Lenses and optical instruments

Laboratory course for students of the TUHH

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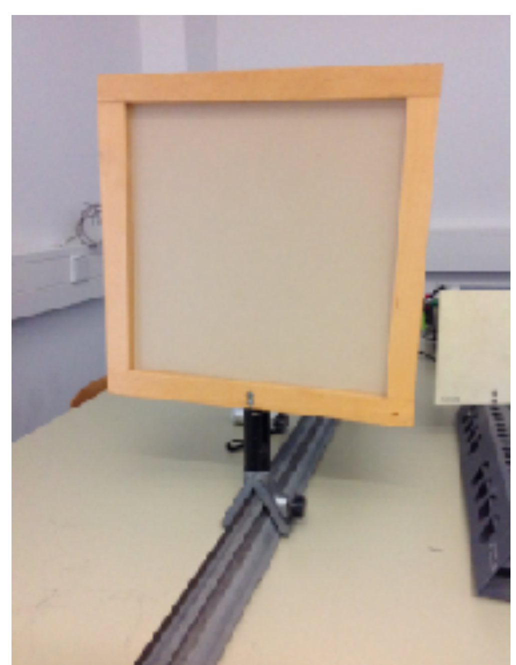
Experimental procedure

Lens holder

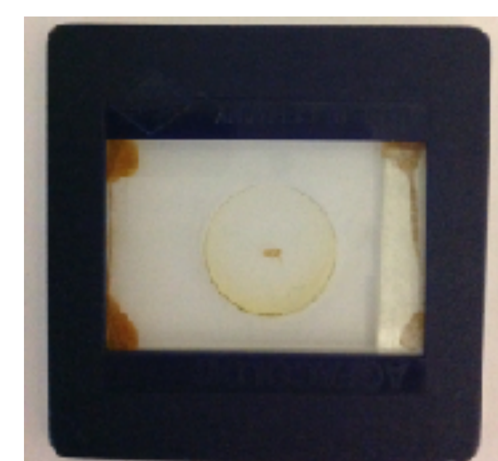
Lenses

Lamp

Screen

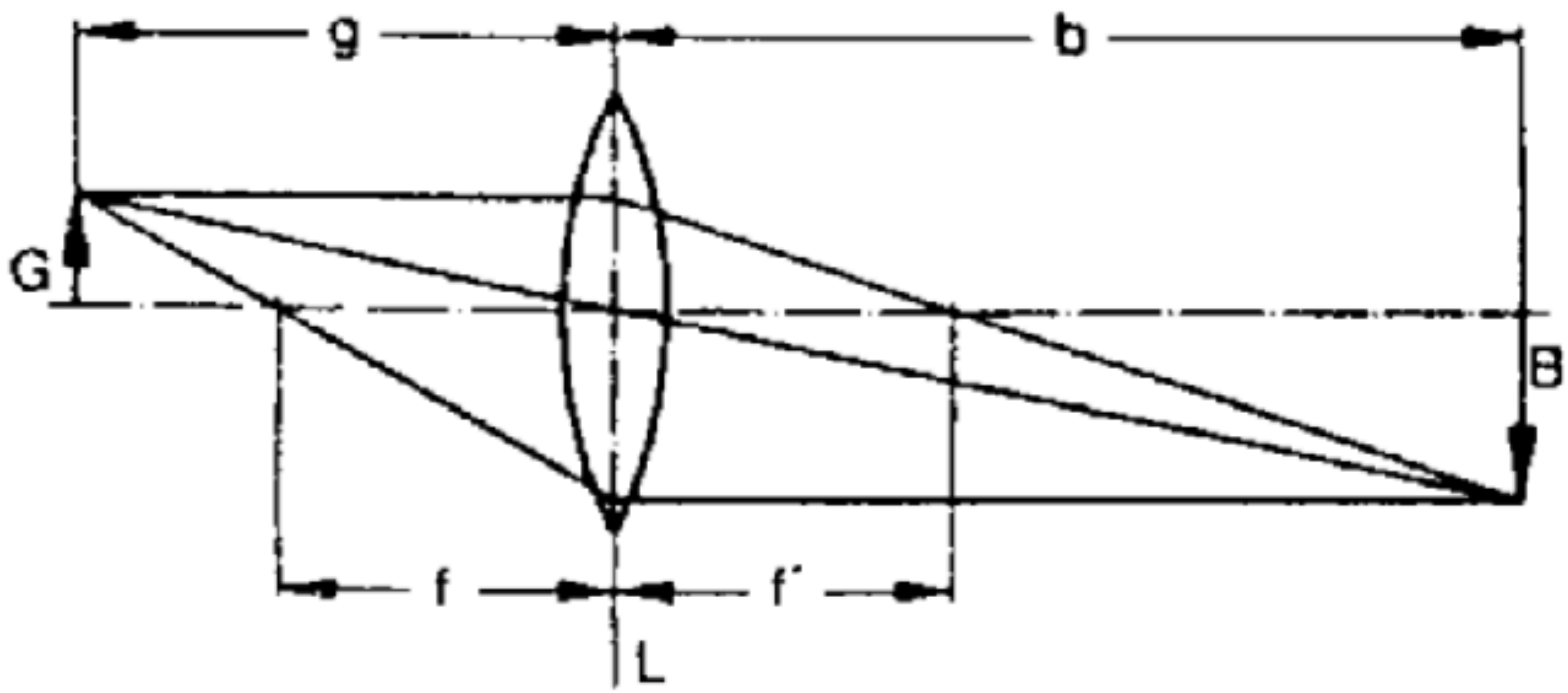


Objects



Experimental procedure

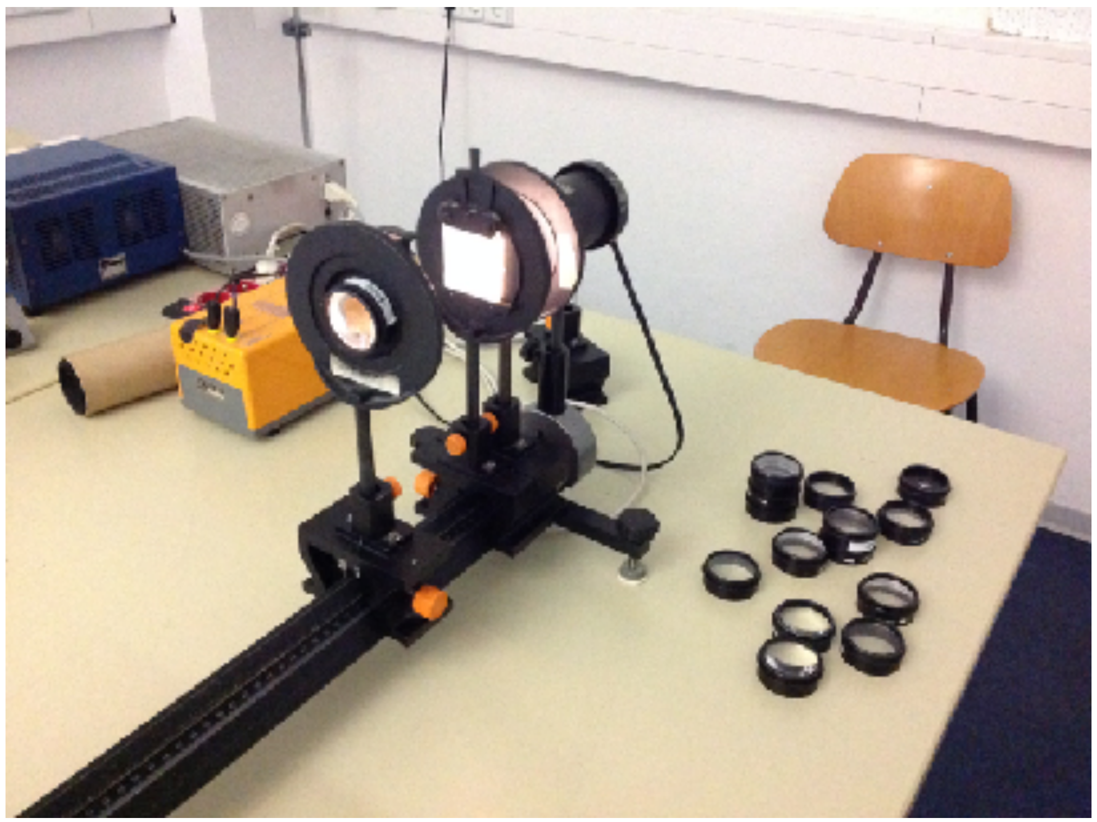
1. Determining the focal length of a lens:



