INSTRUCTIONS FOR USE

Senior optical bench

DO106037

TWINSE

Description

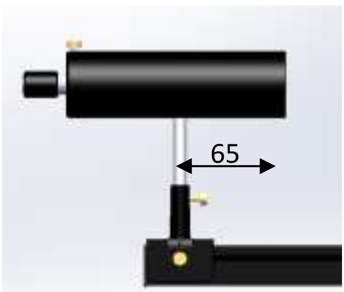
This senior optical bench enables pupils to discover and understand optics in complete autonomy. Simple to use, it is suitable for handling by pupils either for teacher's demonstrations.
Features:

- 1 aluminium rail in Ω shape, 1950 mm long
- 4 aluminium sliding holders
- 3 lens and slide holders (lens ø40) with clips on aluminium rod
- 1 prism mount on aluminium rod
- 1 frost screen 150x150 graduated on aluminium rod
- 1 ECOLED source 3W and its power supply
- 1 set of 4 mineral glass lenses (F +125/+250/+500/-100)
- 1 set of 8 metallic tokens (4 diaphragms with holes ø1/2/5/10, 1 number "1", 1 slit and 3 slits, 1 letter "d")

Use

- Place the lens holders and the screen on the sliding holders.
- On one of the sliding holders, place the ECOLED source.
- Connect the 6V power cable to the back of the light source and plug into the mains.
- The bench is now ready for use for a variety of experiments to measure focal length and observe diffraction.

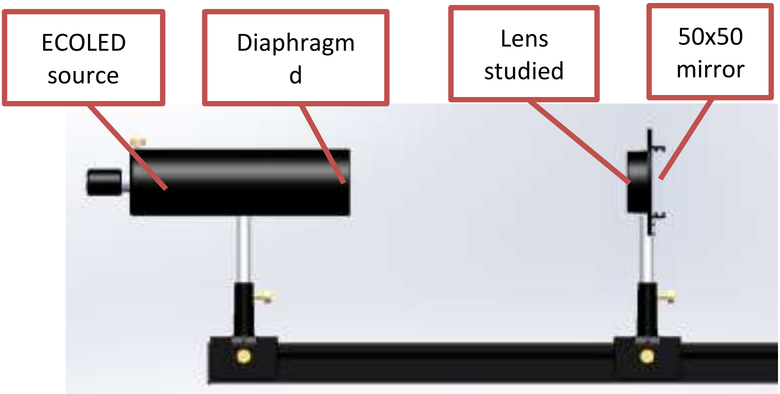
Important: For focal length study, you need to know that the distance between the aluminium rod and the diaphragm is 65mm



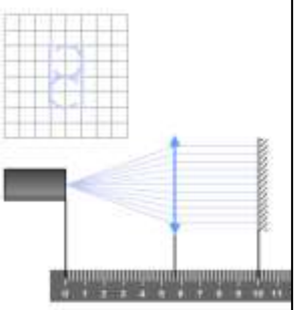
Focal length of thin lenses

The aim is to demonstrate the different methods of determining the focal length of thin lenses.

1. Autocollimation

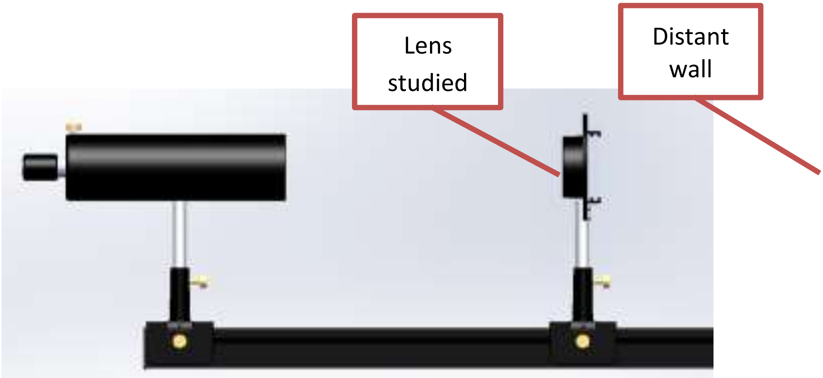


- Place the light source on the 0 mark.
- Place the diaphragm with the letter "d" in the ECOLED source.
- Place a converging lens in a lens holder.
- Place a 50x50 mirror on the same lens holder.
- Move the assembly along the bench until you obtain a sharp inverted image of the same size on the on the diaphragm.
- The distance between the diaphragm and the lens then corresponds to the focal length of the lens.

