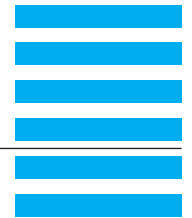


Choosing the right Focusing Lens

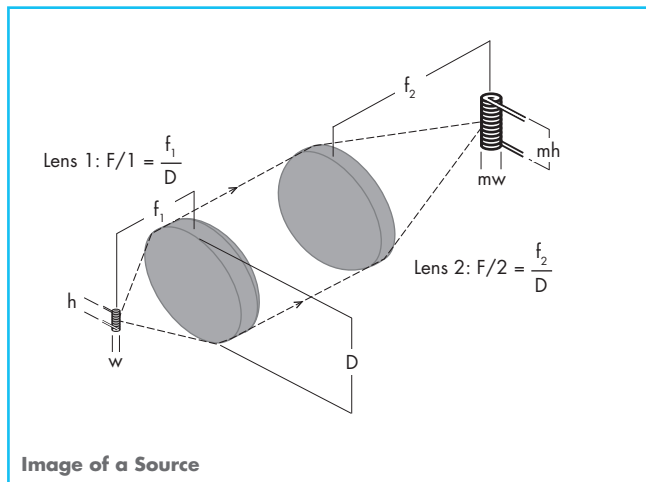


The Fig. below shows a typical optical system. The light of a filament is collected by the condensing optics (lens 1) and is focussed by lens 2, resp. the filament will be imaged on the probe. The magnification of the filament on the probe is given by the ratio of the F-numbers.

$$m = (F/2) / (F/1), \text{ where } F\text{-number} = f/\varnothing$$

With a good collimated beam, the diameter of the beam is constant and the magnification m is given by the ratio of the focal lengths.

$$m = f_2/f_1$$



Our light sources with condensing optics produce beams with 35 and 48 mm diameter. This means that the beam diameter of the condenser defines the diameter of the focussing lens.

If you have to irradiate relatively large probes (compared to the source) choose the focal length of the focussing lens in such a way that the image of the source is of the same size as the probe.

Are there limiting apertures, as for example when imaging the source on a fiber optics or a monochromator slit, the focal length of the focussing lens is defined by the maximum possible aperture angle (and the diameter of the beam).

The F-numbers have to be matched

The maximum possible aperture angle for the monochromator is given by its F-number and for the fiber optics by the numerical aperture (N.A.).

Example:

For a 35 mm diameter beam and a F/4 monochromator the focusing lens also should have at least a 35 mm diameter and a focal length of $35 \times 4 = 140$ mm (F-number = f/\varnothing).

Plano convex lenses have low spherical aberration. In practice we choose a lens with 38 to 50 mm diameter and 150 mm focal length (142 mm would be custom-made. For the practical application a value close to 142 is sufficient.).

The N.A. of quartz fibers is 0.22. With $N.A. = 1/(2F\text{-number})$ this corresponds to an F-number of 2,3. For a 35 mm beam the focal length of the focussing lens should be $35 \times 2,3 = 80,5$ mm.

This means for given condensing optics with F/1,0 to F/1,5 the source will always be magnified on a monochromator slit or a fiber optic! To understand this fundamental concept is very helpful for choosing the size of a source for the specific application. It is for example not very useful to use a 200 μm fiber for a 250 W Halogen lamp with a filament $7 \times 3,5 \text{ mm}^2$. Even a 10 W lamp with $1,7 \times 0,65 \text{ mm}^2$ does not give a better result.

A much better result can be achieved with arc lamps. Compared to halogen lamps they have a very small arc with approx. ten times higher radiance. The arc size of a 75 W Xe arc lamp for example is only $0,25 \times 0,5 \text{ mm}^2$.

