Lab-VII Converging Lens

Goal of this experiment

- Understand the basic knowledge of thin lens

Help to understand the applications of lens

- Determine the focal lengths of converging lenses using different methods

Pre-lab report (20%)

- **It is not allowed to do experiment without pre-lab report!**
- **Every 10 minutes late for -0.5 points; more than 30 minutes late, then not allowed to do experiment and get 0 point for this experiment.**
- **Asking for absence must be done in advance, no make-up otherwise.**

Experiment title

Purpose：

Principle：

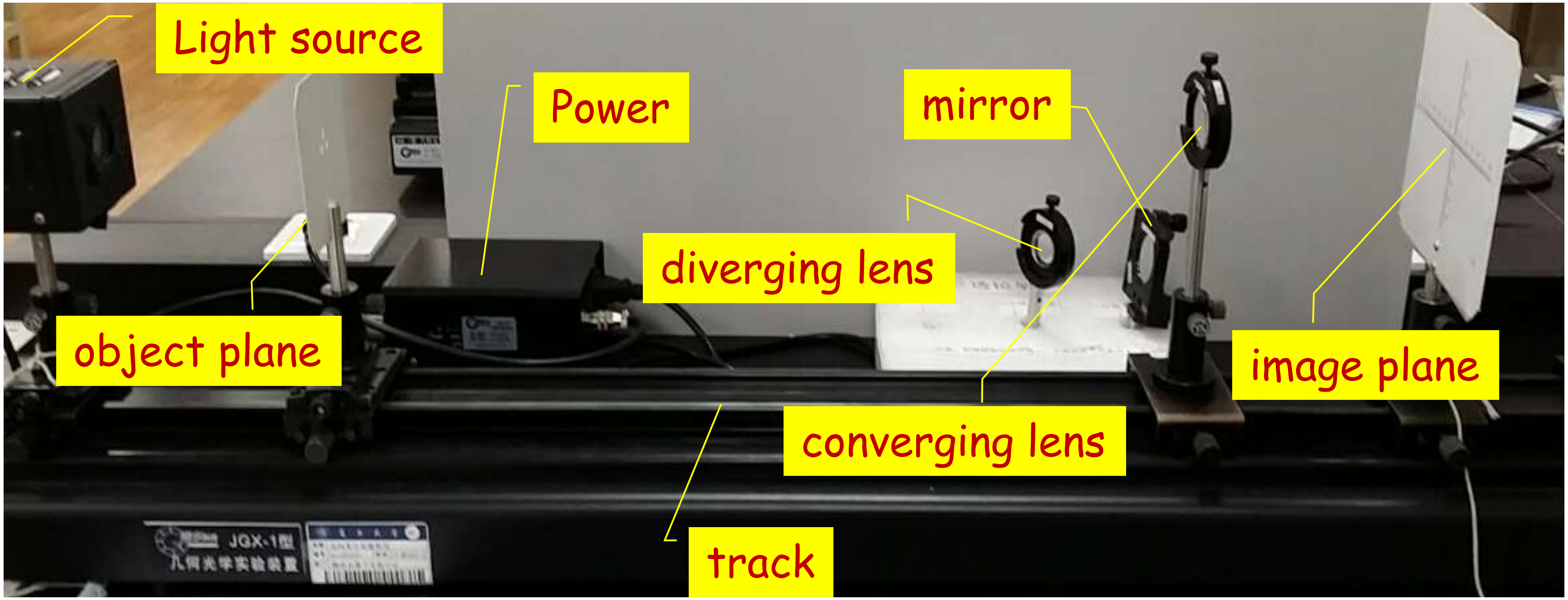
(Including backgroud, theory, important formula, circuit and ray diagram)

Content and procedures：

Briefly!