The focal lengths of two different converging lenses are to be determined by measuring the image distance ***b*** and object distance ***g*** for each lens.

Experimental procedure

1. Determining the focal length of a lens:

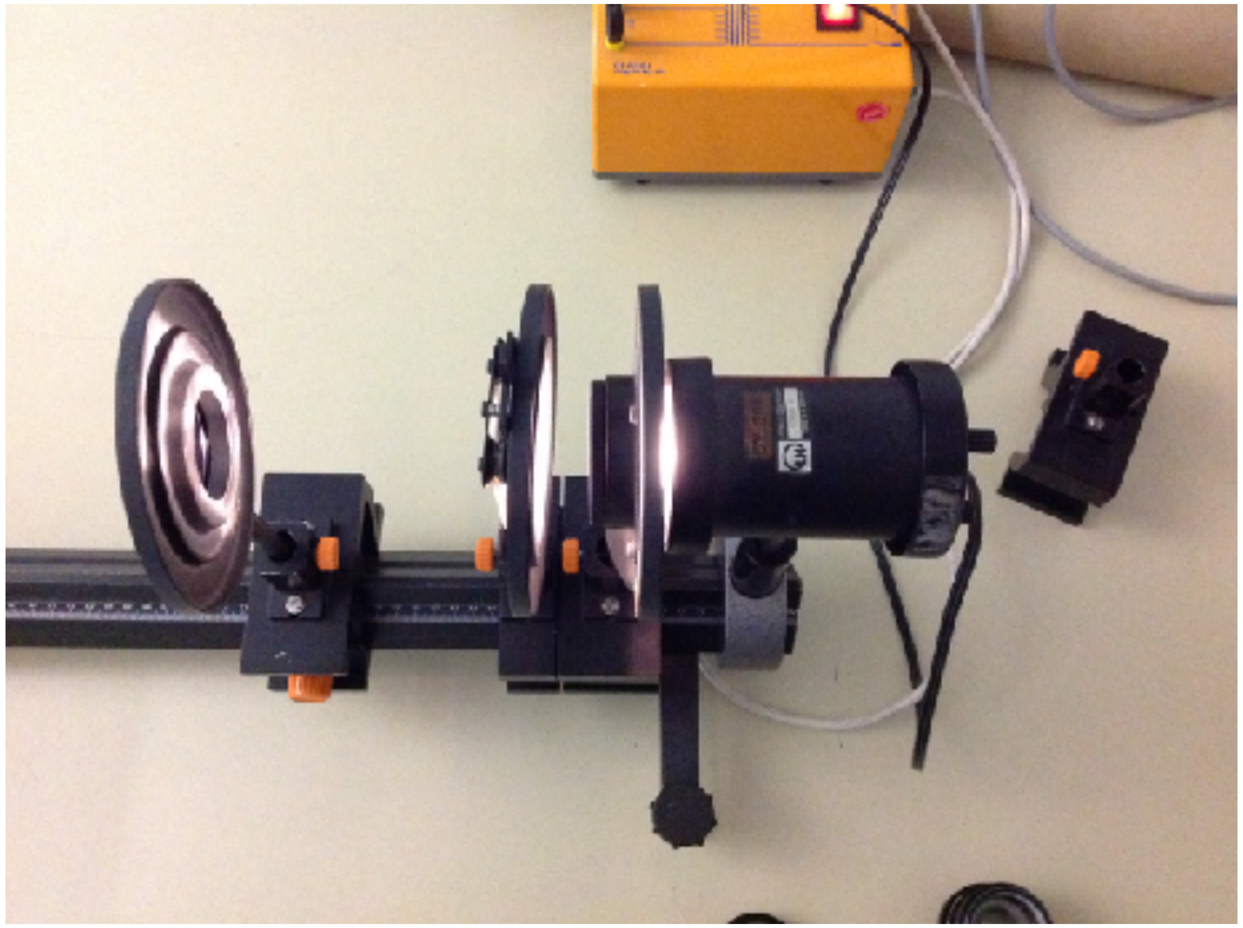


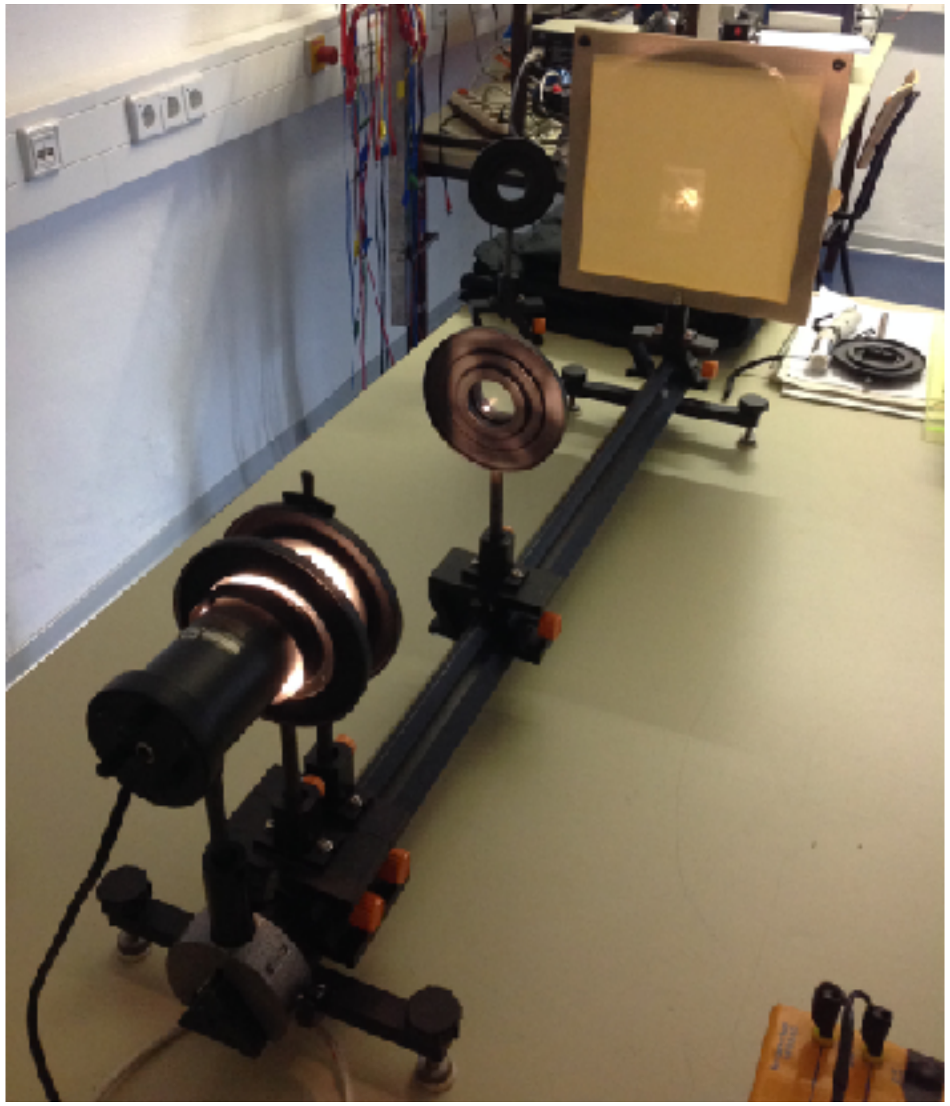
First a parallel beam of collimated light is produced using a lamp with the double condenser lens.

