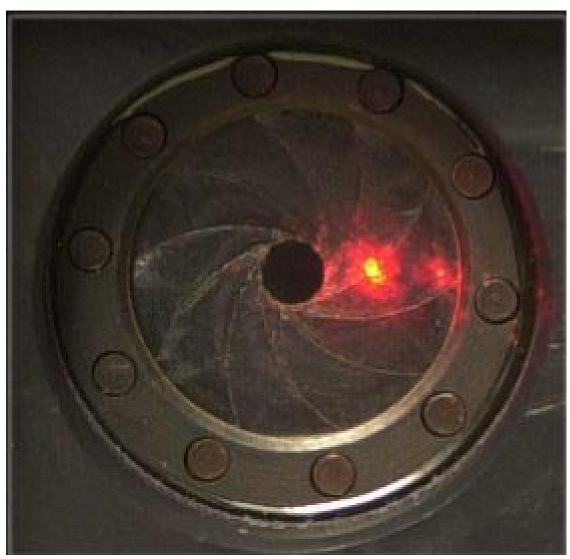


If only one diffraction spot is allowed through the back focal plane then no information about the spacing of the slits is passed on to the image and individual slits will not be resolved. Note, however, that each diffraction spot is made up of beams scattered from all parts of the object. Therefore, information about the size and shape of the object as a whole is passed on to the image through a single diffraction spot.

If the central (zero order) spot (undiffracted straight-through beam) is solely used, the resulting image is known as the bright field image . If a non-zero order diffraction spot is solely used then a dark field image .



Spot selection for bright field imaging



Spot selection for dark field imaging

Source : http://www.doitpoms.ac.uk/tlplib/diffraction/info.php