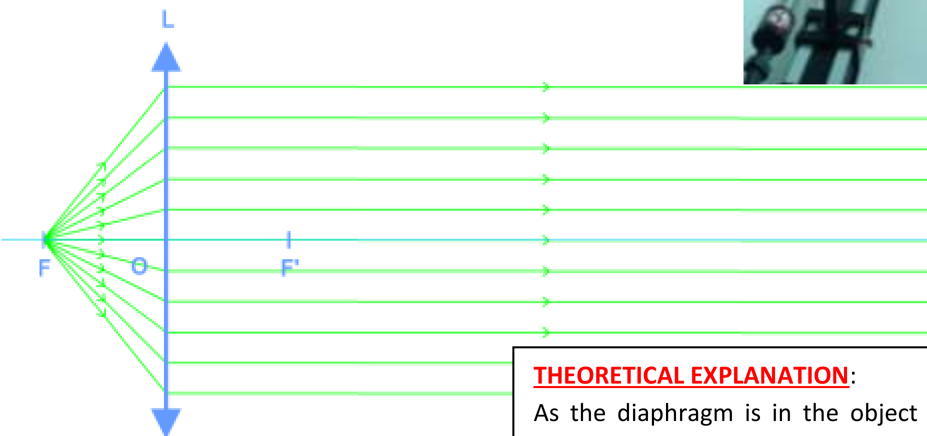


THEORETICAL EXPLANATION:
As the diaphragm is in the object focal plane of the lens, it gives an image at infinity.
Thanks to the mirror, on the return, this image at infinity becomes an object at infinity which gives a real image in the object focal plane or on the diaphragm.

2. Image at infinity method

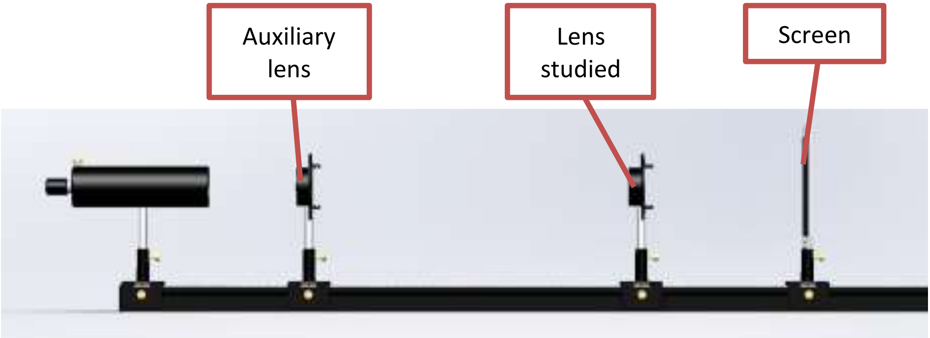


- The configuration is the same as before, but without the 50x50 mirror.
- Move the sliding holder with the lens to be studied until you obtain a sharp inverted image on the wall.
- The distance between the object and the lens then corresponds to the focal length of the lens.

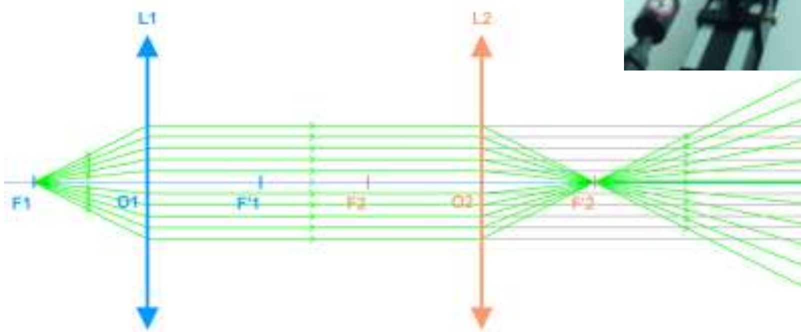


THEORETICAL EXPLANATION:
As the diaphragm is in the object focal plane, it gives an image at infinity.
This remains sharp whatever the distance from the wall.