Next the object is positioned close to the condenser lens and a converging lens is used to produce a sharp image on the screen.

Experimental procedure

1. Determining the focal length of a lens:

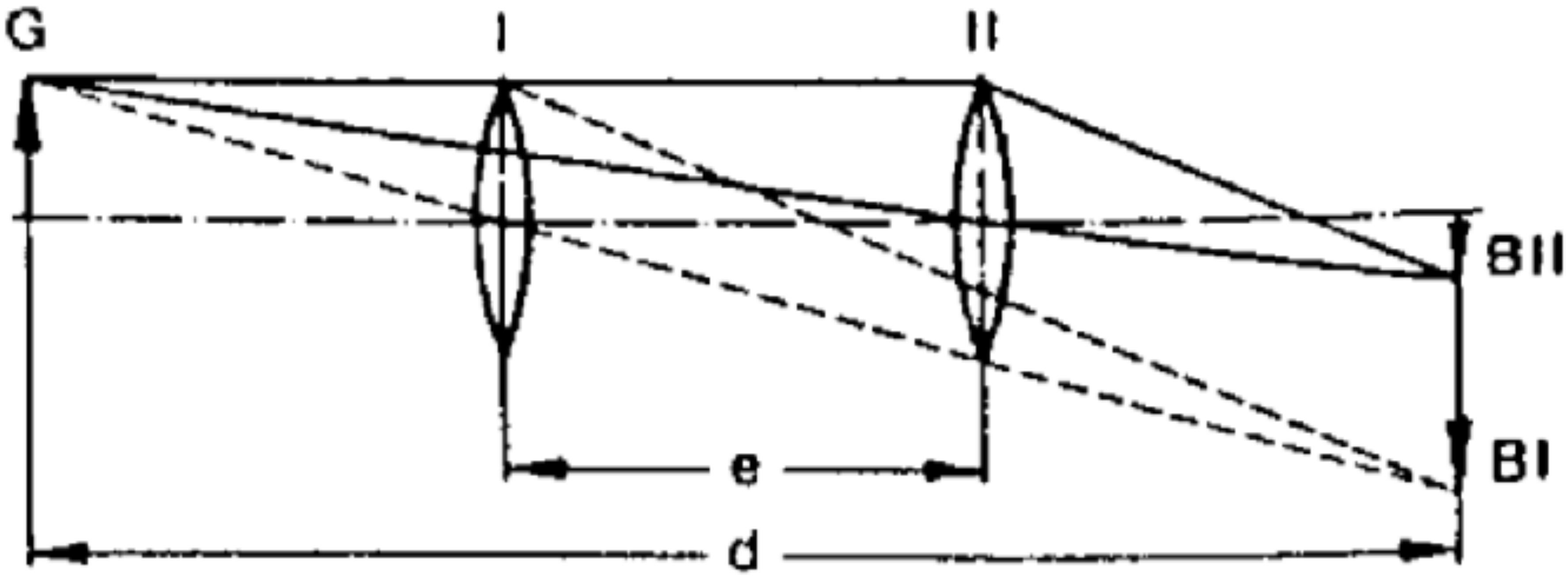




The image distance and the object distance are measured from the middle of the thin lens.