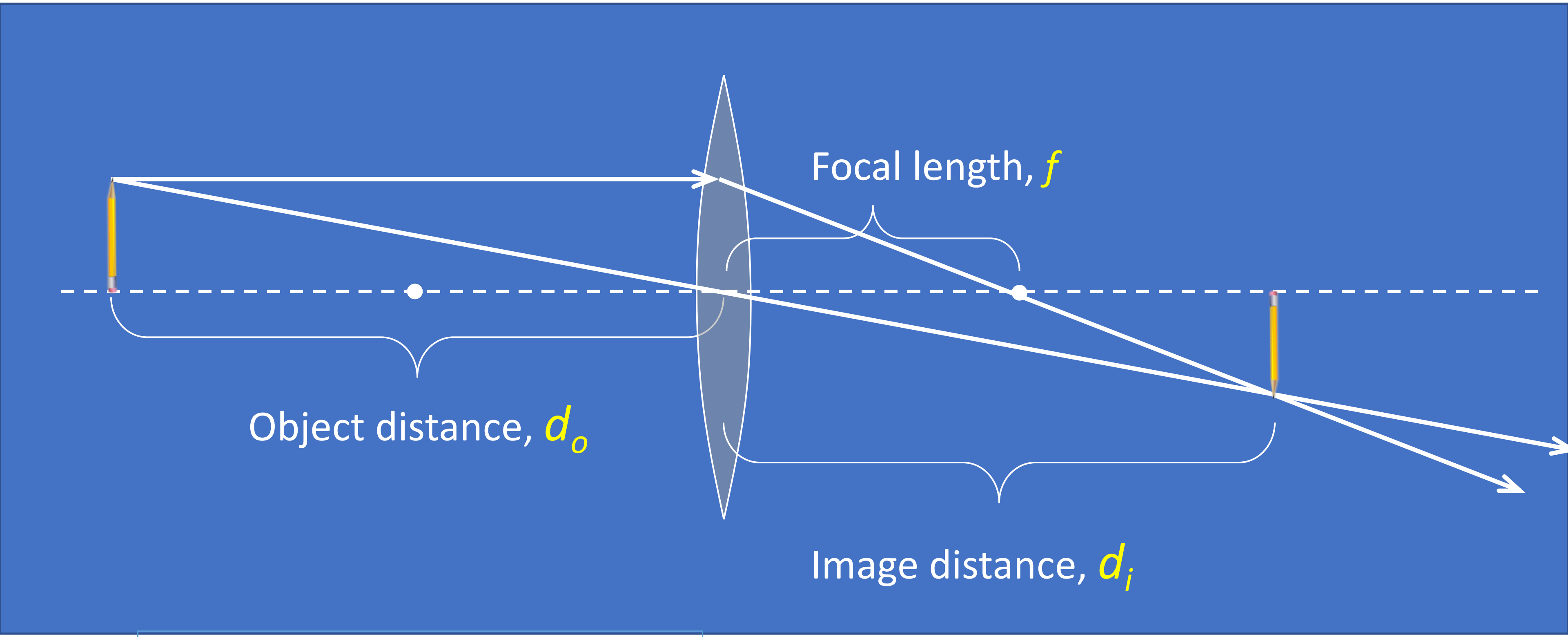
Prepare the table for record!

Experiment setup:



Note: Do not touch the lens/mirror with hand

Lens equation



Focal length(f):

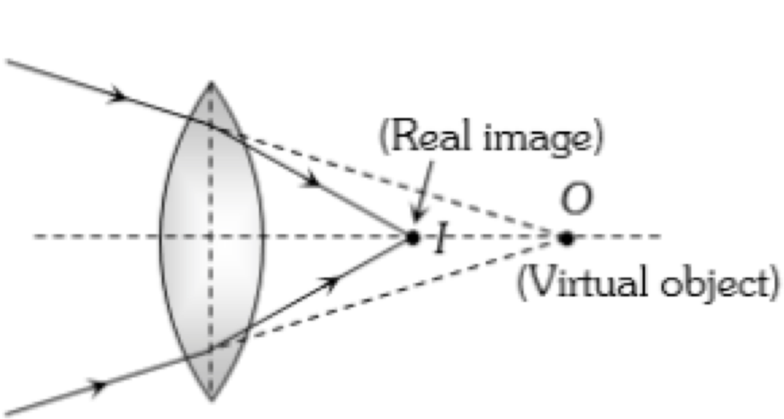
$$\frac{1}{d_i}+\frac{1}{d_o}=\frac{1}{f}\Rightarrow f=\frac{d_i \times d_o}{d_i+d_o}$$

Magnification(M):

