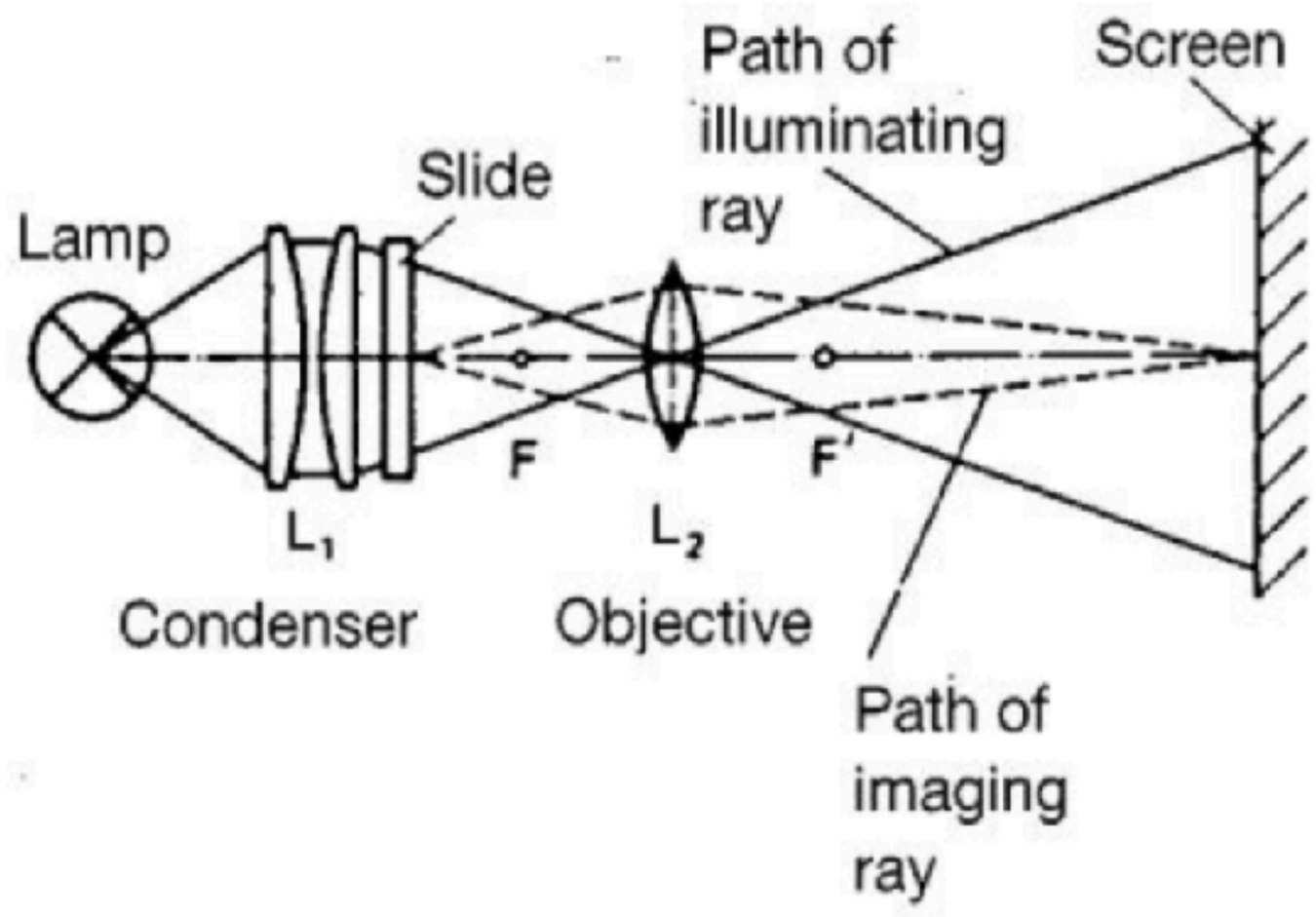
Lenses and optical instruments

Laboratory course for students of the TUHH

Wladimir Banda-Barragán

Experimental procedure

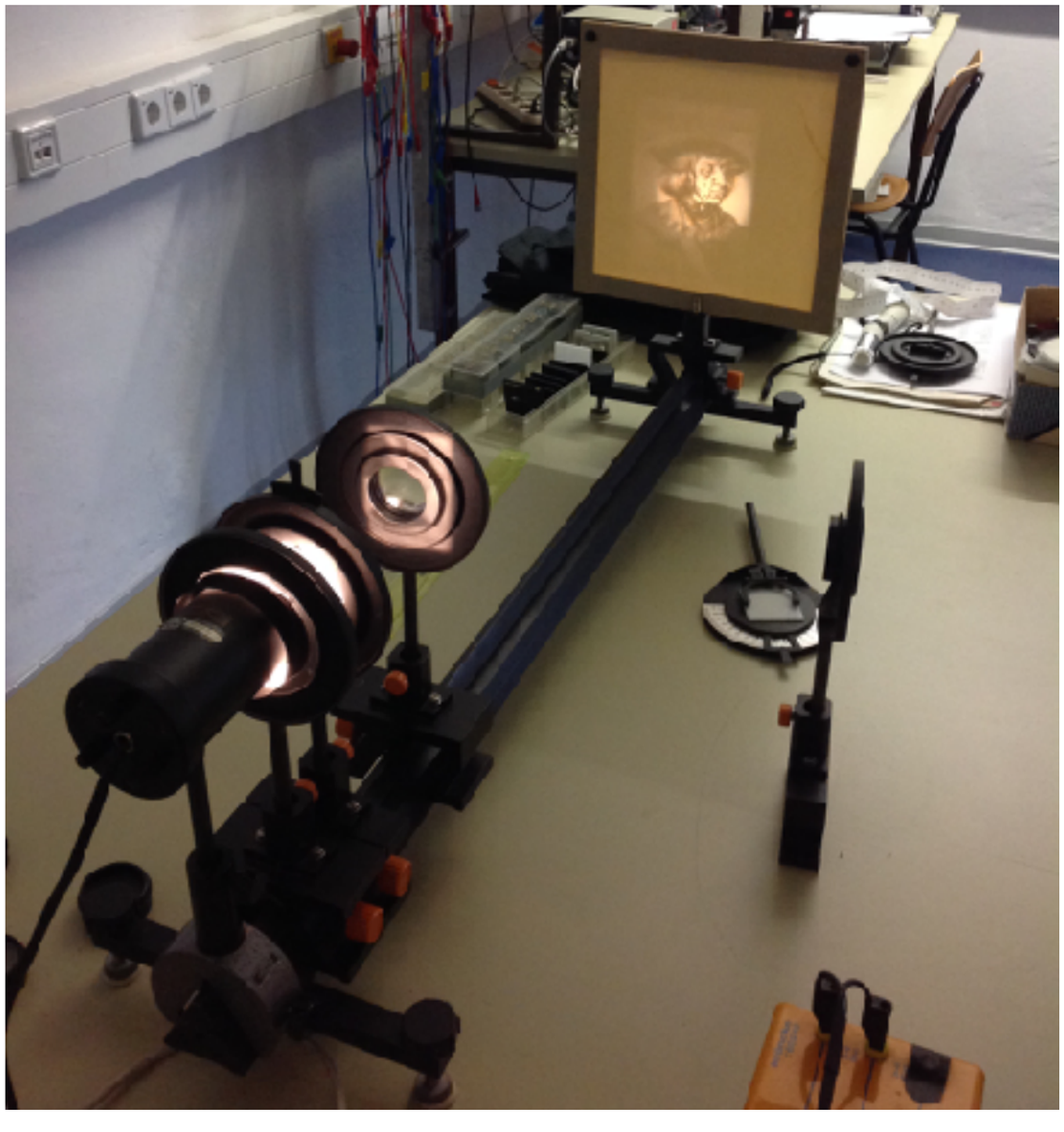
3. Slide projector:



The magnification ***V*** of the slide projector can be determined by directly measuring ***B*** and ***G***.