3. Object at infinity method

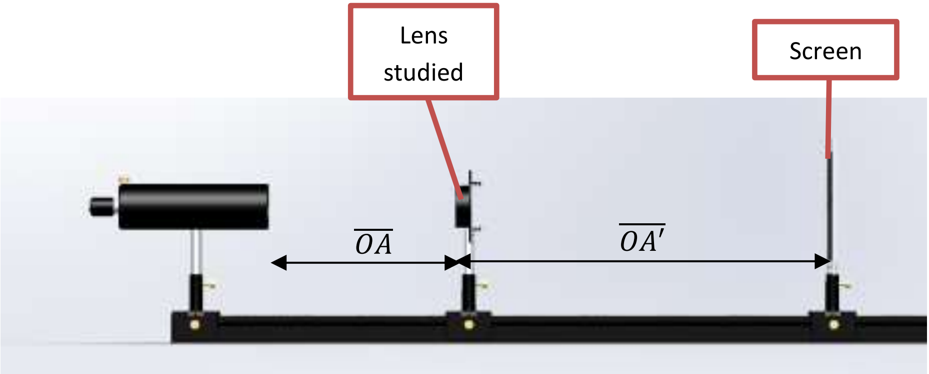


- This time an auxiliary lens is used, placed so as to obtain a sharp image at infinity (cf. image at infinity method).
- Then place the lens to be studied and the screen on the bench.
- Move the screen in relation to the lens until you obtain a sharp image.
- The focal length of the lens is then the distance between the lens and the screen.



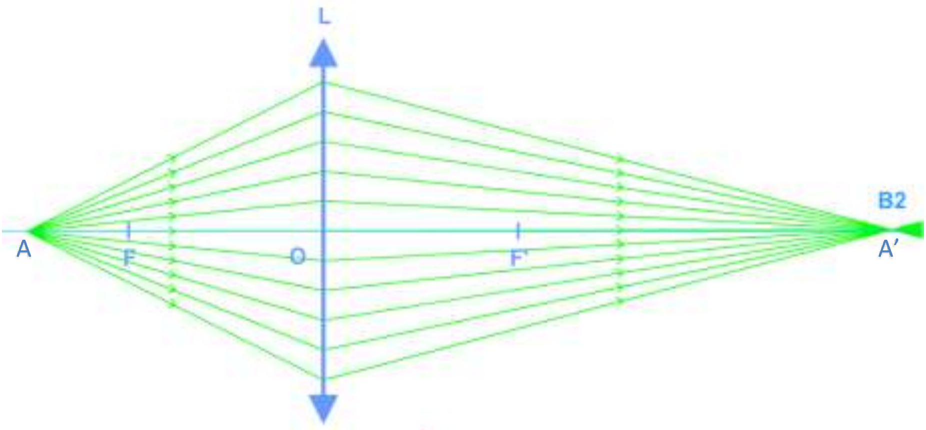
THEORETICAL EXPLANATION:
The first lens allows you to obtain an image at infinity which will serve as the object at infinity for the lens to be studied.
Thus by placing the screen in the image focal plane of the lens to be studied you obtain a sharp image.

