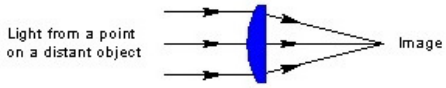
Test configurations supported by OS200B

OBJECT AT INFINITY



Used for camera lenses, or any lens designed to form an image of a distant object.

The image source is a collimator, and a microscope is used to view the image

Limits on the collimator

The clear aperture ("CA") of the collimator must be at least as large as the CA of the lens under test. Good practice suggests allowing a few mm of margin[1].

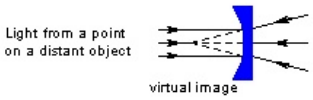
For example, the 400 mm collimator has a CA of 47 mm. This suggests it can be used for testing lenses up to 40 or even 45 mm CA.

Limits on the microscope

The Numerical aperture ("NA") of the microscope must be at least as large as the NA of the lens under test. Good practice suggests allowing some additional margin.

For example the 10X microscope lens has an NA of 0.25. This suggests it can be used for testing lenses up to NA 0.2, or even NA 0.22. (NA 0.2 corresponds to F2.5)

NEGATIVE LENS



Used for negative lenses.

The image source is a collimator, and a microscope is used to view the image

Limits on the collimator

The CA of the collimator should be at least as large as the CA of the lens under test. (but also see discussion below.)

Limits on the microscope

(1) The working distance of he microscope must be at least as long as the distance from the back surface of the lens to the image.
(2) The NA of the microscope lens must be at least as large as the NA of the lens under test

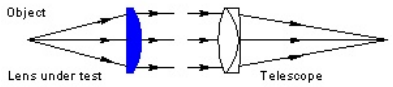
Discussion:
On many occasions you do not need to measure the full-aperture performance of a negative lens, but merely want to measure its EFL[2]. In this case it is not necessary to meet limit #2

For example the 4X microscope lens has an NA of 0.1 and a working distance of about an inch.. This suggests it can be use for measuring the EFL of any negative lens with BFL of 1 inch or more, and can do a full-aperture test on a lens with NA of 0.08 or lens

[1] If he collimator does not completely fill the aperture of the lens under test, you will only be testing part of the lens. Peripheral rays are usually the most ill-behaved, and you ignore these at your peril. You may even see image quality that is *better* than would be achieved at full aperture.

[2] A single element spherical lens with high NA will not form a sharp image because of spherical aberration. This is true of any singlet, whether positive or negative. Thus it usually is not useful to make a full-aperture image quality measurement on such a lens. On the other hand, it is very often desirable to measure the paraxial focal length of such a lens.

TESTING A LENS "IN PROJECTION"



A general purpose configuration that is especially useful when the lens to be tested has a higher NA than the system microscope

The image source is a back-lit reticle, and a telescope is used to view the image

Limits on the back-lit reticle

It is usually desirable for the light source behind the reticle to have an NA at least as large as the lens under test. [3]
The back-lit reticle supplied with the OS200 fills a cone angle of NA 0.5. (F1) with very good uniformity.

Limits on the telescope

(1) The CA of the telescope should be at least as large as the exit CA of the lens under test . As always, good practice suggests allowing some margin too.

(2) The CA of he lens under test should be no smaller than 1/10 of the telescope CA. Otherwise long exposure times may be required

For example the 200 mm telescope has a CA of 23 mm, which suggests it is appropriate for lenses with CA between 2 mm and 20 mm.

(3) In the case of very fast lenses there is a third requirement. The magnification from reticle to CCD should be no larger than 50X. Or, to say it differently, the EFL of the lens under test should be no smaller than 1/50 of the telescope EFL.

Discussion:
Magnification larger than 50X is not so much an optical problem, but one of operator convenience. With very high magnification only a small part of the reticle will be visible[4].

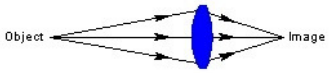
Too many rules? Please consult the chart below:

Telescope focal length (mm)	Telescope clear aperture (mm)	Largest suggested lens CA	Smallest suggested lens CA	Smallest suggested lens EFL
18	9	6	0.5	0.5
45	9	6	1	1
100	16	10	2	2
200	22	20	2	4
400	48	40	4	8
900	100	95	8	18

[3] Please see footnote 3

[4] For example, consider an F1.5 lens with 3 mm EFL. The CA is 2 mm, which should be OK for use with a 200 collimator. However, at 66X the magnification is so high that this setup is probably not a good choice. The horizontal field of view will be only [4.8 mm / 66] 72 microns. This is so small that it will be rather difficult for the operator.

OBJECT AT A FINITE DISTANCE



Used for relay lenses, or any lens designed to operate at a specific object distance .

The image source is a back-lit reticle, and a microscope is used to view the image

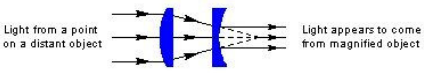
Limits on the back-lit reticle

It is usually desirable for the light source behind the reticle to have an NA at least as large as the lens under test. [5]
The back-lit reticle supplied with the OS200 fills a cone angle of NA 0.5. (F1) with very good uniformity.

Limits on the microscope

The Numerical aperture ("NA") of the microscope must be at least as large as the NA of the lens under test. Good practice suggests allowing some additional margin.

TESTING AN AFOCAL INSTRUMENT



Used for beam expanders, telescopes, and similar afocal instruments

The image source is a collimator, and a telescope is used to view the image

Limits on the collimator

The CA of the collimator must be at least as large as the entrance pupil of the instrument under test.

Limits on the telescope

The CA of the telescope must be at least as large as the exit pupil of the instrument under test.

Discussion:
If the module under test is fixed focus (like a beam expander) then best practice suggests that either the collimator or telescope have adjustable focus.

[5] When the NA of the light source is smaller than the NA of the lens, the illumination is said to be "partially coherent" This has interesting consequences, but the issue is far beyond the scope of this footnote. The interested reader is referred to the OSA Handbook of Optics for a good discussion.