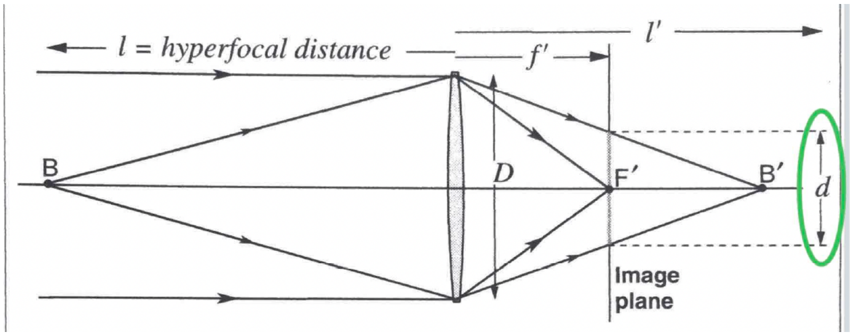
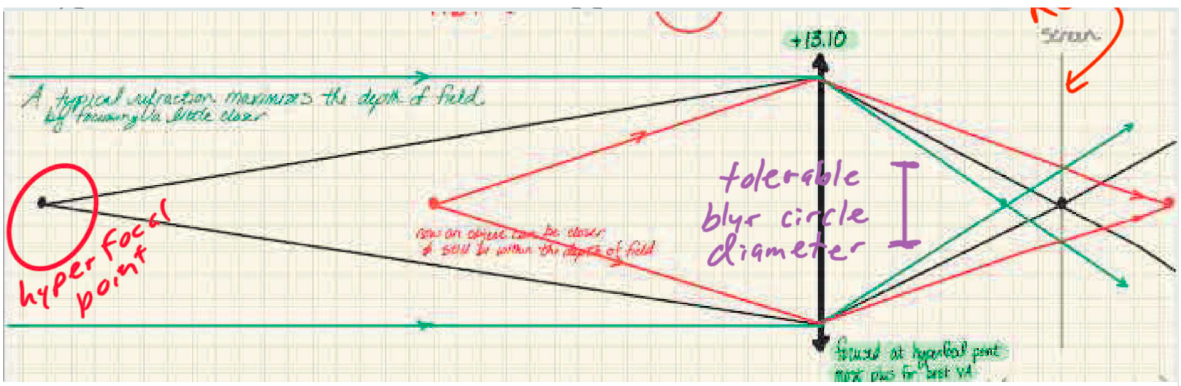
Notes (2/10/2026)

Hyperfocal Distance



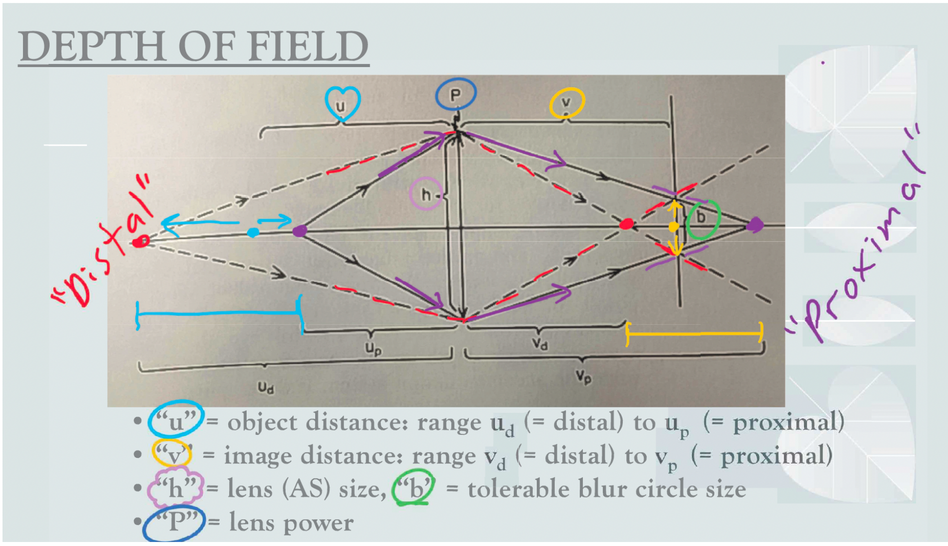
Hyperfocal distance is the closest object distance that is still in focus when the optical system is focused for infinity.



Hyperfocal Distance depends on the blur circle size tolerance.

The Hyperfocal Distance is ½ the Depth of Field (measured in diopters).

Depth of Focus & Depth of Field



Depth of Field deals with object space
Depth of Focus deals with image space

Depth of Field
The total axial range for the object without noticeable image quality change.
Can be expressed as a distance or the dioptric equivalent.