Experimental procedure

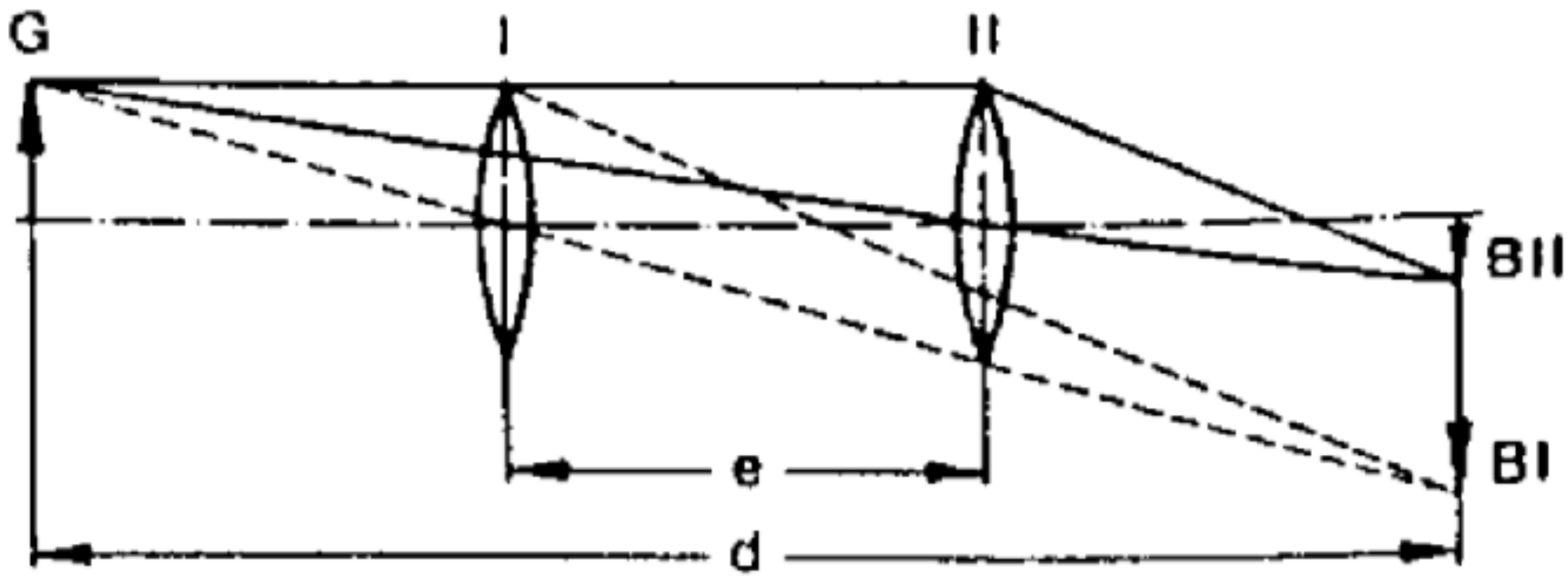
2. Bessel method:



There are two different possible positions I and II in which a thin lens can produce a sharp image of an object at a distance ***d*** from the screen.

Experimental procedure

2. Bessel method:



For the lens in position I a sharp magnified image BI is produced on the screen.

For the lens in position II the object distance is equal to the image distance of the lens in position I and a sharp demagnified image BII is produced on the screen.

Experimental procedure

2. Bessel method:

Hence, at the two possible positions the image and object distances are both exchanged (i.e., $g_1 = b_2$ and $g_2 = b_1$).