Experimental procedure

3. Slide projector:



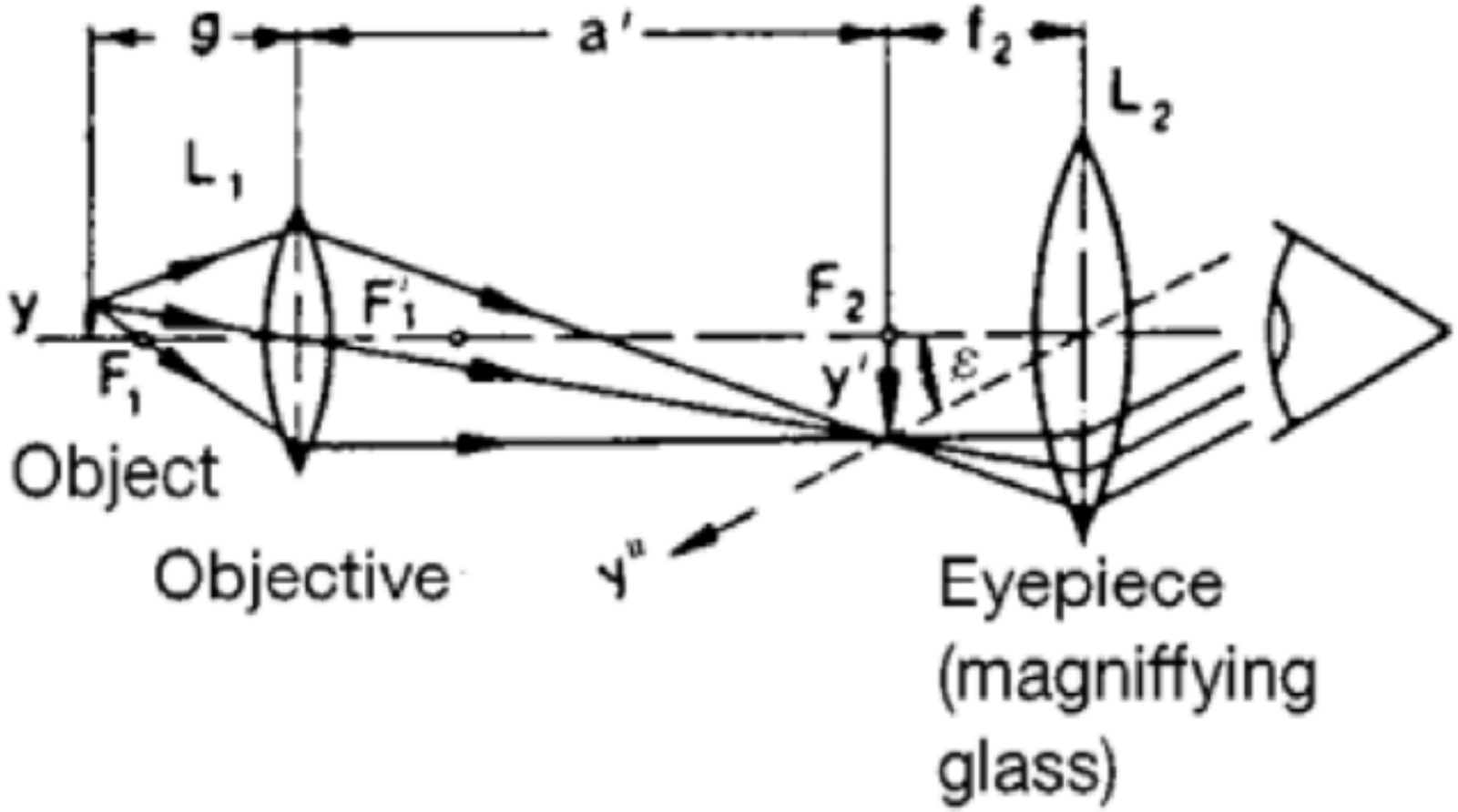
The magnification **V** can also be determined by measuring ***g***, ***b*** and ***f***.