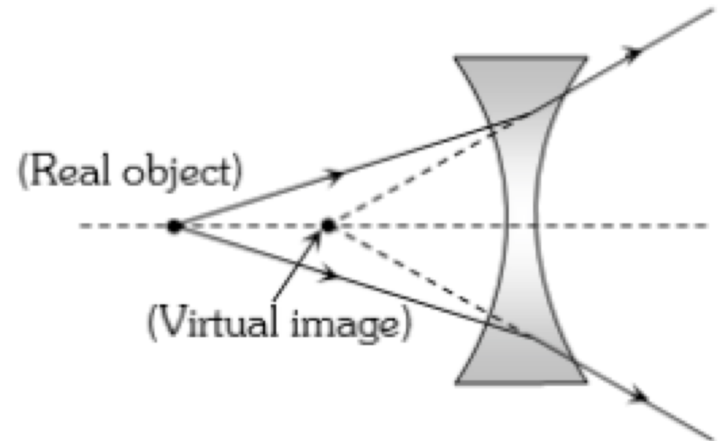
$$M = d_i / d_o$$

Lens equation

$$\frac{1}{d_i}+\frac{1}{d_o}=\frac{1}{f}\Rightarrow f=\frac{d_i\times d_o}{d_i+d_o}$$



Convex Lens



Concave Lens

Real image: di>0; Virtual image: di<0
Real object: do>0; Virtual object: do<0
Convex lens: f>0; Concave lens: f<0

To locate the image-------Ray diagram:

Ray 1(aqua) is the ray which travels parallel to the axis and after going through the lens it passes through the focal point.

Ray 2(gold) passes through the center of the lens.

Ray 3(pink) goes through the focal point and then travels parallel to the axis after passing through the lens.

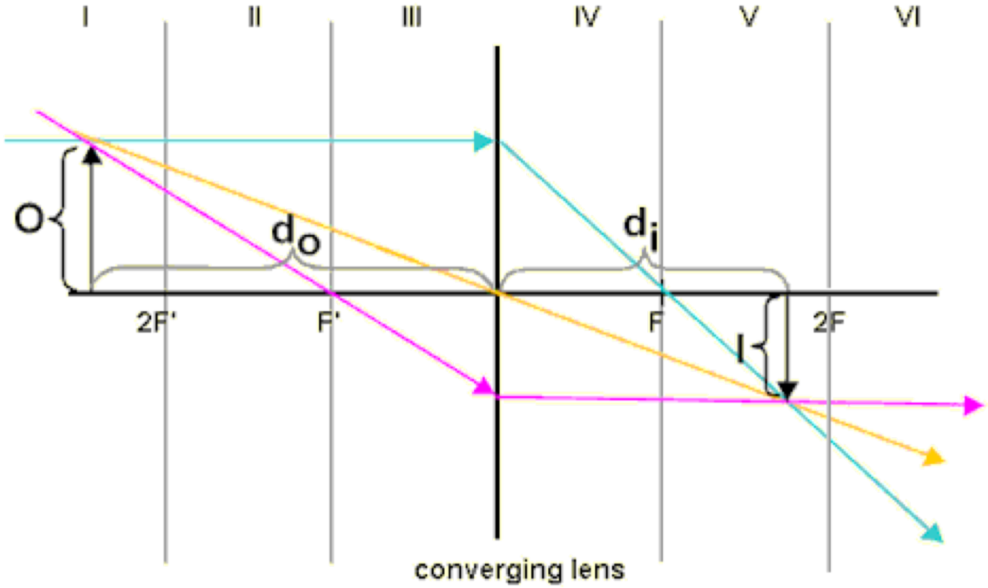
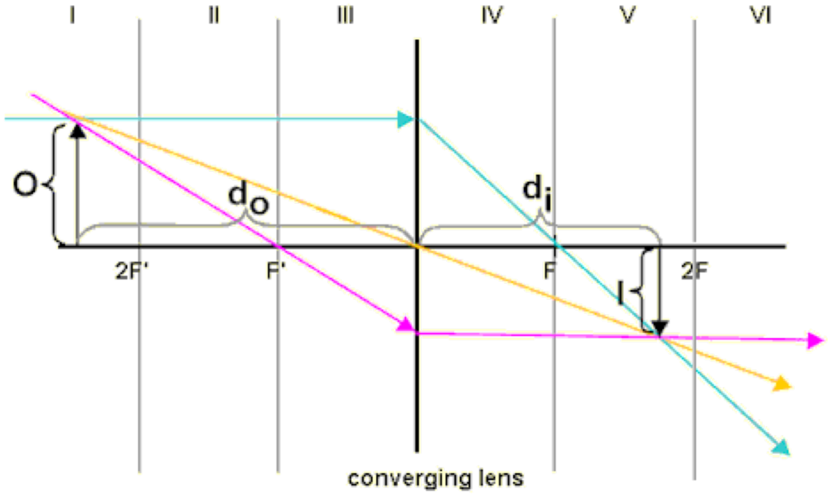