$$g_1 + b_1 = d \tag{3a}$$

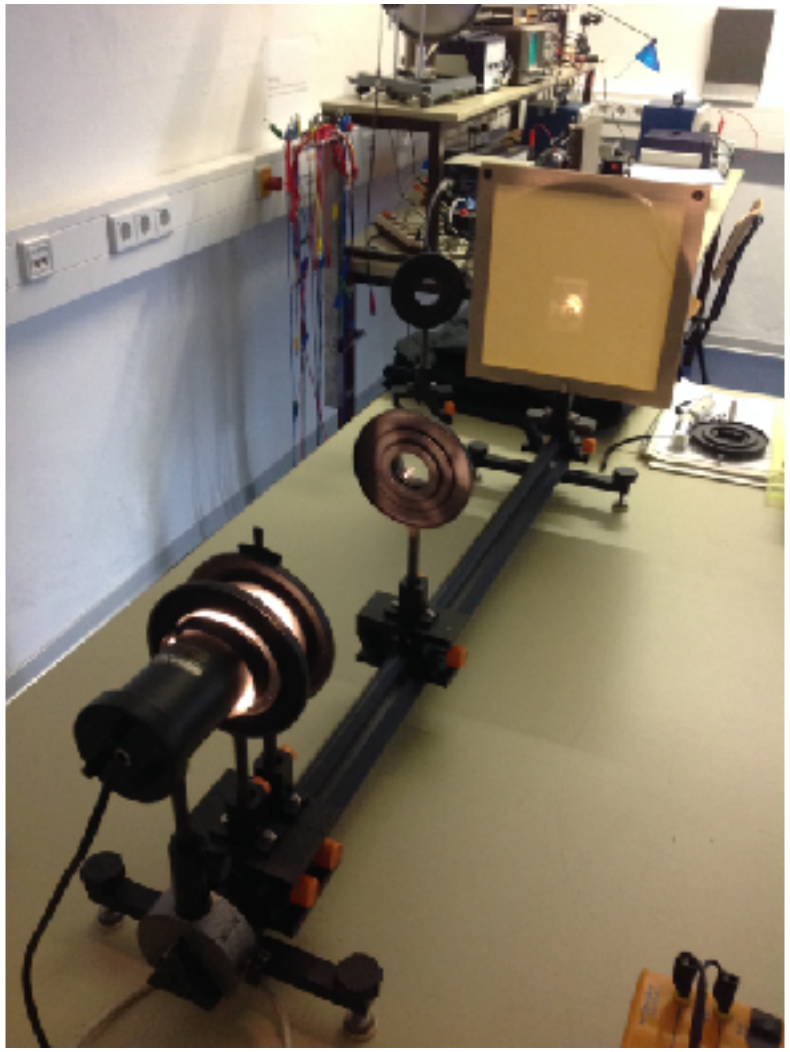
$$b_1 - g_1 = e \tag{3b}$$

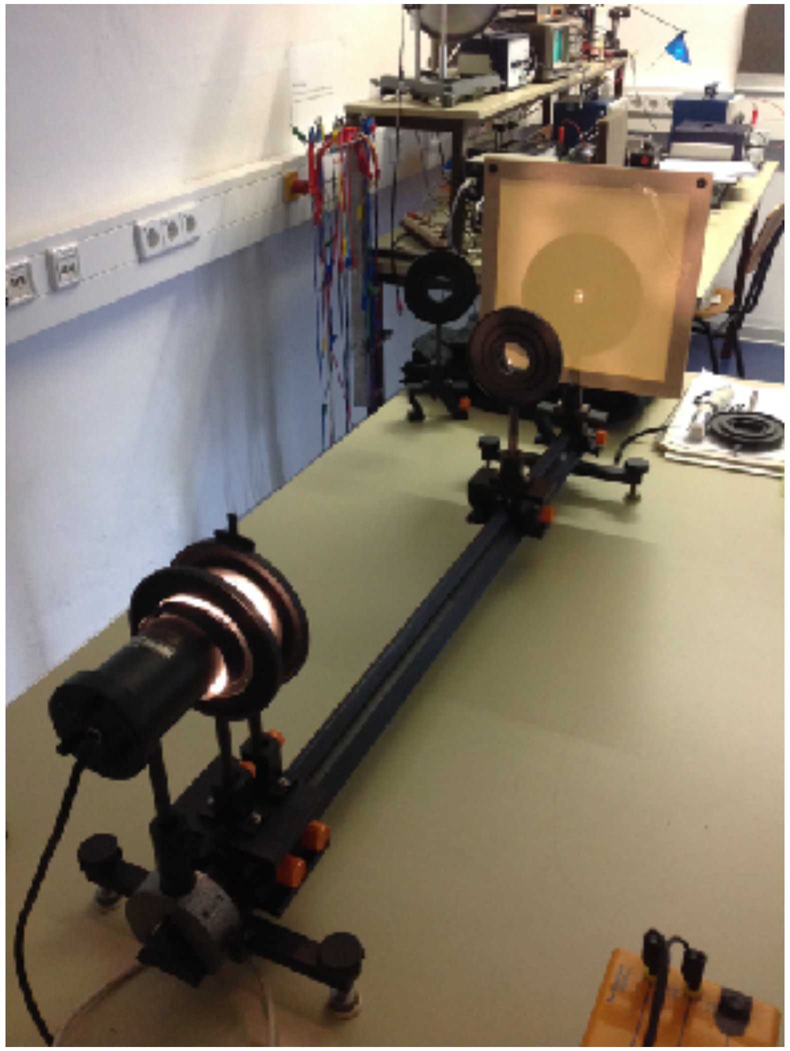
$$b_1 = \frac{1}{2}(d + e) \quad \text{and} \quad g_1 = \frac{1}{2}(d - e)$$