$$V = \frac{B}{G} = \frac{b}{g} = \frac{b - f}{f} \qquad (6)$$

Eq. 6.1 6.2 6.3

Experimental procedure

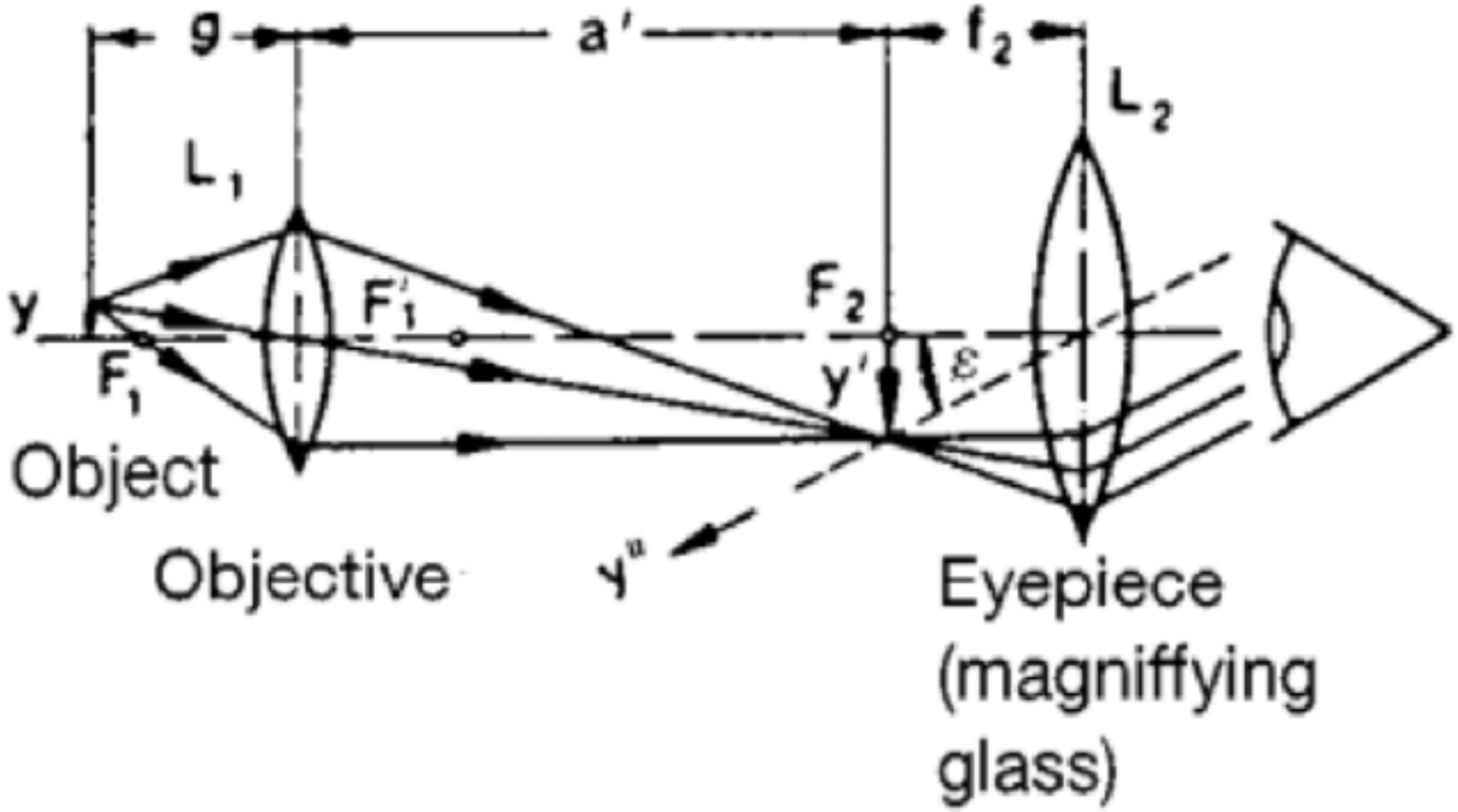
4. Microscope



A light microscope is an optical instrument which produces highly magnified images of very small objects.

Experimental procedure

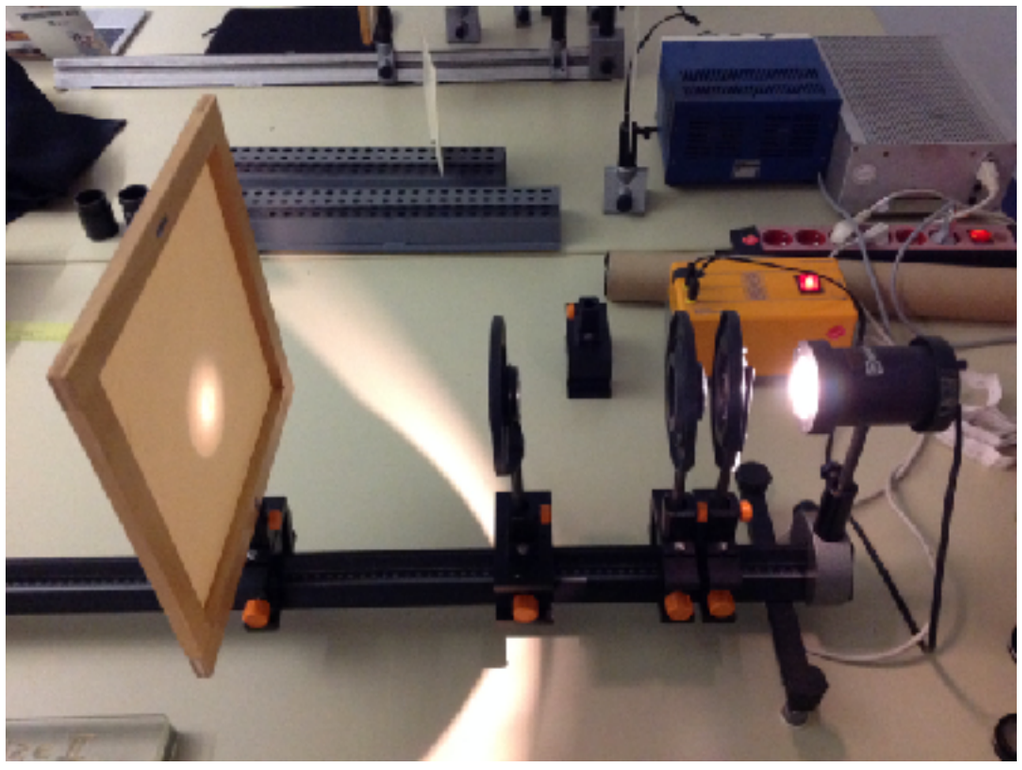
4. Microscope



The objective lens L_1 has a short focal length (e.g. f_1=+20 mm). A real intermediate image is viewed through the eyepiece lens L_2(f_2= +50 mm), which acts as a magnifying glass.

Experimental procedure

4. Microscope



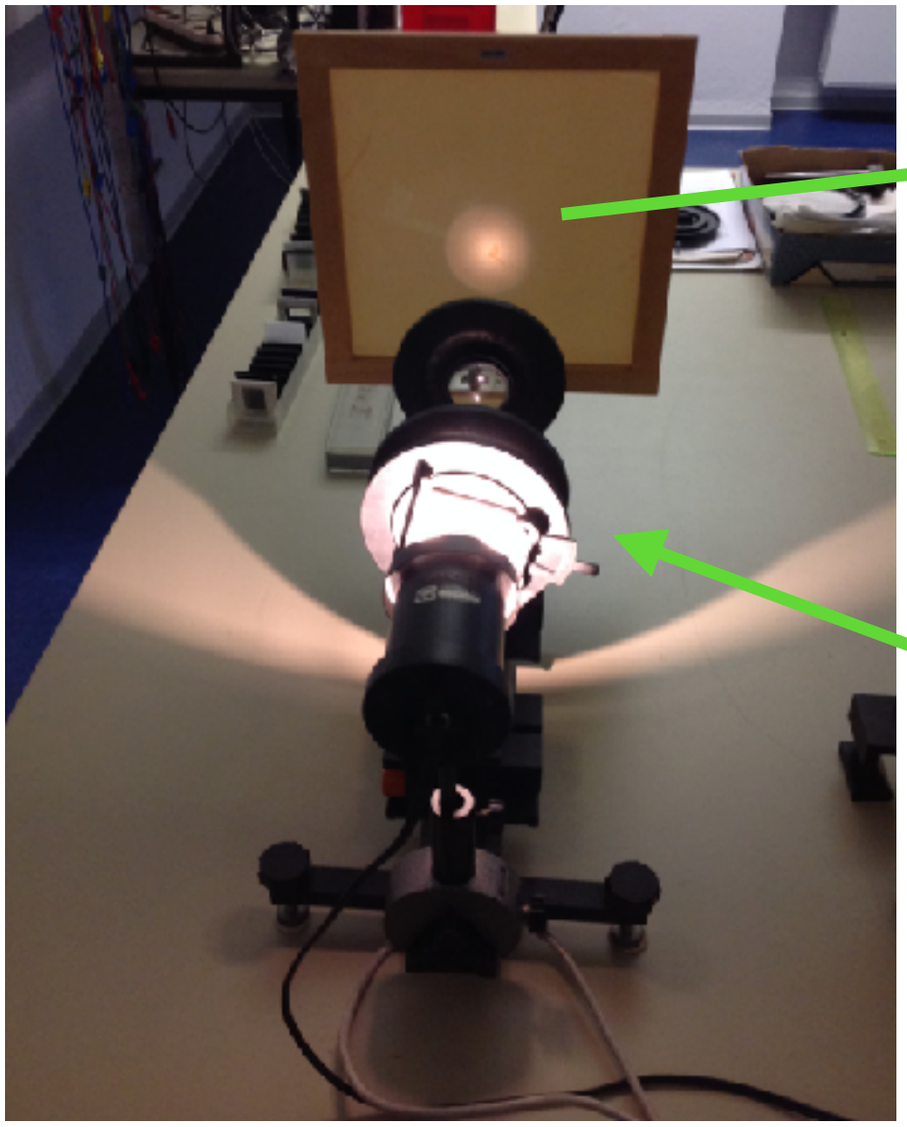
The overall magnification can be calculated from the image height *y"* *and* the object height (*y*).