Depends on Aperture Stop diameter and Maximum Blur Circle tolerance.

Use similar triangles for calculations.

Depth of Focus
Similar to Depth of Focus but occurs in image space.
How far from the screen can an image be formed and still have a reasonably clear image.

Depth of Field & Depth of Focus Calculation
Calculations of Depth of Field & Focus require a blur circle diameter to be provided.
Depth of Field & Focus are equal when using Dioptric Measurement.
Depth of Field & Focus are not equal when using Linear (metric) Measurement.
The Object is not necessarily located at the axial (longitudinal) center of the Depth of Field.
The Image is not necessarily located at the axial (longitudinal) center of the Depth of Focus.

Use the equation to see the relationship between the variables:

Depth of field = 2(b/hv)

b= blur circle diameter
h = aperture diameter
v = distance from aperture to center of depth of focus

Depth of Field / Depth of Focus Example

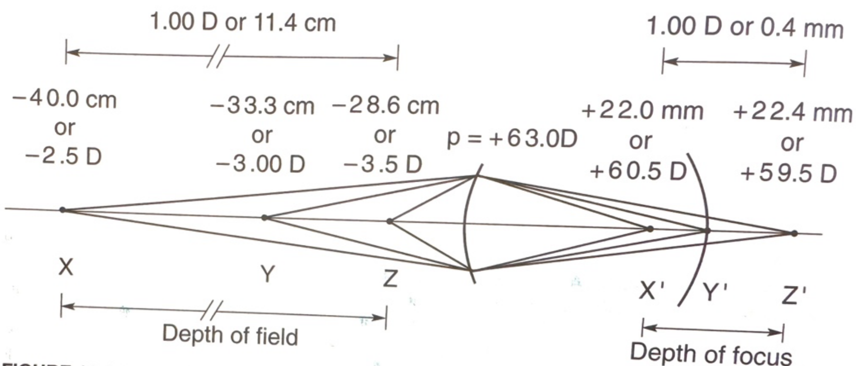
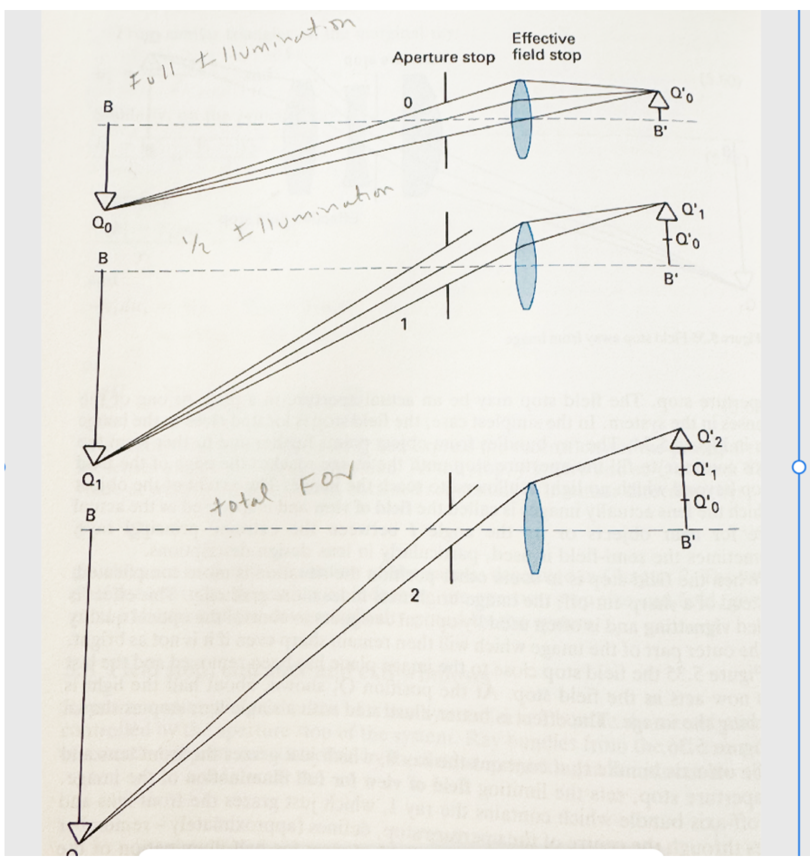


FIGURE 11-6. The depth of field is conjugate to the depth of focus. Although the depth of field and depth of focus are dioptrically equal (1.00 D), they are not linearly equal (11.4 cm versus 0.4 mm). (The 3.00 D myopic eye in this figure is uncorrected and unable to accommodate.)