$$f = \frac{d^2 - e^2}{4d} \tag{4}$$

Experimental procedure

2. Bessel method:





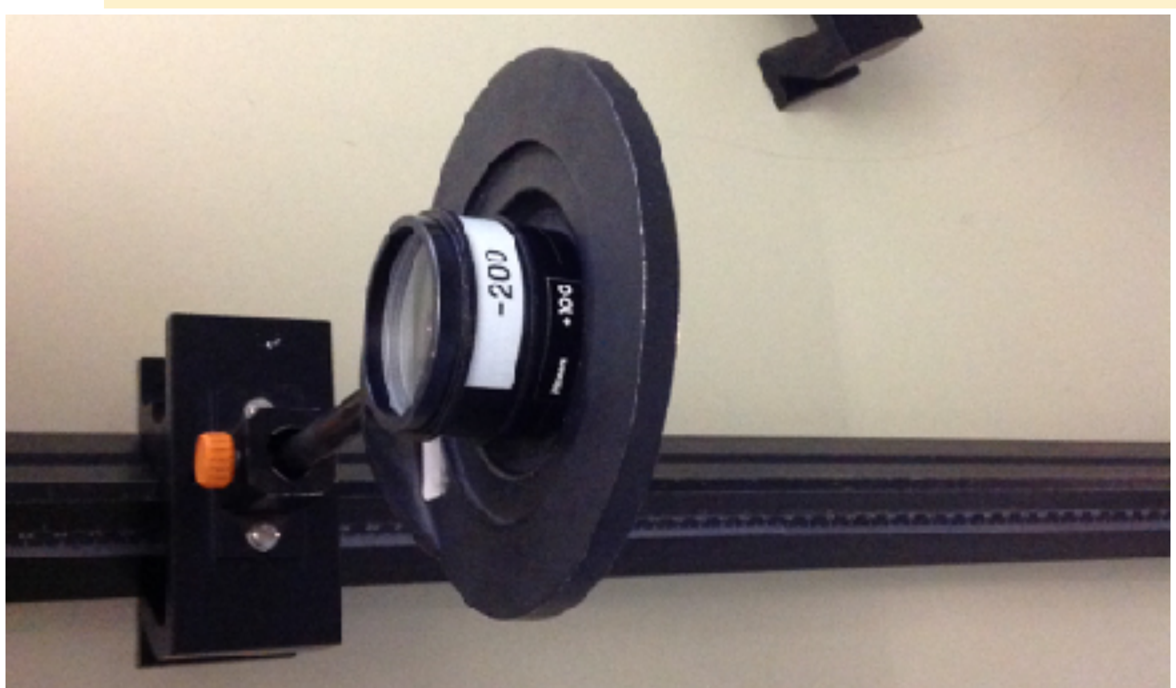
Thus, the focal length of a converging lens $\boldsymbol{f_s}$ can be determined from the vales of $\boldsymbol{d}$ and $\boldsymbol{e}$.

Experimental procedure

2. Bessel method:

This method can also be used to determine the focal length of a diverging lens f_Z by measuring the focal length of a lens system f_{ges} consisting of a diverging lens and a converging lens:

$$\frac{1}{f_Z} = \frac{1}{f_{ges}} - \frac{1}{f_S} \quad \text{oder} \quad f_Z = \frac{f_{ges} \cdot f_S}{f_S - f_{ges}} \tag{5}$$



The power of the converging lens $1/f_s$ must be greater than that of the diverging lens $1/f_Z$ to produce a real image.