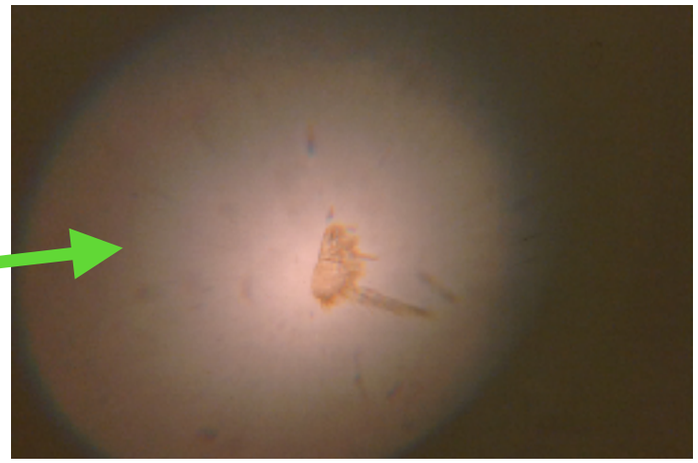
$$V = \frac{y''}{y} \qquad (7)$$

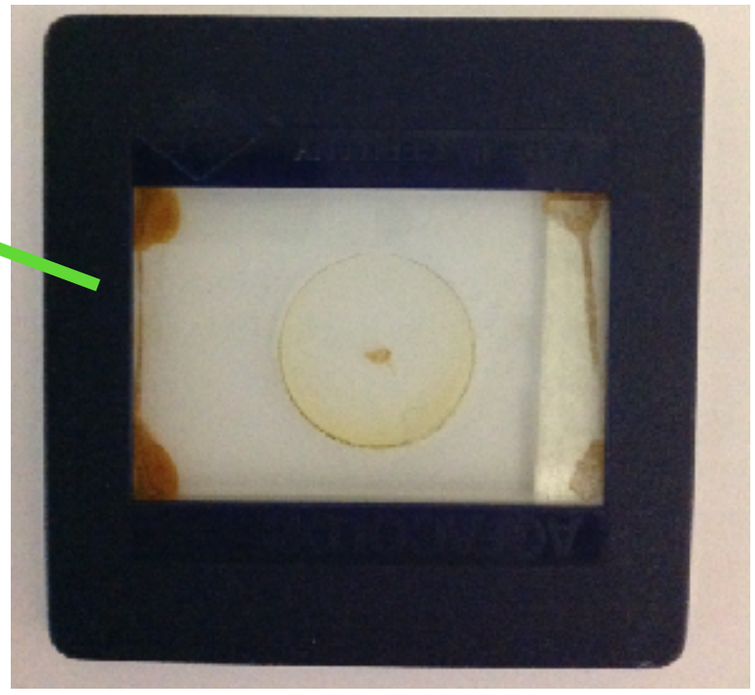
$$V_{mikr} = \left(\frac{a'}{f_1} - 1\right) . \frac{250\ mm}{f_2} \qquad (9)$$