4. <u>Descartes' thin lens formula</u>



- Place the lens to be studied on the bench.
- Move the screen until you obtain a sharp image on it.
- $\overline{OA}$ is the distance between the lens and the object (algebraic distance) and $\overline{OA'}$ the distance between the lens and the screen (algebraic distance).
- The focal length can be calculated using Descartes' thin lens formula:

$$\frac{1}{f'} = \frac{1}{\overline{OA'}} - \frac{1}{\overline{OA}}$$



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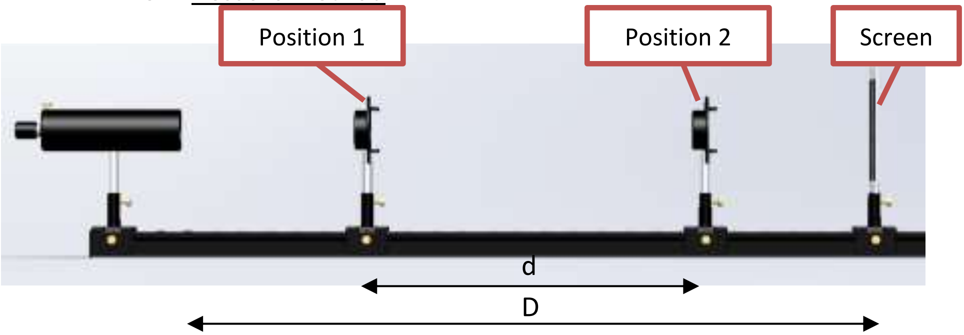
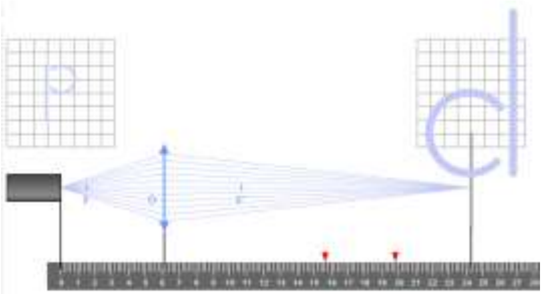
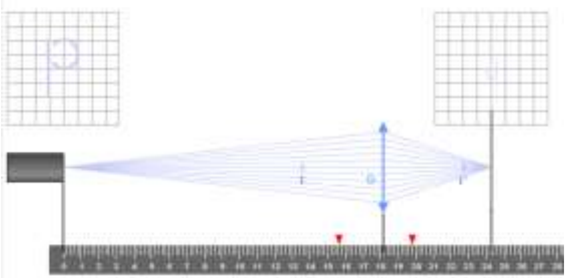
5. Bessel's method



- The configuration is the same as the previous one.
- Move the sliding holder with the lens to be studied from the diaphragm towards the screen until you obtain a sharp enlarged inverted image on the screen. Note the value of this position 1 (X_1).
- Continue moving the sliding holder towards the screen until you obtain on a second, but substantially smaller sharp inverted image. Note the value of this position 2 (X_2).
- D is the distance between the object and the screen and $d = X_2 - X_1$





THEORETICAL EXPLANATION:
The focal length of the lens is then given by Bessel's equation:

$$f' = \frac{D^2 - d^2}{4xD}$$

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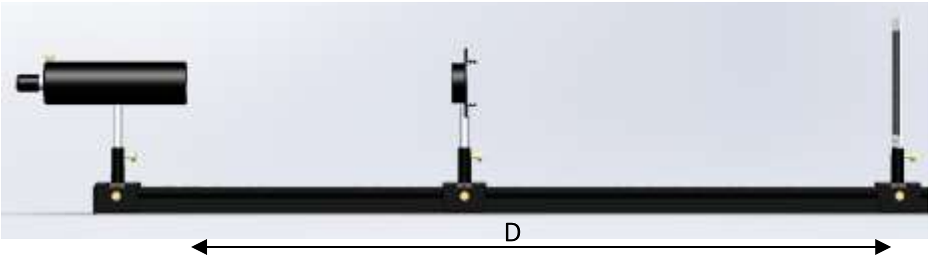
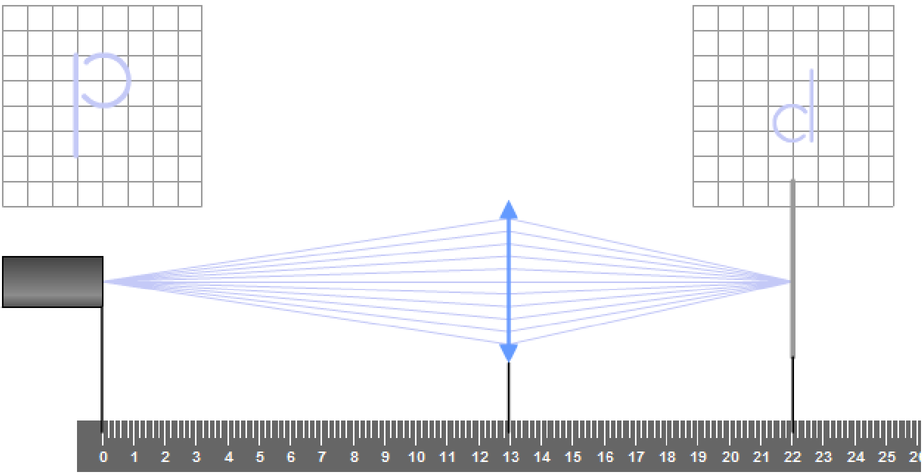
6. Silbermann's method