Image properties of Converging Lens



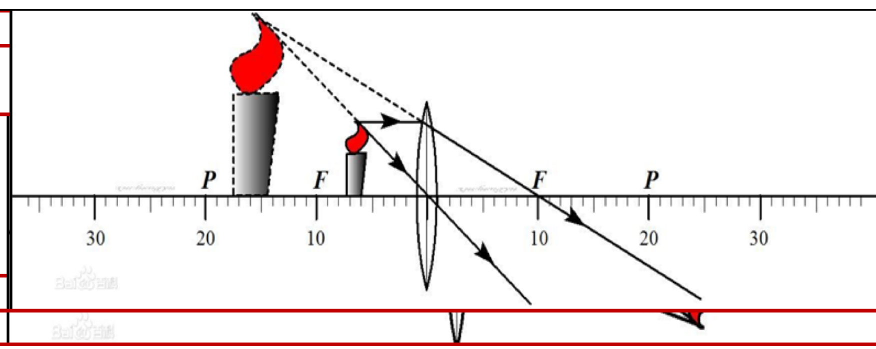
Region I is greater than two focal lengths in front of the lens.
Region II is between one and two focal lengths in front of the lens.
Region III is within one focal length in front of the lens.
Region IV is within one focal length behind the lens.
Region V is between one and two focal lengths behind the lens.
Region VI is beyond two focal lengths behind the lens.