Experimental procedure

4. Microscope



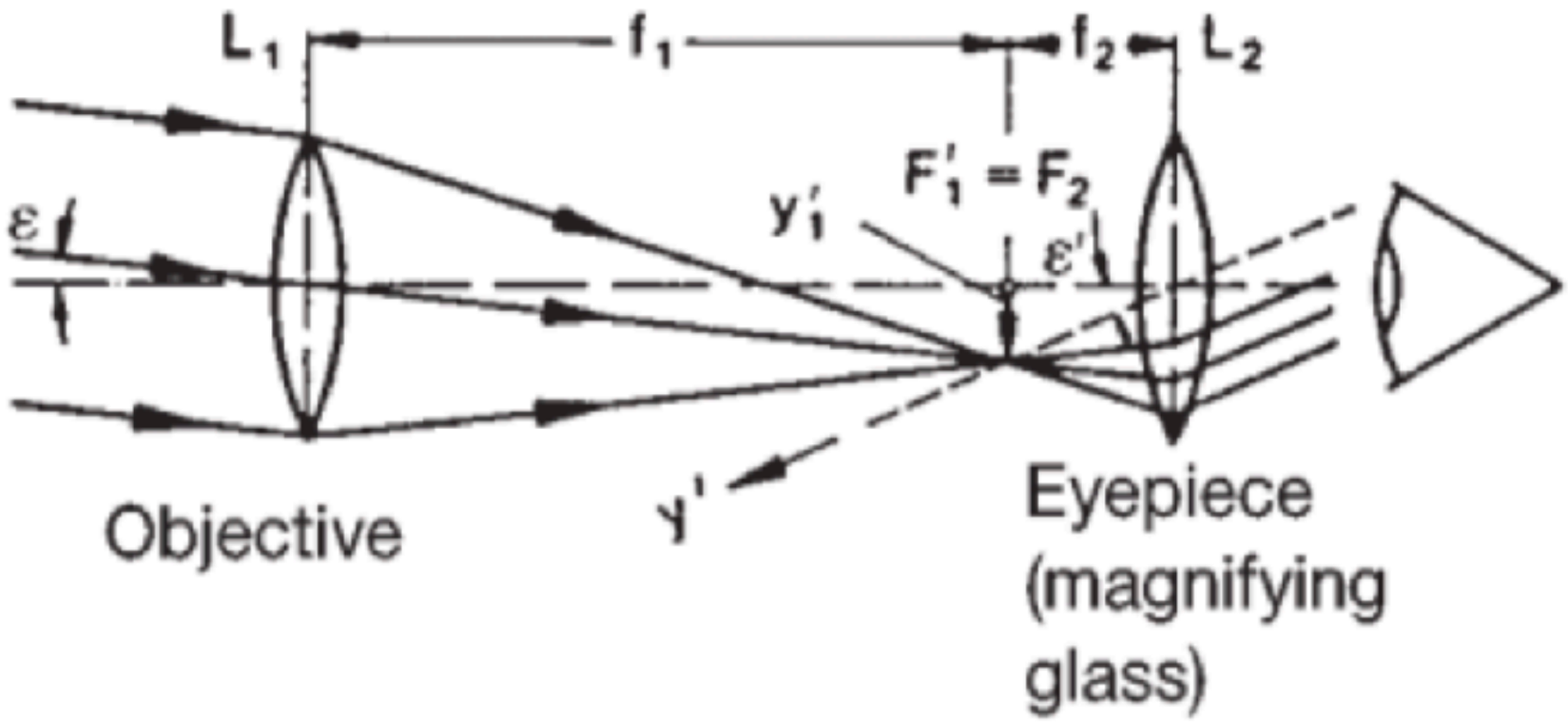




Magnified image

Experimental procedure

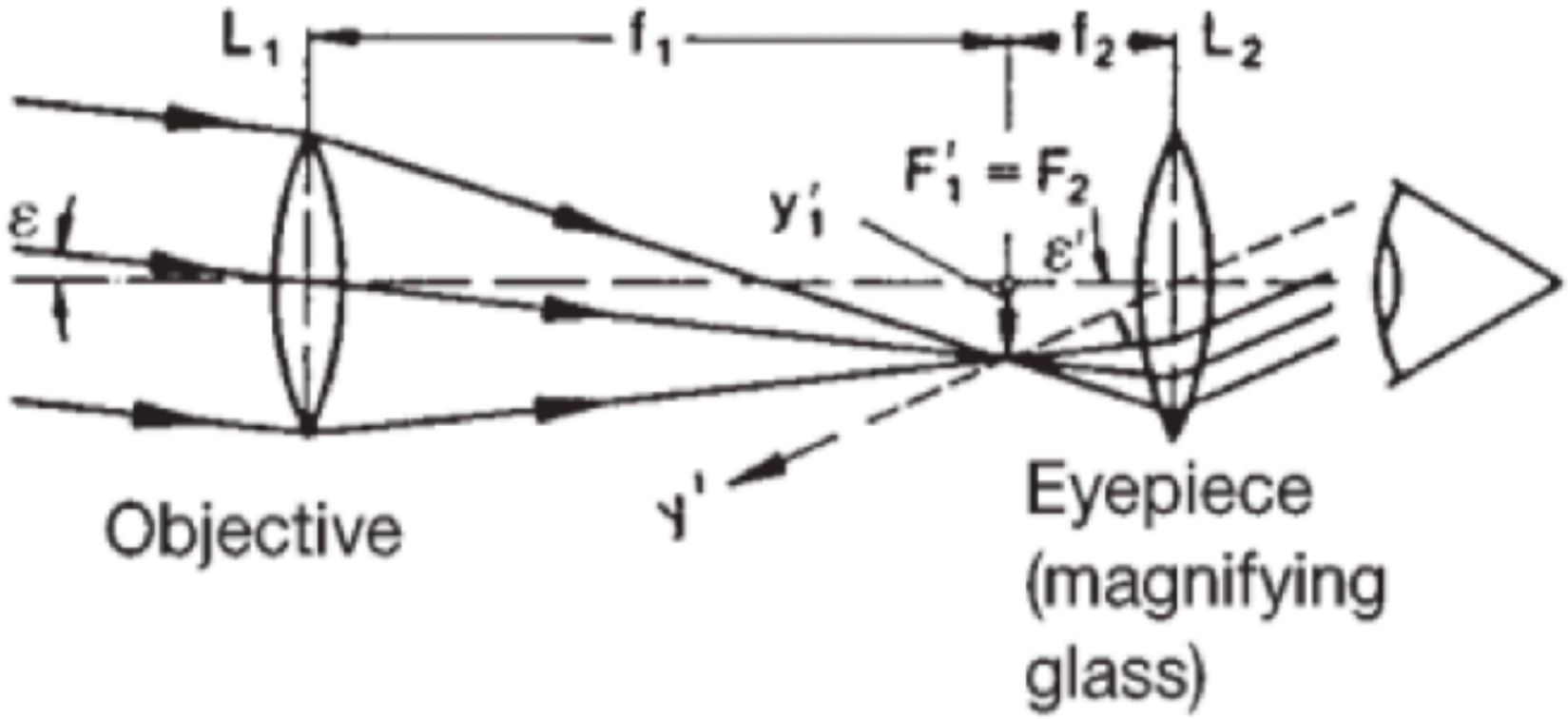
5. Astronomical refracting telescope:



An astronomical refracting telescope consists of two converging lenses the first of which, the **objective**, forms a real inverted image which is examined using the second lens, the **eyepiece**.

Experimental procedure

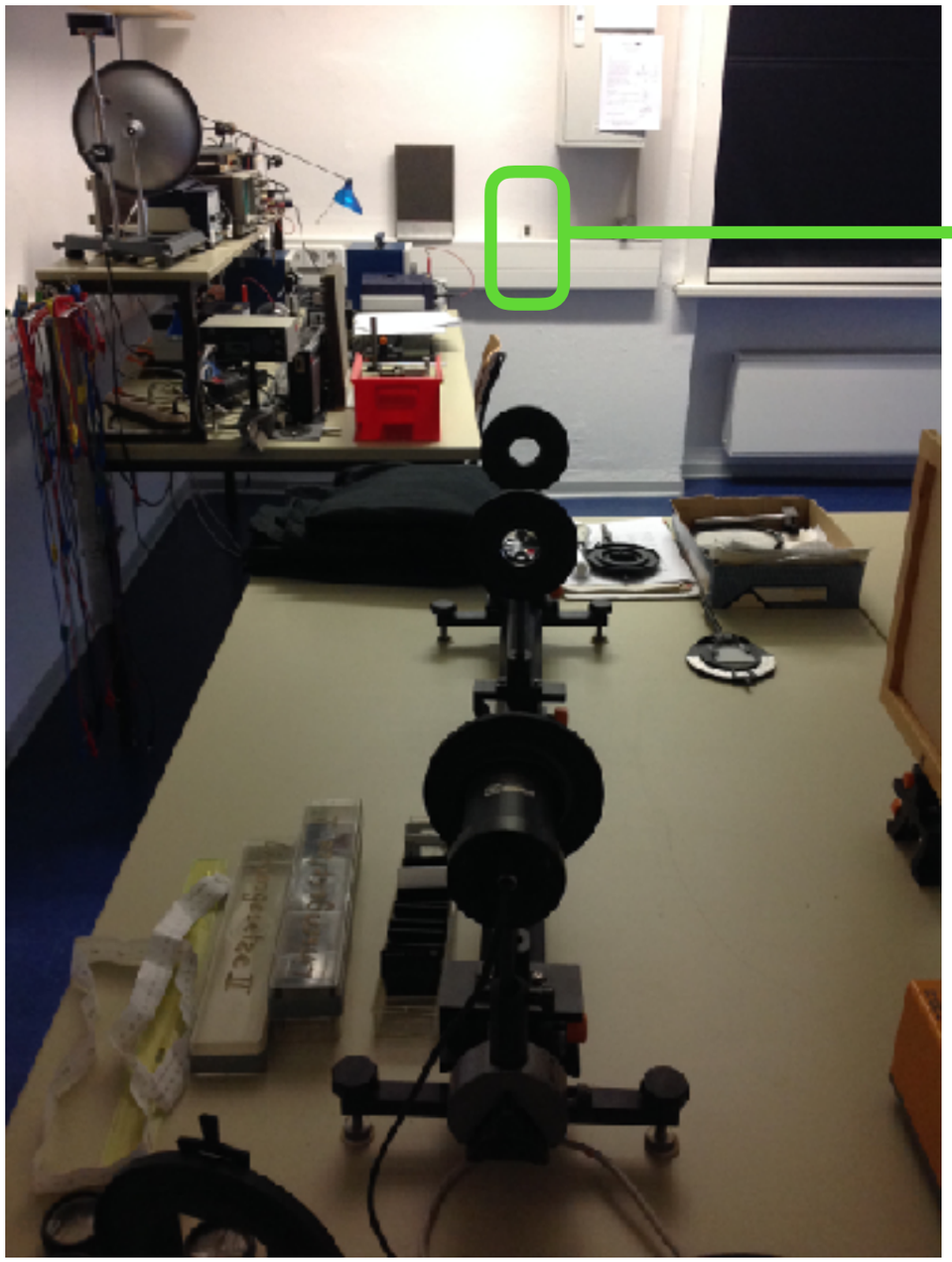
5. Astronomical refracting telescope:



A converging lens with a rather long focal length f_1 (e.g. +300 mm), and another one with a shorter focal length f_2 (e.g. +50 mm) are separated by $f_1 + f_2$.