- This method is a special case of Bessel's method.
- This time we are looking for the position of the lens and the screen that gives an inverted image on the screen that is the same size as the object.
- In this case, the focal length of the lens is: $f' = \frac{D}{4}$

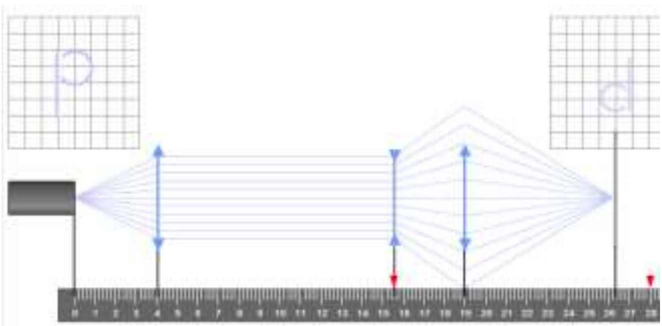


THEORETICAL EXPLANATION:
This is a special case of Bessel's method where d=0. Therefore if we apply Bessel's equation, we obtain: $f' = \frac{D}{4}$

7. <u>Diverging lenses - Badal's method</u>

In the case of diverging lenses, a real image cannot be produced by a real object.

- Use the configuration for the object at infinity method (page 7) with 2 converging lenses. Then deduce the focal length of the second lens f'_2 which is the distance between lens 2 and the screen.
- Then place the diverging lens to be studied in the object focal plane of the second converging lens (namely at a distance f'_2 before the second lens). Then move the screen until you obtain a sharp image. d is the distance between the 2 positions of the screen.
- $f_3' = \frac{f'_2}{\mathrm{d}}$



Representation of optical instruments

With this bench, it is also possible to represent different optical instruments in order to understand how they work.

1. <u>Microscope</u>

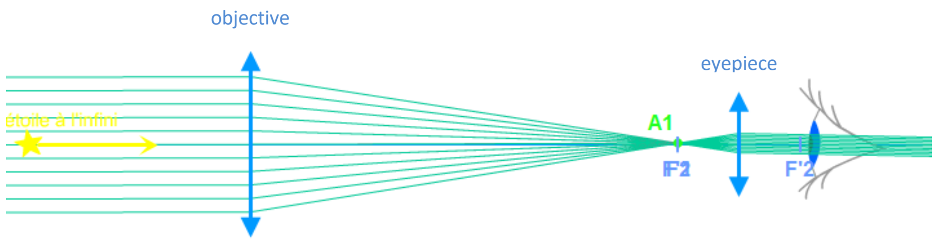
- Place the light source on the 0 mark.
- Place the diaphragm with 1 slit in the ECOLED source.
- Place the F+125 lens near to the diaphragm.
- Then place the F+250 lens 20 cm away from the first lens.
- Move the pair of lenses to focus the image.
- Measure the width of the image obtained.
- Repeat the operation with the two lenses 50 cm apart.
- Compare the image obtained with the one before.