Region III

$f = 10\text{cm}$

$f < d_0 < 2f$ / $d_0 < f$

$d_0 = 2f$



Upside-down / Upright

Smaller / Larger

Upside-down

Real image / Virtual image / Equal size

$M<1$ / $M>1$

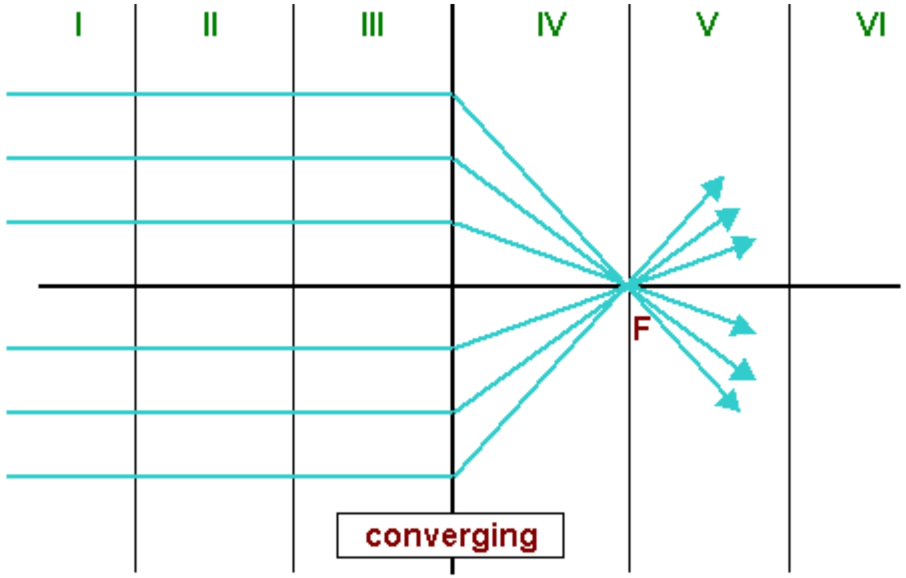
Real image

$M=1$

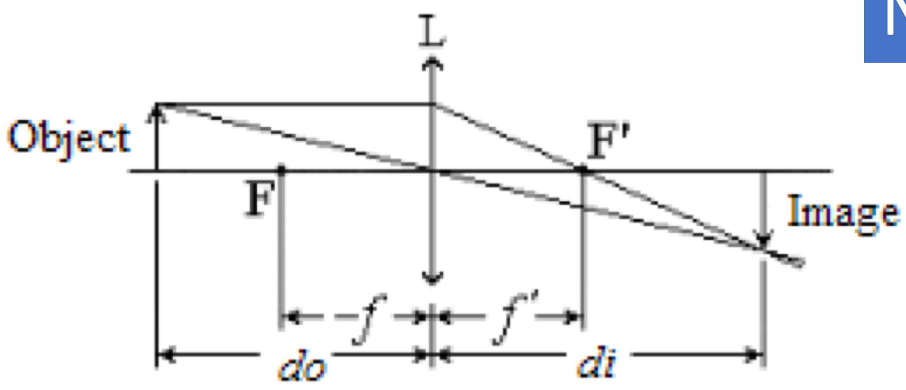
Experiment and data collection

Roughly measure the focal length of converging lens:

Far away object:
window



Method one: using the thin lens equation

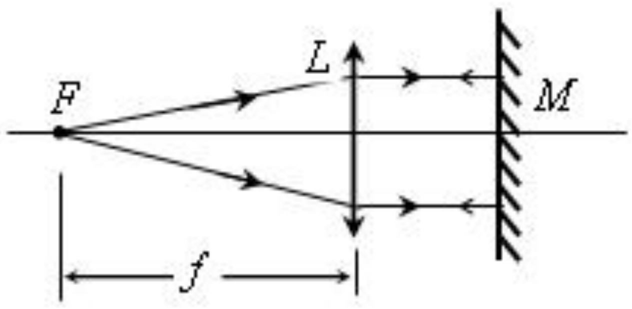


Note: choose d_o>f

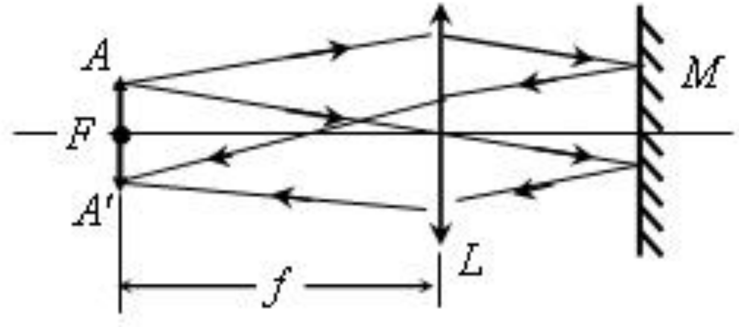
$$\frac{1}{d_i}+\frac{1}{d_o}=\frac{1}{f}$$

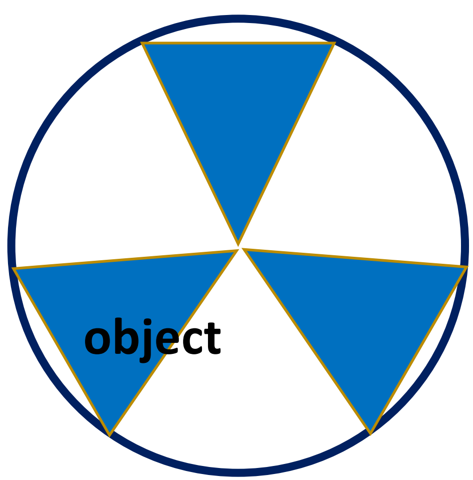
Position (Object) /mm	Position (Lens) /mm	Object distance (d_o)/mm	Position (Image) /mm	Image Distance (d_i)	Focal Length (f)	Magnification (M)