Experimental procedure

5. Astronomical refracting telescope:



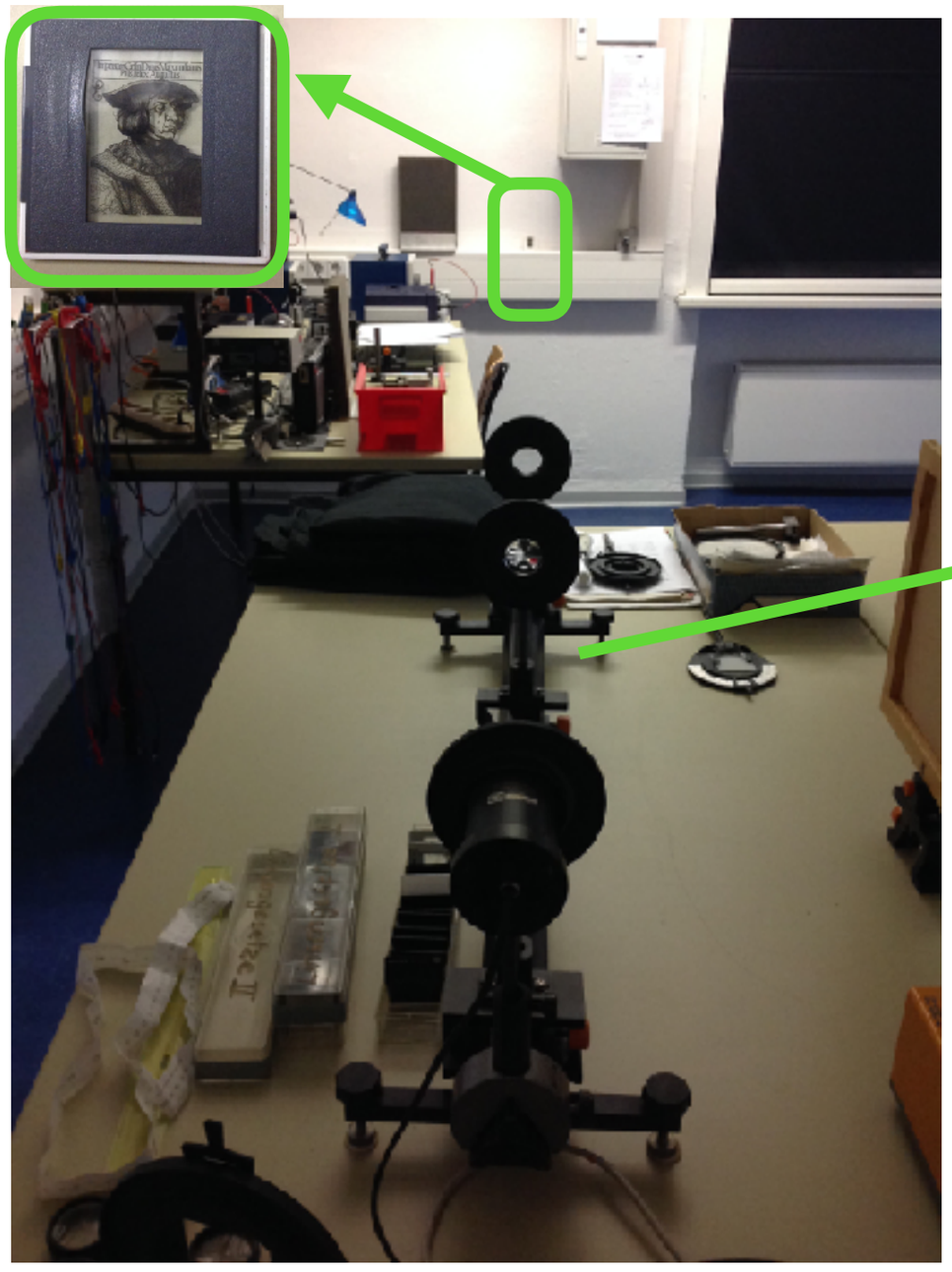
The angular magnification (for small angles) is given by:

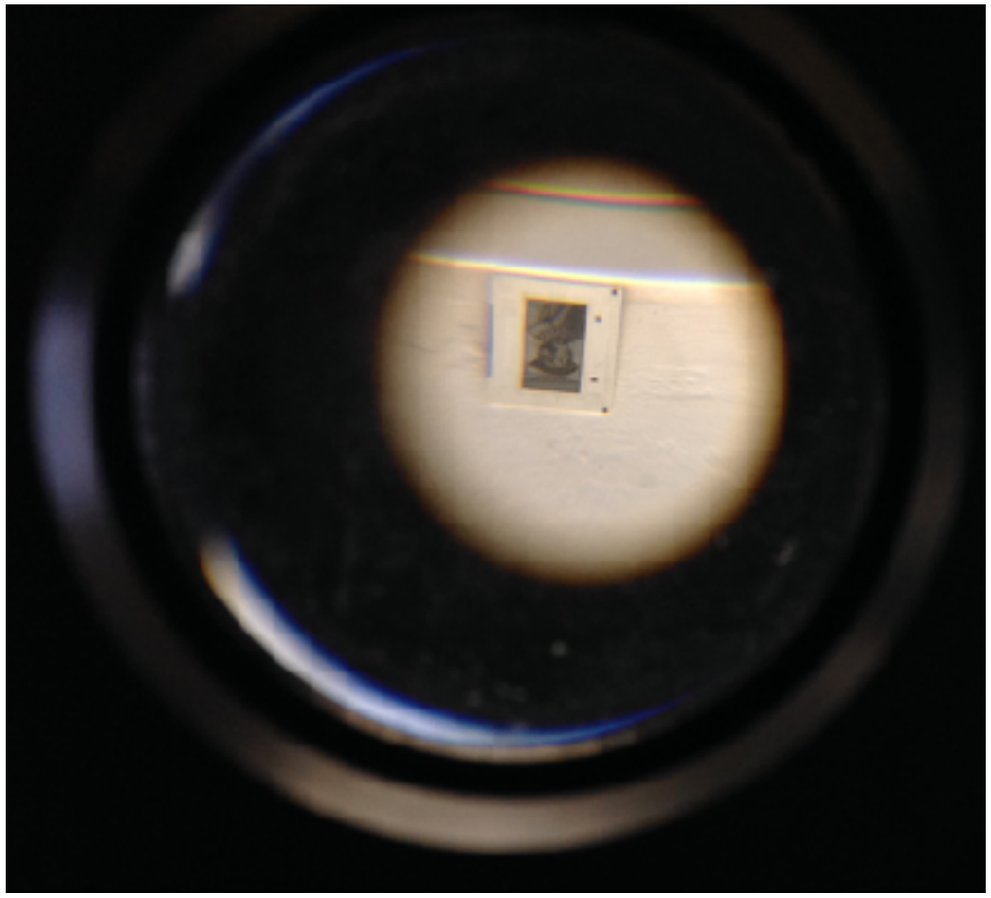
$$\Gamma = \frac{\varepsilon'}{\varepsilon} = \frac{Y_1'/f_2}{Y_1'/f_1} = \frac{f_1}{f_2} \qquad (10)$$