2. Keplerian telescope

Supplementary accessories:

- 1 senior sliding holder
- 1 lens ø40 F+50

- Place the light source on the 0 mark.
- Place the diaphragm with 1 slit in the ECOLED source.
- Then place the F+50 lens 5 cm from the diaphragm. This will enable you to simulate an object at infinity.
- Then place the F+250 lens 5 cm on the bench.
- Finally place the F+125 lens about 37.5 cm away from the previous lens.

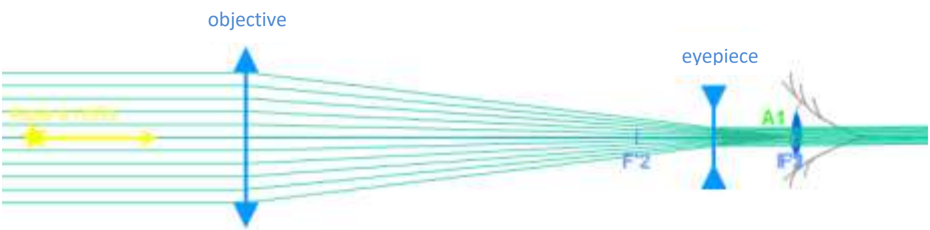


3. <u>Galileo's telescope</u>

Supplementary accessories:

- 1 senior sliding holder
- 1 lens ø40 F+50

- Place the light source on the 0 mark.
- Place the diaphragm with 1 slit just in the ECOLED source.
- Then place the F+50 lens 5cm from the diaphragm. This will enable you to simulate an object at infinity.
- Then place the F+250 lens 5cm on the bench.
- Finally place the F-100 lens about 15 cm away from the previous lens.



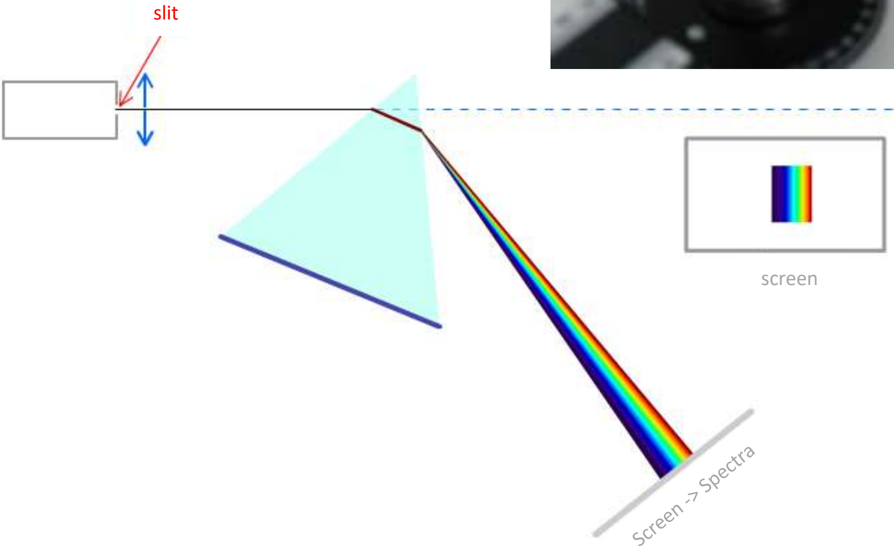
White light diffraction

1. Prism

Supplementary accessories:

- 1 prism
- 1 senior OB rail 500mm
- 1 angular hinge for senior OB

- Place the light source on the 0 mark.
- Place the diaphragm with 1 slit in the ECOLED source
- Then place the F+250 lens 25cm from the diaphragm. This will enable you to simulate an object at infinity.
- Then place the prism mount with the prism on the bench.
- Place the screen next to the bench to observe what happens.



2. <u>Grating</u>

Supplementary accessories:

- 1 diffraction suitcase

- Place the light source on the 0 mark.
- Place the diaphragm with 1 slit in the ECOLED source
- Then place the F+250 lens 25cm from the diaphragm. This will enable you to simulate an object at infinity.
- Then place the 300 line/mm grating.
- Observe the diffraction of the light.
- Repeat the operation with another grating.

