

Introduction

The reflecting objectives designed and manufactured by Beck Optronic Solutions are based on the work of CR Burch. In his 1947 paper he showed that, by careful selection of the radii and their separation, a 2-mirror reflecting microscope objective can be free of spherical aberration, coma and astigmatism.

Theory also shows that, by having an adjustment for the separation between the two mirrors, the image quality can be corrected for a range of tube lengths and cover glass thicknesses. These two models may only be adjusted at the factory. As standard they are preset for a tube length of 160mm and a cover slip of 0.17mm (your reflecting objectives may have been set with different values if you had requested them at the time of purchase).



On receiving your objective...

When you first receive the objective, unscrew it from the box and inspect it carefully to ensure that there has been no transit damage. Check also that the adjustment keys and the silverpoint slide have been included (5001, X15 NA0.28 model only).

Mounting the Objective

The Beck Optronic Solutions reflecting objectives are mounted using a standard Royal Microscopical Society thread.

Screw the objective into the microscope or mounting plate and fully tighten it.

The large scalloped ring which you used to screw the objective into the mount has 6 small set screws (A). Slackening these screws a little allows the objective body to be rotated in the mount in order to change the orientation of the main body. You may wish to make this adjustment to bring the spiders into a particular position, or, in the case of the x15 NA0.28 objective, to bring the centering adjustment screws (B) into a more conventional position. Remember to re-tighten the screws when you have finished.

Mirror Centering Adjustment

It is typical of this type of mirror system that the image quality is particularly sensitive to very small centering misalignment of the secondary mirror.

The X15 NA 0.28 may be adjusted by the user to remove any residual centring error if there are any signs of asymmetry in point images. As an aid to removing this centering error, a 'silverpoint' slide is provided. It is a metallised microscope slide which has a large number of pinholes in the range of 0.5 to 5 micron diameter. When the reflecting objective is correctly adjusted and focused, their images should be a perfect 'Airy disc' encircled by two or three diffraction rings.

Mount the slide and illuminate it in transmission; focus it and find an area of the slide showing only small pinholes. Adjust the secondary mirror by using the two Allen keys.

There is also a second pair of these holes at right angles to the first pair so that the mirror can be adjusted in both x and y directions. Ensure the screws are tight when finished.

The aim is to eliminate any coma (which is asymmetric - comet-like) so that the images become perfectly circular. You will be confident that the objective is correctly adjusted when each point image is perfectly circular, the diffraction rings are continuous and the image looks the same either side of best focus. [The procedure is described in detail with example images in the document "Aligning a Beck Optronic Solution Reflecting Objective". This can be found on our website – www.reflectingobjectives.com.]

Centering the Optics

1) The X15 NA0.5 reflecting objective, as well as being supplied adjusted for tube length and cover slip thickness, is adjusted to remove any centring errors and fully locked to avoid the need for resetting. However, occasionally it has been found necessary to re-adjust them; after a hard knock for example. If re-adjustment is necessary, the objective can be returned to BOS for adjustment. However, we now leave the main body shell without Loctite. This allows the user to unscrew the body shell to reveal the adjustment screws. They have the same general layout as shown in the sketch but there are also four lock screws in the lower face of the objective. These lock screws will need to be slackened a little before making any adjustments. Remember to tighten all screws before replacing the main body shell.

2) A major feature of the reflecting objective is that it has no chromatic aberration. This means that, even if you have no means for observing an image at a wavelength outside of the visible region, you can properly align it in the visible region first, before mounting it into your system.

Specifications

	5001 x15 NA 0.28	5002 x15 NA 0.50
Focal Length	13.35 mm	13.41 mm
Magnification	X15	X15
Field of view at the object	1.2 mm diameter	1.2 mm diameter
Numerical aperture	0.28	0.50
% of central area obstructed	25%	21.5%
Working distance (approximate)	24.5 mm	23.2 mm
Mounting thread	RMS, 0.8" 36 T.P.I, BSW	

References

The first paper to show that a high NA, high magnification microscope objective could be made from two spherical mirrors is that of CR Burch - Proc Phys Soc of London 59, 41, 1947

There is an excellent paper by Seymour Rosin entitled 'Inverse Cassegrain Systems' - August 1968, Vol 7, No 8. This paper develops the aberration theory and shows many variants of the two-mirror system.

About Beck Optronic Solutions

Beck has a reputation for excellence in design and manufacture of precision optics that can be traced back over 175 years. Based near London, UK, Beck delivers complex, integrated electro-optic systems for defence and commercial use across the electromagnetic spectrum from UV to LWIR. **For pricing or further information please contact us at:**

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