Determining Field of Illumination using Chief Ray



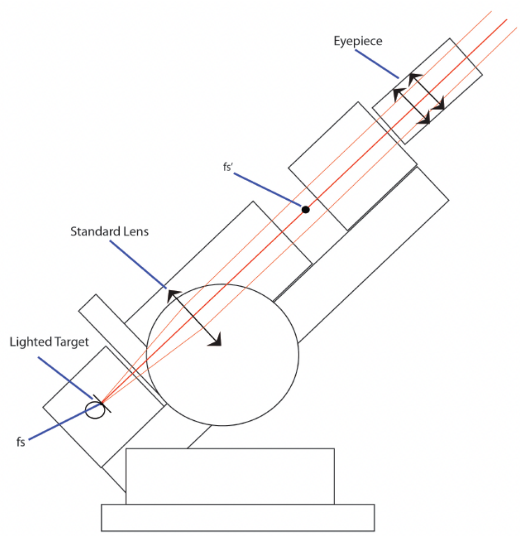
The standard for FOV expression is Field of Half Illumination.

Total FOV results in significant Vignetting.

Lensometer

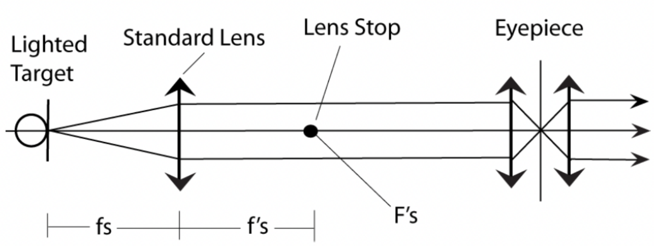
Used to measure vertex power of lenses (front or back).
An unknown lens (test lens) is placed at the lens stop and the lensometer drum is turned until a clear image of the lighted target is obtained.

Lensometer Optics



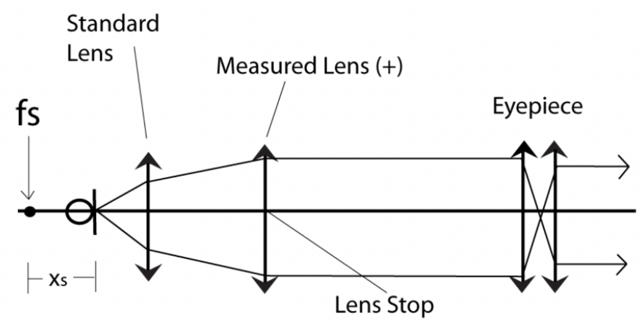
Important Elements

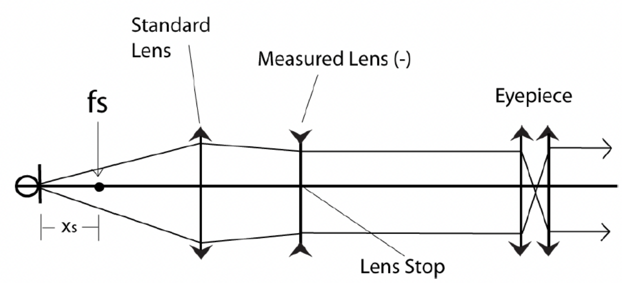
Moveable Target (lighted)
Standard Lens (+20D is typical)
Lens Stop (position of lens to be measured)
Eyepiece (Keplerian TS)



With the measuring drum set to plano (0.00D) the lensometer target is located at the focal point of the standard lens (which sets the limit the lens power can measure $\pm$ 20.00D). When the lens to be measured is placed at the secondary focal point of the standard lens, the target is moved (which changes the vergence of light incident on the tested lens) until parallel light emerges from the eyepiece (which provides a clear image of the target).

Lensometer Optics





These two diagrams illustrate the change in target position and resulting vergence incident at the test lens to measure the power of a plus powered lens and a minus powered lens.

To measure a plus lens, the target is moved closer to the standard lens which results in diverging light rays at the test lens.

To measure a minus lens, the target is moved farther from the standard lens which results in converging light rays at the test lens.

The amount of target movement required for lens "neutralization" is found using Newton's relation:

$$x_s = f_s^2 \, F_v'$$

Where:

- x_s = target movement
- f_s = focal length of standard lens
- F_v' = back vertex power of test lens

Example

When an unknown lens is placed at the lens stop of a lensometer with a +20D standard lens the target moves closer to the standard lens 5mm. What is the power of the test lens?

$$x_s = f_s^2 \, F_v'$$

$0.005 = (0.05)^2 F'v$

$F'v = +2.00D$

When a -8.00D spectacle lens is placed at the lens stop of a lensometer, the image of the target is clear when the target is located 12.8mm farther from the standard lens. What is the power of the standard lens?

$$-0.0128 = f_s^2(-8.00D)$$

$$f_s = \sqrt{0.0016}$$

$$f_s = 0.04m$$

$$F_s = 25.00D$$