Diffraction and interference

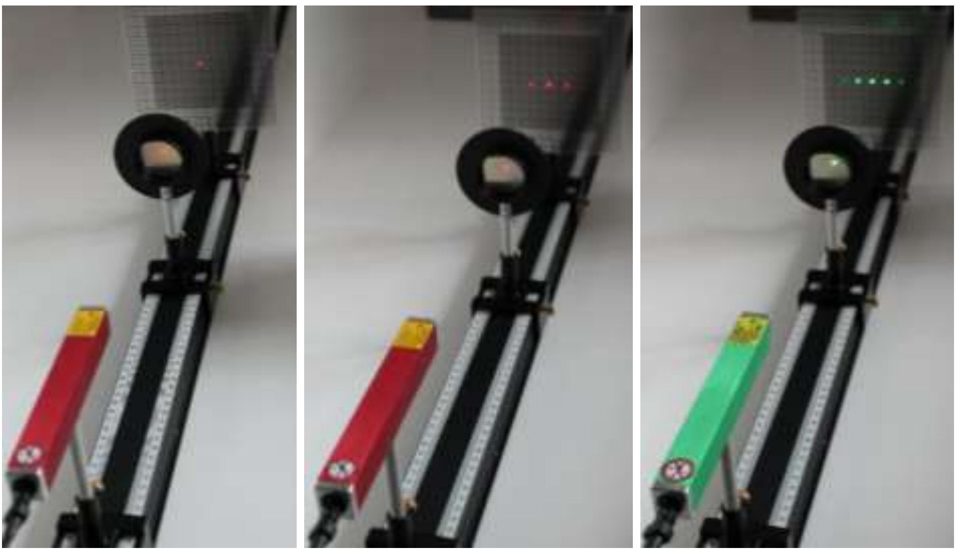
Using a TRIO laser, it is also possible to do diffraction and interference experiments.

1. Grating

Supplementary accessories:

- 1 red TRIO laser
- 1 green TRIO laser
- 1 diffraction suitcase

- Place the red TRIO laser on the 0 mark.
- Then place the 300 line/mm grating.
- Observe the diffraction of the light from the laser on the screen.
- d is the distance between the grating and the screen.
- x is the distance between the main mode and rank 1 mode.
- It is then possible to find the number of lines in the grating.
- Repeat the operation with another grating or a green TRIO laser.

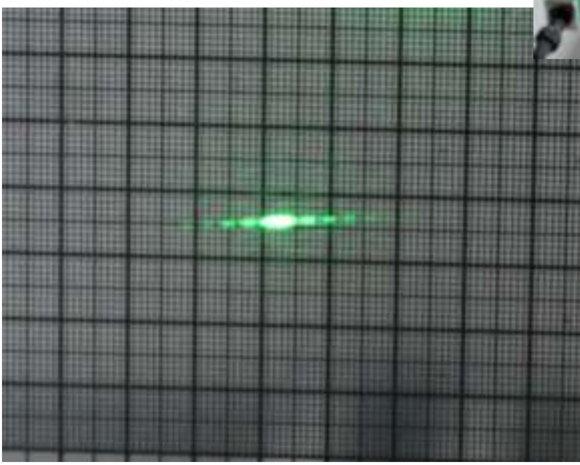


2. Diffraction slits

Supplementary accessories:

- 1 green TRIO laser
- 1 diffraction suitcase

- Place the green TRIO laser on the 0 mark.
- Then place the slide 7 slits/7 lines.
- Observe the diffraction of the light from the laser on the screen.
- d is the distance between the grating and the screen.
- x is the distance between the main mode and rank 1 mode.
- It is then possible to find the width of the slit.



3. <u>Young's slits</u>

Supplementary accessories:

- 1 token laser
- 1 diffraction suitcase

- Place the green TRIO laser on the 0 mark.
- Then place the slide Young slits with variable gap.
- Observe the diffraction of the light from the laser on the screen.