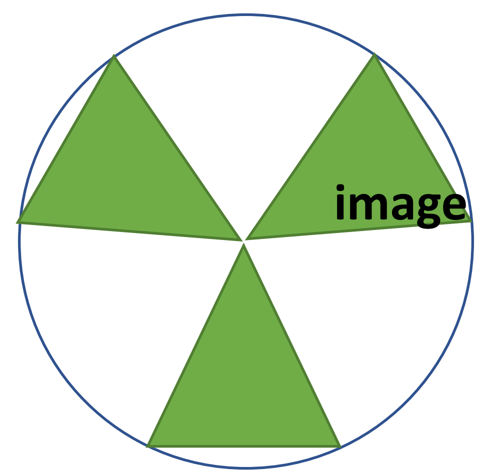
Method two: autocollimation approach

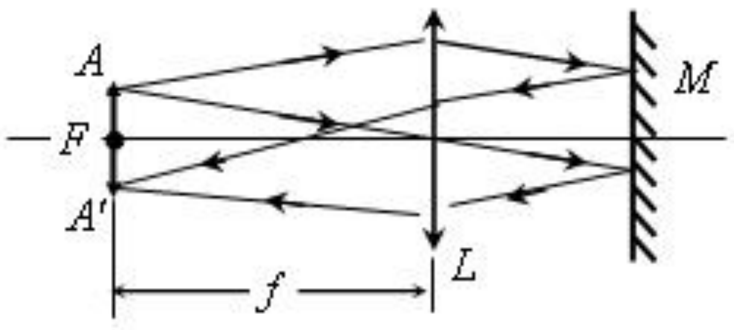


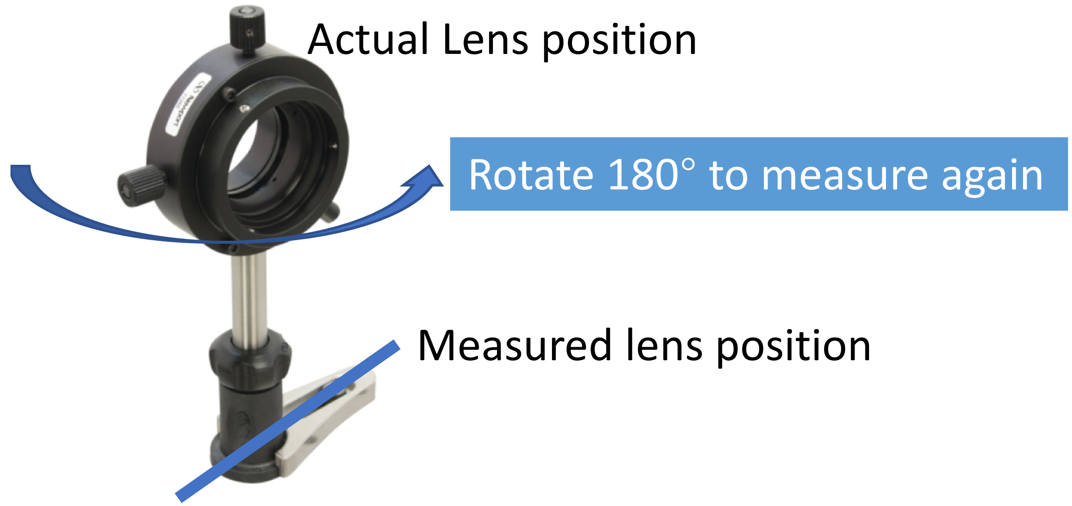
Upside-down & Equal









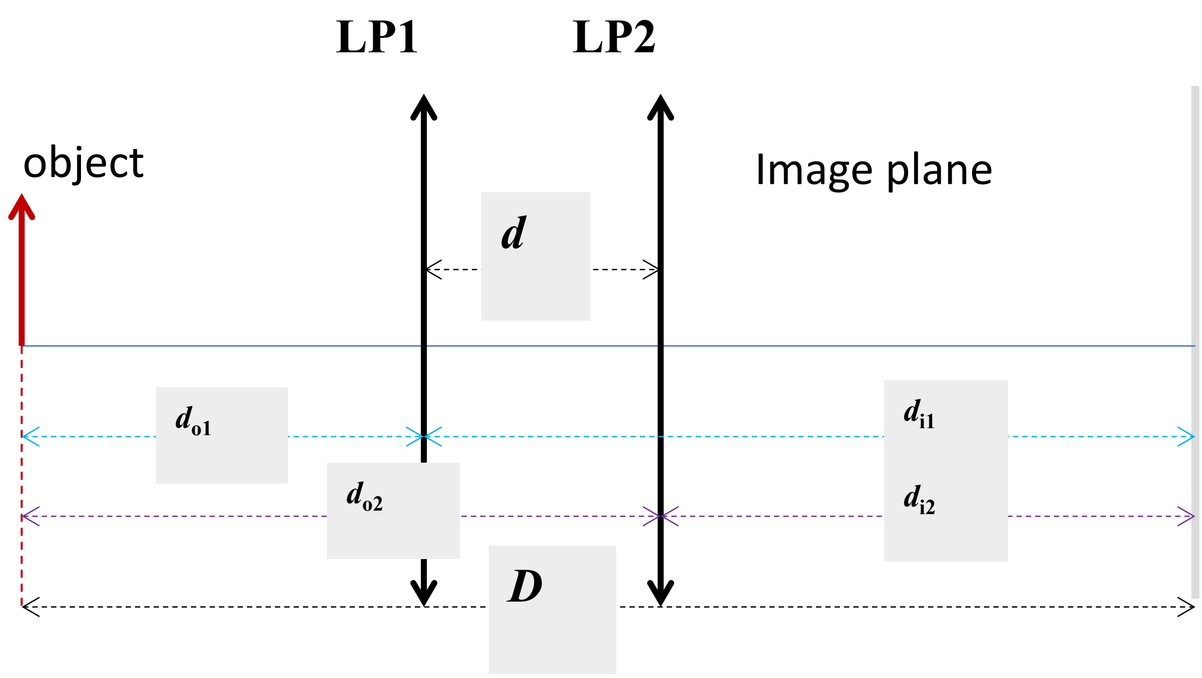


		Position (Object) /mm	Position (Lens) /mm	Average position (Lens) /mm	f /mm	Average f /mm
Before rotating 180 degrees	1	*****	*****	*****	*****	*****
	2		*****			
	3		*****			