Eq. 10.1 10.2 10.3

Experimental procedure

5. Astronomical refracting telescope:

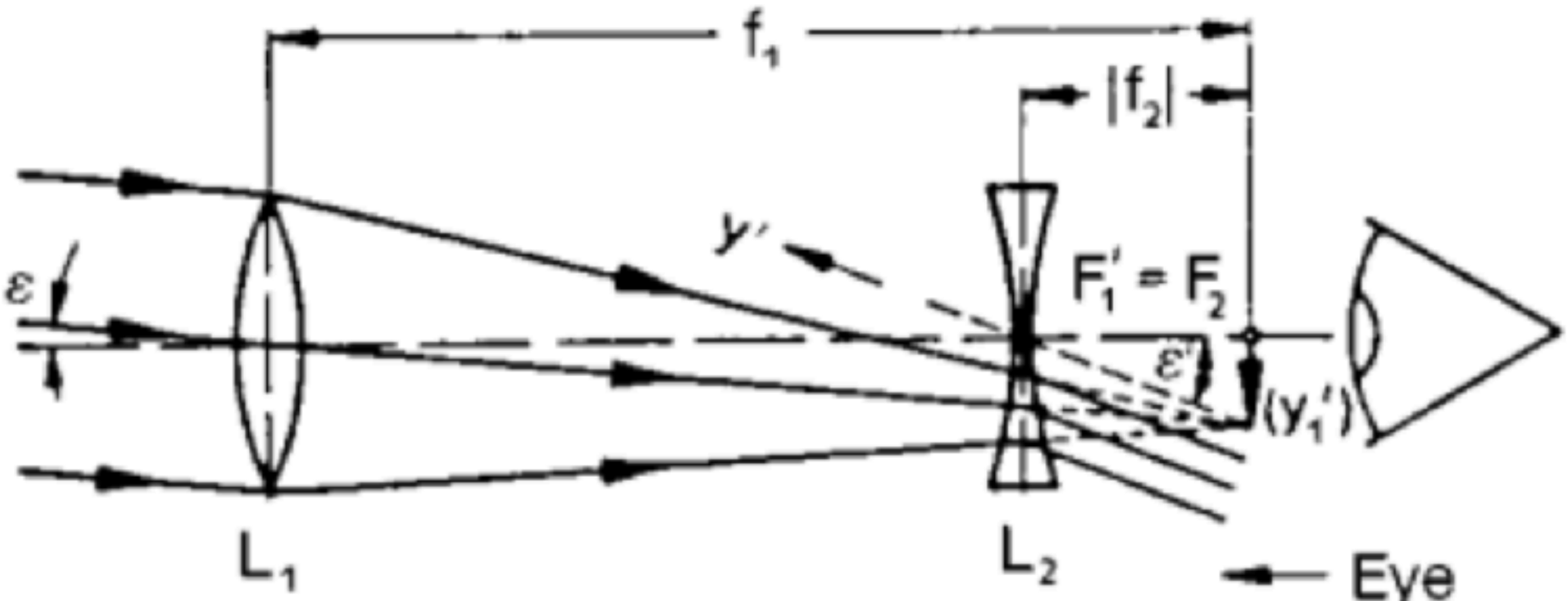




Looking through the lens with shorter focal length, you can see an inverted, magnified image of a distant object.

Experimental procedure

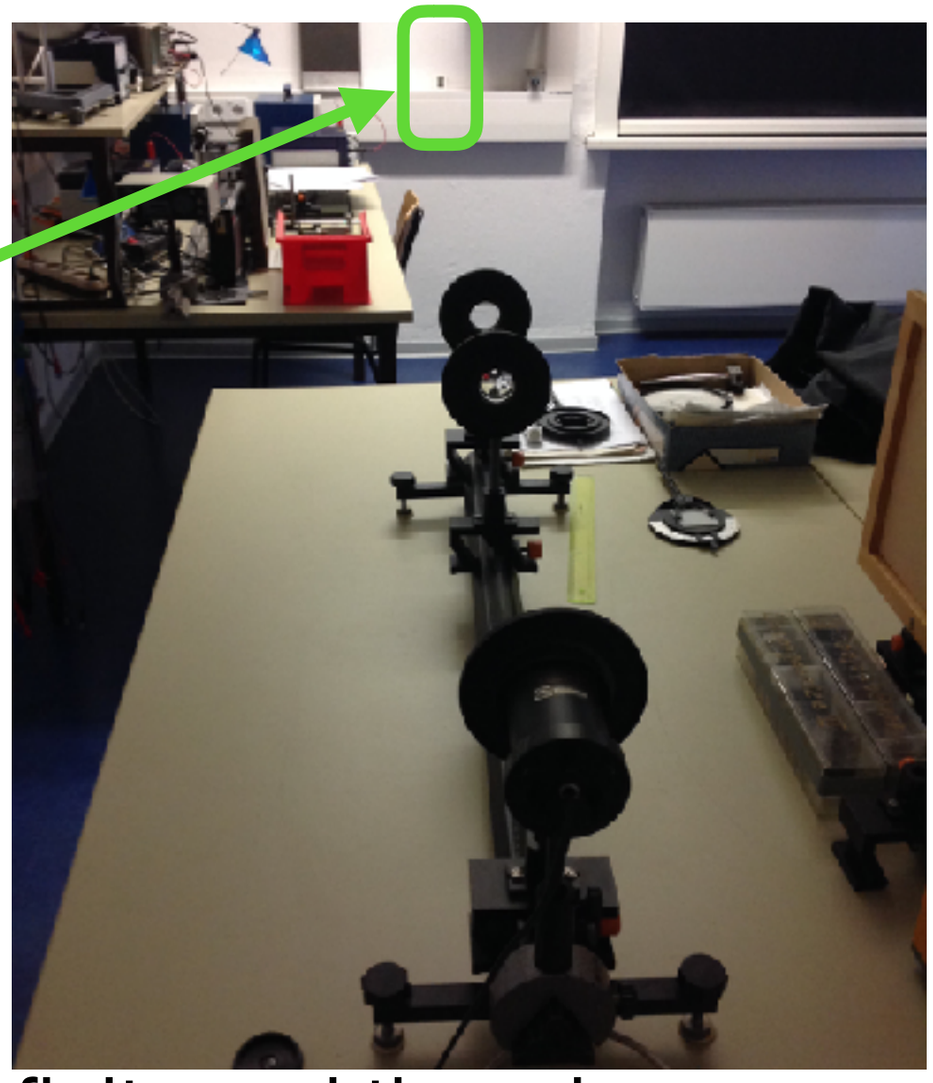
6. Galilean telescope:



Constructed in 1609. The objective is a converging lens, and the eyepiece is a diverging lens placed so that the focal points of the two lenses coincide beyond the eyepiece.