After rotating 180 degrees	1		*****	*****	*****	
	2		*****			
	3		*****			

Method three:

Bessel approach

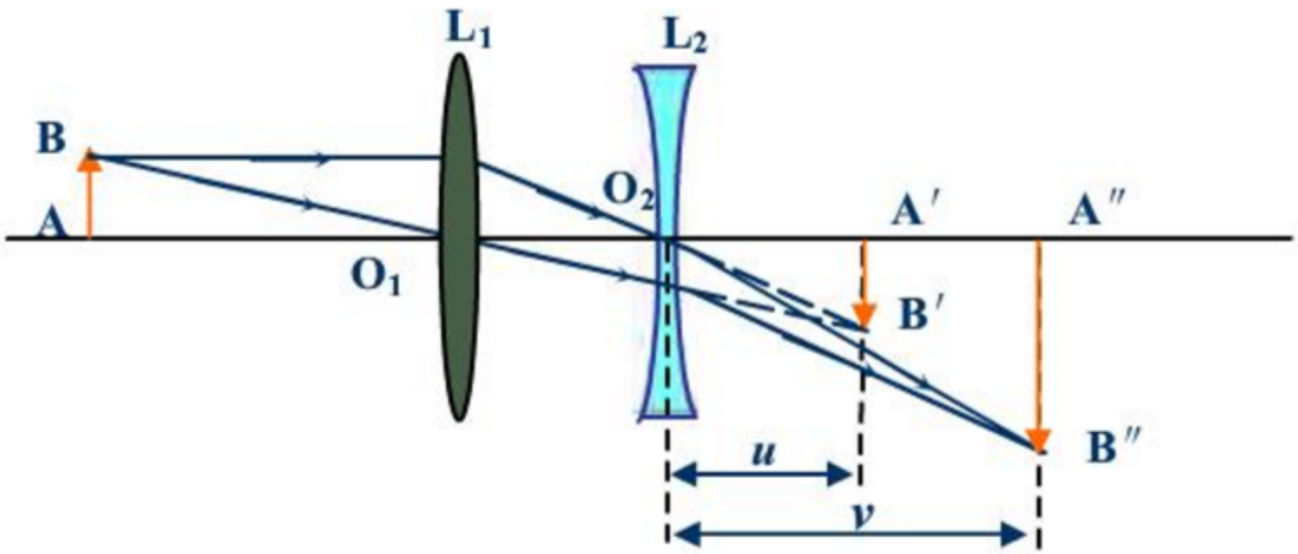
Derivition of the equation: $f = \dfrac{D^2 - d^2}{4D}$



Note: choose D>4f but not too large

Optional:

Measure the focal length of a diverging lens



$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$$

Note: u<0 (virtual object)

Let’s start the experiment!