Experimental procedure

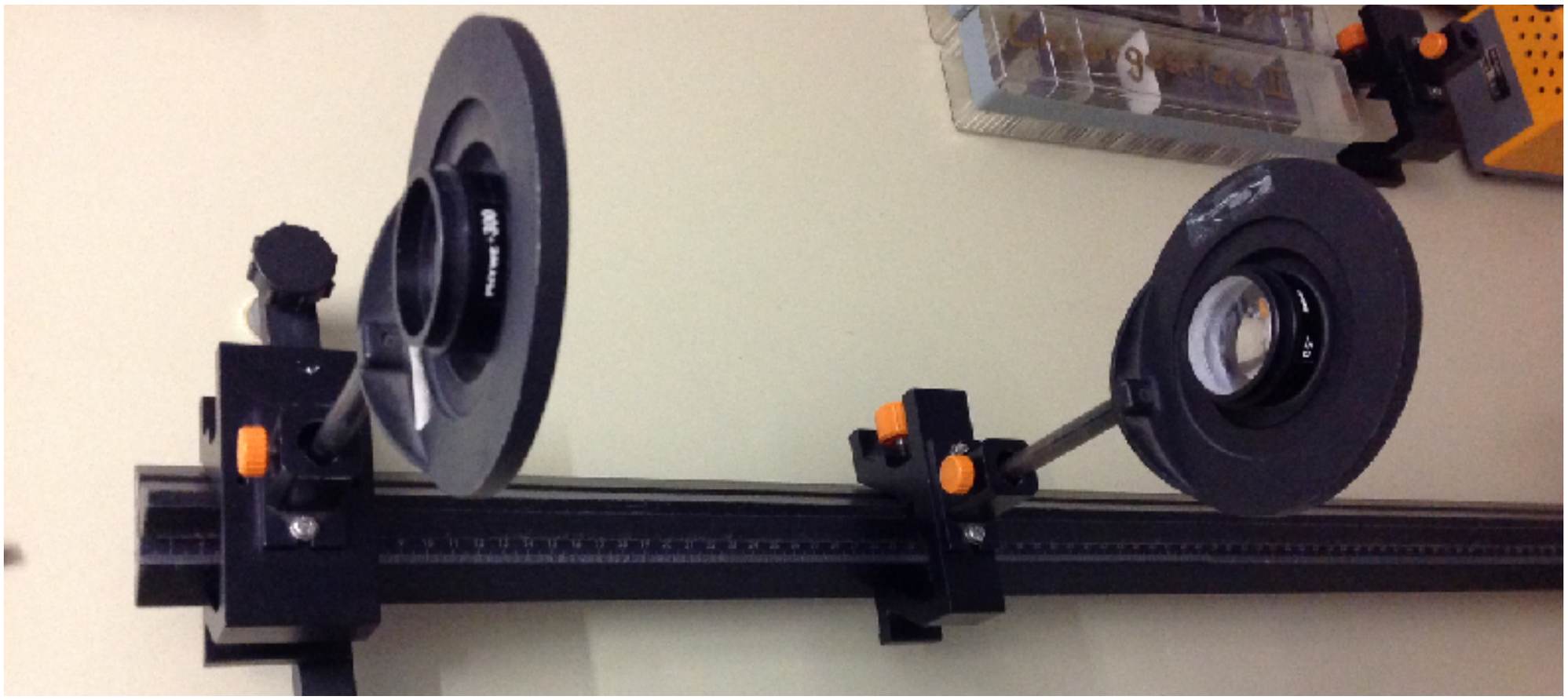
6. Galilean telescope:



An upright image is obtained at infinity and there is no intermediate image. The small overall length and the upright image make this design suitable for opera glasses with a magnification of two to three times.

Experimental procedure

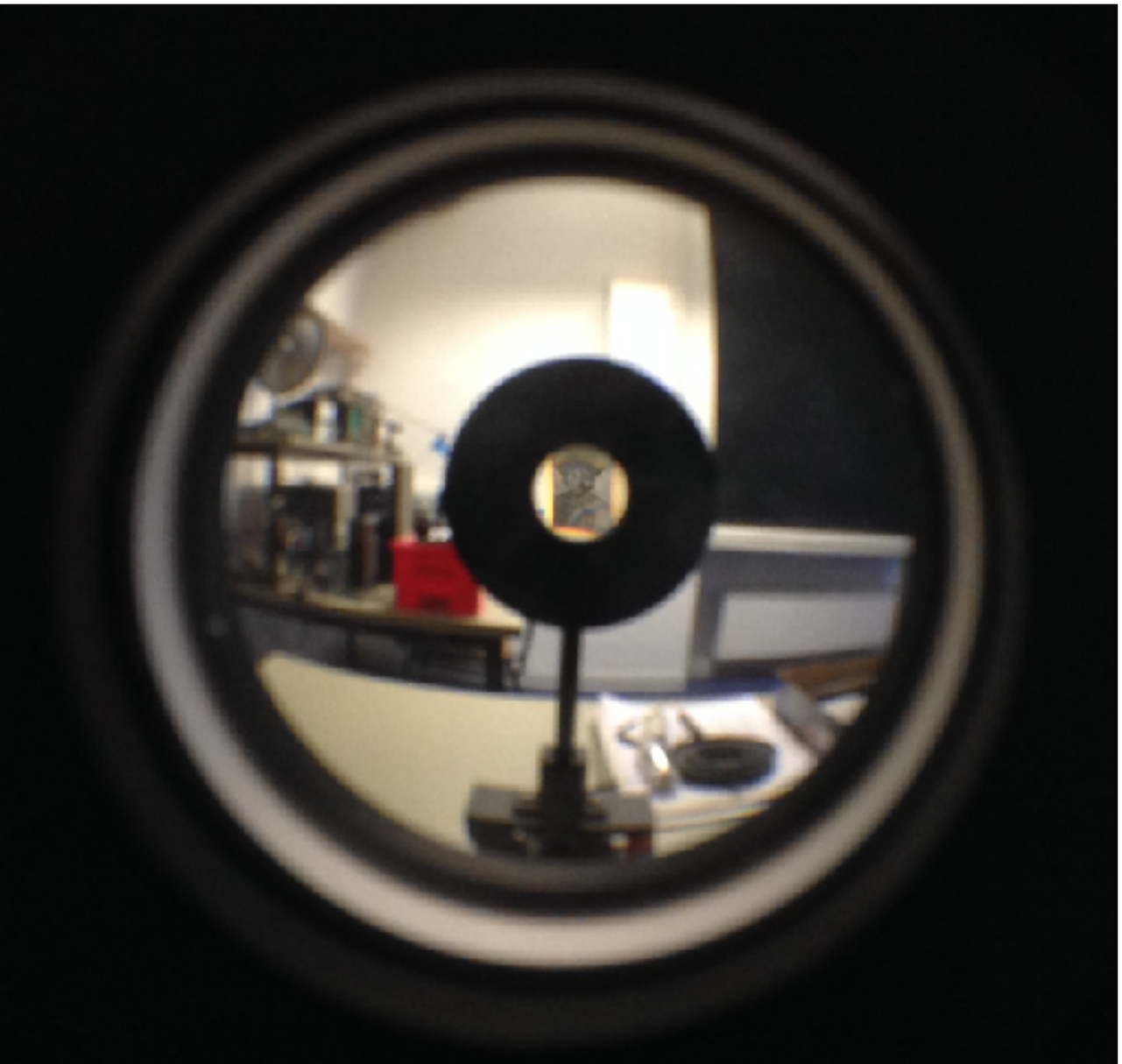
6. Galilean telescope:



A converging lens with a rather long focal length f_1 (e.g. +300 mm) and a diverging lens with a short focal length f_2 (e.g. -50 mm) are set up with a separation given by $f_1 - |f_2|$.

Experimental procedure

6. Galilean telescope:



After focusing you can see an upright magnified image of distant objects through the eyepiece. The magnification of the telescope is again given by:

$$\Gamma = \frac{f_1}{|f_2|} \qquad (11)$$